ENABLER-BASED CAPABILITY MATURITY MODEL FOR DEPLOYMENT OF LEAN SIX SIGMA IN MSMEs

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ABSTRACT
Usage of Lean and Six Sigma methodologies for process improvement has received widespread acclaim for enhancing quality, eliminating wastage, and elevating overall efficiency across sectors. For Micro, Small, and Medium Enterprises (MSMEs), however, adoption of these approaches still proves to be a challenge owing to numerous constraints like limited financial resources, absence of infrastructure, poor technological support, and limited trained human resource. These limitations usually hinder MSMEs from reaping the full benefit of Lean Six Sigma practices. Given this problem, the current study suggests a holistic maturity assessment framework intended to determine the readiness of MSMEs to implement Lean Six Sigma. Based on an extensive literature review, a list of key enabling factors has been established. These enablers are systematically ranked based on the Analytic Hierarchy Process (AHP), thereby maintaining a rigorous decision-making process. The ranked enablers are then integrated into a capability maturity model that assists organizations in assessing their existing preparedness level as well as pinpointing specific internal areas that need to be developed in order to enable successful implementation of LSS.

Keywords: Lean Six Sigma, MSMEs, Analytical Hierarchy Process, Capability Maturity Model

I. Introduction
In the present competitive business environment, small and medium-sized enterprises are finding it more and more difficult to provide greater value to their customers while at the same time facing increasing costs of operation and shrinking profit margins. To stay competitive, it becomes imperative that these companies provide quality products at reasonable prices. Lean Six Sigma (LSS) has emerged as an important methodology accepted by manufacturing and service sectors alike for the purpose of continuous improvement. Its usage is increasing in organizations looking to develop performance and sustain quality standards. Lean and its philosophy focus on weeding out the non-value-added processes, whereas Six Sigma aims to minimize variability and defects to ensure output is meeting customer requirements.

While both strategies have their own unique advantages, effective implementation often involves a change of culture within an organization. Staff and stakeholders need to be persuaded to see inefficiency and wastage as barriers to excellence and to actively seek improvement. Six Sigma specifically focuses on reducing process variation and seeks to provide near-perfect results, measured by a statistical standard of just 3.4 defects per million opportunities. But working at this level of accuracy is not always cost-effective, particularly for financially limited organizations such as MSMEs. Alone, Lean methods will not always mitigate all types of waste, and Six Sigma techniques will not always compensate for process variability. Aware of this, most organizations have incorporated Lean and Six Sigma into a single methodology to capitalise on their respective strengths.

This combined process i.e Lean Six Sigma, has proven to provide quicker and more effective outcomes than individually applying each methodology. However, for MSMEs, such implementation of a combined approach poses major challenges. These are mainly due to constraints in infrastructure,

resources, and human capital. Many organizations do not succeed in implementing Lean Six Sigma because they lack proper internal preparation and resist changing. In order to meet such challenges, organizations must have a good sense of internal conditions necessary to facilitate a smooth LSS implementation. These internal conditions, or "enablers," consist of such factors as leadership support, employee involvement, training initiatives, and coordination between different departments. Determining, prioritizing, and bolstering these enablers is necessary in order to make an organization ready.
This study fills the gap for an organized assessment framework to enable MSMEs to gauge their readiness for Lean Six Sigma implementation. By conducting a comprehensive literature review, key enablers are determined and ranked in a manner through the application of AHP technique. A Capability Maturity Model is subsequently developed to assess how well these enablers are set up within an organization. This system acts as a guideline for MSMEs to step by step shift to Lean Six Sigma principles by initiating with internal preparedness and capability building. Finally, the maturity model established in this research can serve as a self-assessment and strategic guide. It informs MSMEs about where they are and how they can develop their internal systems and capabilities to facilitate successful implementation of Lean Six Sigma concepts.

