

Review Paper on Six-Sigma Technique

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Abstract: Six Sigma techniques have proven to be very successful in maintaining high profitability by product up-gradation and continuous improvement for all company organizations. The rate of growth of fair-size companies and organizations is directly linked to the Six-Sigma methods implementation. Six-Sigma is a term originally introduced around 1985. Six-sigma is a theory, a metric and a process that brings business perspective and opportunities to achieve great performance levels in both products and services. Comprehending the key characteristics, barriers, aspects and weak points of six sigma methods will enable organizations to promote their tactical directions and increase the need for supervision and training. That also generates appropriate possibilities for six sigma projects to be implemented. The main focus in six-sigma is on enhancing capacity and reducing waste. This paper describes in detail the definition of six-sigma. The paper also focuses on the six-sigma methodology along with factors needed to successfully incorporate six sigma methodologies.

Keywords: DMAIC, Six Sigma, TQM, phases of sigma, tactical directions.

I. INTRODUCTION

For many organizations improving quality is becoming an important business practice, including suppliers, retailers, delivery companies, banking and finance organizations, health care providers and government agencies. Quality is a strategic weapon that can offer significant advantage to companies that use its basic principles effectively[1]. A company that can attract customers through quality enhancement and regulation has the potential to overpower its rivals. A factor in long-term business success is implementing a successful quality strategy. It has long been recognized that quality management is an effective technique for gaining comparative advantage. For many years traditional quality initiatives such as quantitative quality control, zero flaws, and total quality management have been key initiatives. Six-sigma can be seen as a new trend for improving quality that has gained attention and recognition in many industries around the globe[2].

Table 1: Six Sigma Numbers

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

Six-sigma is a structured, task-oriented, statistical based approach designed to reduce uncertainty, eradicate errors and eliminate waste from goods, procedures, and transactions. The Six Sigma program is a significant force for quality and business development in today's business world. Statistical methods and statisticians play a fundamental role in this process. Six- sigma is the theory and the technique that improves quality by data analysis with statistics to determine the root cause of the quality issue and applying controls[3].

Statically, six-sigma describes the process where scope is at least six times the standard deviation of the process between the mean of process quality calculation and the closest requirement mark. With only 3.4 defects per million opportunities (DPMO) Six-sigma reaches the zero flaws[4].



Fig. 1: Six Sigma cycle.

1.1. Six-Sigma:

- Demonstrates need to identify possibilities and remove shortcomings as identified by consumers.
- Understands that uncertainty is hampering the ability to provide high quality service.
- Includes decisions based on data and integrates a complete set of quality tools within a powerful structure for effective problem solving.
- Provides highly sustainable cultural infrastructure for beneficial results.
- It promises benefit when applied correctly in operations.

II. SIX SIGMA METHODOLOGIES

Table 2: Six Sigma Methodology

Six Sigma Steps	Process
Define	Define customers' requirements and expectations. Identify problem of quality
Measure	Measure the method to satisfy the needs of the customer Create a data collection strategy Monitor and analyze data to identify problems and shortcomings
Analyze	Analyze the cause and nature of the defects. Determine method variations. Prioritize future growth prospects
Improve	Improve the process to eliminate variation Develop creative alternatives and implement enhanced plan
Control	Control process variations to meet customer needs Implement the improvements of systems and structure Monitor and control the improved process.

Six-sigma is a technique for continuous improvement which includes various phases that are logically connected to each other. The six sigma approach is generally described by the acronym DMAIC (Defining, Measuring, Analyzing, Improving and Control) which is used to continuously improve existing products or processes[5]. One of the main aspects of six-sigma is employee commitment, motivation and compensation at all levels of the company. Executive level champions direct project collection, capital securing and goal setting for enhancement efforts. Employees receive karate titles such as Master Black belt, Black belt, Green belt, etc., reflecting their training in implementing six sigma methodologies in any organization, it is necessary to set up six-sigma team structure to accomplish all the methodology level. In the following paragraphs each step of the technique is discussed.

- Define phase:** The goals of the improvement project are clearly defined during the defined process. The parameters which have a major influence on the company's quality goals are called parameters critical to quality (CTQ). The CTQ goals are defined in the description process through Voice of Customer (VOC). VOCs are collected through conducting of brain storming sessions among clients[6]. The key methods used in this phase are project charter, CTQ flow down and process mapping. Project charter is a text defining project objectives. This includes the components such as business case, statement of issue and statement of goal. Business case shows the project's intent in which the goals and priorities are set. The next item is the statement of problem which clearly expresses the problem to be executed. The six sigma team will determine the target values after the problem statement has been identified through careful evaluation of past data. These attributes are described in a declaration called the statement of goal. Method mapping is the key step for an enterprise to understand the processes involved. The method map (SIPOC chart) starts with the raw materials supply and finishes with the benefits the consumer has provided.

- **Measure phase:** Past data relating to CTQs is collected in this phase. For each CTQ, baseline statistics such as sample mean (μ), standard deviation (\bar{y}) and process capacity indices C_p and C_{pk} are calculated. The mean is the simple average of a data set of the observations. The sample mean is calculated by combining all sample observations and dividing the sample number of observations. Standard deviation tests the uncertainty about the mean of the observations. It is equal to the variance of the positive square root. The variance also measures observer fluctuations around the mean[7]. The process capability index is an easily grasped aggregate measure of process performance's goodness.

