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# "A Hybrid Framework for Lean Six Sigma Implementation in Small Industries: Integrating Barriers and Critical Success Factors"

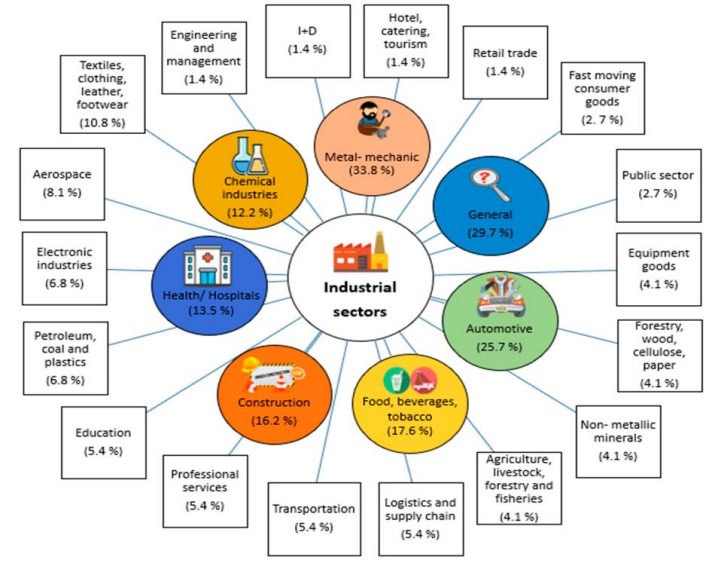
[1]Prashant N. Shende, [2]Dr. Rupesh R. Gawande,
[1]Research Scholar, Department of Mechanical Engineering, Bapurao Deshmukh College of Engineering, Sevagram, Wardha, Nagpur University
[1]Assistant Professor, Department of Mechanical Engineering, Yeshwantrao Chavan College of Engineering, Nagpur University, Nagpur
prashantshende2@gmail.com
[2]Research Guide, Department of Mechanical Engineering, Bapurao Deshmukh College of Engineering, Sevagram, Wardha, Nagpur University
wsdcoe@rediffmail.com

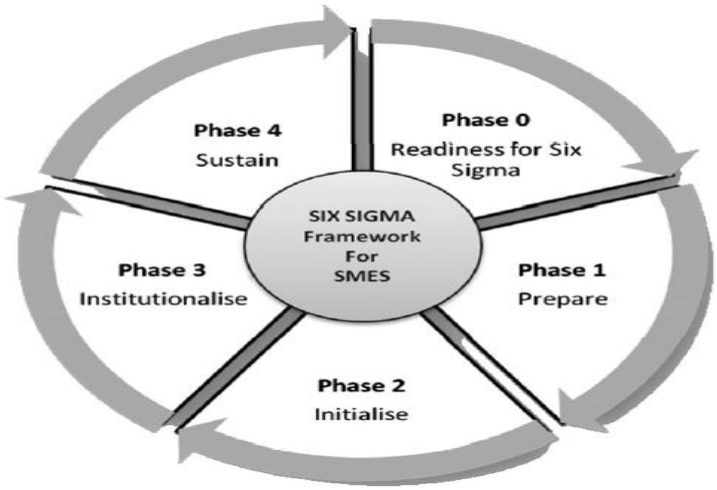
**Abstract:** Lean Six Sigma (LSS) has come in as a powerful management strategy of enhancing quality, productivity and efficiency in operations within organizations. Although enormous organizations have managed to introduce Lean six sigma practices with great success, in most cases, small industries have experienced severe difficulties in the process because they lack resources, experience as well as resistance by the organization. This current paper suggests a hybrid model that incorporates barriers and critical success factors (CSFs) that affect the implementation of the Lean Six Sigma in the small industries. The paper examines the current literature to determine the significant obstacles that include financial limitations, management dedication, inadequate training, and resistance to change besides some of the success factors which comprise leadership backing, employee participation, constant training and strategic alignment. On these aspects, a conceptual hybrid model is made to be followed in successful application of Lean Six Sigma in small scale industries. The paper of the research takes the quantitative method by the way of using survey data gathered by the researcher among employees and managers operating in the chosen small industries. The relationship between barriers, success factors and implementation effectiveness is examined using statistical methods namely the descriptive analysis, correlation, and regression analysis. It is anticipated that the study will inform the policymakers, managers, and practitioners in further insights into the dynamics of the Lean Six Sigma adoption in the small industry environment and the recommendations regarding the strategic imperatives that can make the implementation process more successful. The hybrid framework is a contribution to the existing knowledge since the approach incorporates both facilitating and inhibiting variables of the implementation of Lean Six Sigma into a systemic model that may be applied in the field of small-business industrial settings.