II. Literature

The integration of Lean manufacturing and Six Sigma techniques is now a popular method for process efficiency improvement and quality enhancement. Lean finally targets the removal of waste and reduction of processes, whereas Six Sigma targets at reduction of process variation and improvement in customer satisfaction. While bigger organizations have recorded significant success with these solutions, small and medium-sized enterprises (SMEs), especially in emerging economies, have found it challenging to integrate them effectively because of limitations in capital, human skills, and infrastructure.
In spite of the established advantages of Lean Six Sigma (LSS), including cost savings, enhanced process efficiency, and enhanced product quality, its implementation in MSMEs has been sporadic. Small businesses usually do not have the formal planning and assistance mechanisms necessary to implement these methodologies. In many cases, the attempt to implement is made without a good understanding of the key factors that are necessary for the success. In order to bridge this gap, it is crucial to determine and comprehend the internal factors or enablers of which impact the effective implementation of Lean and Six Sigma in MSMEs. There are many studies that highlight the significance of these enablers in defining an organization's capacity for maintaining LSS practices.

2.1 Importance of Enablers in LSS Implementation

Enablers are not immediate targets, but necessary requirements that need to exist so that organizations can achieve their goals. For Lean Six Sigma, enablers provide the foundation for implementation and sustainability. Organizational culture, leadership commitment, employee engagement, infrastructure, and well-established communication mechanisms form the enablers. Table 1 provides an enablers list found through a literature survey.
Manville et al. (2012) state that enablers play a major role in determining LSS program success. In the absence of enablers, even the technically best initiatives can fail. Moreover, Psychogios et al. (2012) categorize the factors for implementing LSS into enablers, which support movement, and inhibitors, which resist it. While enablers enable the organization to implement LSS smoothly, inhibitors pose challenges like resistance to change, insufficient training and resource constraints. Numerous studies have reinforced the notion that identification and reinforcement of enablers make successful implementation more likely. Antony (2012) is an example, where organizational leadership, strategic

goal alignment, and training were among the highest contributors to successful implementation. Their absence, on the other hand, was the most common feature of failed attempts.

2.2 Review of Past Research on LSS Enablers

Authors like Jeyaraman and Teo (2010) have developed frameworks specifically for LSS enabler implementation in the electronics industry. Their research in Singapore identified senior leadership, culture, and training as key. Sreedharan and Sunder (2018) added that employee engagement and resource availability were among the most critical factors in LSS success across various industries. Despite this growing body of research, many MSMEs still fail to implement LSS effectively. According to Albliwi et al. (2014), this is often due to a failure to recognize or prioritize these enabling elements. Without deliberate focus on the right enablers, organizations are more likely to fall back into inefficient, traditional practices.

This study builds on the existing literature by identifying the most frequently cited enablers across studies and organizing them into a prioritization framework. Eleven critical enablers have been selected for further analysis using the AHP methodology. These were chosen based on their frequency of appearance and perceived importance in successful implementation cases.

Employee commitment: Companies can perform well and obtain competitive advantage if its employees are working with full commitment (Hu et al, 2019). It has led to higher productivity and quality. It helps the company to improve continuously and move towards their long-term goal (Bhasin and Burcher, 2006). Employee commitment plays a role as a vial form in implementing Lean Six Sigma. The enablers are discussed, explained and summarized in Table 2.

Employee training: Training the employees on basic concepts as well as various tools and techniques is very necessary to implement lean six sigma. Employees must be trained in such a way that they are able to train their subordinates and can also adapt to any changes (Sreedharan and Sunder, 2018).

Senior management support: In many industries people in management level don't support their employees. The progress and development of the company reflects the characteristics of the leadership. Most of the top-level employees consider several factors such as: profile of the company or industry, their objectives and goals of the company as key for the achievement or catastrophe of the company. However, issues related to human factors are not considered. For a company to be successful, senior management should encourage the employees to provide suggestions and stress on employee's education and training (Achanga et al, 2006).

Organizational Infrastructure: Company's infrastructure should be good enough to facilitate effective material as well as information flow. It should connect the processes and employees together so that problems can be surfaced right away.

Strong relationships between workers: It is very important for the employees to trust, respect and openly communicate with each other (Rathi and Khanduja, 2015). Unless and until there is a strong relationship between the workers, a company can never become a Lean organization (Mann, 2009).

