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# Critical Success Factors for Six Sigma implementation by SMEs

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**Abstract**— Six Sigma is a business strategy for improving the bottom line of the businesses. In recent times the small and medium size enterprises also have started adopting the Six Sigma project management approach for improving their effectiveness. In this paper an attempt has been made to explain the critical success factors for implementation of Six Sigma in small and medium scale auto component manufacturing industries.

**Index Terms**— Six Sigma, small and medium indusrties (SME), auto components, critical success factors, business strategy

## 1 INTRODUCTION

Six Sigma is a business strategy that enables organizations to increase their profits by optimizing their operations, improving quality and eliminating defects[4]. It is a work philosophy to achieve, maximize and maintain commercial success by understanding needs of the [12]. Many of the well-known large companies all over the world doing business in different sectors have benefited enormously by adopting Six Sigma business approach.

Six Sigma uses facts and data obtained from measurement of processes with in an organization, not by comparing with some external standard. In other words, it precisely measures what is actually happening with in the production and service processes and determines how to improve them.

Embarking on a Six Sigma program means delivering top-quality products and service while virtually eliminating all internal deficiencies [14]. Apart from reduction of defects in manufacturing, Six Sigma also makes support processes to get rid of errors and inefficiency thus helping all the stake holders of a business like management, customers and employees to a great extent.

There is a perception that Six Sigma is applicable only for large companies possessing better resources. But, Six Sigma is equally applicable for companies of any size if deployment is done with proper thinking and the appropriate considerations. A detailed analysis is essential regarding what are the critical success factors for adopting Six Sigma in small and medium scale industries. Some of the important issues and factors that prove critical for six sigma project management approach in small scale manufacturing industries have been presented here.

## 2 THE NEED FOR SIX SIGMA APPROACH

Quality programs are valuable because they can create a quality perspective and culture. Six Sigma is an overall business improvement initiative rather than just a quality initiative. Six Sigma fixes identifiable, chronic problems that directly impact bottom line of an organization. Six Sigma projects are selected to reduce waste, which translates into lower costs, happier customers and improved bottom line. Six Sigma is not just theory. It defines, measures, analyses, improves and controls the vital few processes linking the improvement of quality directly to the bottom-line results.

Six Sigma is not just about statistics but rather based on the scientific method, utilizing statistical thinking [13]. Statistical Thinking is a philosophy of learning and action based on the following fundamental principles:

- all work occurs in a system of interconnected processes
- variation exists in all processes and
- understanding and reducing variation are keys to success

The main concepts in Six Sigma include identifying defects and trying to eliminate them to less than 3.4 defects per million opportunities (DPMO). In the 1990s, Six Sigma became a business-centric system of management. The focus of Six Sigma gradually shifted from product quality to business quality. It was possible to produce defect-free products using lowest cost of production and earn high profit. The world-class companies such as General Electric, Johnson & Johnson, Honeywell, Motorola, and many others adopted Six Sigma and the results accomplished speak for themselves. Six Sigma became a synonym for improving quality, reducing cost, improving customer loyalty and achieving bottom-line results. Though the original goal of Six Sigma was to focus on manufacturing processes, later marketing, purchasing, billing, and invoicing functions were also involved [4].

All companies large and small, share many common features and problems. Large companies, because of scale, may reap higher financial gains as a result of a given breakthrough, but this should not be taken to suggest that small companies would not benefit tremendously from its use – Joseph De Feo, CEO of Juran Institute, USA. Research with some of the leading Six Sigma companies show that their financial gains outweigh the expenses for implementation of Six Sigma.

## 3 SIX SIGMA FOR AUTO COMPONENT MANUFACTURING INDUSTRY SECTOR

The two major constituents of the automotive sector are original equipment manufacturing and auto component manufac-

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turing industries. In view of current trends and prospect of global economic growth all segments of the auto industry have major impetus. So, automotive component manufacturing sector has turned out to be a booming industrial sector. The auto industries offer a wider variety of products and also keep replacing them more frequently. As a result the component suppliers to auto industries, to be effective, should respond to the market-driven issues quickly and effectively. Because of the global competition cost effectiveness is the vital requirement of this sector.