**Keywords:** Lean Six Sigma, Small Industries, Implementation Barriers, Critical Success Factors, Hybrid Framework, Operational Excellence, Quality Management

## Introduction:

The contemporary aggressive business world is making organizations shift more towards the concern of operational efficiency, cutting wastage, and improving the quality of products. Lean Six Sigma (LSS) has come to be a potent management tool that combines the concepts of Lean production with those of Six Sigma in an attempt to attain process enhancements and operational excellence. Lean is based on the removal of waste and enhancing the process flow, and Six Sigma is concentrated on the reduction of variation in processes and refining the quality by utilizing the methods of statistics.




Despite the wide deployment of Lean Six Sigma in big companies in the manufacturing and services industry, the introduction of the program to the small industries is relatively low. Small and medium-sized enterprises (SMEs) are important players in the economic development, creation of employment, as well as industrial growth. Nevertheless, these industries are usually faced with a number of challenges in instituting advanced quality management practices owing to the financial constraints, and lack of technical skills and proper infrastructure.

It has been pointed out by various studies that the success of Lean Six Sigma implementation is highly dependent on some main critical success factors (CSFs) including commitment of the leaders, employee contribution, employee training, good communication and strategic plans. Meanwhile, there is a list of barriers that can interfere with the successful implementation such as the resistance to changes, the absence of awareness, the lack of support of the management and the poor organizational culture.

Although enabling and inhibiting factors have been considered essential, numerous studies have been conducted on the barriers and success factors independently. Integrated frameworks that take into consideration both factors are not well integrated to enable an effective implementation of the Lean Six Sigma in small industries. Thus, the current research work tries to fill this gap by creating a hybrid framework that will incorporate both barriers and critical success factors to the implementation of the summer of the small industries based on Lean Six Sigma.

It is expected that the proposed framework would offer a holistic perspective of the interrelations between these factors and give useful advice to managers and practitioners within the small industries on the successful implementation of Lean Six Sigma practices.

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**Literature Review:**

Antony et al. (2005) used the empirical study to look at the implementation of the Six Sigma concept in small and medium-sized manufacturing companies in the United Kingdom. The article examined the nature of adoption of six sigma practices by SMEs in the administration of quality and to improve performance in the establishments. The authors analyzed the advantages and issues linked to the implementation of Six Sigma and gathered data in a few manufacturing companies. The results showed that Six Sigma can assist the organizations to minimize defects, enhance the process ability and customer satisfaction. Nevertheless, SMEs have some challenges that include inadequate supply of skilled workers, financial resources, and understanding of statistical tools necessary in the implementation of Six Sigma. The authors also pointed out that commitment at the top management level, involvement of employees, and the continuity of training are the key parameters to success of implementation of Six Sigma within the small and medium enterprises.

The article by Arnheiter and Maleyeff, (2005) discussed the issue of combining the Lean management and Six Sigma process as a single process improvement instrument. The authors clarified that Lean manufacturing is aimed at wasted materials mainly removed and enhancement of the flow of the production processes whereas Six Sigma was oriented to the reduced variation of the processes and bettering the products of excellent quality using statistical methods. With this combination of two methods, organizations would be able to attain efficiency and quality improvement at the same arc. The research indicated that Lean Six Sigma is an all-encompassing tool of productivity, diminution of operation cost, and client fulfillment. An additional recommendation by the authors was that organizations that would be successful in implementing Lean Six Sigma must not ignore employee training, good leadership, and culture of continuous improvement as the means of attaining success over a long period.