Implementing lean as a philosophical function: As lean is a philosophy rather than a method to improve short-term finances, the management's verdicts should be based on long-standing goals rather than immediate profits (Angelis et al, 2011). All the employees must work towards this common purpose and not focus on financial goals. Top management should ensure that all the employees have the same mindset.

Integrating customers to LSS: Companies must consider customers as a part of their organization in order to be successful. Communication between the company and the customer is essential and should be effective as it benefits both the parties. Standardized procedure for effective communication

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between the company and the customer is necessary so that customer needs and demands are understood and value is generated for the customers.

Effective communication among departments: It is very important for the departments to trust each other and deliver accurate information on time (Mann,2009). Companies must develop a standard procedure in order to share information effectively.

Integrating suppliers to LSS: It is very important to respect and challenge the supply network so that they can improve continuously (Vinoth et al,2016; Raghuram and Saleeshya, 2016). An organization must consider their suppliers as a part of their own organization in order to become a Lean organization (Stankalla et al, 2018).

Performance measurement system: An organization must measure the performance of each and every employee and department in order to improve the process effectiveness and performance of the establishment (Antony et al, 2012).

Quality of HR and linking to LSS: The Human resource department should ensure that they are hiring the right personnel who are capable of working in any given situation. The newly employed personnel must be trained in such a way that they understand the long-term goal of the company and are ready to help the company achieve it (Coronado and Antony, 2002).

There is a vast amount of literature outlining the factors which will help in lean six sigma implementation. These enablers were identified and described as seen in the previous section. The importance and importance of these aspects will be established through Analytic Hierarchy Process. Once when these factors are listed, each of these factors are further studied. The enablers of LSS execution should be achieved so as to enhance the implementation possibilities of a company. Towards the objective, the should further exploration of each of these enablers to improve the LSS implementation capability.

Table 1 Identification of Enablers of Lean Six Sigma implementation

S. No.	Enablers	Achanga et al.	Panizzolo et al.	Hu et al. 2019	Angelis et al.	Womack and	Shah, 2003	Coronado and	Meyer and Allen,	Bhasin and	Antony et al.	Pattanaik and	Naslund, 2008	Mann, 2009	Sahoo and Yadav,	Rathi and	Sreedharan and	Swarnakar and	Stankalla et al.	Raval et al. 2018	Sanders et al.	Matawale et al.	Sharma et al.	Pandey et al.	Caldera et al.	COUNT
1	Employee commitment	x	x	x	x			x		x	x				X		x			x	x		x	x	x	14
2	Training the employees	x	x					x	x		x		X		X	x	x			x		x		x		12
3	Support of senior management	x	x		x	x			x				X		X	x	x			x		x			x	12
4	Organizational Infrastructure					x		x			x				X	x	x				x			x		8
5	Strong relationships between workers	x	x	x										x	X	x				x	x		x			9
6	Implementing lean as a philosophical function		x		x		x			x				x			x								x	7
7	Integrating customers to LSS					x					x	x						x	x				x			6
8	Effective communication among depts.	x	x								x			x		x				x						6

9	Integrating suppliers to LSS				x						x							x	x						x	5
10	Performance measurement system										x				x	x	x								x	5
11	Quality of HR and linking to LSS							x			x	x											x			4

