Identification and Prioritization Lean Six Sigma Barriers in MSMEs

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Abstract. The competition in market is increasing day by day and there is always fluctuation in demand and supply. To retain in market, organizations have to meet the customer demand to get customer utmost satisfaction. Mainly, micro, small and medium enterprises (MSMEs) are struggling with such problems as they are having limited resources. To stay remain in competition there is only one way to improve productivity by optimum utilization of available resources by reducing waste and defects in product and processes. In this context, Lean Six Sigma (LSS) is emerging as a potential strategy that can be able to improve the processes very easily. LSS is the integration of two different continuous improvement approaches; Lean and Six Sigma that is used to reduce waste and variation in processes but many organizations still facing challenges to implement LSS successfully. So, the main aim of present study is to identify the barriers of LSS and prioritize them using analytic hierarchy process (AHP). The most critical barrier category comes out as management based barrier as it possess highest AHP index. This study will help the mangers and researchers to focus on critical barriers of LSS so as to implement it in a smoother way.

Key Words: Lean Six Sigma, MSMEs, Barriers, AHP, Six Sigma

1. Introduction

MSMEs play an important role in the growth of manufacturing economy of any nation because their contribution in manufacturing activities is very high. MSMEs are struggling with their lower productivity level due to limited resources and investment available with them. Only way to improve productivity without adding much capital investment is by fully utilizing resources or by reducing capacity waste. There are many methods is available to reduce waste but among all quality tools Lean Six Sigma is found to be very effective method because it reduce waste as well as variation in the processes [1]. To understand the concept of Lean Six Sigma it is essential to understand Lean and Six Sigma both. Six Sigma is efficient strategy used to get operational excellence by deploying continuous process improvement. Six Sigma has been effectively executed worldwide for over 20 years, conveying basic improvements to the profit of various large and small organizations [2]. Motorola presented the idea of Six Sigma in the mid-1980s as a good business system to enhance quality. By observing the success of Six Sigma in the manufacturing sector, this process improvement methodology was implemented to many other service organizations like financial and hospitals [3]. Still, MSMEs are not much familiar with sustainable benefits of Six Sigma strategy. The motivation behind adoption of Six Sigma by large number of organizations is that, it solves the critical to quality (CTQ) issues in a logical manners [4]. Lean concept was created by Toyota in the 1950s to dealt with problem of huge waste generation in plant. The thought was to recognize and get rid of each one that was wasteful. Lean seeks
to identify irrelevant and inefficiencies process and to isolate it [5]. The seven wastes of Lean include overproduction, transportation, inventory, processing, waiting, motion and defects. Today, independent of the business domain, corporations must concentrate on speed, customer value and effectiveness to be all around focused. Lean standards have empowered enterprises to accomplish significant financial advantages while enhancing quality, cycle time and costs. The Lean methodology is centered on the identification and elimination of waste in production, service industries and product development [6]. Some of key tools and technique of Lean manufacturing include kaizen, kanbans, poke yoke, five S, quick changeover, pull production and value stream mapping. In LSS, Lean is very useful to reduce waste or steps which are not adding value into processes and Six Sigma is very helpful to reduce the variability in business processes [7]. If both methodology used separately, is not much effective and efficient therefore there is need of integration of Lean and Six Sigma to increase the effectiveness of the process [8]. From literature, it was observed that this idea has been suggested by many authors in 2003 but implementation of this approach is found from 2005 onwards. In LSS, DMAIC methodology and Lean principals has been applied collectively to make improvements in existing system in a very logical way [9]. Utilizing Six Sigma as the lead initiative allows the formal infrastructure of Six Sigma to remain in the Lean Six Sigma implementation [10]. DMAIC model has been used to provide the framework and selected tools from Lean concept has incorporated within this framework. As reported in literature, MSMEs are struggling with lower productivity and this major hurdle in growth of MSMEs. In this context, LSS is emerged as a well-organized process and waste improvement methodology to enhance the productivity levels of MSMEs [11]. Still MSMEs have very limited resources and capital to utilized and invest, most of MSMEs are not in condition to make expenditure an addition of extra capacities or to invest in any productivity improvement program. So, prior invest in implementation of LSS in MSMEs to tackle various CTQ issues, it is very essential to know about various hurdles in smooth execution of LSS. The prime aim of present study is to identify the barriers of LSS success in MSMEs. Further, after identification of barriers, these barriers needs to be prioritized, so that critical barriers can be easily handled with due care. During LSS implementation, practitioners can be able to focus on critical barriers in order to ensure successful execution across the plant.

