

# A Review Paper on Six Sigma

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**Abstract**— Six sigma is a concept that was originally developed by Motorola in about 1985. Six sigma is a philosophy, a measure and a method that provides business with perspective and tools to achieve new level of performance in both services and products. In six sigma the main focus is on improvement to increase capability and to reduce waste. This article represents the concept of six sigma in details. Also this paper focuses on the methodology of six sigma(DMAIC) along with factors needed for successful implementation of six sigma methodology.

**Keywords:-** six sigma, TQM, DMAIC.

## I. INTRODUCTION

Improving quality has become an important business strategy for many organizations including manufacturers, distributors, transportation companies, financial services organizations, health care providers, and governmental agencies. Quality is a competitive tool that can result in considerable advantage to organizations that effectively employ its basic principles. A business that can delight customers by improving and controlling quality has the potential to dominate its competitors. Developing an effective quality strategy is a factor in long-term business success.

Quality management has long been established as an important strategy for achieving competitive advantage. Traditional quality initiatives such as statistical quality control, zero defects, and total quality management have been key initiatives for many years. Six sigma can be considered as a recent quality improvement initiative that has gained popularity and acceptance in many industries across the globe.

Six Sigma is a disciplined, project-oriented, statistically based approach for reducing variability, removing defects, and eliminating waste from products, processes, and transactions. The Six Sigma initiative is a major force in today's business world for quality and business improvement. Statistical methods and statisticians have a fundamentally critical role to play in this process.

Six sigma is both the philosophy and the methodology that improve quality by analyzing data with statistics to find the root cause of quality problem and to implement controls.

TABLE I  
SIX SIGMA NUMBERS

Sigma	Defects per million
1	690,000
2	308,733
3	66,803
4	6210
5	233
6	3.4

Statically six sigma refers to the process in which range between mean of process quality measurement and nearest specification limit is at least six times the standard deviation of the process. Six sigma approaches the zero defect with only 3.4 defects per million opportunities (DPMO).

## II. SIX SIGMA DEFINITIONS AND PHILOSOPHY

### A. Six sigma is often defined as:

A quality improvement program with a goal of reducing the number of defects to as low as 3.4 parts per million opportunities or 0.0003%.

This has a number of different meanings and interpretations (Henderson and Evans,2000). Its origin comes from statistics where sigma represents the amount of variation about a process average.

From a business perspective, six sigma may be defined as:

A business strategy used to improve business profitability, to improve the effectiveness and efficiency of all operations to meet or exceed customer needs and expectations (Kwak and Anbari, 2006).

Various other definitions include:

Six sigma is a formal methodology for measuring, analyzing, improving, and then controlling or "locking-in" processes.

This statistical approach reduces the occurrence of defects from a three sigma level or 66,800 defects per million opportunities (DPMO) to a six sigma level of less than 4.0 DPMO (Bolze, 1998).

Six sigma is a comprehensive, statistics-based methodology that aims to achieve nothing less than perfection in every single company process and product (Paul, 1999).

Six sigma is a disciplined method of rigorous data gathering and robust statistical analysis to pinpoint sources of error and ways of eliminating them (Harry and Schroeder, 1999).

Minitab describes six sigma as an information-driven methodology for reducing waste, increasing customer satisfaction, and improving processes, with a focus on financially measurable results (Goh, 2002).

statistical focus of various six sigma definitions reflects its basic philosophy. Six sigma is an operating philosophy that can be shared beneficially by everyone, including customers, shareholders, employees, and suppliers.

Fundamentally, it is also a Six sigma application in services customer-focused methodology that drives out waste, raises levels of quality, and improves the financial performance of organizations to breakthrough levels (Chua, 2001).

### III. SIX SIGMA VS TQM:

At the first six sigma looks very similar to tqm or other quality management approaches. But it is quite different than the TQM. What is new in six sigma? Both tqm and six sigma stress the importance of cross functional design, customer input, design from manufacturability, robust design. The difference is that design for six sigma following the structured method in design the project. Thus the six sigma design process is more prescriptive in nature than TQM.

In TQM the area of process management stresses on clarity of process ownership, less reliance on inspection, statistical process control, total productive maintenance. Six sigma takes a somewhat different action by stressing process improvement through the use of DMAIC or similar routine for improvement.