Table 2 Enablers of Lean Six Sigma implementation in MSMEs

Enablers	Description	References
Employee commitment	Level of interest an employee shows towards assigned tasks.	Achanga et al, 2006; Panizzolo et al, 2012
Employee training	Employees are given some kind of instructions or advice from a more experienced employee.	Meyer and Allen, 1997; Antony et al, 2012
Senior management support	Senior officials backing the paper and the team that are implementing it.	Mann, 2009; Sahoo and Yadav, 2018
Organizational Infrastructure	Fundamental facilities and systems that support the functioning of the organization.	Coronado and Antony, 2002;
Strong relationships between workers	A strong relationship between workers requires trust, respect, self-awareness, and open communication.	Hu et al, 2019; Mann, 2009
Implementing lean as a philosophical function	Base the management decisions on implementing the long-term philosophical practice rather than short-term profits.	Shah, 2003; Angelis et al, 2011
Integrating customer to LSS	Considering customers as an integral part of the implantation process.	Swarnakar and Vinodh, 2016; Matawale et al, 2013
Effective communication among depts.	Effective information and knowledge sharing between various departments in an organization.	Mann, 2009; Rathi and Khanduja, 2015
Integrating supplier to LSS	Respecting the extended supplier network by constructively challenging them and supporting continuous improvement.	Swarnakar and Vinodh, 2016; Stankalla et al, 2018
Performance measurement system	A system to measure the performance and get the feedback.	Sahoo and Yadav, 2018; Sreedharan and Sunder, 2018
Quality of HR and linking to LSS	Hiring capable employees, empowering them, and developing leaders from within is very important.	Pattanaik and Sharma, 2009; Antony et al, 2012

III. Analytic Hierarchy Process (AHP)

Many researchers have reviewed the development of Analytic Hierarchy Process (Ishizaka and Labib, 2011). This process has been used in arenas such as planning, resource allocation, selecting the best alternative, optimization etc. Analytic Hierarchy Process is a multi-criteria administrative tool (Saaty, 2013). This tool is basically an approach for pairwise comparisons. It can be used to calibrate both qualitative as well as quantitative measures. The scale ranges from 1/9 to 9, from least significant to most significant.

AHP has been used widely in various fields such as healthcare and medical research (Schmidt et al, 2015), machine selection, supplier selection, resource allocation, agile enablers (Saleeshya et al, 2012b), flexible manufacturing system (Shang and Sueyoshi, 1995), computer aided machine tool selection (Duran and Aguilo 2008), integrating both fuzzy and hierarchy concepts to analyse the software quality (Lin et al, 2008), issue resolution for conceptual design using AHP, Selection of appropriate schedule delay analysis method (Adhikari and Kim, 2006) etc.

3.1 Enabler based AHP Model for Lean Six Sigma Implementation

The Analytical Hierarchy Process (AHP), first introduced by Thomas Saaty in the 1970s, is an established decision-making technique employed to resolve complex problems having more than one criterion. AHP assists in decomposing a complex issue into a hierarchically structured framework, enabling comparisons between items in a systematic and quantifiable format.

This method allows for the integration of both qualitative and quantitative evaluations in a strong means to prioritize alternatives according to expert opinion. AHP is particularly well-suited to situations where decision-making is affected by human perception, experience, and expertise. It has been used in a broad range of fields including resource allocation, strategic planning, policy analysis, and technology choice throughout the years.

In the present research, AHP has been utilized to determine relative importance of each of the eleven identified enablers of Lean Six Sigma implementation in MSMEs. By so doing, we can identify which enablers are more important in supporting adoption of LSS practices and hence need to be given more emphasis during the preparatory stage.

3.2 Application of AHP to the Study

To apply the AHP framework, a questionnaire was created containing pairwise comparison. These were designed to evaluate the relative importance of each enabler when compared against others. Industry experts with experience in process improvement and Lean Six Sigma were consulted to provide responses with the help of the scaling listed in Table 3.

Table 3 Scaling for Pairwise Comparison

Scale	Description
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extreme importance

Reciprocals were used for the inverse comparisons. The data collected from the expert judgments were compiled into a pairwise comparison matrix. For each pair of enablers, the numerical score reflects how much more important one factor is compared to another.

The comparison matrix included all eleven enablers: Employee Commitment, Employee Training, Senior Management Support, Organizational Infrastructure, Strong Relationships, Lean Philosophy Orientation, Customer Integration, Departmental Communication, Supplier Integration, Performance Metrics, and HR Quality Alignment.

An example of how this works:

If “Senior Management Support” is rated significantly more important than “Employee Commitment,” then the corresponding matrix cell would have a high value (e.g., 9), and the reciprocal (1/9) would be recorded in the reverse position.

Once the pairwise matrix was completed as shown in Table 5, the process continued with normalization and weight calculation.

