Six Sigma Methodology

Idea In Short

Six Sigma is a strategic framework for improving value over time by eliminating variances and errors. Six Sigma is also a statistically generated performance target of running with only 3.4 defects per million actions, a goal of near perfection on customer requirements. The process improves as variances and flaws are eliminated, and the quality of the products and services increases as well. Although the primary focus of Six Sigma was statistical process control at first, it has evolved into a management framework. It can be applied to a wide range of corporate activities and difficulties, from strategic planning to operations to customer service, to maximize the impact of your efforts.

Six Sigma is a word that refers to a set of strategies and management tools for improving the efficiency and effectiveness of business processes. It gives statistical methods for identifying faults, determining the reason of an error, and reducing the chances of an error. As a result, Six Sigma fosters a culture of continuous process improvement, allowing companies to offer better products and services to their consumers. The six-sigma framework can trace its origin from the ages of Carl Friedrich Gauss who came up with the concept of the bell-shaped curve which was one of the oldest tools for finding errors. Later, in the 1920s, American physicist Walter expanded upon the concept and postulated that the sigma implied where a process needs improvement. However, the credit to make the concept mainstream goes to the engineers at Motorola. In the late 1980s, the engineers at Motorola realized that the traditional approach of flagging defects per thousand was not quite effective, and decided to flag defects per million products. Motorola, Inc. came up with the idea in 1986. They coined the term "Six Sigma" and developed the entire culture associated with it. Thus, the Six Sigma framework, as we know today, was born. Six Sigma can be used to develop a management system for identifying and eliminating faults in any process in any business. It outlines strategies for increasing the efficiency of a company's structure and the quality of its processes, as well as increasing the company's profitability. The phrase "Six Sigma" comes from the bell curve in statistics, where sigma stands for standard deviation from the mean. As a result, a six-sigma process will have a very low

defect rate. A fault is defined as a failure of a business process or product. A process is considered efficient when it produces less than 3.4 faults per million possibilities. The primary focus of Six sigma is as follows:

- Reduce Variation
- Reduce Defects
- Delighting Customer
- Reduce Cost
- Reduce Cycle Time

Key Principles

Customer focus

Define

The major goal is to provide the most value to customers. As a result, a company must comprehend its consumers' wants as well as the factors that influence sales. It necessitates the establishment of quality standards in response to market or customer needs.

Measure

The SIPOC model encourages teams to examine critical process factors including the process's suppliers [S], the process's essential inputs [I], the process's various functions [P], the process's expected outputs [O], and the process's customer [C] or end-user, who receives the process's outputs. SIPOC is a visual tool that aids in the understanding of the complete process, from beginning to conclusion. It provides useful information on areas where big problems remain. Problems might emerge at the supplier's end, and they can be linked to input specifications or processes and outputs that fail to fulfil customer expectations. A SIPOC table, also known as a SIPOC diagram, is a great way for teams, upper management, and all stakeholders to address problems.

Analyze

The 5 Whys technique is one of the most effective tools for root cause analysis. Every team faces roadblocks in its daily work. However, using the 5 Whys will help you find the root cause of any problem and protect the process from recurring mistakes and failures.

- Why didn't the newsletter arrive on time? The updates were not implemented until after the deadline had passed.
- Why weren't the updates rolled out on time? Because the new features were still being worked on by the developers.
- Why were the new features still being worked on by the developers? One of the new developers was unfamiliar with the processes.
- Why wasn't the new developer up to date on all of the procedures? He had not received sufficient training.
- Why wasn't he properly trained? Because the CTO feels that new staff do not require extensive training and should learn on the job.

Improve

Kaizen events are frequently implemented as part of a larger lean manufacturing strategy. Lean manufacturing is a vital procedure that assists a facility in reducing waste and increasing efficiency. When done correctly, a company can save money and increase safety, benefiting all aspects of the business. It is vital to identify and eliminate waste in order to establish a lean manufacturing facility. Sometimes, a simple process modification is all that is required to eliminate waste. A Kaizen event can be a fantastic answer when something more complex is required. Process changes, training, physical changes or standardization are the most important techniques of Kaizen events.

Control

Visual controls are a subset of the larger concept of visual management. Visual management is a process by which information is conveyed via visual means rather than aural, written, or any other ways people communicate. A visual control is intended to direct a person to a specific action. They are different from visual displays, which are intended simply to share information without a hint of the action that is needed. Some common visual controls include Andon lights, strobe lights, instructional signage, and floor markings.