Achanga et al. (2006) examined the critical success factors that play a role in implementing the Lean practices in small and medium enterprises. The research underlined that SMEs have particular challenges in comparison with big organizations because of the little resources and infrastructure. Using the case study as analysis method, the authors noted that there are four key factors that influence greatly under the implementation of Lean, those being, the commitment of the administration, particularly the management, financial capacity, organizational culture, and employee training. The researchers have reached the conclusion that the effective implementation of Lean practices in the SMEs needs strong leadership support and adequate resource allocation. Another significant value that the authors mentioned concerned the need to build a culture that fosters the spirit of innovation, collaboration, and improvement in the organization.

Antony et al. (2007) examined how the Six Sigma strategy can be applied to service organizations, and how advantageous and problematic the application of Six Sigma is. The research was able to prove that when implemented well, the Six Sigma has the capacity to enhance the quality of service, the efficiency of operations, and customer satisfaction. Nevertheless, the authors also discovered that there are barriers that organizations face during the implementation process such as resistance to change, lack of the management support and poor training of employees. The study indicated that to effectively implement the Six Sigma methodology, organizations should develop awareness among the employees on the need of using such a methodology, the organizations should have continuous training programs to employees.

Antony (2008) reviewed the possibility of applying Six Sigma to small and medium enterprises and also addressed the benefits and limitations that may be imposed by this approach. The research also observed that Six Sigma can enable SMEs make quality, productivity, as well as customer satisfaction improvements of a high level. Nevertheless, the author observed that the process of implementation in the SMEs needs to be simplified as there are little resources and knowledge available. The study highlighted the need to have a flexible approach of SMEs and concentrate on key Six Sigma tools that can be easily implemented. Moreover, the research noted the need to have the management commitment and participation of the employees and effective training to implement it successfully.

The article by Snee (2010) has addressed Lean Six Sigma as a continuous improvement approach methodology that combines Lean methodology with six sigma methods. The analysis described how Lean Six Sigma offers any organization with a structured methodology of enhancing business processes, and minimizing waste materials and improving the quality of products and services. The author pointed out that effective implementation of Lean Six Sigma must be based on a powerful leadership, good management of the projects, and decisions made with the use of data. Another observation made in the study was that continuous improvement culture should be built and employees should be trained adequately by organizations to ensure that Lean Six Sigma initiatives are maintained in the long-run.

A framework of Six Sigma implementation suggested by Kumar et al. (2011) was made specifically at the level of small and medium-sized enterprises. The research was intended to be a map that SMEs would use in order to effectively apply the Six Sigma practices. The framework involves a number of steps like; establishing awareness, training and capacity building, product identification, introducing enhancement initiatives and performance measurement. The authors highlighted that the implementation of the organizational change requires SMEs to pay attention to the organizational change process. The research came to a conclusion that strategic and carefully developed implementation model can assist SMEs in struggling their way, and attaining sustainable quality improvement.

Laureani and Antony (2012) have explored the critical success factors which determine the success of the implementation of Lean Six Sigma. Some of the key factors that have been identified through the study include leadership commitment, employee involvement, communication and continuous training programs. The authors stressed the fact that the organizations should develop an organizational climate that promotes teamwork, innovation, and continuous improvement. Another important fact mentioned in the study was that Lean six sigma projects should be organized according to the organizational strategies because long term sustainability is provided.

Dora et al. (2015) considered the determinants and barriers influencing the implementation of Lean in SME food processing. According to the study, failure to access financial resources, lack of managerial support, low technical skill and the organization reluctance towards change are among the major challenges facing SMEs. Nevertheless, the study proved that, Lean practice can make a significant contribution towards operational performance, productivity, and competitiveness within SMEs. The authors implied that SMEs ought to prioritize on capitalizing on training of employees, management commitment, and a phase-by-phase implementation of Lean tools in a bid to realize turn out to be successful.

