

Six Sigma - Definition & its Origin

Six Sigma is a data-based methodology to improve performance by reducing variability. It requires thorough understanding of product and process knowledge and is completely driven by customer expectations.

In other words, it is a methodology to achieve 3.4 defects per million opportunities. It can also be used to bring breakthrough improvements in the process. It focuses on the bottom-line and is a proven methodology for problem solving.

Goals of Six Sigma

- To reduce variation
- To reduce defects /rework
- To improve yield /productivity
- To enhance customer satisfaction
- To improve the bottom-line
- To improve top-line
- Shortening cycle-time

Sigma Level Vs. Number of Defects

Sigma Level	Number of defects per Million
2 Sigma	308537
3 Sigma	66807
4 Sigma	6210
5 Sigma	233
6 Sigma	3.4

Evolution of Six Sigma

The need for process improvements and a continuous improvement methodology like Six Sigma came into existence only due to

- rising customer expectations in terms of quality, delivery and cost,
- global competition - Japanese and Chinese threats,
- proven technique for quantum jumps in business results.

In the year 1980, Motorola started facing survival problems due fierce competition from Japanese companies. The CEO of Motorola - Bob Galvin was determined to overcome the competition. He challenged his organization to achieve a ten-fold improvement in performance over a period of five years. To achieve the same, strong emphasis was given to training of employees and also performing global benchmarking.

Bill Smith was a veteran engineer in Motorola and he wrote a research paper on product quality and its performance after delivery to customer. In his report he discovered that the products with fewer non-conformities (high quality) were the ones that performed well after delivery to the customer. It was accepted by everyone but the challenge that came in front of Motorola executives was to develop a solution to tackle this problem.

Mikel Harry having a doctorate from Arizona University worked with Bill Smith in developing a four-phase problem solving approach - Measure, Analyze, Improve and Control. A few years later Bob Galvin launched a long-term quality program called "The Six Sigma Quality Program" in Motorola.

Looking at the success of Motorola, many companies like Texas Instruments, Allied Signal etc started using Six Sigma methodology to bring organization-wide improvements.

In 1990's Jack Welch launched Six Sigma in GE in a big way. He implemented Six Sigma in all areas and ensured that the entire organization participates in the initiative. He changed the performance incentives and made them based on individual's ability and enthusiasm to take part in Six Sigma initiatives. He transformed GE to a state where Six Sigma had become the culture of the organization and not just a methodology for bringing organization-wide improvements.

What is Six Sigma?

Definition of Six Sigma

Six Sigma is not a mere methodology or a quality tool. It is a philosophy i.e. a systematic way of thinking to solve quality problems. **Six sigma involves use of statistics to convert raw data into facts about how the processes of the organization are being run.** The thrust is on creating processes which can replicate the same results over and over again with near 100% predictability.

Variation: The Root Cause of Dissatisfaction

Experts in the field of quality have been fighting variation for decades. It is this variation that can be attributed towards creating inconsistent processes. These inconsistent processes lead to different experiences for different customers. It may even lead to different experiences for the same customer at different times.

Thus variation has a significant monetary impact on the working of the organization. This is because it is the root cause of process deficiencies and dissatisfied customers. It is for this reason that top management of various organizations of the world have systematically tried to remove variation from their processes.

How Variability Conquers Your Organization?

Variability is inherent in every process. It a part and parcel of business, however it needs to be managed with an iron fist. This is because variability in every business process tends to cumulate and the end result is mediocre performance. Consider the case of a hotel. There are many processes in a hotel like checking in, ordering room service, housekeeping and check out.

Here is how minor defects in each of these processes are capable of leaving customers thoroughly dissatisfied and enraged. Let's assume that each of these processes has a 97% efficiency. Therefore out of a 100 cases, only 3 defects will be present. Here is what happens:

Total Number of defects for the hotel: $0.97 \times 0.97 \times 0.97 \times 0.97 = 0.8852 = 88.52\%$

Hence even though each of the processes may be doing pretty well if you look at it from an individual standpoint, the organization is doing badly. Any business where roughly 12% of the customers will have bad experiences predictably cannot be expected to survive for long.

