



Six Sigma in Manufacturing Industries: Barriers to Implementation

Pallawi B Sangode & Himanshu R Hedao

Dr. Ambedkar Institute of Management Studies and Research, Nagpur, India

Abstract

Six Sigma is a set of management techniques intended to advance business practises by approaching zero defects in the system. It is a data driven approach and a methodology that drives towards eliminating errors. Six Sigma strategy is adopted by companies all over the world including Indian firms for reducing process variations thereby improving the business performances. Though this concept was derived and introduced back in 1986 and gained universal applicability, many firms still lag in implementing this methodology in their systems. This paper is a small attempt to understand the barriers and the reasons for the non-implementation of Six Sigma by the manufacturing firms. The paper has concluded that one reason for improper implementation of Six Sigma in the organisation is poor selection of the project that requires improvement.

Keywords: DMAIC Process, Critical to Process, Master Black Belts, Organisational Alignment

JEL Classification: L21, M11, M10

Paper Classification: Research Paper

Introduction

Every organisation aims at profit maximization and growth. Growth and profits are directly related to the level of satisfaction that is imparted by the product or the services to the customers. Customer wants value for money. He wants the best quality in the given cost. So how does an organisation achieve this quality? Quality is a subjective constraint. Every customer has a different taste of quality. So, it is the job of the organisation to provide everything in terms of quality that every customer demand. So, from where does this quality start? It starts from the moment the manufacturer purchases the raw material from the supplier. This quality is percolated in the product through right set of processes, activities with the use of right resources in terms of human and technology and ultimately right quality is achieved by reduction in defect in the product. Lesser is the tolerance limit for defect, better is the quality. This concept drives the organisation towards the concept of least deviation in the products that are manufactured. This drives the organisation towards Six Sigma.

What is Six Sigma?

Six Sigma is the degree of quality that strives for near excellence and perfection. Six Sigma is a discipline that is driven by data. It is a methodology for eliminating defects (driving towards six standard deviations between the mean and the nearest specification limit) in any process. The application Six Sigma is spread from manufacturing to transactional and from product to service. When a process produces not more than 3.4 defects per million opportunities, six sigma is said to be achieved. A Six Sigma defect is defined as anything beyond and outside of customer specifications and requirements. Thus, anything that does not satisfy the customer is called a defect. The role of Six Sigma professional or the team is to identify this defect, reduce it and confirm that the defect does not repeat or occur.

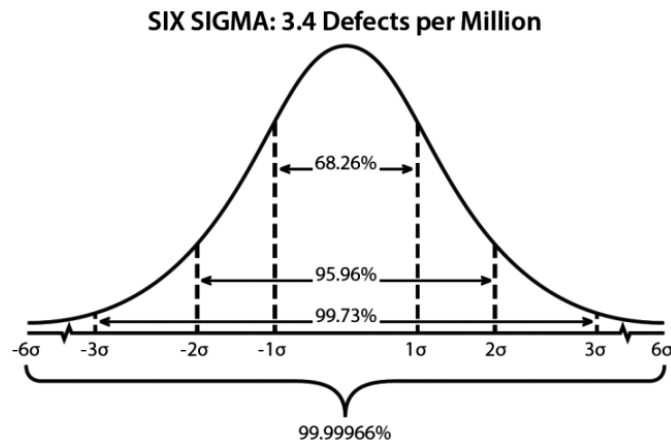


Figure 1: Six Sigma Curve (Approaching Perfection)

Figure 1 shows the bell shape curve which also signifies the six sigmas. The central peak of the curve is where the variable attributes are supposed to lie. The deviation from the centre shows the increasing defects in the process. One sigma indicates 68% of the process in control. Two sigma means 95.96% products lie in the specification limits. Thus, Six Sigma means 99.00066% of the products lie in the specification limits. Thus, the defect rates on each side of the curve are 0.00017%. This accounts to 3.4 defects in per million opportunities. Less is the standard deviation, more is the accuracy. Six Sigma encompasses the complete 'professionalizing' of quality management functions. Before the introduction of Six Sigma, quality management in practice was largely consigned to the production floor and to statisticians in a separate quality department. Then a formal program that ranked the professional based on their knowledge and experience to organise projects on quality improvement was introduced. This is known as Six Sigma belts. Professionals are ranked in the role they play in Six Sigma Projects.