Mapping the value stream

Define

The main purpose is to give clients the best value possible. As a result, a business must understand both its customers' desires and the factors that drive sales. It necessitates the

implementation of quality standards in response to market or consumer requirements.

Measure

Time study is an organized method of directly monitoring and measuring human work with a timing device in order to determine the time required for a qualified worker to complete the work at a specified level of performance. It follows the basic technique for measuring systematic work. The work is broken down into little, easily measurable components or pieces. Those components' measurements, and to arrive at a time for the entire job, synthesis from those measurable components is used. The observer first undertakes preliminary observation of the work (a pilot study) to identify suitable elements which can be clearly recognized on subsequent occasions and are of convenient length for measurement.

Analyze

By grouping potential causes into smaller categories, a cause-and-effect diagram investigates why something happened or might happen. It can also be used to highlight how relevant variables are connected. It's also known as a fishbone diagram or an Ishikawa diagram, and it's one of the Seven Basic Tools of Quality. One of the reasons cause and effect diagrams are often known as fishbone diagrams is that the full diagram resembles a fish skeleton, with the fish head to the right and the bones branching off to the left.

Improve

5S was created in Japan, and the original "S" terms were in Japanese, so English translations for each of the five steps may vary. The basic ideas and the connections between them are easy to understand, though.

Step Name	Japanese term	Meaning
Sort	Seiri (tidiness)	Remove unnecessary ite area
Set in order	Seiton (orderliness)	Organize and identify stora use
Shine	Seiso (cleanliness)	Clean and inspect each ar
Standardize	Seiketsu (standardization	Incorporate 5S into stan procedures

Sustain	Shitsuke (discipline)	Assign responsibility, trac continue the cycle

Control

Standard Work provides a framework for formally facilitating and recording the small changes that drive continuous improvement, and by extension, incrementally raise standards across the board. It serves as a baseline for setting goals and defining key performance indicators (KPIs), adds structure, discipline, and consistency to processes, and provides clarity around roles and responsibilities.

Focus on Lean

Define

Once the problem has been identified, necessary changes are to be made to the process to remove flaws or activities from the supplied process that do not add value to the customer. Various tools are employed to detect problem areas and outliers if the value chain is unable to reveal the problem area. This helps reduce bottlenecks.

Measure

Things are dynamic from an agile standpoint. Every iteration, the product owner must prioritize the backlogs based on the needs and outcomes. As a result, a tool can help speed up the procedure while also providing reliable findings. As the name implies, it is a matrix representation that prioritizes backlogs by taking into account a variety of contributing factors. A prioritization matrix, in short, is a tool that helps the product owner and team to prioritize their tasks.

Analyze

Regression analysis is a set of statistical methods used for the estimation of relationships between a dependent variable and one or more independent variables. It can be utilized to assess the strength of the relationship between variables and for modelling the future relationship between them. Regression analysis includes several variations, such as linear, multiple linear, and nonlinear. The most common models are simple linear and multiple linear. Nonlinear regression analysis is commonly used for more complicated data sets in

which the dependent and independent variables show a nonlinear relationship.

Improve

SMED (Single Minute Exchange of Dies) is a LEAN Manufacturing technique that cuts the time it takes to change equipment down to single digit minutes. The reduction in changeover time enables a more efficient and, as a result, typically less expensive procedure, freeing up more focus and resources for the development of other vital items. SMED can be used to change mechanical processes as well as human processes. The loss of Muda, Mura, and Muri, as defined by Lean, is one of the three key regions. SMED deals with all three types of waste, although the removal of Mura is the main focus (unevenness).

Control

A training requirement is a quality or qualification that you must have in order to be allowed to do something or to be suitable for something.

Include stakeholders in the process

Define

All stakeholders should collaborate and contribute to finding solutions to complicated situations through a disciplined procedure. The team must master the approaches and principles that will be used. As a result, specialist knowledge and training are necessary to reduce project failure risks and guarantee that processes run smoothly.

Measure

MSA (Measurement System Analysis) is a mathematical and experimental approach of determining the amount of variation present in a measurement process. Variation in the measuring procedure can have a direct impact on the total variability of our process. MSA is used to certify a measuring system's accuracy, precision, and stability before it may be employed. The following are examples of sources of variation in a measurement process:

- Personnel – operators, skill levels, training, and so on.
- Tools- Gages, fixtures, and test equipment used, as well as their accompanying calibration systems

- Items to be measured – the part or material samples measured, the sampling plan, etc.
- Environmental factors – temperature, humidity, etc.