The answer to this challenge that variation poses can be found only in Six Sigma. Six Sigma achieves for 99.99966% accuracy meaning 3.4 defects per million.

Six Sigma: A Systematic Tool to Conquer Variability

The Six Sigma philosophy stems from the belief that statistics and numerical facts can be used to control the quality of manufacturing processes and service organizations.

Six Sigma processes are completely driven from the point of view of the customer. They start by identifying what is important to the customer i.e the critical to quality metrics. The next step is to identify the gaps in the process that are the cause of not being able to meet the CTQ's and as a result causing immense customer dissatisfaction.

The usage of Six Sigma has grown by leaps and bounds. Today almost every major organization in the world is following Six Sigma initiatives and making their processes more controlled and more predictable.

What Six Sigma is Not? - Fallacies about Six Sigma

Six Sigma has really become a management buzzword. A lot of people use it in very different contexts. As a result a variety of meanings have been conjured up for the very simple six sigma process. To simplify matters and to ensure that the readers have an accurate understanding of what the Six Sigma process is not, here is an article listing clearly the hypes and hyperboles that have been used to sell Six Sigma to many multi-billion dollar corporations.

Here are the most common fallacies pertaining to Six Sigma:

- **A Tool for Overnight Transformations:** The Six Sigma effort takes a long time to take root and build. It is not common for consultants to try and sell Six Sigma as humungous savings in the next quarter concept. However any practitioner of Six Sigma knows this is nowhere near the truth. The reason this is misleading is because the true benefits of Six Sigma really sink in after the development of a Six Sigma culture. This obviously required a lot of training as well as conditioning. It is for this reason that companies that are planning to undertake Six Sigma programs must know that they are time consuming.
- **Not Achieved by a Small Team:** Another fallacy on similar lines is to send a small team of management for a six sigma training and ensuring that the entire organization will be transformed into an epitome of efficiency. While it is true that managers are the key pillars that drive the success of six sigma initiatives at any organization, they are not the only ones that are responsible for the results. Six Sigma is consciously cultivated at various levels of the organization. There should be a planned program to ensure that the Six Sigma mindset is being passed on from manager to subordinate all the way till the shop floor. This is a time consuming process, however it is the only way to be successful.
- **Training Does Not Guarantee Results:** There are many organizations that fall prey to consultants who sell them over-priced six sigma training for their employees. Training is an essential part of the Six Sigma

transformation but Six Sigma is not a college exam. Six Sigma needs side by side implementation experience. The correct way is to have trainings that are interspersed with application. This will also ensure that only consultants that will stick for the long term partner with your organization.

- **Not Achieved by Expensive Consultants:** Nothing has stained the holy grail of Six Sigma as much as these self-proclaimed expert consultants. Some of them charge such humungous fees that organizations have started calling Six Sigma as Sick Sigma. Six Sigma is an internal initiative, consultants can be used to train a few people. However, it requires commitment from the senior management to ensure that the organization is adhering to a Six Sigma way of life. Many suave talking consultants have fooled corporations into paying millions. Beware!

Understanding Sigma Levels

What Is Sigma?

Sigma or standard deviation is a statistical measure of dispersion in data. It is a measure which uses the characteristic of past data to make judgements about how the process will perform in the future. If a given set of data has normal probability distribution then the number of defects that will occur in the process over a period of time can be known depending upon the sigma level of the process.

What Are Sigma Levels?

The sigma (standard deviation) is multiplied with the numbers 1, 2, 3 etc to come up with a range. For example lets assume that the average of a data set is 10, while the sigma is 2. Hence 1 sigma will include all the data points between 10 ± 2 i.e. between 8 and 12. A 2 sigma measure would include $10 \pm 2(2)$ i.e. all data points between 6 and 14. So on and so forth.

However, it is a known fact that in a normal distribution the points tend to be around the mean. Therefore all the points will be closer to the average. Hence as one goes to farther and farther sigma levels the additional gains in terms of productivity are less.