Executive Leadership (Six sigma) includes the CEO and other members of top management who provide overall alignment by establishing the strategic focus of the Six Sigma program within the context of the organization's culture and vision. Champions take responsibility for Six Sigma implementation across the organization in an integrated manner. The Executive Leadership draws them from upper management. Champions also act as mentors to Black Belts. Master Black Belts, identified by Champions, act as in-house coaches on Six Sigma. They devote 100% of their time to Six Sigma. They assist Champions and guide Black Belts and Green Belts. Apart from statistical tasks, they spend their time on ensuring consistent application of Six Sigma across various

functions and departments. Black Belts operate under Master Black Belts to apply Six Sigma methodology to specific projects. They are full time employees for Six Sigma. They primarily focus on Six Sigma project execution and special leadership with special tasks, whereas Champions and Master Black Belts focus on identifying projects/functions for Six Sigma. Green Belts are the employees who take up Six Sigma implementation along with their other job responsibilities, operating under the guidance of Black Belts. Yellow Belts, are those employees that have basic training in Six Sigma tools and generally participate in projects.

Steps in implementing Six Sigma

Step 1: Define the priorities of the customers with respect to quality. First attributes of a product are identified that are considered most important by the customer in evaluating the quality of the product. These attributes are called Critical to Quality characteristics. The perception of the customer about quality is updated from time to time by conducting customer surveys. Quality Function Deployment is one important tool to capture the voice of Customer. The tools that are used at this level are the project charter, process flowchart and Quality Function Deployment.

Step 2: Measure the processes and the defect arising in the product due to the process. The important processes that influence the critical to quality characteristics are identified and performance techniques are established for these processes. At this stage brainstorming sessions, benchmarking, process flowchart, and tools are used to measure or quantify the problem.

Step 3: Analyse the process to determine the most likely cause of defects. At this stage the process is analysed in detail to identify and understand the root causes of the defects. Here the primary tools of quality like the Ishikawa Diagram can be used to identify the sources of defects for a problem. Once all probable defects are identified, the one which is critical and important is prioritized. The analysis of the problem is basically done through the basic tools of quality like the histograms, Pareto chart, run chart, Control Chart, Scatter plot, Regression analysis, fishbone diagram, process map review and analysis etc.

Step 4: Improve the performance of the process and remove the causes of the defects. For all the key variables, the specification limits are fixed. A system is established to measure the deviations in the variable. Improvements and changes are done in the process to reduce the deviations and assure that the variable lies in the specification limits. In this phase control charts are used to continuously monitor the deviations and the signals in the process. Other tools that are used are Brainstorming, Mistake Proofing, Design of Experiments, QFD/House of Quality, Failure Modes and Effects Analysis (FMEA), and Simulation Software etc.

Step 5: Control to ensure that the improvements are maintained over time. Once the improve stage ensures the process remains in the limits and the variable values least fluctuate, the modified process is subjected to vigil at regular intervals of time to ensure key variables unacceptable variations.

Selecting Six Sigma Project

For the organisation, while implementing Six Sigma the major problem faced is identifying the right project for implementing Six Sigma. Most organizations do identify the project areas that require improvements, but the difficulty arises in practically analysing those opportunities to create significant and meaningful projects. If the project selection process is structured, well defined and meticulous, the results would be useful and meaningful.

Organisations should therefore establish a Project Selection Steering Committee that is completely devoted to identifying the right and the needy projects. This should be followed by generating Project Ideas that focus on issues, opportunities and problems in the project. Final stage should be prioritising the projects based on requirement and its importance to the organisation.

The study (Filifel, Zakic, & Tornjanski, 2017) on Identification and Selection of Six Sigma Projects, provided the sources for the identification of potential projects, top down and bottom up approaches, the process of selection of projects, guidelines that assist the selection of appropriate projects. The study suggests that the selection criteria must be precisely chosen in harmony with the needs, objectives and capabilities of the organization. Organizations should implement systemic methods of potential Six Sigma project identification. The organisation should master sophisticated methodology, techniques and tools for project selection. This would aid to carry out Six Sigma projects which would bring the highest rate of benefit to the organization and which would be best aligned with goals and abilities of a company.

Literature Review

While studying the existing literature on the barriers to the implementation of Six Sigma practices, many review studies were identified that list vivid barriers. Few of which are listed as follows.