Training for quality is dramatically different for both tqm and six sigma. In tqm training for all employees is provided in one week tqm course. Six sigma specialists are trained in different courses, differentiated by task.(black belt usually 4 week, green belt usually 2 week.)Customer focus is important element of TQM and six sigma. In both TQM and six sigma customer input is important at two level : the organization and the project level.

### IV. SIX SIGMA METHODOLOGY

#### A. six sigma methodology

Six sigma is a process improvement methodology which includes different phases logically linked with one another. Six sigma methodology is generally described by the acronym DMAIC (Define, Measure, Analyze, Improve and Control) is used for continuous improvement of already existing products or processes [24]. One of the important aspects of six sigma is the involvement, training and reward of employees at all levels of the organization. Champions at the executive levels guide the selection of projects, securing of resources and goal setting for improvement efforts. Employees are given martial arts titles such as Master black belt, Black belt , Green belt, etc., reflecting their training

Table 2 .Six Sigma Methodology.

Six sigma steps	process
<b>Define</b>	Define the requirements and expectations of the customers. Identify the quality problem
<b>Measure</b>	Measure the process to satisfy the customer's need Develop a data collection plan Collect and compare data to determine issues and shortfalls
<b>Analyze</b>	Analyze the cause of defects and variation Determine the variation in process Prioritize opportunities for future improvement
<b>Improve</b>	Improve the process to eliminate variation Develop creative alternatives and implement enhanced plan
<b>Control</b>	Control process variations to meet customer needs Implement the improvements of systems and structure Monitor and control the improved process.

and status in project improvement efforts. Prior to implement six sigma methodology in any organization, it is necessary to establish six sigma team structure to accomplish all the phases of the methodology. The each phase of the methodology is discussed in the following paragraphs.

#### B. Define phase

In the define phase, the goals of the improvement activity are clearly defined. The parameters which greatly influence the goals of the enterprise in respect to quality are called critical to quality (CTQ) parameters. In the process of defining, the goals CTQ are identified through Voice of Customer (VOC). VOC is collected by conducting brain storming sessions among the customers. Project Charter, CTQ flow down and Process mapping are the important tools used in this phase. Project charter is a document stating the purposes of the project. It contains the elements such as business case, problem statement and goal statement. Business case indicates the purpose of the project in which the goals and objectives are established.

The next element is the problem statement which clearly expresses the problem to execute. After establishing the problem statement the six sigma team has to decide the target values by thoroughly observing the past data. These values are mentioned in a statement called Goal statement. Process mapping is the key step in understanding the processes involved in an enterprise. The process map (SIPOC chart) starts with supplying raw materials and ends with the benefits received by the customer

#### C. Measure phase

In this phase past data pertaining to CTQ s is collected. The baseline statistics such as sample mean ( $\mu$ ), standard deviation ( $\sigma$ ) and process capability indices Cp and the Cpk for each CTQ are calculated. The mean is the simple average of the observations in a data set. The Sample mean is determined by adding all observations in a sample and dividing the number of observations in that sample. Standard deviation measures the variability of the observations around the mean. It is equal to the positive square root of variance. The variance also measures the fluctuations of the observation around the mean. The larger is the value, the greater is the fluctuation. The process capability index is an easily understood aggregate measure of the goodness of process performance.

#### D. Analyze phase

In this phase critical analysis is carried out with the help of certain tools such as Fishbone diagram (Cause and Effect diagram) and Pareto diagram. Fishbone diagrams are used to identify and systematically list the different root causes that can be attributed to a problem. Thus, these diagrams help to determine which of several causes has the greatest effect. The main application of these diagrams is the dispersion analysis. In dispersion analysis, each major cause is thoroughly analyzed by investigating the sub causes and their impact on quality characteristics. The Fishbone diagram helps to analyze the reasons for any variability or dispersion. Pareto diagram is useful to reduce the many causes to vital few. The Pareto diagram helps the management to quickly identify the critical areas (those

causing most of the problems) that deserve immediate attention.