Observations

- Sigma levels which are less than 3 are not desirable. Companies with less than 3 sigma levels will not be able to survive in a competitive marketplace.
- After Sigma Level 3 the gains are very small. But these gains make a considerable difference to the overall cost of quality as explained in costs of poorly performing processes.

To be a six sigma organization, the processes of an organization must be able to support this kind of efficiency sustainably. Building such robust processes requires a lot of intelligence and effort.

Sigma Level	Defects/Million	Percentage Defects
1	691462	69%
2	308538	31%
3	66807	6.7%
4	6210	0.62%

5	233	0.023%
6	3.4	0.00034%
7	0.019	0.0000019%

Six Sigma Methodology - DMAIC & IDOV

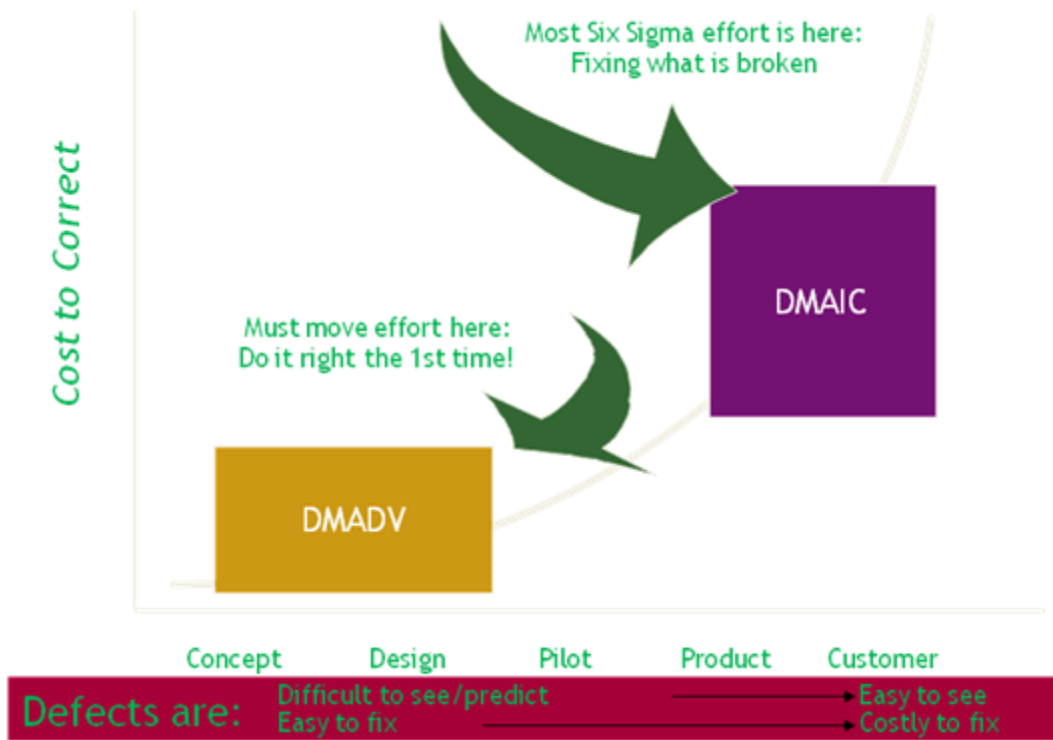
Six Sigma is a process oriented methodology designed to improve business performance by improving specific areas of strategic business processes. There are 2 different methodologies available for carrying out improvements in processes or operations.

Improvements can be of two types: improving the existing process or designing a new process altogether. When we have an existing process and we want to improve the process we deploy the DMAIC methodology. While designing a new process or completely revamping the existing process the Design for Six Sigma or IDOV methodology is deployed.