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Table 5 Pairwise comparison matrix

	EC	TE	SMS	OI	SRW	LPF	CLSS	ECD	SLSS	PMS	QHR
EC	1.00	5.00	0.11	5.00	3.00	0.11	0.11	0.14	0.11	5.00	0.14
TE	0.20	1.00	0.11	3.00	3.00	0.20	0.20	3.00	7.00	0.20	0.33
SMS	9.00	9.00	1.00	5.00	3.00	7.00	7.00	5.00	9.00	5.00	5.00
OI	0.20	0.33	0.20	1.00	0.20	0.14	0.14	0.20	0.11	5.00	3.00
SRW	0.33	0.33	0.33	5.00	1.00	0.14	0.20	0.20	0.11	0.20	3.00
LPF	9.00	5.00	0.14	7.00	7.00	1.00	0.14	0.14	0.11	5.00	3.00
CLSS	9.00	5.00	0.14	7.00	5.00	7.00	1.00	5.00	0.11	5.00	3.00
ECD	7.00	0.33	0.20	5.00	5.00	7.00	0.20	1.00	0.11	0.20	3.00
SLSS	9.00	0.14	0.11	9.00	9.00	9.00	9.00	9.00	1.00	5.00	3.00
PMS	0.20	5.00	0.20	0.20	5.00	0.20	0.20	5.00	0.20	1.00	3.00
QHR	7.00	3.00	0.20	0.33	0.33	0.33	0.33	0.33	0.33	0.33	1.00

Each value in the matrix was normalized by dividing it by the total of its corresponding column. The average value of each row in the normalized matrix was then computed to generate the priority weights for each enabler as in Table 6.

Table 6 Normalized Matrix

	EC	TE	SMS	OI	SRW	LPF	CLSS	ECD	SLSS	PMS	QHR	Priority
EC	0.02	0.14	0.04	0.01	0.08	0.01	0.01	0.01	0.02	0.15	0.20	**0.06**
TE	0.00	0.03	0.04	0.00	0.01	0.16	0.32	0.01	0.14	0.15	0.01	**0.08**
SMS	0.21	0.26	0.35	0.14	0.23	0.16	0.32	0.28	0.41	0.10	0.16	**0.24**
OI	0.11	0.26	0.07	0.03	0.01	0.00	0.01	0.04	0.02	0.19	0.07	**0.07**
SRW	0.01	0.09	0.04	0.08	0.03	0.00	0.04	0.01	0.05	0.00	0.11	**0.04**
LPF	0.11	0.01	0.07	0.20	0.18	0.03	0.02	0.01	0.02	0.10	0.07	**0.07**
CLSS	0.21	0.01	0.12	0.25	0.08	0.23	0.11	0.20	0.14	0.06	0.20	**0.14**
ECD	0.11	0.09	0.05	0.03	0.13	0.16	0.02	0.04	0.02	0.06	0.01	**0.07**
SLSS	0.21	0.03	0.12	0.25	0.08	0.23	0.11	0.28	0.14	0.06	0.16	**0.15**
PMS	0.00	0.00	0.07	0.00	0.18	0.01	0.04	0.01	0.05	0.02	0.00	**0.04**
QHR	0.00	0.09	0.05	0.01	0.01	0.01	0.01	0.12	0.02	0.10	0.02	**0.04**

3.3 Results of the AHP Weighting

After performing the AHP calculations, each enabler was assigned a priority value. These values indicate the relative importance of each factor in the context of Lean Six Sigma implementation readiness. The results revealed the following rankings as shown in Table 4.

Table 4 Ranking obtained from AHP Analysis

Rank	Enablers
1	Senior management support
2	Integrating supplier to LSS
3	Integrating customer to LSS
4	Employee training

5	Implementing lean as a philosophical function
6	Organizational Infrastructure
7	Effective communication among depts.
8	Employee commitment
9	Strong relationships between workers
10	Quality of HR and linking to LSS
11	Performance measurement system

These weights will serve as the foundation for maturity assessment in the next chapter.