2. Literature search methodology

The systematic literature review followed three phase described following.

2.1 Data search strategy phase

In this paper the article considered for study are in English language published between 2005 and 2018. Google Scholar, IEEE, Science Direct and web of science database are used to find out the relative data.

2.2 Conducting phase

In this phase execution of plan has been done to find out relative data to the LSS Barriers. To find out the articles ‘Six Sigma’, ‘Lean’, ‘Lean Six Sigma’, ‘failure factor’, ‘barriers’ ‘obstacles’ and ‘MSMEs’ keywords has been used. These keywords are choose because it cover the topic related to barriers of Lean Six Sigma in MSMEs. Initially all articles related to these keywords are downloaded and then inclusion and exclusions criteria has been applied to extract the articles which are related to our study. Table 1 show the inclusion and expulsion criteria.

| Inclusion criteria | Expulsion criteria |
|--------------------|-------------------|
| The paper published in English language between 2005 and 2018 are selected. | The papers in other languages rather than English. Any paper published before 2005 Online sites, books and grey literature (conferences, reports, working papers from research groups, technical reports, etc.). |
2.3 Reporting and describing phase
In this phase the article which totally related to our study (LSS barriers) has been extracted. The articles which are included in study are selected by reading the abstract and title which will help to save the time. After selecting the research papers, the paper which are published in weak journals are excluded. The articles which are included in study is well known journal like Emerald, Elsevier, ProQuest and Taylor & Francis. After this identification of LSS barriers has been done by exploring these selected research paper thoroughly. Then prioritization of those barriers has been done to find the most critical barriers.

3. LSS barriers
LSS execution may prove to be a costly concern for any industry if applied in faulty manner. Therefore, it is very essential to have knowledge about barriers of LSS which may obstruct its effective adoption [12]. A barrier is something that makes it difficult or impossible to implementation of LSS in MSMEs. It is important to list barriers of the LSS before implementation. During literature review all barriers of LSS are included and then with the help of expert opinion the barriers related to LSS has been selected. Table 2 show the list of LSS barriers.


| LSS barriers | References |
|---------------|------------|
| Lack of top management commitment and involvement | Alblawi et al.(2014), Arumugam et al.(2012) [9,13] |
| Lack of education and training | Alblawi (2014), Yadav (2017) [9,14] |
| Lack of estimation of execution cost | Aboelmaged (2011) [15] |
| Voice of customer misunderstanding | Antony et al. (2012a), Yadav (2017) [16,14] |
| In effective roadmap for implementation | Chakravorty (2009), Lee (2009) [17, 18] |
| Lack of Lean/ Six Sigma expertise | Jayaraman et al. (2012) [19] |
| Unclear future plan and visions | Jayaraman et al. (2010), Yadav (2017) [20,14] |
| Human factors ignorance | Alblawi et al. (2014) [9] |
| Poor awareness about Lean/Six Sigma | Chakravorty and Shah (2012) [21] |
| Lack of participation and engagement of employee | Arumugam et al. (2012) [13] |
| Lack of process thinking and process ownership | Alblawi et al.(2014), Hilton et al.(2012) [9,22] |
| Lack of technological resources | Alblawi et al.(2014), Yadav (2017) [9,14] |
| Misalignment between organizational goals, project aim and customer demand | Alblawi et al. (2014) , Ho at el. (2008) [9,22] |
| Narrow view of LSS tools Set, practices and techniques | Antony et al. (2012a), Yadav (2017) [16,14] |
| Poor project selection and prioritization | Aboelmaged (2011) , Rathi et al. (2015) [15,24] |
| Poor communication | Chakravorty(2009), Hilton et al.(2012) [17,22] |
| Poor organization capabilities | Chakravorty (2009) , Rathi et al. (2015) [17,25] |
| Resistance to culture change | Antony et al. (2012a)[16], Yadav (2017) [16,14] |
| Insufficient organizational resources | Antony et al. (2012a)) [16] |
| Weak infrastructure | Sne (2010), Rathi et al. (2015) [26,27] |
| Wrong section of LSS tools | Yadav (2017), Singh M. & Rathi R.(2018) [16,28] |

