

Six-Sigma

Six Sigma is a business management strategy originally developed by Motorola, USA in 1986. As of 2010, it is widely used in many sectors of industry, although its use is not without controversy.

Six Sigma seeks to improve the quality of process outputs by identifying and removing the causes of defects (errors) and minimizing variability in manufacturing and business processes.^[3] It uses a set of quality management methods, including statistical methods, and creates a special infrastructure of people within the organization ("Black Belts", "Green Belts", etc.) who are experts in these methods.^[3] Each Six Sigma project carried out within an organization follows a defined sequence of steps and has quantified financial targets (cost reduction and/or profit increase).^[3]

The term *Six Sigma* originated from terminology associated with manufacturing, specifically terms associated with statistical modeling of manufacturing processes. The maturity of a manufacturing process can be described by a *sigma* rating indicating its yield, or the percentage of defect-free products it creates. A six sigma process is one in which 99.99966% of the products manufactured are statistically expected to be free of defects (3.4 defects per million). Motorola set a goal of "six sigma" for all of its manufacturing operations, and this goal became a byword for the management and engineering practices used to achieve it.

Historical overview

Six Sigma originated as a set of practices designed to improve manufacturing processes and eliminate defects, but its application was subsequently extended to other types of business processes as well. In Six Sigma, a defect is defined as any process output that does not meet customer specifications, or that could lead to creating an output that does not meet customer specifications.^[3]

The idea of Six Sigma was actually "born" at Motorola in the 1970s, when senior executive Art Sundry was criticizing Motorola's bad quality.^[5] Through this criticism, the company discovered the connection between increasing quality and decreasing costs in the production process.

Before, everybody thought that quality would cost extra money. In fact, it was reducing costs, as costs for repair or control sank.^[6] Then, Bill Smith first formulated the particulars of the methodology at Motorola in 1986.^[1] Six Sigma was heavily inspired by six preceding decades of quality improvement methodologies such as quality control, TQM, and Zero Defects,^{[7][8]} based on the work of pioneers such as Shewhart, Deming, Juran, Ishikawa, Taguchi and others.

Like its predecessors, Six Sigma doctrine asserts that:

- Continuous efforts to achieve stable and predictable process results (i.e., reduce process variation) are of vital importance to business success.
- Manufacturing and business processes have characteristics that can be measured, analyzed, improved and controlled.
- Achieving sustained quality improvement requires commitment from the entire organization, particularly from top-level management.

Features that set Six Sigma apart from previous quality improvement initiatives include:

- A clear focus on achieving measurable and quantifiable financial returns from any Six Sigma project.^[3]
- An increased emphasis on strong and passionate management leadership and support.^[3]
- A special infrastructure of "Champions," "Master Black Belts," "Black Belts," "Green Belts", etc. to lead and implement the Six Sigma approach.^[3]
- A clear commitment to making decisions on the basis of verifiable data, rather than assumptions and guesswork.^[3]

The term "Six Sigma" comes from a field of statistics known as process capability studies. Originally, it referred to the ability of manufacturing processes to produce a very high proportion of output within specification. Processes that operate with "six sigma quality" over the short term are assumed to produce long-term defect levels below 3.4 defects per million opportunities (DPMO).^{[9][10]} Six Sigma's implicit goal is to improve all processes to that level of quality or better.

Six Sigma is a registered service mark and trademark of Motorola Inc.^[11] As of 2006 Motorola reported over US\$17 billion in savings^[12] from Six Sigma.

Other early adopters of Six Sigma who achieved well-publicized success include Honeywell (previously known as AlliedSignal) and General Electric, where Jack Welch introduced the method.^[13] By the late 1990s, about two-thirds of the Fortune 500 organizations had begun Six Sigma initiatives with the aim of reducing costs and improving quality.^[14]

In recent years, some practitioners have combined Six Sigma ideas with lean manufacturing to yield a methodology named Lean Six Sigma.

Methods

Six Sigma projects follow two project methodologies inspired by Deming's Plan-Do-Check-Act Cycle. These methodologies, composed of five phases each, bear the acronyms DMAIC and DMADV.^[14]

- DMAIC is used for projects aimed at improving an existing business process.^[14] DMAIC is pronounced as "duh-may-ick".
- DMADV is used for projects aimed at creating new product or process designs.^[14] DMADV is pronounced as "duh-mad-vee".

DMAIC

The DMAIC project methodology has five phases:

- *Define* the problem, the voice of the customer, and the project goals, specifically.
- *Measure* key aspects of the current process and collect relevant data.
- *Analyze* the data to investigate and verify cause-and-effect relationships. Determine what the relationships are, and attempt to ensure that all factors have been considered. Seek out root cause of the defect under investigation.
- *Improve* or optimize the current process based upon data analysis using techniques such as design of experiments, poka yoke or mistake proofing, and standard work to create a new, future state process. Set up pilot runs to establish process capability.

- *Control* the future state process to ensure that any deviations from target are corrected before they result in defects. Implement control systems such as statistical process control, production boards , visual workplaces, and continuously monitor the process.

DMADV or DFSS

The DMADV project methodology, also known as DFSS ("**Design For Six Sigma**"),^[14] features five phases:

- *Define* design goals that are consistent with customer demands and the enterprise strategy.
- *Measure* and identify CTQs (characteristics that are **Critical To Quality**), product capabilities, production process capability, and risks.
- *Analyze* to develop and design alternatives, create a high-level design and evaluate design capability to select the best design.
- *Design* details, optimize the design, and plan for design verification. This phase may require simulations.
- *Verify* the design, set up pilot runs, implement the production process and hand it over to the process owner(s).

Six Sigma Methodology:

There are two types of methodologies followed in all six sigma projects. Their simplicity and ease makes it possible to implement them in any organization. These are as under:

I. DMAIC:

The DMAIC methodology is used for those projects that are targeted to improve the existing business processes. The type of six sigma methodology work on following main steps:

- **Define:** The **Define** phase of **DMAIC six sigma methodology** include: finding the project goals and sub-goals, establishing an infrastructure to meet these goals and project planning to improve functioning.

- **Measure:** This phase includes relevant data collection, preparation of various metrics based on the available data etc. It basically involves measurement of important aspects of the current process etc.
- **Analyze:** In this phase of **DMAIC six sigma methodology**, defects are analyzed to establish the ‘Cause & Effect’ relationships. This step ensures that all factors are considered and determines the root cause of defects in the process.
- **Improve:** This phase make use of data, metrics and analysis done in the above phases. The processes are improved by using better techniques that eliminates the root causes of defects.
- **Control:** This phase includes continuous control and monitoring of process improvement process to assure future products and services with zero defects.

II. DMADV:



The DMADV type of Six Sigma methodology is also known as DFSS ‘Design For Six Sigma’. It targets those projects in an organization that creates new products or process designs. Therefore team working on DMADV type of Six Sigma methodology aims to create product or process that best meets the customer needs.

- **Define:** The Define phase of DMADV methodology determines goals that meet the organization’s business needs and are in accordance with the customer demands.
- **Measure:** This phase of **Six Sigma methodology** works by measuring and identifying the characteristics that are **Critical To Quality (CTQ)**, determine customer needs and specifications, product capabilities, risk factors etc.
- **Analyze:** In this phase alternative processes are designed and analyzed to meet the customer needs. The best design is then selected among them.

- **Design:** The best design chosen from above phases is designed, optimized and planned.
 - **Verify:** In this phase of DMADV Six Sigma methodology, the design performance and its ability to meet customer needs is verified.
-