Consistency Check

A key feature of AHP is its ability to validate consistency in judgments. A Consistency Index (CI) was calculated with the help of the maximum eigenvalue (λ_{max}) of the comparison matrix using the equation 1.

$$CI = \frac{\lambda_{max} - n}{n-1} \ldots\ldots\ldots (1)$$

Where n is the number of enablers (11 in this case). The CI was further compared with a Random Index (RI), a standard figure derived from the matrix size.

The consistency index should be below 0.1 (10%) to verify that comparisons by experts were consistent. The CI value in this study was less than the cutoff value, an affirmation that judgments were reliable and could be utilized for further analysis.

IV. Capability Maturity Model Integration (CMMI)

Capability Maturity Model Integration (CMMI) is generally implemented in software companies to measure the company's maturity in their work and the processes that they employ for product development (Wilkie et al, 2005; Lee and Wu, 2007). Maturity refers to how consistently an organization applies its processes to effectively achieve its objectives. There are five different maturity levels, initial, repeatable, defined, managed and optimized (Purani et al, 2015). This Model is also used as a comparison model to other methods and standards. CMMI aims to improve all the processes in manufacturing products or providing services in the company (Pane and Sarno, 2015). Different types of CMMI models were developed for process optimization. A group of professors from Software Engineering Institute formed a group along with private and government partners to develop CMMI framework. They integrated the existing capability maturity models to frame a model which can be utilized by everyone (CMMI, 2002). It is upgraded frequently if any changes are requested by companies. The CMMI process works on increasing the process efficiency through consideration of elements to be changed for an effective process (Carnegie University, 2002). This process of measuring maturity levels has been adopted by many other industries (Raghuram et al, 2021). CMMI has been adopted by different industries like construction (Sarshar et al, 1999) and automotives (Lin et al, 2009) to measure their maturity levels. Many researchers have integrated CMMI into the six-sigma process (Siviy et al, 2007; Li and Lin, 2011), agile methodology (Alegria and Bastarrica, 2006) and lean manufacturing (Kundu and Manohar, 2012) to optimize the process and bring down the defects in product and services.

4.1 Capability Maturity Model for Lean Six Sigma Implementation

A Capability Maturity Model (CMM) is a formal tool that is used to evaluate how effectively and methodically an organization deals with its internal processes. Implemented initially in software development, the idea has become a generic technique for measuring process maturity in most industries.

Within the framework of Lean Six Sigma (LSS), the model is used as a standard to gauge the readiness of the business to implement and maintain continuous improvement techniques. The maturity level is the higher the more standardized and polished the processes within the organization. If applied accurately, this model has the ability to make organizations aware of where they stand and the path that needs to be taken to move towards optimized performance.

For this study, the Capability Maturity Model has been tailored specifically to evaluate the readiness of MSMEs to implement Lean Six Sigma practices. The model is based on five progressive levels of maturity, each representing a stage of development in organizational capability as shown in Table 7.

Table 7 Capability Maturity levels for LSS implementation

Capability Maturity level	Description	Process management
1	Initial	The processes are poorly controlled and managed by the organizations. No awareness of LSS.
2	Managed	Organizations make sure that the processes are well planned and controlled. There is an awareness about LSS.
3	Defined	The processes are well defined based on standard work methods and tools. The company works systematically and inspection is done regularly.
4	Quantitatively Managed	Quantitative objectives for process performance and quality are set. For LSS implementation there is a quantitative methodology.
5	Optimized	Organizations focus on continuous improvement in processes and their performance. Lean and Six Sigma tools are implemented for continuous quality improvement.

To determine the maturity level of an MSME, each of the eleven enablers—identified and weighted using AHP—is evaluated using a structured questionnaire. Respondents are asked to rate their organization on a scale of 1 to 5 for each enabler, where:

1 – Very Poor, 2 – Below Average, 3 – Average, 4 – Good, 5 – Excellent

These scores are then multiplied by the corresponding AHP-derived priority weights to calculate a weighted score for each enabler. The total of these weighted scores gives an overall maturity score for the organization.

4.2 Maturity Level Calculation

Once all individual enabler scores are collected and weighted, the final cumulative score is used to place the organization on the maturity scale. The ranges for each maturity level are defined as in Table 8.