Six Sigma approach since its inception has been usually associated with large OME companies because of their financial strength and manpower resources. Gradually midsize companies have also started adopting this program and reaping financial benefits. Automotive component manufacturing sector also must adopt Six Sigma on priority basis to increase its effectiveness.

Elimination of some of the misconceptions about Six Sigma approach, by educating the auto component manufacturing SMEs about the applicability of Six Sigma for them, is the need of the hour. The most common misconceptions or myths about Six Sigma approach are:

- Six Sigma is applicable to only to large companies
- Six Sigma is a complicated, statistical methodology that is difficult to understand
- You must hire an outside consultant
- You need experts to make it work
- Six Sigma is repackaged Total Quality Management
- Six Sigma is only statistics without real savings
- Six Sigma is just training the people
- Six Sigma is a "magic pill" to fix problems with little effort

The small scale companies that have realized the value of Six Sigma and adopted it are achieving better growth and enhanced savings from the Six Sigma projects.

## 4 Critical success Factors (CSF) for implementation of Six Sigma by SMEs

The success of a Six Sigma implementation effort cannot be taken for granted. Many a times the failures in Six Sigma implementation by companies are due to improper and impractical approach without proper groundwork and planning. In general following are some of the most common critical success factors (CSF) for six sigma implementation which the companies should give proper attention to:

1. Management commitment and participation
2. Organizational infrastructure
3. Cultural change
4. Training
5. Linking six sigma to customers
6. Linking six sigma to financial gains and business strategy
7. Linking six sigma to employees
8. Linking six sigma to suppliers
9. Understanding six sigma methodology
10. Project management skills
11. Project prioritization and selection
12. Leadership for Six Sigma

Let us see how these factors affect the Six Sigma implementation endeavors of small and medium scale companies:

### 4.1 Management commitment and participation

The leadership should be fully committed and supportive of adoption of Six Sigma by an organisation. Due to poor leadership and lack of commitment from senior management, Six Sigma is viewed by some organisations as just a passing management fad which only adds to cost without significant financial gains. But, if the management is genuinely interested in Six Sigma implementation, senior managers should first understand the concepts, benefits and implementation steps of Six Sigma by participating in an overview training of Six Sigma. Once they are convinced, they should encourage and infuse confidence in other people before they venture down this new path. Before a training program for other employees, senior management representatives should address them taking it as an opportunity to give them a commitment of support from management and communicate how important their participation will be towards the success of the program and the business. The selection of projects is in most cases strongly supported or even determined by top management.

### 4.2 Organizational infrastructure

Organisations should be structured by recruiting or selecting the right players for the Six Sigma implementation. Commitment of senior leadership to supply the needed people, money and other resources is vital. Freeing the top talent within the company from other duties to work on new Six Sigma initiatives and supporting them to qualify as Six Sigma specialists is the core strength of the Six Sigma infrastructure. Thus Six Sigma projects would consume a lot of company resources and as a result, though the substantial benefits could be attained by firms of any size, normally only large firms would cope with the Six Sigma endeavors reaping the rich gains.

Small companies lack resources in the form of time and personnel. These organisations tend to have a lean organisation and therefore they find it difficult to appoint a facilitator or co-ordinator for the implementation process. In addition, they also have limited resources to provide internal training. Lack of resources in these aspects leads to a need for a careful analysis of which strategy to use when implementing statistical methods in order to succeed.

Third generation Six Sigma, or simply called Gen III Six Sigma, has changed this scenario considerably by reducing the training and infrastructure needed to get useful results from a Six Sigma project. Gen III has introduced the concept of the White Belt Six Sigma practitioner who facilitates use of Six Sigma in work cells or similar settings. White Belts apply Six Sigma to problems that would not justify the requirement of a Six Sigma Black Belt thus bringing down the cost of implementation.

The other requirements would be necessary software support for utilization of quality tools and effective use of information technology for application of Six Sigma. In the present day scenario the cost of a statistical software package and expertise required for usage of it are quite manageable by SMEs.