The authors of the article by Lande et al. (2016) discussed the critical success factors of Lean Six Sigma implementation in small and medium Chinese enterprises. The research has also established many variables that contribute to the implementation success, such as top management endorsement, the input of the employees, strategy planning, and culture of continuous improvement. The authors reached a conclusion that the organizations have to provide the supportive environment that would promote the involvement of the employees and their innovation. Another finding of the study was that awareness and motivation of the employees can only be created through effective communication and training programs.

The article by Albliwi et al. (2014) has been a systematic literature review done to determine the essential factors of failure of Lean Six Sigma implementation. The analysis of many research articles was carried out and several reasons that may cause unsuccessful implementation were identified. These can be lack of leadership dedication, poor choice of project, lack of employee training, poor communication, and organizational resistance. The authors accentuated the importance of these issues being considered in organizations and worked out effective strategies to reduce the possibility of the failure.

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Attar (2023) reviewed the critical success factors affecting the implementation of Lean Six Sigma in the small and medium-sized enterprises. The paper has identified that leadership commitment, organizational culture, employee training, and competent communication have a major role to play in guaranteeing the success of Lean Six Sigma programs. This study also highlighted the need to put these factors with reference to a systematic framework to make the implementation effective. The author concluded that through the practices of Lean Six Sigma that are reinforced by effective managerial and organizational support, SMEs are able to realize considerable changes in how they perform during the operation and compete with their rivals.

**Objectives of the Study:**

1. To identify the key barriers affecting Lean Six Sigma implementation in small industries.
2. To determine the critical success factors that support successful Lean Six Sigma adoption.
3. To develop a hybrid framework integrating barriers and critical success factors for Lean Six Sigma implementation in small industries.

**Hypotheses:**

- Hypothesis ($H_1$): The negative relationships between implementation barriers and the effectiveness of the Lean Six Sigma implementation in small industries are great.
- Hypothesis ($H_2$): The critical success factors play a major positive role in the successful implementation of Lean Six Sigma in the small industries.

**Research Methodology:**

The current research paper will be based on the quantitative format of research in order to test the relationship between barriers, critical success factors and introduction of Lean Six Sigma in small industries. It will be research aimed at gathering the primary data as the direct evidence provided by the respondents in the small-scale manufacturing and industrial organizations.

**Research Design**

The aspects of understanding the factors that affect the implementation of Lean Six Sigma are done through a descriptive research design. The design assists in the examination of the perception and experiences of the employees and managers on factors and barriers that influence the success and adoption of Lean six Sigma practice within the small industries.

**Data Collection Method**

It is also founded on the primary data gathered using a structured questionnaire. The questionnaire will be closed ended, and the questions will be pre-prepared on a five-point Likert scale which will be strongly disagree though to strongly agree. The questions will be created in such ways that they will involve quantifying the effect of implementation hurdles and most crucial success factors of Lean Six Sigma.

**Sampling Technique**

The sampling method applied to use small industries as respondents is a convenience sampling method. The approach is appropriate as it will enable the researcher to obtain data through available respondents who are directly engaged in the operational or managerial processes inside the firm.

**Sample Size**

The sample used in the research contains 100 participants who are employed in various units of the various industries that are selected (production, quality control and operations).

**Data Analysis Techniques**

The data gained are analyzed with suitable statistic tools in order to appreciate the correlation between the variables of the study. The techniques employed are the following:

- Percentage analysis
- Mean and standard deviation
- Correlation analysis
- Regression analysis

These techniques help in evaluating the influence of barriers and critical success factors on Lean Six Sigma implementation.

**Research Framework**

The study design of the research is founded on the two key variables namely the barriers to implementation and critical success factors, which determine the effective implementation of Lean Six Sigma within the small industries. The model assists in the analysis of interaction and influence of these variables to determine the effectiveness of the Lean Six Sigma practices.