Table 8 Range of sum of the Weighted score

Capability Maturity level	Range of sum of the Weighted score (x)
1	$1 \le x < 2$
2	$2 \le x < 3$
3	$3 \le x < 4$
4	$4 \le x < 5$
5	$x = 5$

In this study, for example, in this study, an MSME was evaluated using expert feedback, and the total weighted score came out to be 3.34. According to the model, this places the organization at Level 3 – Defined.

This implies that while standard operating procedures are in place, and there is some level of systematic process control, there is still room for improvement in areas like leadership involvement, employee training, or supplier/customer integration before the company can transition to full-scale LSS implementation. This assessment is shown in Table 9.

Table 9 Weighted score for enablers

Enablers	Priority Weights	Questions	Score 1	2	3	4	5	Weighted Score
SMS	0.18	Does the senior management encourage new papers and the team implementing it?			3			**0.54**
SLSS	0.12	Do you challenge your network of partners and suppliers and help them to improve?					5	**0.61**
EC	0.10	Do your employees enthusiastically work towards the task assigned to them?		2				**0.21**
LPF	0.10	Are the decisions of the management based on long-term lean philosophy, rather than short-term profits?					5	**0.48**
SRW	0.09	Do your employees trust, respect and openly communicate with each other?			3			**0.27**
CLSS	0.09	Do you engage with the customers to participate and improve your processes?				4		**0.36**
TE	0.08	Are your employees trained in such a way that they can teach their subordinates and can adapt to any changes?		2				**0.15**
ECD	0.07	Do departments share accurate information and knowledge with each other?		2				**0.14**
OI	0.07	Is your infrastructure good enough to create flow of material and information?				4		**0.27**
PMS	0.06	Do you measure the company performance regularly and obtain feedback?				4		**0.25**
QHR	0.04	Does your HR hire the right personnel and ensure that they are able to develop as leaders?		2				**0.08**

V. Results and discussion

By analyzing the priority values derived from the Analytical Hierarchy Process (AHP) and conducting a structured assessment of enabler performance within the organization, several key insights emerged. The most dominant factor identified was senior management support, indicating that leadership involvement is essential in driving Lean Six Sigma (LSS) initiatives. Without proactive engagement and sponsorship from top-level executives, LSS programs are likely to lose momentum or fail altogether.

Following closely in importance was supplier integration, reinforcing the notion that process excellence extends beyond internal operations. To achieve consistent quality and reliability, organizations must align closely with their external partners and promote shared standards. The third highest-rated enabler was customer involvement, which reflects the growing need to listen to end-user feedback and use it to shape internal improvements.

5.1 Priority Weight Analysis

The ranking of enablers based on the AHP analysis provided a clear picture of where an organization should focus its attention when preparing for LSS execution. The summary of the top-ranked enablers is explained below:

- **Senior Management Support** – Signifies leadership's role in resource allocation, strategic alignment, and cultural change.
- **Supplier Integration** – Highlights the importance of involving vendors and supply chain partners in the quality improvement journey.

- **Customer Engagement** – Encourages companies to maintain open communication with clients and prioritize their evolving needs.
- **Employee Training** – Ensures that staff are equipped with the skills and understanding necessary to execute improvement tools and methodologies.
- **Lean as a Long-Term Philosophy** – Promotes a culture of continuous improvement, rather than short-term cost-cutting.
- **Organizational Infrastructure** – Supports efficient flow of information and materials, enabling smooth execution of improvement strategies.
- **Interdepartmental Communication** – Encourages collaboration across teams and reduces siloed operations.
- **Employee Commitment** – Reflects the dedication of personnel toward improvement goals and their willingness to contribute ideas and efforts.
- **Workplace Relationships** – Stresses the need for mutual respect and cooperation across the workforce.
- **Quality of HR & LSS Alignment** – Underlines the importance of hiring, retaining, and developing staff aligned with improvement objectives.
- **Performance Measurement Systems** – Involves tracking results through KPIs to guide improvements and measure progress.