DMAIC v/s DFSS

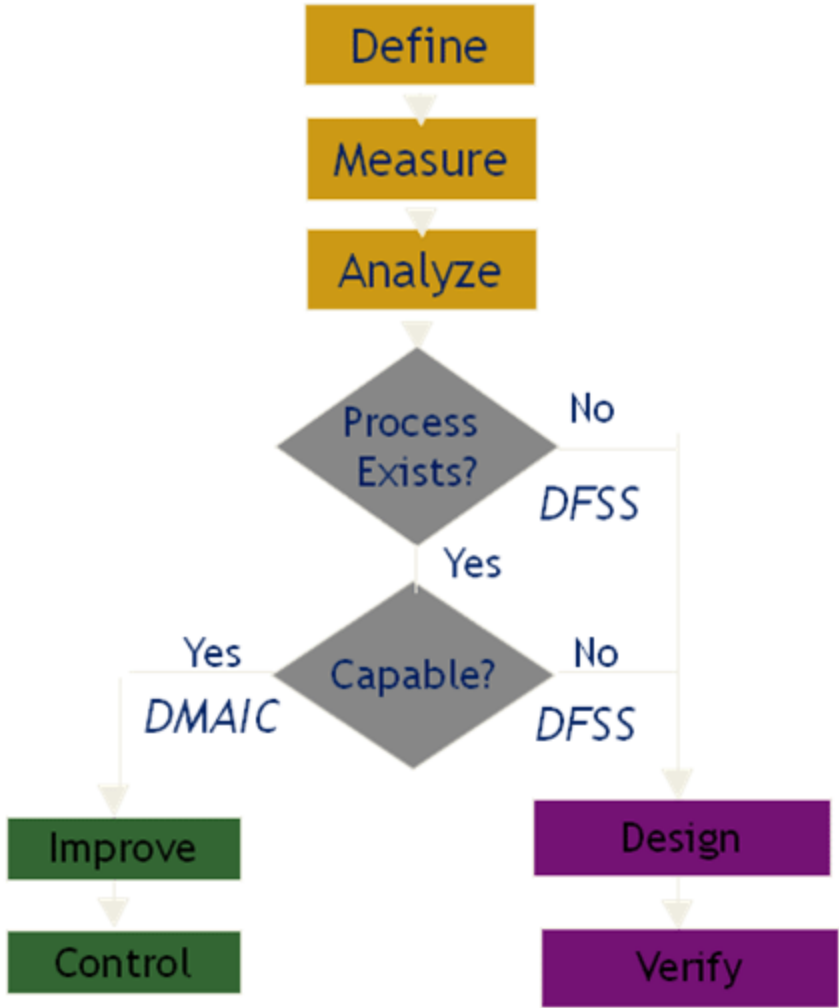
DMAIC	DFSS
Structured and iterative process improvement methodology	Rigorous approach to designing processes that will exceed customer expectations
Focus on defect reduction	Focus on defect prevention



DMAIC Methodology

Define	<p>Define the problem.</p> <p>Define the customer(s) and the requirements.</p> <p>Define the current capability.</p> <p>Define the key processes that will have the greatest impact on customer.</p>
Measure	<p>Identify the statistical measures to monitor the key process.</p> <p>Set up the data collection plan.</p> <p>Measure the process</p>
Analyse	<p>Determine the analysis tools and methods to be used.</p> <p>Summarize the data measured.</p> <p>Run the analysis and determine the root causes, effects, etc.</p>
Improve	<p>Improve and Implement.</p> <p>Focus on developing process/technology to improve the root cause.</p> <p>Test the method on sample process and validate the improvement.</p>

Control	Standardize and document the process and implement the plan. Monitor the process and feedback the results back to the process for continuous improvement.
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DFSS (IDOV) Methodology

Identify	Develop a team. Create team charter. Gather VOC. Perform competitive analysis. Develop CTQs and formally tie design to VOC.
Design	Identify functional requirements. Develop alternative concepts. Evaluate alternatives and select a best-fit concept.

	Deploy CTQs and predict sigma capability.
Optimize	Determine process capability. Develop detailed design elements. Predict performance. Optimize design.
Verify	Test and validate the design. Share feedback with manufacturing and sourcing to improve future manufacturing and designs.