**Analysis of the study:**

**Table 1: Demographic Profile of Respondents**

| Variable | Category | Frequency | Percentage (%) |
|---|---|---|---|
| Gender | Male | 65 | 65% |
| | Female | 35 | 35% |
| Age | Below 30 years | 28 | 28% |
| | 31–40 years | 40 | 40% |
| | 41–50 years | 22 | 22% |
| | Above 50 years | 10 | 10% |
| Work Experience | Below 5 years | 30 | 30% |
| | 6–10 years | 38 | 38% |
| | 11–15 years | 20 | 20% |
| | Above 15 years | 12 | 12% |

**Table 2: Implementation Barriers of Lean Six Sigma in Small Industries**

| Implementation Barriers | Mean | Standard Deviation | Interpretation |
|---|---|---|---|
| Lack of top management commitment | 4.12 | 0.76 | High |
| Lack of employee training | 3.95 | 0.81 | High |
| Financial constraints | 4.08 | 0.69 | High |
| Resistance to change | 3.78 | 0.84 | Moderate |
| Lack of technical knowledge | 3.89 | 0.73 | High |

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**Table 3: Critical Success Factors for Lean Six Sigma Implementation**

| Critical Success Factors | Mean | Standard Deviation | Interpretation |
|---|---|---|---|
| Top management support | 4.25 | 0.70 | Very High |
| Employee involvement | 4.10 | 0.75 | High |
| Continuous training programs | 4.05 | 0.72 | High |
| Effective communication | 3.92 | 0.79 | High |
| Strategic planning | 3.98 | 0.74 | High |

**Table 4: Correlation between Barriers, Critical Success Factors and Lean Six Sigma Implementation**

| Variables | Barriers | Critical Success Factors | LSS Implementation |
|---|---|---|---|
| Barriers | 1 | -0.46 | -0.52 |
| Critical Success Factors | -0.46 | 1 | 0.63 |
| LSS Implementation | -0.52 | 0.63 | 1 |

**Table 5: Regression Analysis for Lean Six Sigma Implementation**

| Independent Variables | Beta Value | t-value | Significance (p-value) |
|---|---|---|---|
| Implementation Barriers | -0.41 | -3.82 | 0.000 |
| Critical Success Factors | 0.58 | 5.16 | 0.000 |

**Overall Conclusion:**

The current paper reviewed the adoption of the Lean Six Sigma (LSS) in small industries by combining the barriers, as well as the critical success factors that determine its adoption. The results show that despite the fact that Lean Six Sigma can be the means to achieve substantial improvements in the operational efficiency, product quality, and organizational performance, the implementation stages of the tool in the small industries are frequently impeded by a number of issues. Such issues primarily entail financial deficit, inadequate management dedication, incompetence in technical skills as well as resistance to change in the organization.

Another important revelation of the study is that the successful application of the Lean Six Sigma highly relies on the availability of some key success criteria which include an effective support element of the top leaders, involvement of the employees, ongoing training programs, effective communication and proper planning. These success factors can be rationalized into the organization system and ensure that the negative influence of the implementation barriers is minimized, which makes it easier to adopt the Lean Six Sigma practices.

According to the analysis, the research paper suggests a hybrid model of the two barriers and critical success factors to facilitate the Lean Six Sigma implementation in small industries. This model offers a progressive way of thinking that can assist managers in determining the possible obstacles and put relevant measures to be effective quality improvement efforts. Generally, the research is relevant to this current literature since it presents a viable model, which can assist small industries in realizing operational excellence by applying lean six sigma practices.

**Future Scope of the Study**

- The small, medium and large industries can be conducted in comparative studies that establish the distinctions in Lean Six Sigma implementation practices.
- Future studies could utilize a higher level of statistical methods including structural equation modeling (SEM) to examine correlation in variables.
- The effects of Lean Six Sigma implementation on organizational performance and productivity can be analyzed over the long period of the research.
- More research can be conducted regarding the combination of Lean Six Sigma with Industry 4.0 solutions, including automation and digital manufacturing.
- Future-studies can be carried out to examine how organizational culture and leadership have contributed to enhancing the success rate of the Lean Six Sigma implementation.
- Further research can be done on the creation of viable models or frameworks of smaller industries execution.

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