Tyagi, Soni, & Khare (2014) while reviewing the issues in implementation of Six Sigma in small and medium enterprises documented that the lack of resources is critical barrier to Six Sigma implementation in SMEs and lack of knowledge is the most important barrier for implementation of Six Sigma programme but the leadership issue is also crucial for the failure or success of implementation of Six Sigma. Improvement in all processes/services by reducing defects can enhance savings or increase profit of an organization as shown in literature. The key barrier to the implementation of Six Sigma in small medium enterprises become lack of training and guiding for successful completion of project, training program for each employee should be started by company but training program was too costly for SMEs. Sao & K (2015) study on the Six Sigma Methodology in manufacturing industries identified key barrier to the implementation of Six Sigma in small medium enterprises as lack of training and guiding for successful completion of project, training program for each employee should be started by company but training program was too costly for SMEs. The study says that now a days, it is very easy in SMEs to get better external resources for guidance without paying more cost. The critical barrier to Six Sigma implementation in SMEs followed by others are: poor participation of employee, lack of training and knowledge, internal resistance, lack of resources, lack of executive commitment, poor training and poor six sigma project selection etc. A & R V (2013) study on the barriers for the implementation of Six Sigma documented that lack of knowledge, education and some of the misconceptions about Six Sigma has made the SMEs to be sceptical about the applicability of Six Sigma for them. Apart from these there are some genuine technological, organizational and financial limitations of SMEs that act as barriers for Six Sigma implementation by them. Other barriers are as listed below.

- Lack of resources
- Internal resistance from the employees
- Lack of leadership from top executives and top management
- Lack of knowledge about Six Sigma as a process and methodology and its benefits
- Insufficient organizational alignment

- Cultural barriers based on the qualification and knowledge
- Poor training and coaching to the employees who work for quality
- False notion that Six Sigma is too complex to use
- Wrong identification of the process parameters
- Lacunae in data collection since Six Sigma is a data driven approach, correct data must be collected.
- Selection of a project for Six Sigma that does not necessitates the use of it.

Chaudhari (2012) paper on the Key for Implementation of Six Sigma in Indian Industries concluded that management commitment and continuous support is the most crucial factor when it comes to six sigma implementation. Project prioritization and selection is the second most crucial. Though linking Six Sigma to human resources and suppliers have lower scores, they should be given due importance because they are still important as per the scale. No employee is ready to leave the present job, but because of less availability of Six Sigma people, industries were ready to pay considerably more. It can be said that effective implementation of Six Sigma is thus possible in India; the only requirement is to have an earnest mission of satisfying and further delighting the customer. Vashisht & Attri (2017) studied barriers in the implementation of Six Sigma in manufacturing organizations that aimed at identifying the barriers in six sigma implementations concluded that in the fast altering global market there is a rise in the used of Six Sigma. The results that are generated by adopting Six Sigma depends majorly on the way the process is being utilized. So it is necessary for every organization to recognize the obstacles impeding the proper implementation of Six Sigma. The lack of top management support and proper leadership acts as major obstacle to Six Sigma implementation. As Six Sigma is a statistical methodology so the identification and improper presentation of data related to Six Sigma also acts as barriers to its implementation. There are also some technical and financial restrictions associated with Six Sigma implementation. Technical restrictions are those that require advance technology that collect, process and analyse data. The financial barrier deals with the training of the employees for Six Sigma Certification. Abdolshah & Yusuff (2008) studied fundamental elements for the successful performance of Six Sigma projects in service industries and aimed at identifying the key performance indicators of six-sigma and elements to cover a wider range of services. The study found that one of the most important limiting factor in service sectors is the difficulty in quantifying and collecting data from service processes. Quality of the service must be defined and measured by defining quality factors. Also quality programs which are focused on opportunities must be established strongly. Customer has a main roll in service industries. For proper implementing of Six Sigma in service industries, the operational strategies and customer with respect to need and satisfaction must be deliberated. This is one of the differences is the application of DMAIC (Define, Measure, Analyze, improve and Control) to a service project. One important problem is that most of service industries don't have a proper attitude about customer and related qualified data. So it will be more efficient, if before 'define phase', a phase for considering customer and operational strategies is mentioned. This study identified a design phase before define phase for considering the operational strategies, customer and design perspectives in the service environment. The study also identified the fundamental elements in the form of challenges and its solutions for proper implementation of Six Sigma. Elgadi,