5.2 Maturity Assessment Outcome

Using the responses gathered through the maturity assessment questionnaire and applying the AHP-weighted scoring system, the evaluated MSME obtained a total weighted score of 3.34. According to the capability maturity model framework, this score places the organization at Level 3 – Defined.

Being at Level 3 means that the company has already taken steps to formalize and standardize its operations. Standard work instructions exist, and quality inspections are likely being performed consistently. However, despite this structured approach, the organization has not yet fully embraced the data-driven and strategic nature of Lean Six Sigma. Process improvements may still be reactive rather than proactive, and cultural transformation is only partially complete.

To move toward Level 4 (Quantitatively Managed) and ultimately Level 5 (Optimized), the company must focus on enhancing specific enablers that currently show weaker performance.

5.3 Opportunities for Improvement

The analysis of the individual enabler scores revealed specific gaps. Some critical factors that require improvement include:

- **Employee Training:** Staff members do not currently possess sufficient knowledge or confidence to train others or adapt quickly to process changes.
- **Interdepartmental Communication:** There is a noticeable lack of coordination and timely exchange of information between departments.
- **HR Quality:** The current hiring and personnel development strategy may not be fully aligned with long-term Lean Six Sigma goals.
- **Performance Measurement:** While some KPIs may exist, the company lacks a comprehensive performance tracking system to monitor progress and inform decisions.

By strategically focusing on these areas, the organization can improve its internal capabilities and climb to higher levels of LSS maturity.

5.4 Strategic Implications

The findings of this study provide a roadmap for MSMEs seeking to implement Lean Six Sigma but are uncertain about their readiness. The combination of AHP prioritization and capability maturity assessment allows organizations to:

- Pinpoint critical areas that require immediate attention.
- Allocate resources more effectively by focusing on high-priority enablers.
- Create targeted training and development plans.
- Build a strategic foundation for long-term continuous improvement.

This systematic approach not only minimizes the risk of implementation failure but also ensures that the cultural and infrastructural groundwork for Lean Six Sigma is solidly in place before full-scale execution begins.

VI. Conclusion

The study aimed to create a structured framework to evaluate how ready MSMEs are to adopt Lean Six Sigma (LSS) practices. Sensing the increased pressure on these businesses to stay competitive in spite of insufficient means, the study suggested a model for maturity evaluation based on critical enablers. By way of literature review, eleven enablers were identified and ranked subsequently by the Analytic Hierarchy Process (AHP), an established decision-making method. The enablers varied from leadership engagement to supplier partnerships and staff training. Each was analysed for its influence in producing a favourable environment to ensure LSS success.

The enablers that were ranked were then integrated into a five-level Capability Maturity Model (CMM), used as a diagnostic tool. Organizations can utilize this model to assess the current state, point out strengths, and define areas that need development prior to launching full-scale Lean Six Sigma programs. The implementation of the model to a real MSME generated interesting results. The company scored 3.34, putting it at Level 3 – Defined on the maturity scale. This indicates that the company had started to standardize its procedures and had gained some experience of structured operations, but a number of foundation elements remained underdeveloped.

Critical enablers such as customer focus, supplier involvement, and senior management commitment were in place, but others such as employee training, HR alignment, and cross-functional communication lagged behind. Closing these gaps will be necessary if the firm wants to move to higher levels of maturity.

VII. Practical Implications for MSMEs

For small and medium-scale enterprises with major challenges in implementing Lean Six Sigma, the present research provides a pragmatic and systematic solution. Assessing internally using the model proposed first, MSMEs can sidestep the typical pitfalls of hurried or poorly supported LSS implementations.

This assessment tool empowers business leaders to:

- Make informed decisions about resource allocation.
- Build strategic training and improvement programs.
- Establish a culture of continuous development.
- Benchmark progress in their journey toward operational excellence.

VIII. Future Scope

Although the model provides a strong foundation, there are opportunities to further enhance it. Future research could expand the set of enablers based on emerging industry trends or specific sector requirements. Additionally, using a larger sample size across diverse industries would strengthen the model's validity and generalizability. Integration with real-time analytics or digital transformation indicators could also make the tool more dynamic, helping organizations continuously update their readiness assessment as they evolve.

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