Important Concepts of Six Sigma

Types of Variables

In the equation - $Y = f(X)$, Y is the dependent variable and it is dependent on the variable X. In other words, when there is a change in value of X then value of Y will automatically change. The following are the characteristics of both types of variables:

Y	X
Dependent variable	Independent variable
Output of the process	Input to the process
Effect	Cause
Symptom	Problem
It is monitored	It is controlled

It is important to know that the variable or the factor that we want to improve is a Y or an X. If the variable under control is a Y then we should identify the Xs or the independent variables that affect Y and we should focus on improving the Xs and thereby improving the Y. There could be more one X that influences the Y and we should try to brainstorm along with the team to identify as many Xs as possible and then perform Pareto analysis or other prioritization tools to identify the critical Xs that impact our Y.

Customer

Customer is the person (whether internal or external to the organization) who uses the output that the organization produces. A customer could be

1. Internal to organization - Employees, other departments
2. Intermediate - person or department who uses the output to perform some operations on the output
3. External - People outside the organization who actually use the output to satisfy their needs

Customer Requirements

Customer requirements can be defined as the needs of the customer and his expectations from the output that the organization is producing and delivering. When the organization is able to meet all the customer requirements then it will lead to Customer Satisfaction. On the contrary, if the organization is unable to meet the customer requirements then the customers will be dissatisfied and over the period of time they will turn away from the organization's product. Customer requirements are also called Voice of the customer - "VOC".

Tools for identifying Customer Requirements

1. Customer one to one interview
2. Customer complaints - past history
3. Surveys
4. Focus groups

While performing the above the following questions should be asked:

- What are our customer's needs?
- What is the Customer's perception on our Process performance?
- How is Process Performance measured by Customer?
- What performance level of the Process does the Customer expect?
- What can we improve upon?

Critical to Quality (CTQ)

CTQ stands for 'Critical to Quality'. In other words it represents the critical requirements of the output. CTQ's could be derived from Customer requirements, Risks, Economics and Regulations. For eg a CTQ could be on-time delivery or accuracy etc. It is very critical to identify and define CTQs appropriately because it depicts the quality parameters that relate to wants and needs of the customer.

VOC to CTQ Conversion

Once we have collected the voice of the customer (VOC) we then will have to arrive at Critical to Quality (CTQ) elements so that the customer requirements can be incorporated into our process and the output can be produced as desired by the customer.

Characteristics of Six Sigma

Six Sigma is a well-known management breakthrough. There is a dearth of experts who have defined the process in their own way and have come up with a long list of characteristics. However, according to us this performs a task of confusing people rather than actually giving them insight into the way Six Sigma actually works. The best way to describe six sigma would be to say that it is process focussed and data driven. At the crux that's what it is, it is the application of statistical methods to ensure quality with consistency. The latter part of the article will explain this better.

The Six Sigma Equation

$$Y=f(x)$$

The simple looking equation mentioned above can be described as the crux of the Six sigma philosophy. The component parts of the equation are as follows:

- Y = Outputs also known as Dependent Variables
- X = Inputs also known as independent Variables
- F = Function of

What the equation is actually saying is that the outputs we receive are the function of the inputs that we give to our process. Hence if we were able to control the inputs with precision, the outputs would also be controlled in a precise manner

Data Driven

Here is how a typical Six Sigma project works:

1. A thorough understanding is reached about the required state of affairs for outputs i.e. the Y's are clearly defined
2. A process map is drawn to understand the process through which X's (inputs) are transformed into Y's (outputs)
3. Statistical methods are used to find out which amongst the inputs has the greatest bearing on the desired state of outputs. Inputs are never equally important, some of them are more important than the other and must be controlled in such a manner.
4. A desired state of affairs is decided in terms of the amount of inputs that should be added to get the desired outputs.
5. A process is created to monitor the inputs being added to the production. Simultaneously outputs are measured to check whether they confirm to the norms which have been agreed upon

Hence **the entire Six Sigma process is dependent upon the use of precise statistical controls. It uses numbers to define the desired state of outputs, the required inputs and whether the process is working as expected.**

Consistency

Along with being process and data driven, the whole Six Sigma philosophy is about being consistent. It is about sustained intensity rather than short bursts of power. Six Sigma focuses on developing the capability to deliver the same results over and over again with zero variance rather than delivering it once. Data is used to find out how the process should function, then numbers are used to keep a track of whether the process is functioning the way it was supposed to.