### 4.3 Cultural change

One way of achieving Six Sigma success is by changing the mind-set of a company. If a small scale company feels intimidated by the idea of adopting the Six Sigma methodology or it is in any way unsure of its ability to succeed at it, it is not alone. Most of the businesses feel the same way at the beginning. But once they understand and recognize what Six Sigma can achieve for their organization, it's easy to embrace it with confidence and enthusiasm. Establishment should build a culture congenial towards embarking upon on sustainable Six Sigma development projects within the company by providing necessary education and awareness to all the employees.

Adoption of Six Sigma project management approach will lead to the cultural breakthrough in the companies in many areas. Definitely there will be positive effect on culture of the organization. Change in approach is due to introduction of methodical project controlling and creation of a knowledge management concept. It will change the culture in an organized manner by adopting systematic and practical D-M-A-I-C approach towards solving the problems in the system. Basically it will make your organizational goals "SMART".

S= Simple
M= Measurable
A= Achievable
R= Realistic
T= Time bound.

According to Professor Douglas Montgomery, QREI Editorial, 2005, "Six Sigma has perhaps been the most successful business improvement strategy of the last 50 years". The future of Six Sigma depends on keeping it relevant to today's business needs and to continue to enhance and expand the traditional Six Sigma toolkit. As the use of Six Sigma matures, more and more companies begin to use Six Sigma as a culture change vehicle and leadership development tool.

Management of cultural breakthrough that occurs in an organisation, as a result of Six Sigma projects, on a continuous basis and imbibing it as permanent feature across the entire spectrum of the organisation is the most vital responsibility of the organisation.

### 4.4 Training

In order to achieve the set goals, a firm must train their employees as Six Sigma Professionals. These individuals are given different title or certifications, according to the level of knowledge obtained and mastered through training. Some of these terms used are; Champion, Black Belt, Green Belt, Yellow Belt, Master Black Belt, and Sponsor among others. However, training of people which is the most important aspect of Six Sigma implementation is one of the major hindrances for SMEs due to the cost factor. But, as mentioned earlier, the concept of the White Belt Six Sigma practitioner who can facilitate Six Sigma projects in place of a Six Sigma Black Belt would solve this problem to certain extent. Some of the key points regarding training for Six Sigma are:

- Senior executives should participate in a training program designed to enable them to rationally take part in project reviews
- Make the training programs thorough, but don't overwhelm people by excessive training
- The number of people that go through the training process should be optimum
- Training duration should be good enough for the instructor to cover the training volume within the available time
- The training programs should not be a mile wide and an inch deep
- If the ability to apply the learning is not reflected in the project reviews, adjustments in the depth and pace of the training program should be done

### 4.5 Linking Six Sigma to customers

The company should deliver to the client quality products or service at a competitive price. It is fundamentally important to understand what the customer wants and needs and to use this information to guide research and development on existing products or design of new ones. Numerous companies all around the world have achieved this by adopting Six Sigma methodology.

Every Six Sigma project starts with the customers. The focus of the project would be determining the factors that are critical to the customer. Because Six Sigma process is so deeply rooted in customer satisfaction, clients are often consulted during the DMAIC stages of Six Sigma projects. They can give input to the company regarding their expectations from the products or services or what they are willing to pay for. In other words Six Sigma listens to voice of the customer (VOC).

Due to the highly organized process of Six Sigma implementation, the customer will be able to notice changes. Some of the changes eliminate wastes in the production process making maximum use of input materials. When materials are fully utilized, the cost of production will automatically go down. Customers of Six Sigma companies experience firsthand benefits in the form of quality products at good prices.

Another crucial thing is that the Six Sigma methodology tries to eliminate wastage of time in all chains and levels of a business. When products and services are delivered fast, there is a possibility to produce more quantity within the same time frame used previously. The client will feel this difference.

Due to the fact that when the production cost goes down, savings can be passed on to the customer, the relationship between a Six Sigma company and its customer grows and turns out to be more stable. This improves brand and customer loyalty which is the definition for long term success in any business model.

### 4.6 Linking Six Sigma to financial gains and business strategy

Integration of Six Sigma with financial accountability and business strategy is must for success. Six Sigma places a clear focus on bottom line financial results. No Six Sigma project gets approved unless the bottom line impact has been identified. Many projects have reported saving between USD 175,000 up to USD 1 million. In the case of SMEs also bottom line would be the main focus for strong management commitment and support to Six Sigma projects.