Birkett, & Cheung (2016) paper on 'Identifying the Barriers behind the lack of Six Sigma Use in Libyan Manufacturing Companies' identified the factors impeding the adoption of Six Sigma in LMCs (Barriers) as lack of top management commitment, lack of training trained professionals, courses and providers, lack of knowledge and awareness about Six Sigma, and cultural effect of resistance to change. The factors enabling the adoption of Six Sigma in Libyan Manufacturing Companies called as the Enablers were identified as:

- ✓ Sufficiency of time to implement Six Sigma
- ✓ Customers unsatisfied
- ✓ Most heard about Six Sigma
- ✓ Certain about Six Sigma and its benefits to the company
- ✓ Unhappy with the current quality system
- ✓ Six Sigma not costly to their company
- ✓ Sufficiency of financial resources
- ✓ Good communication between all departments in the company
- ✓ Interest in adopting Six Sigma

Research Methodology

Objectives

Though Six Sigma program is a widely used tool for continual improvement, commonly practised in the organisations all over the world. Many small firms are still hesitant to the implementation of Six sigma. This laid the objective of identifying the reasons for which the firms restrict the entry of Six Sigma in their processes.

1. To identify the barriers in the implementation of Six Sigma methodology by the manufacturing firms.

The type of organisation, the work culture, the cultural backgrounds and top management commitments etc. define the level to which the six sigma programs could be established in the firm. But all the reasons or the barriers do not contribute equally in every organisation. This laid the second objective of this research to prioritise or rank the barriers that need immediate attention from the organisation.

2. To quantify and prioritise these barriers based on their intensity of difficulty in implementing them.

Data Collection

The population for this study was the manufacturing sector of Nagpur region. Simple random sampling has been used to build the sample. A total of 35 firms were selected as a part of sample. This comprised of the firm that manufactures defence, explosives, industrial wires, pipes, tanks, automobile, farm, and construction equipments, rubber products, printing inks, casting products and abrasives etc. from the selected sample. Fourteen firms did not respond to the questionnaire for the reasons of confidentiality and unavailability time. A total of 21 manufacturing firms responded to the questionnaire thereby contributing to 60% of response rate.