#### E. Improvement phase

Failure Mode and Effect Analysis (FMEA) is carried out in this phase to identify the possible types of failures. The objective of conducting FMEA is to anticipate all possible types of failures that could occur. The FMEA tabular form includes parameters such as mode of failure, effects of failure and its severity rating (S), possible causes of failure and their intensity of occurrence (O), current prevention methods, detection column (D), Risk Priority Number (R), recommended actions and Responsible persons. The severity column has an entry designating the severity of the effect for the failure mode, that is, the seriousness of the impact of the particular failure. The occurrence column has an entry designating the likelihood that is the failure will occur. The detection column has an entry designating the likelihood that the detection method is accurately detect the failure. Based on the data observations the team has to decide the entries in the above mentioned columns in the FMEA tabular form by adopting a suitable scale. The Risk Priority Number aids in prioritizing the failure mode with the higher number designating highest priority. The Risk Priority Number is calculated by multiplying the values in the columns of severity rating, intensity of occurrence and detection.

#### F. Control phase

The control phase aims to institutionalize the improvement results from six sigma through documentation and standardization of the new procedures. It includes the setting up of monitoring and process control systems. Control charts are used to monitor the system performance. In the control phase control charts are prepared in respect of CTQs to sustain the quality improvement.

#### V. ELEMENTS FOR SUCCESSFUL IMPLEMENTATION OF SIX SIGMA:

who have implemented six sigma agree that the most important factor for successful implementation is top management support and commitment. Managers must be involved in creation and management of the process management system and also participate in projects themselves. Six sigma should be part of everybody's job including top managers and senior authorities. Without top management support and commitment the true importance will be weakened.

Six sigma is a breakthrough management strategy, because it involves adjustments to the firm's values and culture for its introduction. It also involves change in the organization structure and infrastructure. Usually when important change occurs, people of the organization are afraid of unknown and they don't understand the need for the change. Some organization cultures are fear based. Mistakes are not allowed and usually people from such organization used to hide defects. On the other hand six sigma flourishes in open and safe environments where defects are seen as an opportunity to improvement.

Both manufacturing and service use full time improvement specialist called black belts. Typically these specialist are trained in four weeks of training in hands on experience in improving one or more processes. Many

organizations uses green belt trained employees who have training of two weeks. There are also master black belts who receive extensive training beyond black belt level and whose main responsibilities are to serve as an instructor and to provide technical assistance and mentoring. For each six sigma project improvement team is formed, consist of employees who have knowledge of the process and have had a green belt training. Six sigma uses structured method for process improvement called DMAIC(Define, Measure, Analyze, Improve, Control) method. DMAIC is a closed loop process that eliminates unproductive steps, often focuses on new measurements, and applies technology for continuous improvement.

#### VI. CONCLUSION

The fundamental idea of Six Sigma is that if performance is improved, quality, capacity, cycle time, inventory levels, and other key factors as reduction waste, energy sources and environment will also improve. Thus, when these factors are improved, both the provider and the customer experience greater satisfaction in performing business transactions. Six sigma is an effective way to find out where are the greatest process needs and which are the softest points of the process. Also, Six sigma provide measurable indicators and adequate data for analytical analysis. Definitely six sigma is a powerful methodology that can properly implemented, results with significance savings and improvements.

#### REFERENCES

- [1] Douglas C. Montgomery<sup>1</sup> and William H. Woodall<sup>2</sup>, "An overview of six sigma", international statistical review(2008),76,3,329-346.
- [2] Plecko A, vujica Herzog N, polajnar A, Flnco d.o.o, "An application of six sigma in manufacturing compny." APEM journal ,Advances in production engineering and management(2009).
- [3] Hongbo Wang, "A Review of six sigma approach: implementation ,methodology and future scope."
- [4] K.G. Durga Prasad, K.Venkata Subbaiah, G.Padmavathi, "application of six sigma methodology in an engineering educational institution. " int.j.Emg.Science, 2(2), 222-237. June-2012
- [5] Ayon Chakrabarty and Kay Chuan Tan, "The current state of six sigma application in services"MSQ 17,2
- [6] Nilesh V. fursule, Swati N. fursule, Satish v bansod, "understanding the limits and benefits of six sigma technology." International journal of scientific and research publications, vol-2, issue -1.jan-2012.