Analyze

A root cause is a component that contributed to a nonconformance and should be eradicated permanently through process improvement. The root cause is the most fundamental problem—the most fundamental reason—that puts in motion the entire cause-and-effect chain that leads to the problem (s). Root cause analysis (RCA) is a word that refers to a variety of approaches, tools, and procedures used to identify the root causes of problems. Some RCA approaches are more directed toward uncovering actual root causes than others, while others are more general problem-solving procedures, and yet others just provide support for the root cause analysis core activity. RCA is a reactive process, which means it is carried out after an event has occurred. However, once a root cause analysis is completed, it acts as a proactive mechanism since it can predict problems before they occur.

Improve

A workflow management system is an approach for improving how an organization's processes are structured. A workflow management system can be used to discover the particular causes of problems in your processes if you've noticed that numerous of them are creating delays, customer discontent, supply chain issues, or regulatory noncompliance. After that, you can correct them and improve your efficiency.

Control

Statistical Process Control (SPC) is a method for continuously monitoring, controlling, and optimizing a process. Six sigma is actually a subset of SPC. Control charts and experimental design are commonly connected with SPC. SPC distinguishes between common and assignable causes of variance. Around three targets, the team finds and eliminates assignable-cause variation while reducing common-cause variation. – – qualities such as nominal-is-best, larger-is-better, or smaller-is-better.

Ensuring a flexible ecosystem

Define

When an inefficient or faulty process is abolished, employees' attitudes and work practices must be altered. The efficient implementation of projects can be aided by a flexible and responsive environment to changes in processes. The departments involved should be able to adjust to the change quickly. Companies that evaluate their data on a regular basis and make necessary modifications to their procedures may gain a competitive advantage.

Measure

Process capacity is described as a statistical assessment of a characteristic's inherent process variability. A process-capability study can be used to evaluate a process's capacity to meet specifications. A capability estimate is frequently created at the start and completion of a quality improvement programmed, such as Six Sigma, to reflect the extent of progress that happened. Several capacity assessments are commonly used, including: Potential capability (Cp) and actual capability during production (Cpk) are process capability estimates. Cp and Cpk show how capable a process is of meeting its specification limits, used with continuous data. They are valuable tools for evaluating initial and ongoing capability of parts and processes.

Analyze

The analysis of variance (ANOVA) is a statistical method that divides observed aggregate variability within a data set into two parts: systematic components and random factors. Random factors have no statistical impact on the supplied data set, whereas systematic influences do. In a regression research, analysts utilize the ANOVA test to examine the impact of independent factors on the dependent variable.

Improve

A Pull System is a control-oriented system that responds to indications indicating that additional production is required. A pull system is in contrast to the standard push approach used in mass production.

Control

TPM or total productive maintenance is a method that helps users to improve processes, production quality, and quality systems by utilizing diverse machines, people, processes, and equipment. TPM's primary purpose is to integrate equipment into corporate processes. In some circumstances, equipment adds value to a company. The business's worth is diminished without the equipment. As a result, we can see that TPM's true purpose is to predict certain unplanned downtimes and reduce or eliminate them entirely.

The Six Sigma Methodology

The six-sigma framework utilizes one of the two approaches, DMAIC approach, under which we first define, measure, analyze, improve and the control the processes or the DMADV approach. The fundamental differences between the two processes are highlighted in the table below.

DMAIC	DMADV
It aims at improving the existing processes	It aims at developing new processes that efficient than the existing ones.
It is a corrective method	It is a preventive method
It uses quantitative statistical tools	It uses qualitative tools like KANO model
It is a short-term approach.	It is more long-term oriented.
Control systems are established with DMAIC in order to keep check on the business' future performance	Here, a suggested business model mus simulation tests to verify efficacy.

DMAIC Methodology

Define

Under this phase, we aim to define the processes that need to be followed, in specific and unambiguous terms. The definition is arrived at by including all the stakeholders, so that frequent changes can be prevented.

Measure

We look at the process objectively and try to come up with a source of problem that is data driven.

Analyze

This phase helps us to look up at the data obtained in measure process and come up with theories that can pin-point at the reason for the problems. The cause of the problem that is identified in this stage is used in next phase.

Improve

It focuses on generating solutions that can be used to overcome the problems. The solutions that are generate in this phase links brainstormed solutions to the needs of the customers.