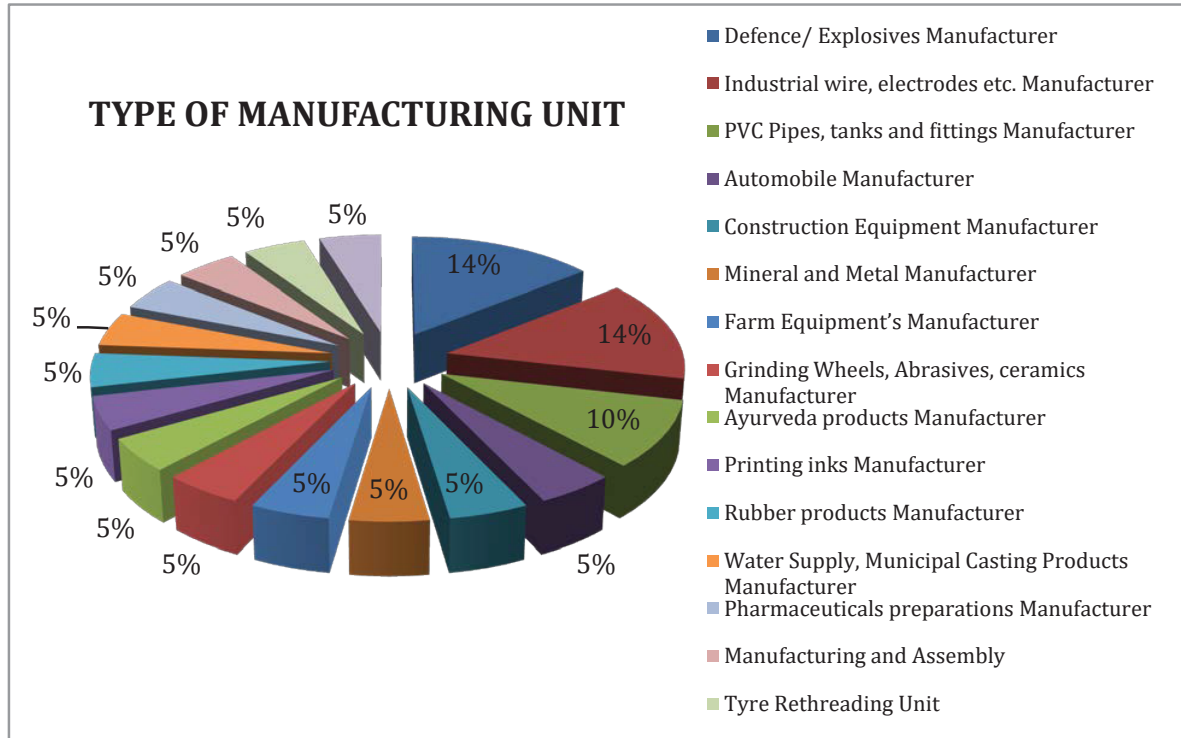


Figure 2: Type of manufacturing unit used for the study

Primary Data Collection Method: A structured questionnaire comprising of 10 barriers to the implementation of Six Sigma practices was designed for primary data collection. These determinants as barriers were put on five point Likert Scale, 1 being never practised and 5 being extensively practised.

Data Analysis

The first phase of this study involved identifying the manufacturing firms that implemented Six Sigma. Thus in this phase, the firms were surveyed for the use of Six Sigma. In the second phase, those firms that did not implement Six Sigma were surveyed. The data revealed that only 10 per cent of the firms implement Six Sigma practices. This data can be subject to some error because of simple random sampling done. Firms that practised Six Sigma revealed that they also find some barriers that cause problems in executing the six sigma projects smoothly in their organisations.

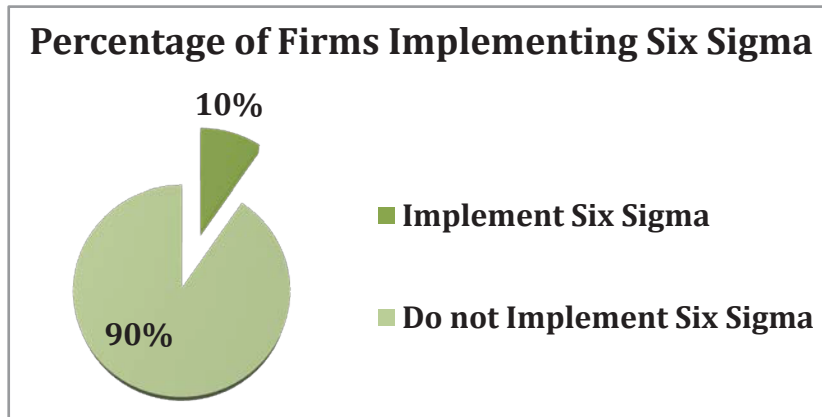


Figure 3: Firms implementing Six Sigma

Table 1 shows the average response of all the respondents of the study. The barriers that were identified were:

1. Lack of Resources (Financial, Human, Time): Small scale firm that has limitations in terms of cost, find it difficult to implement Six Sigma as training to the human resources and certifying them with Six Sigma through the certified organisations is a cost baring process.
2. Internal Resistance to the implementation of Six Sigma: Poor communication, self-interest, lack of skills and attitude elevate the resistance to change by the employees in the organisation.
3. Lack of Leadership from Top Executives and Lack of Knowledge about Six Sigma: To implement Six Sigma and to motivate the employees to certify for Six Sigma requires the top management to understand the real benefits and implementation process. Lack of knowledge and interest from the top management can stand as a hindrance to the implementation of Six Sigma.
4. Insufficient Organisational Alignment: Six Sigma specialists exist at different levels – each with a different role to play. For the execution at project level, there are black belts, master black belts, green belts, yellow belts and white belts. These people conduct projects and implement improvements in projects. Thus a proper hierarchy is maintained in the Six Sigma. This also requires a proper organisation alignment to support the hierarchical levels of the methodology.
5. Cultural Barriers (Professional, Knowledge): Cultural barriers in terms of educational background of the employees and knowledge level also limit the extent of understanding and implementation of Six Sigma.
6. Poor Training and Coaching: Six Sigma follows a process called as DMAIC process. To implement this process, the user must be properly trained to understand the problem area or the areas for continual improvement. Further he must be trained to implement each and every step in sequence and derive proper benefits. Since six sigma is a data driven process, the user must be trained to derive data accurately from the process.

7. Considering Six Sigma too complex to implement: This barrier deals with the misconception of the methodology. As employees are not compatible with quantitative data, deriving quantitative data and analysis of the same may look complex and tedious. This could also result in wrong identification of the process parameters.
8. Poor Six Sigma Project Selection: This barrier deals with identification of wrong project for improvement.