Six Sigma is about looking at the fundamental ways in which businesses operate in order to find a better way. Every

part of this process is about improving the service or product a company offers to its customers. Companies should adopt correct business strategies to get out of some of the troubles and the roadblocks on journey to Six Sigma success.

Customer focus is not the only goal of Six Sigma projects as illustrated by some of the studies. The three most frequent measures used to quantify the success of Six Sigma projects are cost, productivity and revenue [7]. For SMEs these factors are more crucial than other reasons like becoming world-class organization, creating better image of product/service, etc.

Many managers may look to Six Sigma as a quick fix tool and hence not sufficiently grasp the 'big picture'. Appropriately deployed, Six Sigma can produce excellent results. Companies should focus on process and believe in increased knowledge of variation and an increased use of statistical tools for quality improvements. They should see the benefit of emphasis on education and training. However, Six Sigma must not exist as a distinct concept; instead it should get integrated with the actual processes.

### 4.7 Linking Six Sigma to employees

The whole philosophy of Six Sigma is that everyone involved strives to achieve perfection by eliminating as many defects as possible and by making their products and services as efficient as possible. So, a company-wide commitment is essential for success of Six Sigma.

Develop a plan to communicate the Six Sigma program to your entire organization. The initial most basic and important things to communicate are:

- What the business goals are
- What Six Sigma is
- How embarking on this journey helps the organization
- How the deployment will be done
- How each employee will be able to participate

As the program progresses, things to communicate are:

- Six Sigma training plans
- Six Sigma Projects – being considered, in progress and completed
- Benefits realized to the organisation
- Impact on customers —sales volume, feedback from customers and increase in number of customers

Make people feel part of the Six Sigma program. Don't let them become bystanders watching from the side-lines. Eventually, the company will need all the employees to participate in the program. They will support projects as team members and propose suggestions for projects. If the program launch makes the general employee population feel left out, it will be difficult to gain its support and contribution when the need arises later on.

Trained and Certified Six Sigma Professionals are defined by belts. A green belt is a part time member who is responsible for improving processes, while a black belt is a full time project manager. BBs will lead the projects, but they will need the assistance of employees with intimate knowledge and experience to help plan and execute the projects. Leave no employee behind.

However, we see a risk that the belt-based infrastructure has a tendency to glorify some people and, hence, not sufficiently support the value of 'everybody's commitment'. Although GE has saved a lot of money through Six Sigma, Eckes [3] thinks that this tendency to glorify a few persons may result in lower overall employee satisfaction. On the other hand, when introducing Six Sigma, some organisations try to include all the staff in the improvement work and avoid glorifying a few [7].

Some companies link Six Sigma projects for rewards/ recognition to employees. Though this may motivate the employees to excel in their work there is also a negative effect of manipulating the benefits, especially financial gains, of Six Sigma projects to the company for the sake of rewards. However, there should be carefully planned incentive programs for the performers for the success of Six Sigma.

### 4.8 Linking Six Sigma to suppliers

In today's world of specialization, there is increased dependence on suppliers to improve the quality of goods or services. A supplier with poor quality becomes a weak link. There is really no choice, but to get the key suppliers involved in Six Sigma implementation. If a company doesn't help its suppliers improve, the quality of the parts, materials, assemblies or services it could be supplying substandard product or services to its customers. Suppliers are really strategic partners in Six Sigma implementation.

### 4.9 Understanding Six Sigma methodology

The idea behind a Six Sigma process is to eliminate defects. A defect is anything that impairs the quality of a product or service. This could be something physical such as the brakes not working in a vehicle, or it could be something that has gone wrong in the process of making a vehicle. Understanding the project-oriented specific requirements and performance capability of a company is most essential for Six Sigma implementation [7].

Six Sigma process uses a number of terms to describe quality approaches for improving the processes used by the companies for delivering products and services. One instance of this is the DMAIC Process which stands for Define, Measure, Analyze, Improve and Control. Each of these steps should be considered by a business when looking at how well their processes operate on a daily basis. This helps decide whether the concerned person or mechanism is achieving what is required for the business.