3.1 LSS barrier: Categorization
In present study, LSS barriers has been categorised in the five different categorizes name as management based barriers, organization based barriers, technology based barriers, training and educational based barriers and other barriers. In the management based barrier those barriers are included which are being faced by top executives of management. In organization based barriers, the included barriers are related to organization such as weak infrastructures, poor organizational capacity, insufficient organizational resources. In the technology based barriers those barriers are considered which are based on technology such as lack of technology resources and wrong selection of tools. In training and educational based
barriers those barriers are included which are related to skill and education of employes and related to training of employees such as Poor awareness about Lean/Six Sigma, narrow view of LSS as a set of tools, techniques and practices and Lack of education and training. Remaining barriers which are not falling in above said categories, are considered as other barriers. Other barriers include barriers such as lack of consideration of the human factors and lack of understanding of voice of customers. The category of LSS barriers shown in figure 1.

Figure 1. Categorization of LSS barriers

4. Methodology Adopted
This section explain the methodology adopted to prioritize the barriers of the LSS in MSMEs. Firstly, LSS barriers has identified by exploring vast literature using a systematic literature search methodology. Then multi criteria decision making (MCDM) method, analytic hierarchy process (AHP) is used to prioritize among criteria and alternatives and it is also measure the consistency of judgment [27]. AHP is a basic decision making model that build up a hierarchical structure of the components in the given issue and to give decisions about the relative importance of every one of these variables and at last to determine an inclination for every decision alternative concerning each factor. It includes the following steps.
STEP 1: Make comparison matrix from pairwise comparison.
In this step we compare two aspect and give rating to according to their important. The criteria of row is compared to column and a pair wise matrix is being formed. Let  \( a_{ij} \) is the value of comparison matrix according to scale of relative important and \( p \times q \) is size of matrix.

\[
A = \begin{bmatrix}
a_{11} & a_{12} & \cdots & a_{1q} \\
a_{21} & a_{22} & \cdots & a_{2q} \\
\vdots & \vdots & \ddots & \vdots \\
a_{p1} & a_{p2} & \cdots & a_{pq}
\end{bmatrix}
\]  

STEP 2: Sum up each column of the comparison matrix.

\[
S_{pq} = \sum_{i=1}^{n} a_{pq}
\]

STEP 3: Obtain normalized relative matrix.
Divide each element of the comparison matrix with the sum of its column to get the normalized relative matrix.

\[
X_{pq} = a_{pq} / S_{pq}
\]

STEP 4: Estimation of Criteria weights
Sum up the each row of normalized Matrix and divide it by size of the matrix to get the criteria weights.

\[
W_{pq} = \sum_{j=1}^{n} X_{pq}
\]

STEP 5: Estimation of Consistency Index
In this step consistency index has been calculated using the formula. Where \( n \) is the no of aspect we are comparing and \( \lambda_{\text{Max}} \) is maximum eigen value.

\[
(CI) = \frac{\lambda_{\text{Max}}n}{n-1}
\]

STEP 6: Estimation of Consistency Ratio (CR)
In this step consistency ratio was obtained by dividing consistency Index (CI) by random consistency index (RCI). Random consistency index of \( 5 \times 5 \) matrix is 1.12.

\[
\text{Consistency Ratio} = \frac{\text{Consistency Index}}{\text{Random Consistency Index}}
\]