Data Analysis

Here the highest mean (4.33) is observed for the barrier of poor six sigma project selection. Standard deviation is seen highest for poor training and coaching practices, which is 1.12. This indicated diverse and unequal focus on the training and coaching given to the employees of the manufacturing firms in Nagpur.

Table 1: Average responses

Average responses by the firms			
Six Sigma Barriers	Range	Mean	Std. Deviation
Lack of Resources (Financial, Human, Time)	3	3.76	0.83
Internal Resistance	3	3.67	0.8
Lack of Leadership from Top Executives	3	3.71	0.96
Lack of Knowledge about Six Sigma	3	4.19	0.93
Insufficient Organisational Alignment	3	3.43	0.87
Cultural Barriers (Professional, Knowledge)	3	3.57	0.98
Poor Training and Coaching	4	3.48	1.12
Considering Six Sigma too complex to implement	3	3.95	1.02
Wrong Identification of Process parameters	4	4	1.18
Poor Six Sigma Project Selection	3	4.33	1.02

Statement of Hypothesis and its Testing

The determinants or the barriers for the implementation of the Six Sigma practices were identified through the literature review. Through the study of past data relating to the study, it was understood that all the parameters were equal contributors to the non-implementation of the Six Sigma practices. Hence the assumption with which the research work was carried out was that the firms find all the parameters equally important and are moderate in terms of the intensity of impact.

H_0 : The intensity of the barriers to the implementation of Six Sigma is moderate.

For the analysis of this data, the significance level is taken to be 0.05. Using sample data, a chi-square test for independence was conducted. Applying the chi-square test for independence to sample data, the degrees of freedom, the expected frequency counts, and the chi-square test statistic were computed. Based on the chi-square statistic and the degrees of freedom, the P-value was determined.

Table 2: Testing of hypothesis using Chi Square

Six Sigma Barriers	p value	alpha	Null Hypothesis
Poor Six Sigma Project Selection	0.99	0.05	Reject
Lack of Knowledge about Six Sigma	1.00	0.05	Reject
Wrong Identification of Process parameters	0.97	0.05	Reject
Considering Six Sigma too complex to implement	0.74	0.05	Reject
Lack of Resources (Financial, Human, time)	1.00	0.05	Reject
Lack of Leadership from Top Executives	0.99	0.05	Reject
Internal Resistance	0.97	0.05	Reject
Cultural Barriers (Professional, Knowledge)	0.86	0.05	Reject
Poor Training and Coaching	0.70	0.05	Reject
Insufficient Organisational Alignment	0.50	0.05	Reject

$df = (r - 1) * (c - 1) = (10 - 1) * (21 - 1) = 180$, Since the P-value for all the parameters is more than the significance level (0.05), we reject the null hypothesis. Thus, it is concluded that the barriers to the implementation of Six Sigma practices are not moderate but are intense. Since all the p values for the Six Sigma barriers are above the significance level, the barriers are more prominent or intense.

Prioritising the Barriers

The ten barriers identified and their intensity of contribution to the non-implementation of Six Sigma practices in the firms were put in the Pareto Analysis. Pareto analysis works on the principle of 'Vital Few and Trivial Many'. It is assumed that certain barriers are much prominent and need more attention. Identification, analysis and removal of these barriers could aid implementation of Six Sigma. Hence since one objective of this research was to prioritise the barriers, a Pareto chart was constructed.

Table 3: Percentage contribution of the barrier in the non-implementation of Six Sigma

Six Sigma Barriers	Count	Percentage	Cumulative Percentage
Poor Six Sigma Project Selection (Q10)	91	11.4	11.4
Lack of Knowledge about Six Sigma (Q4)	88	11.0	22.4
Wrong Identification of Process parameters (Q9)	84	10.5	32.9
Considering Six Sigma too complex (Q8)	83	10.4	43.3
Lack of Resources (Financial, Human, time) (Q1)	79	9.9	53.1
Lack of Leadership from Top Executives (Q3)	78	9.8	62.9
Internal Resistance (Q2)	77	9.6	72.5
Cultural Barriers (Professional, Knowledge) (Q6)	75	9.4	81.9
Poor Training and Coaching (Q7)	73	9.1	91.0
Insufficient Organisational Alignment (Q5)	72	9.0	100.0

Figure 4 shows the vertical bar chart followed by line chart. This chart is used to segregate the vital items from the many trial items that contribute to a certain effect.

