



Six Sigma Methodologies for Quality Improvement in Corporate World

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ABSTRACT

Six Sigma is now an enormous 'brand' in the world of corporate development. Simply, it is a quality improvement methodology. Today, Six Sigma is used as an all-encompassing business performance methodology, all over the world, in organizations as diverse as local government departments, prisons, hospitals, the armed forces, banks and multi-nationals corporations. While Six Sigma implementation continues apace in many of the world's largest corporations, many organizations and suppliers in the consulting and training communities have also seized on the Six Sigma concept, to package and provide all sorts of Six Sigma 'branded' training products and consultancy and services. Six Sigma, is taking over the world.

The most objective way of looking at Six Sigma is to recognize that the Six Sigma methodology essentially provides a framework and importantly a strongly branded corporate initiative for an organization to train its people to focus on key performance areas; understand where the organization wants to go; understand the services that the organization's customers need most; understand and better organize main business processes that deliver these customer requirements; and measure and improve the effectiveness of these processes.

This paper intends to throw light on Six Sigma methodologies successfully implemented by various corporations around the world such as Motorola, Texas Instruments, IBM, AlliedSignal, and General Electric to reduced costs literally by billions of dollars. More recently Ford, DuPont, Dow Chemical, Microsoft and American Express have started working on instituting the Six Sigma methodologies.

So for that, this paper incorporates a conceptual framework of Six Sigma, Six Sigma methodologies, quality management tools and methods used in Six Sigma, Implementation of Six Sigma methodologies in different organizations, namely, Motorola, General Electric, Wipro, Samsung SDI and LG Electronics and several myths and misunderstanding about Six Sigma along with concluding lines.

Key Words: Six Sigma, Six Sigma Methodologies, Quality Improvement Tools, DMAIC, DMADV.

1. Introduction

Six Sigma is now according to many business development and quality improvement experts, the most popular management methodology in history. Six Sigma is certainly a very big industry in its own right and Six Sigma is now an enormous 'brand' in the world of corporate development. Six Sigma began in 1986 as a statistically-based method to reduce variation in electronic manufacturing processes in Motorola Inc in the USA. Today, twenty-something years on, Six Sigma is used as an all-encompassing business performance methodology, all over the world, in organizations as diverse as local government departments, prisons, hospitals, the armed forces, banks and multi-nationals corporations. While Six Sigma implementation continues apace in many of the world's largest corporations, many organizations and suppliers in the consulting and training communities have also seized on the Six Sigma concept, to package and provide all sorts of Six Sigma 'branded' training products and consultancy and services. Six Sigma, is taking over the world.

Interestingly while Six Sigma has become a very widely used 'generic' term, the name Six Sigma is actually a registered trademark of Motorola Inc., in the USA, who first pioneered Six Sigma methods in the 1980's. The original and technically correct spelling seems to be Six Sigma, rather than 6 Sigma, although in recent years Motorola, GE, IBM, Texas Instruments and many others have developed their own Six Sigma logos using the number six and the Greek sigma character σ .

2. Six Sigma- A Conceptual Framework

Six Sigma is a statistical concept that measures a process in terms of defects. Achieving Six Sigma means your processes are delivering only 3.4 defects per million opportunities (DPMO)- in other words, they are working nearly perfectly. Sigma (the Greek letter σ) is a term in statistics that measures something called standard deviation. In its business use, it indicates defects in the outputs of a process and helps us to understand how far the process deviates from perfection.

Millions of processes are always waiting to be improved. Therefore, there are millions of opportunities or chances to improve the processes and the products. Everything that you do opens up the chances for an error to sneak in. The hope of Six Sigma is to lower those chances. Here is a simplified One-to- Six Sigma conversion scale:

Table 1: One to Six Sigma Conversion Table

Long Term Yield (basically the percentage of successful outputs or operations) %	Defects Per Million Opportunities (DPMO)	Process Sigma
99.99966	3.4	6
99.98	233	5
99.4	6,210	4
93.3	66,807	3
69.1	308,538	2
30.9	691,462	1

(Source: Six Sigma, Chapman, Alan.)