Control

The phase aims at implementing the solution in a manner that the problem doesn't arise again, and the process can be further improved with time.

DMADV Methodology

DMADV is a Six Sigma framework that focuses on the creation of a new service, product, or process rather than the improvement of an existing one. Because of its data-driven foundation, early detection of success, and extensive analysis, this approach – Define, Measure, Analyze, Design, Verify – is extremely useful when adopting new strategies and projects.

Define

The first phase's objectives are to determine the project, process, or service's purpose, to define and then set realistic and measurable goals from the organization's and stakeholder(s) viewpoints, to create the review schedule and guidelines, and to identify and assess any risks.

Measure

The next step is to assess the critical to quality factors, or CTQs. The following steps should be taken: defining needs and market segmentation, identifying crucial design parameters, creating scorecards to evaluate the design components that are most relevant to quality, reassessing risk, and evaluating the production process and product capability. It's crucial to figure out which indicators are most significant to the stakeholder and to translate client

requirements into clear project objectives.

Analyze

Building design alternatives, defining the optimal mix of requirements to achieve value within limits, developing conceptual designs, evaluating and selecting the best components, and finally developing the best possible design will all be done during this phase. During this stage, a cost estimate for the design's overall life cycle cost is calculated.

Design

For the chosen alternative, this step of DMADV involves both a thorough and high-level design. The design's elements are prioritized, and then a high-level design is created. Following this step, a more thorough model will be prototyped in order to identify potential flaws and make necessary changes. Under this we use the following tools:

- Quality Function deployment-A organized strategy for identifying client requirements and translating design specifications or product control characteristics in the form of a planning matrix is known as Quality Function Deployment (QFD) or House of Quality (HOQ). To put it another way, QFD enables for the mapping of consumer desires and technical how-tos, resulting in a deeper grasp of design linkages. Quality Function Deployment (QFD) and House of Quality (HOQ) is a product and service planning approach that begins with the customer's voice.
- FMEA Analysis-A failure mode is a chance for a process to go wrong. Or to look at it another way, it's an opportunity for a defect or variation to occur in a product. Every process has potential weak spots. If we can recognize these in advance, we go a long way towards minimizing the damage caused. That's why FMEA is such a handy tool.
- Brainstorming is a technique for quickly coming up with a big number of innovative ideas. Brainstorming is energizing, goes quickly, and is synergistic, resulting in a wide list of ideas that can later be boiled down, or funneled down, to a smaller list of priority topics. It is to be used when a wide range of choices is sought, when you want to come up with new ideas or when a complete team's participation is requested.
- Design of experiments (DOE)- is a branch of applied statistics concerned with the planning, execution, analysis, and interpretation of controlled tests in order to

determine the factors that influence the value of a parameter or combination of parameters. DOE is a versatile data gathering and analysis tool that may be applied to a wide range of experiments.

It allows for the manipulation of many input elements in order to determine their impact on a desired outcome (response). DOE can identify crucial interactions that might be missed when experimenting with one component at a time by altering several inputs at the same time. All potential combinations can be studied (full factorial) or simply a subset of the possible combinations can be investigated (partial factorial).

Verify

The team validates that the design is acceptable to all stakeholders in the final phase. To assure the greatest possible quality, several pilot and production runs will be required. Expectations will be validated here, the deployment will be broadened, and all lessons learnt will be recorded. A plan to transfer the product or service to a routine operation is also included in the Verify step, as is ensuring that the change is sustainable.

Two perspectives of the Six Sigma Framework

Six Sigma from a business viewpoint

Six sigma is defined as a "business strategy used to improve business profitability, improve the effectiveness and efficiency of all operations to meet or exceed customer wants and expectations" in the business world. Once firms understood the benefits, the six-sigma approach was quickly expanded to other functional areas like as marketing, engineering, purchasing, service, and administrative support. The widespread adoption of six sigma was made possible in part because firms were able to define the benefits of six sigma in terms of financial returns by tying process improvement to cost savings.

Six Sigma from a statistical viewpoint

The term "six sigma" is derived from statistics and statisticians. From a statistical, probabilistic, and quantitative standpoint, Six sigma is described as having less than 3.4 errors per million opportunities or a success rate of 99.9997 percent from a statistical standpoint, where sigma is a term used to represent variation about the process average/ mean. When a company operates at the three-sigma level for quality control, it means it has

a 93 percent success rate or 66,800 defects per million opportunities. As a result, the six sigma approach is an extremely strict quality control system.