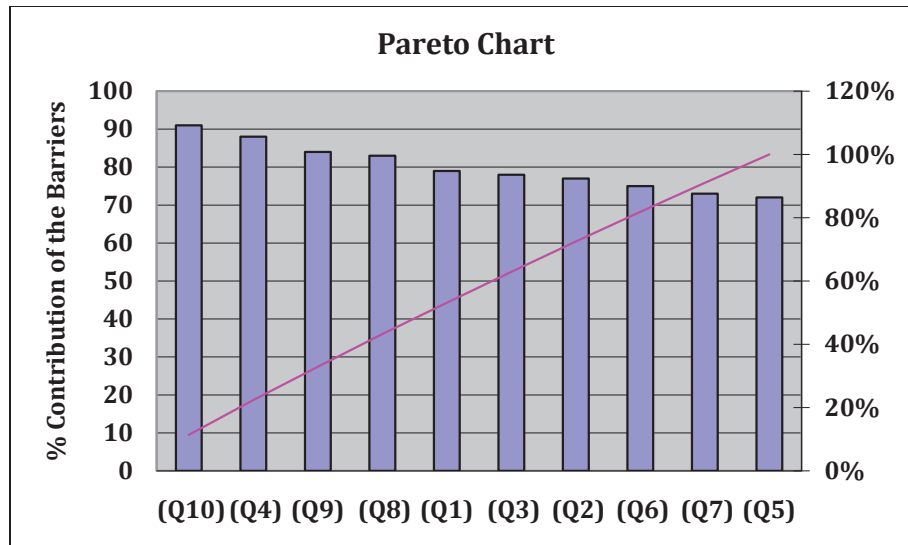


Figure 4: Pareto Chart for barriers to Six Sigma

From all the ten barriers identified, poor selection of Six Sigma project has contributed majorly to the non-implementation while inefficient organisational alignment has contributed least. But since the line chart shows a stiff increase from parameter one to parameter ten, this shows that all components are more or less equal contributors.

Findings

From the data collected from the respondents of the study i.e. the manufacturing firms, following results were obtained in terms of the barriers and their intensity of impact on the non-implementation of Six Sigma.

Lack of Resources (Financial, Human, Time): Implementation of Six Sigma projects require a lot of resources in terms of human, finance and time etc. Human resources who are the part of these projects need training that varies from level to level. There are green belt employees who execute six sigma projects, black belts who are the six sigma leaders and Master Black belts who are leaders to many projects. These belts require lot of training that incurs a lot of cost to the company. Moreover, a concept beyond Six Sigma is lean that thrives to remove all non-value adding activities and also requires a lot of time and money. Since all these resources of any organisation are limited, they prefer not to implement Six Sigma. The average response of 3.76 shows that lack of resources is one important hurdle to the implementation of Six Sigma.

Internal Resistance: Any change in the organisation requires lot of efforts in terms of employee engagement, training etc. The already settled employees at senior level are accustomed to the traditional functioning of the organisation. When some change for good has to be brought in the organisation there is a lot of resistance from the employees. People do not want to change their style of working and move out of their comfort zones. Thus, this barrier was observed to contribute to around 9.65% to the non-implementation of the Six Sigma practices.

Lack of Leadership from Top Executives: Six Sigma is a methodology, an approach to zero defects. It is a plan that starts from the top management and with right communication penetrates to the lower level. But the disinterest or lack of leadership by the top management in leading Six Sigma project hinders its implementation. Six Sigma is said to be a fad in the current manufacturing process and not a real applicable tool of process improvement. Hence lack of leadership from the top executives makes its difficult to implement it in processes. The data reveals that this barrier contributes 9.7% to the obstruction in Six Sigma implementation.

Lack of Knowledge about Six Sigma: Though the concept of Six Sigma has a past origin, most firms are not aware about its actual process. The concept of six sigma, the DMAIC process of Six Sigma, lean Six Sigma, zero defect are not known to small firms. Due to lack of resources, firms do not indulge in understanding the concept or firms also feel that their systems do not require this technique. Organisations that have used six sigma as a short run process have not benefited through it. Hence the management should try to bring complete awareness and clear understanding of Six Sigma methodology through proper training and awareness programs.

Insufficient Organisational Alignment: Implementation of Six sigma follows a top down approach. First the top management is made aware of the methodology and application. Six sigma leaders also form a part of this top management. They lead and orient the bottom levels for the usage of six sigma techniques. Proper flow of guidelines and instructions, monitoring from the top level to the bottom level and frequent and continuous updating of the project from bottom to the top contributes to the success of the project. Any misalignment in this structure may become an obstacle in the proper implementation of Six Sigma. This study shows that this factor also contributes to the barrier but has the least intensity as compared to the other factors.