From the above conversion table, it can be seen that every time you move up a sigma, it can easily a 20% increase for each sigma level. The processes functioning at one sigma level represents 691,462 defects per million opportunities, which translates to a percentage of non-defective outputs of only 30.854%. That's obviously really poor performance. The process functioning at a three sigma level represents 66,807 defects per million opportunities or delivering 93.3% non-defective outputs. That's much better, but still results in wastage of money and disappointing customers. With a proper dedication a company can move from three sigma to four sigma within 1 year. However, a good rule of thumb is 'the higher your sigma level is- the longer it will take you to reach the next Sigma.

The central idea of Six Sigma management is that if you can measure the defects in a process, you can systematically figure out ways to eliminate them, to approach a quality level of zero defects. So, in short, Six Sigma is several things:

- A statistical basis of measurement: 3.4 defects per million opportunities
- A philosophy and a goal: as perfect as practically possible
- A methodology
- A symbol of quality

Six Sigma is a two-way quality management approach towards achieving zero errors by removing process defects for existing products and by designing varied process flow for new products. From a consumer's point of view, Six Sigma is a highly disciplined process that enables product and service deliveries to a near perfect standard.

3. Six Sigma Methodologies

Six Sigma Methodologies provide the techniques and tools to improve the capability and reduce the defects in any process. 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.

3.1. DMAIC

DMAIC is used for projects aimed at improving an existing business process. The DMAIC project methodology has five phases:

- *Define* the system, the voice of the customer and their requirements 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.

Some organizations add a *Recognize* step at the beginning, which is to recognize the right problem to work on, thus yielding an RDMAIC methodology.

3.2. DMADV or DFSS

DMAIC is used for projects aimed at creating new product or process designs. The DMADV project methodology, known as DFSS (Design For Six Sigma), 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.
- *Design* an improved alternative, best suited per analysis in the previous step.
- *Verify* the design, set up pilot runs, implement the production process and hand it over to the process owner(s).

4. Quality Management Tools and Methods Used in Six Sigma

Within the individual phases of a DMAIC or DMADV project, Six Sigma utilizes many established quality-management tools that are also used outside Six Sigma. The following are the main methods:

- i. 5 Whys
- ii. Analysis of variance/General linear model/ANOVA Gauge R&R/Regression/Correlation/Scatter diagram/Chi-squared test of independence and fits
- iii. Axiomatic design
- iv. Business Process Mapping/Check sheet
- v. Cause & effects diagram (also known as fishbone or Ishikawa diagram)
- vi. Control chart/Control plan (also known as a swimlane map)/Run charts
- vii. Cost-benefit analysis
- viii. CTQ tree
- ix. Design of experiments/Stratification
- x. Histograms/Pareto analysis/Pareto chart
- xi. Pick chart/Process capability/Rolled throughput yield
- xii. Quality Function Deployment(QFD)
- xiii. Quantitative marketing research through use of Enterprise Feedback Management (EFM) systems
- xiv. Root cause analysis
- xv. SIPOC analysis (Suppliers, Inputs, Process, Outputs, Customers)
- xvi. COPIS analysis (Customer centric version/perspective of SIPOC)
- xvii. Taguchi methods/Taguchi Loss Function
- xviii. Value stream mapping

5. Implementation of Six Sigma Methodologies in Different Organizations

Six Sigma is far more than the latest quality trend. Companies that have implemented Six Sigma have achieved outstanding financial results and developed a disciplined, pragmatic plan for improved financial performance and growth.

Companies such as Motorola, Wipro, Texas Instruments, LG Electronics, Samsung SDI, IBM, AlliedSignal, and General Electric have successfully implemented Six Sigma and reduced costs literally by billions of dollars. More recently Ford, DuPont, Dow Chemical, Microsoft and American Express have started working on instituting the Six Sigma methodologies.

5.1. Six Sigma Methodologies in Motorola

Motorola Inc., who first developed the methodology in the mid-late 1980's and who provide extensive Six Sigma training and consultancy services, provide the following:

At Motorola University, Six Sigma has literal, conceptual and practical definitions. According to them, Six Sigma is defined at three different levels:

- As a metric

- As a methodology
- As a management system

Essentially, Six Sigma is all three at the same time.