5. Result and Discussion
LSS implementation is mainly limited to big organization and MSMEs are still not benefited with this strategy. Although, a lot framework of LSS for MSMEs are available in literature but still MSMEs are very hesitate to implement LSS across their units due to several hurdles. The identification of LSS
barriers in MSMEs is very important for reducing the fear of failure. In present study 21 barriers of LSS has identified with exploration of vast literature. From comprehensive review, selected LSS barriers are now grouped into five different major category named as organization based barriers, management based barriers, training and education based barriers, technology based barriers and other barriers. After categorization of LSS barriers, it is very essential to prioritize all framed categories in order to find out critical barriers. So during implementation are can attack on critical barriers at early stage to ensure success of programme. For this well-known decision making methodology (AHP) is used to rank the identified barriers in a logical way. A pair wise comparison is done with the help of experts to assigning a numeric value to the barriers on a scale of 1-9 and pair wise comparison metrics was framed. Table 3 show the pairwise comparison matrix which helps to find out the critical barriers category.

Table 3. Pairwise comparison matrix

| Barriers                                      | B1  | B2  | B3  | B4  | B5  |
|----------------------------------------------|-----|-----|-----|-----|-----|
| Management based barriers (B1)               | 1   | 5   | 7   | 5   | 9   |
| Organizational barriers (B2)                 | 0.20| 1   | 3   | 3   | 7   |
| Technology based barriers (B3)               | 0.14| 0.33| 1   | 0.33| 5   |
| Training and education based barriers (B4)   | 0.20| 0.33| 3   | 1   | 5   |
| Other barriers (B5)                          | 0.11| 0.14| 0.20| 0.20| 1   |

With further analysis by utilizing equitation ii, iii and iv the AHP index of all selected barriers has computed and consequent ranks to barriers has been framed as shown in table 4. The most critical barrier category comes out as management based barriers having AHP index 0.48. It summarize that around 48 percent of obstacles for LSS implementation are on account of management based barriers.

Table 4: Criteria weight of barriers with rank

| Barriers | AHP index | Rank |
|----------|-----------|------|
| B1       | 0.23      | 2    |
| B2       | 0.48      | 1    |
| B3       | 0.16      | 3    |
| B4       | 0.10      | 4    |
| B5       | 0.03      | 5    |

This indicates that top management executive duty to understand the needs of LSS and make plane and strategy to implement effectively. Organizational barrier is second most critical barriers with 0.23 AHP index. These two barriers have weightage of 71 percent hence, this can be expressed that these barriers plays major role to implement LSS efficiently MSMEs. On the other side rest 29 percent weightage of barriers is covered by technology based barriers, training and education based barriers and other barriers also create difficulty in proper implementation. The contribution of all barriers demonstrated figure 2.
The consistency index of summarized matrix has been estimated using equation 5 and is found to be 0.11. The consistency ratio of the whole process has been analysed using equation 6 and it is found to be 0.098 which is less than 10 percent. This indicate that whole process is consistent and reliable hence, validates the results of prioritization.

6. Conclusions

LSS is an alternative way to improve the productivity levels of MSMEs without expanding their capacities or without addition of much capital input. But still MSMEs are not fully familiar with sustainable benefits of LSS and also having fear factor for LSS failure during implementation. So, it is essential to extract out LSS barriers in MSMEs before implementing it in order to ensure success. For this, present study identified 21 barriers of LSS regarding MSMEs from comprehensive literature review. Then identified barriers were grouped into five main categories namely organization based barriers, management based barriers, training and education based barriers, technology based barriers and other barriers. Furthermore, the barriers categories have been prioritized using well known AHP approach in order to find out most critical hurdle in the way of LSS success in MSMEs. Management based barrier has been emerged as major barrier having highest weightage (0.48) followed by organizational based barrier (0.23) and they are responsible for ineffective implementation of LSS in MSMEs. This study facilitate the mangers and researchers to implement LSS in their organization effectively by concentrating on critical barriers prior to implementation.

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