Major Six Sigma Tools

Define	Measure	Analyze	Improve	Control
Customer demand	SIPOC	5-Whys	Kaizen Event	Visual cont
Value stream mapping	Time studies	Cause-effect diagram	5S	Standard w
Project charter	Prioritization matrices	Regression analysis	SMED	Training requiremer
Communication plans	MSA studies	Root cause analysis	Workflow improvement	Procedures
CTQ issues	capability studies	ANOVA	Pull systems	Control pla
Business results	Videotaping	Multivariable analysis	DOE	SPC
Benchmarking	Collecting data	Hypothesis testing	TOC	TPM

Scope of Application of Six Sigma framework

The framework aims to address issues faced by most manufacturing businesses such as reduction in idle time, which can be achieved by up to 10–20%, high-defect rates, which can mitigated by up to 8–10%, large non-value added time which can be reduced by around 30–40%, considerable lead time reduction up to 20–30% and cycle time in which reduction was in the range of 10–18% and unmanageable inventory. A close attention of these issues will help in understanding and resolving the major issues faced by most manufacturing businesses. Though the framework is mostly used in manufacturing processes, it can be used almost anywhere, such as in financial accounting to reduce the cycle time to close the books, in personal lives to implement a long pending change, in human resource departments to improve the hire time of an employee or in sales to reduce the set-up time to set up a new customer.

Case Study - Ericsson

The following case study was carried out at one of the Ericsson Group's production plants in Bors (Sweden). Together with the production facility's senior management, a project for improvement was identified. The decision was made to investigate the MINI-LINK production line's assembly and testing operations (push system). The DMAIC cycle was

used to start and complete a Six Sigma project. Define: A problem statement was written, as well as a profit analysis. For 98 percent of the products, the lead time was 80 hours. It was possible to generate a simulation of a fair value for future lead times. At least five business objectives would be enhanced at a reasonable cost, according to the simulations. If the number of products in process is decreased to a tolerable level, the average lead time for the products will be 20 hours. These justifications are strong enough to justify the project. The enhancement seeks to achieve a 99 percent customer delivery precision. Measure: Following brainstorming and debate on how to discover potential root causes, determine their impact on the process, and how they will be measured. In addition, the calibration consistency of index pairs in line was investigated. Analyze: In order to determine the root causes, the following stage was to assess the components and identify areas that needed to be addressed in the Measure phase. Only one of the five assemblies offered was accurate, according to the study of the order in which the products were assembled. Improve: Following implementation, the number of products in the process was reduced by 50 units. Reducing the number of products in process makes problems in the system more visible, which leads to further improvements, such as stopping picking when the buffer stock exceeds 12 units and asking for assistance when the buffer stock falls below 6 units, which makes the process more robust and flexible. Control: The following Lean philosophy criteria were implemented to improve results over time: continuous (step-by-step) improvement (PDCA cycle), Total Preventive Maintenance (TPM), application of Visual Management System (VMS) three times a day, waste removal, and visualization routines. The goal of this study was to see if the Lean Six Sigma strategy could simultaneously improve flexibility, robustness, cost-efficiency, and agility. The implemented improvement project improved the investigated processes' flexibility, robustness, and cost-effectiveness, bringing them closer to agile. Furthermore, preventive maintenance, continuous improvement, and self-governing teams improved the processes' reliability. A simulated trial demonstrated that a new product family may be added to the production process without increasing the overall lead time. Increased production levels need the addition of an extra shift, which is not an issue because the workers are familiar with each other's routines. The result shows that the Six Sigma strategy is suitable for making processes more flexible, robust, and cost-efficient.

7. Advantages

- It adds value to the organization by improving its quality or production.
- The framework is data driven and as such it is easy to monitor and implement.
- The structured nature of the framework makes it easy to track.

8. Disadvantages

- Due to its rigid structure, the framework is notorious to introduce rigidity in the organization.
- It is also known to stifle creativity in the organization.
- It can also lead to an increase in overall cost and block new ideas.

Summary

The six sigma framework aims to address the problems in an organization by improving the existing processes or developing a new process. It utilizes a data driven approach to statistically make the errors insignificant. Customer satisfaction is the major goal of Six Sigma, and to attain it, many ways are used to improve the performance of a product or business process. DMAIC and DMADV are the basic Six Sigma approaches that can be used in a variety of business situations.