- a) **Six Sigma as a Metric**- The term "Sigma" is often used as a scale for levels of 'goodness' or quality. Using this scale, "Six Sigma" equates to 3.4 defects per one million opportunities (DPMO). Therefore, Six Sigma started as a defect reduction effort in manufacturing and was then applied to other business processes for the same purpose.
- b) **Six Sigma as a Methodology**- As Six Sigma has evolved, there has been less emphasis on the literal definition of 3.4 DPMO, or counting defects in products and processes. Six Sigma is a business improvement methodology that focuses an organization on:
- Understanding and managing customer requirements
 - Aligning key business processes to achieve those requirements
 - Utilizing rigorous data analysis to minimize variation in those processes
 - Driving rapid and sustainable improvement to business processes.

At the heart of the methodology is the DMAIC model for process improvement. DMAIC is commonly used by Six Sigma project teams and is an acronym for:

- Define opportunity
- Measure performance
- Analyze opportunity
- Improve performance
- Control performance

- c) **Six Sigma as a Management System**- Through experience, Motorola has learned that disciplined use of metrics and application of the methodology is still not enough to drive desired breakthrough improvements and results that are sustainable over time. For greatest impact, Motorola ensures that process metrics and structured methodology are applied to improvement opportunities that are directly linked to the organizational strategy. When practiced as a management system, Six Sigma is a high performance system for executing business strategy. Six Sigma is a top-down solution to help organizations:
- Align their business strategy to critical improvement efforts
 - Mobilize teams to attack high impact projects
 - Accelerate improved business results
 - Govern efforts to ensure improvements are sustained

The Six Sigma Management System drives clarity around the business strategy and the metrics that most reflect success with that strategy. It provides the framework to prioritize resources for projects that will improve the metrics, and it leverages leaders who will manage the efforts for rapid, sustainable, and improved business results.

5.2. Six Sigma Methodologies in General Electric

Six Sigma is a highly disciplined process that helps us focus on developing and delivering near-perfect products and services.

Why "Sigma"? The word is a statistical term that measures how far a given process deviates from perfection. The central idea behind Six Sigma is that if you can measure how many "defects" you have in a process, you can systematically figure out how to eliminate them and get as close to "zero defects" as possible. To achieve Six Sigma Quality, a process must produce no more than 3.4 defects per million opportunities. An "opportunity" is defined as a chance for nonconformance, or not meeting the required specifications. This means we need to be nearly flawless in executing our key processes.

a) Key Concepts of Six Sigma

At its core, Six Sigma revolves around a few key concepts:

- **Critical to Quality:** Attributes most important to the customer
- **Defect:** Failing to deliver what the customer wants
- **Process Capability:** What your process can deliver
- **Variation:** What the customer sees and feels

- **Stable Operations:** Ensuring consistent, predictable processes to improve what the customer sees and feels
- **Design for Six Sigma:** Designing to meet customer needs and process capability

5.3. Six Sigma Methodologies in Wipro

Wipro is the first Indian company to adopt Six Sigma. Today, Wipro has one of the most mature Six Sigma programs in the industry ensuring that 91% of the projects are completed on schedule, much above the industry average of 55%.

Six Sigma in Wipro simply means a measure of quality that strives for near perfection. It is an umbrella initiative covering all business units and divisions so that it could transform itself in a world class organization. At Wipro, it means:

- (i) Have products and services meet global benchmarks
- (ii) Ensure robust processes within the organization
- (iii) Consistently meet and exceed customer expectations
- (iv) Make Quality a culture within.

a) **Implementation of Six Sigma in Wipro**

Wipro has adopted the project approach for Six Sigma, where projects are identified on the basis of the problem areas under each of the critical Business Processes that adversely impacts the business significantly. Wipro has evolved following Six Sigma methodologies:

i. **For developing new processes**

- (i) **DSSS+ Methodology** - Wipro employs DSSS methodology for software development. The methodology uses rigorous in-process metrics and cause analysis throughout the software development lifecycle for defect free deliveries and lower customer cost of application development.
- (ii) **DSSP Methodology**- used for designing new processes and products.
- (iii) **DCAM Methodology**- used for designing for customer satisfaction and manufacturability.

ii. **For Improving Existing Processes**

- (i) **TQSS Methodology** - used for defect reduction in Transactional processes.
- (ii) **DMAIC Methodology** - used for process improvement in Non-transactional process.

iii. **For Reengineering**

- (i) **CFPM Methodology** - used for cross functional Process mapping.