Cultural Barriers (Professional, Knowledge): Initiatives on Six Sigma entail the requirement of people with right mind set and right attitude towards the organisation. Their professional level and knowledge level define the extent to which they would accept the change with respect to continuous improvement. With a mean response of 3.57 on cultural barrier, it can be understood that it plays a major hurdle in the execution of Six Sigma tool in the organisation.

Poor Training and Coaching: While implementing Six Sigma project, organisation must fully assure the right amount of training being provided to the six sigma employees. There are different levels or belts that define the extent of understanding and ability of implementation of six sigma project in the organisation. Poor training and coaching to the employees have contributed 9.1% to the barrier in the implementation of Six Sigma practices in the organisation.

Considering Six Sigma too complex to implement: Being a data driven and statistical technique, Six Sigma is misunderstood by many organisations as complex and difficult to implement. Considering Six Sigma a tool that requires a lot of mathematical, statistical data and analysis, companies avoid using or implementing it. Moreover, the awareness about Six Sigma is still less among the Indian firms. This creates a reason for non-implementation of Six Sigma with around 10.4% contribution in total.

Wrong Identification of Process parameters: Critical to Process (CTP) are the key process input variables. These are the process parameters which influence other critical approaches, Critical to Quality (CTQ) and Critical to Cost (CTC). Six sigma projects have this critical to process concept as an essential element. The performance level of CTP should be at such a level that it should meet the requirements of the customer. They harmonize improvement or design efforts in tune with customer requirements. This right identification of the process parameter

like the customer requirement stands very important. This study shows that this constraint of wrong identification of process parameter contributes to a greater extent to hinder the six sigma implementation.

Poor Six Sigma Project Selection: The process of Six Sigma implementation starts with identification of the processes that require quality improvement. Six Sigma is not applied to the organisation as a whole but to different processes within. Hence identification of such processes that need improvement becomes crucial phase. Organisations may fail to understand the area that has scope of improvement. The team must be able to derive statistical data relating to the process, quantify the errors or the defects. If such projects are selected for six sigma implementation that has little or no scope of improvement or those which does not derive enough quantitative data to analyse it, the project selection can become a wrong decision. This study has identified that most of the firms surveyed identified this reason as a major hurdle in the non-implementation of six sigma practices.

Conclusion

As the market is changing rapidly, the customer's definition of quality is changing. It is thus a challenging time for the manufacturers as they must bring the best in quality through zero defects. This has prioritized the application of Six Sigma. And for the organisation to implement Six Sigma, the involvement of top management is of utmost importance. The organisation can work in line with its objective through proper leadership by the top executives. Employees need to be trained to impart excellence in the work. They must be given training, orientation and coaching for implementation of the tools that improve the quality. Organisation must form cross functional teams to discuss on the areas that require improvement thus contributing to identification of right project selection for Six Sigma. This study was a small contribution towards identifying the barriers and the hurdles for practising Six Sigma by manufacturing firms. This work can give an insight to the firms on the importance of six sigma. Prioritizing the barriers can help the firms to put in more efforts towards eliminating those barriers.

Scope for Future Work

This study was limited to the manufacturing region of Nagpur city. Time and other limitations restricted the sample size. This study can further be extended to the manufacturing industries of major cities of the Maharashtra state. This research work can further be extended to study more manufacturing firms that lag in implementing Six Sigma. In those firms that implement Six Sigma, comparative study on the processes of Six Sigma can be studied. This could help identifying the right process for other firms. As Six Sigma is a process of continual improvement and now a days does not limit to manufacturing; this study could also be conducted on the service sector to identify the hurdles in the implementation of this methodology.

References

- A, R., & VR, J. (2013). Barriers for implementation of Six Sigma by Small and Medium Enterprises. *International Journal of Advancements in Research & Technology*, 2(2), 1-7.
- Abdolshah, M., & Yusuff. (2008). Fundamental elements for the successful performance of Six Sigma projects in service industries. Retrieved from <http://www.ep.liu.se/ecp/033/023/ecp0803323.pdf>
- Chaudhari, P. (2012). Key For Implementation Of Six Sigma In Indian Industries. *Journal of Information and Opertion Management*, 3(1), 203-205.