- **Analyze phase:** Critical analysis in this process is conducted with the aid of certain methods such as Fishbone diagram and Pareto diagram. Fishbone drawings can be used to systematically classify and describe the different root causes that may be related to a problem. Therefore, these diagrams help determine which of many triggers has the most significant effect. The primary use of these diagrams is the study of dispersion. Each major cause is extensively analyzed in dispersion analysis by analyzing the sub causes and their effect on quality characteristics. The Fishbone diagram helps to explain why any variation or dispersion occurs. Pareto diagram is helpful in reducing to critical few the many factors. The Pareto diagram allows the management to easily identify the sensitive areas that require immediate attention (those that cause most of the problems).

- **Improvement phase:** In this phase Failure Mode and Effect Analysis (FMEA) is performed to find possible modes of failures. The purpose of FMEA conducting is to predict all potential types of failures that might occur. The FMEA tabular type includes criteria like type of failure, consequences of failure and its severity rating (S), possible causes of failure and their occurrence rate (O), methods of control, column identification (D), risk importance number (R), suggested measures and persons responsible. The severity column has an item indicating intensity of the impact for the failure mode, i.e., the extent of the impact of the failure in question. The column of the incident has an entry designating the likelihood that the event will occur. The detection column has an entry defining likelihood of failure being correctly detected by detection method. The team has to decide the entries in the above-mentioned columns in the FMEA tabular form based on the data observations by adopting an appropriate scale. The Risk Priority Number helps to assign the failure mode with the top priority number. The hazard priority number is calculated by multiplying the severity ranking, incident rate and detection values in columns[8].

- **Control phase:** The control process seeks to perpetuate effects of the six sigma changes through reporting and standardization of the new procedures. This involves setting up control and computer systems for processes. Control charts are used to track performance of a program. In the control stage control charts are made to sustain the quality improvement with respect to CTQs.

III. SIX-SIGMA AND EDUCATIONAL QUALITY MANAGEMENT

- **Statistical viewpoint:** Six sigma approaches has two primary outlooks. It has its origins in mathematics and statisticians. From statistical perspective, the word six-sigma is defined as having fewer than 3.4 flaws per million possibilities or a success rate of 99.9997 percent where sigma is a term used to define the variety about the average process. This is described as achieving a success rate of 93 percent or 66,800 defects per million opportunities when an enterprise operates at three sigma level for quality control. The six sigma approach is therefore a very robust definition of quality control where a lot of organizations often operate at three sigma level.

- **Business viewpoint:** Six-sigma is known in the business world as a business model used to increase business productivity, enhance the efficiency and effectiveness of all operations to meet or exceed the needs and expectations of customers. The six sigma methodology was first implemented in manufacturing operations and expanded rapidly to other functional areas such as marketing, engineering, buying, servicing, and evaluating the quality of education and administrative support once the advantages were recognized by the organizations. Specifically, the common six-sigma implementations became possible because companies were able to articulate the advantages of six-sigma provided in financial returns by connecting process improvement with cost savings[9].

- **Educational Quality Management:** Education quality in its most common use refers to the extent that an education system is capable of achieving the generally accepted educational goals, central to which is the development of knowledge and skills. Education systems are considered to be of higher quality mostly when students show higher levels of achievement. Improving quality, in many views, involves taking actions that increase the amount learned by the students. Nevertheless, most experts agree that educational systems have multiple goals, many of which go beyond cognitive awareness transfer, such as improving relevant job skills and attitudes that promote civic engagement. Research on the quality of education is typically scarce, and the reliability of the research is decreasing in many parts of the world. The OECD countries have, however, been trying to reverse this trend for the last eight years. They recognized that good information on education was important to enhancing trade and trade relations and, together, they cooperated in a joint project to improve the quality and reporting of their educational statistics. The number of globally credible education metrics in OECD countries has increased from 36 in 1992 to 51 in 1994, and now covers a wide variety of measures including private spending, wages, and student and public attitudes about education, learning results, and labor market outcomes. Nonetheless, for countries in the MENA region fewer than half of these OECD statistics are available, and those that are accessible are often inaccessible to public access and analysis. It impedes analytical work on educational quality as well as public awareness of success in education, and creates problems for comparison with other parts of the world.

IV. ELEMENTS FOR SUCCESSFUL IMPLEMENTATION OF SIX-SIGMA

Those who have adopted six-sigma believe that top management support and dedication are the most important factor for successful implementation. Managers must be involved in setting up and maintaining the process management program and also be involved in projects themselves. Six-sigma should be part of the process for everyone including top managers and senior officials. Without the support and commitment of the top management the true importance will be weakened. Six-sigma is a revolutionary strategy, because for its implementation it requires changes to the values and culture of the company. It also requires improvement in the structure and infrastructure of the organization [10]. Typically, when there is a significant change, the organization's people are afraid of being unknown and do not recognize the need for change. Some cultures of an entity are based on fear. Mistakes are not allowed and usually people used to conceal faults from such an organization. Six-sigma, on the other hand, thrives in transparent and healthy environments where flaws are seen as an incentive for change.

V. CONCLUSION

The basic idea of Six Sigma is that if output is increased, it will improve quality, power, cycle time, inventory levels and other key factors such as waste reduction, energy sources and the environment. Therefore, both the supplier and the customer experience greater satisfaction in performing business transactions when these variables are improved. Six-sigma is an important way to find out where largest process needs are, and which the process's softest points are. Six-sigma also provides objective parameters and appropriate data for empirical analysis. Six-sigma is certainly a strong approach that can be applied correctly, resulting in savings and changes in importance.

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