5.4. Six Sigma in Samsung SDI

The First National Quality Prize of Six Sigma was given to two companies. One is Samsung SDI and the other is LG Electronics, which are virtually the leaders of Six Sigma in Korea. Samsung SDI was founded in 1970 as a producer of the black/white Braun tube. It began to produce the color Braun tube from 1980, and now it is the number one company for braun tubes in the world.

a) **Why Six Sigma?**

Since its founding in 1970, it has employed several quality management strategies such as QC, TQC/TPM, TQM/ISO9000 and PI. In 1996, it began PI as the beginning stage of Six Sigma. The necessity of PI and Six Sigma stems from the problems of the company. The problems were in the large quality variations in many products, repeated occurrences of the same defects, high quality costs (in particular, high failure costs), insufficient unified information for quality and productivity, manufacturing-oriented small group activities, and infrequent use of advanced scientific methods. The company concluded that the directions for solving these problems lay in scientific and statistical approaches for product quality, elimination of waste elements for process innovation, and continuous learning system for people. These directions in turn demanded a firm strategy for a complete overhaul, implying a new paradigm shift to Six Sigma.

The definition of Six Sigma in the company is "Six Sigma is the management philosophy, strategy and tool which achieves innovative process quality and development of world number one products, and which cultivates global professional manpower, and a way of thinking and working from the viewpoint of customer satisfaction."

b) **Major implementation of Six Sigma**

- (i) Realization of Champion leadership
- (ii) Project selection and implementation
- (iii) Implementation of DFSS.

5.5. Six Sigma Methodologies in LG Electronics

The Digital Appliance Company of LG Electronics (LGEDA) is another company which received the first national Six Sigma quality prize in 2000. LGE was founded in 1958 under the name of Goldstar, and later became LGE in 1995. LGE consists of three companies: Digital Appliance, Digital Media, and Digital Multimedia. LGE-DA received the first national Six Sigma quality award. The major products of LGE-DA are air conditioners, washing machines, vacuum cleaners, microwave ovens, air compressors, refrigerators and motors. As of 2000, the company had 4,800 employees with total sales of \$2.5 billion. LGE now has 30 different overseas subsidiaries in China, Turkey, England, Mexico, Hungary, India, Vietnam, Indonesia, and other countries.

a) **Six Sigma Roadmap**

The Six Sigma quality initiative at LGE-DA means “total customer satisfaction” with the products and services it provides. In order to achieve total customer satisfaction, the company made the Six Sigma roadmap. Six Sigma is divided into three parts: manufacturing 6σ , R&D 6σ and transactional 6σ .

b) **Six Sigma Focus**

Six Sigma at LGE-DA is customer-focused, process-driven and practically implemented through on-going Six Sigma projects. Six Sigma in this company means the following three things:

- (i) **Statistical process evaluation:** They measure defect rates in all processes and use a quality level in measuring process capability.
- (ii) **Business strategy:** They gain a competitive edge in quality, cost and customer satisfaction.
- (iii) **Management philosophy:** They work smarter based on data analysis and teamwork.

Myths about Six Sigma

There are several myths and misunderstandings about Six Sigma. Few are given below:

- Six Sigma is only concerned with reducing defects.
- Six Sigma is a process for production or engineering.
- Six Sigma cannot be applied to engineering activities.
- Six Sigma uses difficult-to-understand statistics.
- Six Sigma is just training.
- Six Sigma works only in manufacturing settings.
- Six Sigma doesn't include customer requirements.
- Six Sigma is repackaged TQM.
- Six Sigma is an accounting game without real savings.
- Six Sigma is a “magic pill” with little effort.

However, Six Sigma actively links people, processes, and outcomes in a rigorous, adaptable way to get the results. No matter the industry, business, product, or service, it will produce the tangible results for the projects.

6. Conclusion

On the basis of above, it can be concluded here that the statistical methodology of Six Sigma sheds light on existing flaws and their causes after thorough analysis. It emphasizes on experimentation following analysis and redefining the processes and their goals. It breaks the mindset, draws the good result in interconnected activities and reducing fluctuations in processes. It also creates a positive chain reaction within the organization that results in improvement in the quality of the product and process of the organizations.

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