This perfection can be achieved is by using what are known as quality tools. These help people to look at how their businesses work perhaps at statistical level. There is a very long list of tools that can be used for application of Six Sigma. Some of the most commonly used tools are:

Histogram, Scatter diagram, Run charts, SPC control charts, Process capability analysis, Measurement system analysis, DOE, Taguchi methods, ANOVA, Hypothesis testing, Regression analysis, Non-parametric test e.g. Mann-Whitney Test, Team problem solving tools, Brainstorming, Process flowchart / mapping, Cause and effect analysis, Affinity diagrams, Pareto analysis, 5S Practice, Matrix analysis, Force field analysis, Balanced scorecard, Project charter, Quality function deployment, FMEA, Kaizen, SIPOC PDCA, Poka-Yoke, Benchmarking, Quality costing, Pareto analysis, 5S Practice, Matrix analy-

sis

One should not be under the impression that for effective Six Sigma implementation all the quality tools listed above should be used. The tools to be used for a particular Six Sigma project may vary depending on the problem at hand and the expected solution. So, SMEs should not get frightened by the list instead adopt the most appropriate tools judiciously.

In conclusion, Six Sigma methodology is designed to make people to think about how their businesses and products work. It is about improving customer satisfaction and making better products and services at a lower cost. This will benefit both the business and the customers in the long run!

### 4.10 Project management skills

A well-developed strategic planning system is required to ensure the success of Six Sigma projects. Organizational goal is the starting point. The size and complexity of operations will determine the number of projects one need to complete each year to achieve the desired quality levels by the chosen target date. The quality goals like ppm reduction, achieving a sigma level, achieving a throughput yield, etc. along with the target date will drive the pace of Six Sigma efforts. The most important factor for success of Six Sigma projects is selection of team. The number of projects and the pace will guide the number of BBs required to implement and lead the projects. Finally, the number of BBs in the organization will determine the number of MBBs needed to support them considering the classroom training and other deployment related activities.

Too many programs die when the people on the front line run into barriers or stumbling blocks created by technical issues they don't fully understand. Or the project team thinks it does understand the problem, but its approach fails to deliver the expected results. The effort will be directionless and the project languishes. Eventually the effort is abandoned. Project leaders or BBs will need support from the senior executives or Champions to address organizational issues, but they will also need support to address their technical issues. Empowerment and authority at all levels is crucial for Six Sigma success.

Effective communication on Six Sigma Program is highly essential for success of a Six Sigma project. MBBs are mentors and coaches for the BBs and GBs. The MBBs meet with their BBs on a regular basis to evaluate the status of the current project, the approach that the BBs and team are using and the results of the effort. The MBB is there to provide course correction and help troubleshoot the unexpected problems the team may encounter. This is especially critical during BBs' or GBs' early projects, until they get their feet solidly underneath them.

MBBs are the best and brightest in the company. Choose people who have demonstrated strong leadership skills under critical situations and the ability to be a change agent. You need people who have successfully carried out the responsibilities of a major project and may have also stepped in to troubleshoot problems for others needing help.

Effective tracking of projects and reviews is another key to success of Six Sigma projects. If reviews are conducted on a regular basis, the process keeps the BBs and GBs on their toes to drive the projects to a successful completion and closure. Reviews are not for only to provide the BB with a technical solution. Reviews ensure that the BBs and GBs are correctly following the Six Sigma strategy and methodology and also using proper Six Sigma tools. Questions and comments during the reviews should be constructive and motivate the people to do well.

In case of SMEs the number of MBBs, BBs and GBs may be very small due to the limited resources. Sometime these roles may also overlap to certain extent such that the leader playing a role equivalent to BB may have to don the role of MBB and also GB depending on the team size and the organisational limitations. In very small organisations the projects are run by white belts to cut down the project cost.

### 4.11 Project prioritization and selection

One of the biggest hurdles to the Six Sigma implementation program is correct project selection identifying the right critical to quality characteristics (CTQs). Development of process control, design of experimental concepts and issues relating to product reliability can be easily handled by the larger industries in which resources are available to train the workforce to apply these concepts. But, that does not mean that understanding of the concept of variation, identification of causes of variation and handling of these causes are not important factors for SMEs. These statistical concepts have equally major part to play in SMEs and the application of such principles can be dealt by training and development of the people within the company.

Normal criteria applied by the companies for the Six Sigma project selection are:

- Focus on CTQ
- Financial benefits to the management
- Customer needs and expectations
- Duration of the projects
- Probability of success
- Measurement of response variable
- Easiness of data collection
- Resources required for projects
- Cost of Poor Quality
- Expertise and skills required to carry out the projects
- Bench marking
- Process map of operations
- Strategic grouping of work
- Risk involved in projects, etc.

### 4.12 Leadership for Six Sigma

There is no substitute for smart working and tenacity. Six Sigma is not a magic wand that solves problems automatically if some data collected from processes are entered into a software program. It requires thinking staff with ingenuity and strong analytical skills. Teams should be formed by selecting people who want to be part of the effort. In other words the people for Six Sigma program are selected by pull rather than push or the members are involved because they were drawn to the opportunity rather than forced to participate. Mark Goldstein of Goldmark Consultants Inc. says 'The ambivalence that I have observed in some training classes generally comes from people who were in the room because they were sent against their will. What effort can you possibly expect

from someone who feels that way, especially when the going gets tough? What kind of an ambassador do you think the "I don't want to be here" folks will make as they move about the operations and interact with other employees? Don't waste their time or yours'.

Senior managers should recognise the accomplishments and insights of BBs in the completed phase of a Six Sigma project. Show appreciation for their wins and for their creative contribution. This process builds confidence in the team and promotes learning.

Senior managers should also use the project review process to understand the barriers for Six Sigma implementation. Allow the team to propose solutions and find out how management can offer the solutions such as financial support, manpower and organizational issues.

## 5 Six Sigma is important for SMEs

Rapid changes are taking place in the industry globally. The need of the hour is to make companies think about adopting the Six Sigma approach such that they can improve their effectiveness in all the realistically feasible ways and to the maximum extent possible. The ongoing industrial changes indicate that more SMEs are becoming serious about Six Sigma approach for improving bottom-line of their business. It is very vital for SMEs in the automotive component manufacturing sector to employ Six Sigma methodologies for defects free production and be globally cost effective. Following are some of the opinions of the experts and authors in this field:

It does not matter what type or size of business Six Sigma methodology is applied to – no matter whether it is a 300 employee company or a 10 employee family business, Six Sigma will work as long as you follow the process effectively – Brue, 2006.

Six Sigma is very appropriate for smaller companies too. The Six Sigma strategy works well in billion dollar corporations as well as $50 million privately held companies. In fact, it has been our experience that the results are usually quicker and more visible in smaller companies – Dr Matthew Hu, Vice President of Technology and Innovation, ASI, USA

The integration of Six-Sigma with other methodologies, such as lean Manufacturing, is taking place with Six-Sigma providing the overall deployment and problem solving structure. In the longer term, it will be necessary to integrate Six-Sigma as one component of an overall quality management or improvement system [10].
The greatest barrier to implementation of Six Sigma in SMEs to date has been the way the major Six Sigma training providers have structured their offerings - Snee and Hoerl, 2003

SMEs may have to adopt Six Sigma slightly differently compared to large companies with plenty of resources. Resources used for the Six Sigma projects by SMEs should be optimized at the same time target should be attaining maximum organizational effectiveness. This is possible by customization of the implementation process.

## 6 Conclusion

The main realization the companies need to have is that Six Sigma is not about statistics, but about statistical thinking. Six Sigma as a strategy helps companies to identify and eliminate defects in business processes drastically by focusing on performance characteristics. Unlike other quality management systems, Six Sigma brings financial element into the picture and if implemented properly it helps the companies to improve their return on investments considerably.

If a company is at 3 sigma level the rejections are around 67000 per million and with the adoption of six sigma the rejections would be as less as only 3.4 PPM. The cost benefit ratio would be too attractive to be neglected. But it calls for a lot of expertise on the part of practitioners to run projects effectively and extensive training is necessary to produce any noteworthy results. As a result, though the substantial benefits could be attained by firms of any size, only large firms could cope with Six Sigma endeavors reaping the rich gains.

An attempt has been made here to discuss the critical success factors (CSFs) for implementation of Six Sigma by SMEs. The main idea is to change the common misperception of the SMEs about Six Sigma and encourage them to employ it to reap rich dividends.

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