



**INTERNATIONAL JOURNAL OF BUSINESS, MANAGEMENT
AND ALLIED SCIENCES
(IJBMAS)**

A Peer Reviewed International Research Journal

**SIX- SIGMA: A DATA- DRIVEN APPROACH AND METHODOLOGY FOR ELIMINATING
DEFECTS IN ANY PROCESS**

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ABSTRACT

Six - Sigma is a measure of quality that strives for near perfection and a disciplined data driven approach and methodology for eliminating defects (driving towards six sigma standard deviation between the mean and the nearest specification limit) in any process from manufacturing to transactional and from product to service. The statistical representation of six- sigma describes qualitatively how a process is performing. The six sigma DMAIC process (Define, Measure, Analyze, Improve, and Control) is an improvement system for existing processes falling below specification and looking for incremental improvement. The six sigma DMADV process (Define, Measure, Analyze, Design, and Variety) is an improvement system used to develop new processes or product at six sigma quality level. The word sigma is a statistical term that measure how far the given process deviates from perfection. The central idea perceived six- sigma is that if you can measure how many defects are in the process, you can systematically figure out how to eliminate them and get as close to zero defects as possible. And gauge of quality and efficiency and a measure of excellence. In present scenario six-sigma applied as a methodology to accelerate improvement, instead of as a futile exercise in statistics. In this context an attempt has been made to study the Six Sigma Methodology and Tools, Innovation and Implementations.

Six Sigma Methodologies

MAIC was developed, and this evolved into DMAIC, where D stands for define, M stands for measure, A stands for analyze, I stands for improve and C stands for control. Experience shows that D is the essential phase for achieving dramatic improvement quickly, and C is the most critical phase for realizing return on investment in six sigma projects. The define phase requires the implementation of many tools, and the control phase can aid in sustaining improved result, which requires the use of internal controls as well as management involvement. The success of DMAIC methodology depends on working well on the right projects. The right project is the one that has a significant return on investment. Sometimes people get training in six- sigma but cannot find projects or sometimes a company commits to six- sigma but does not allow time to work on projects. Getting projects started is easy; the difficult part is completing and closing those projects. Thus the right first priority is to identify the right projects to work on which will have an impact on the bottom line and generate savings for the business. Several potential projects must be identified and evaluated based on a cost and benefit analysis. A simple measure, like the project prioritization index (PPI), can be used to prioritize projects according to the following equation.

$$PPI = (\text{benefits/cost}) \times (\text{probability of success} / \text{time to complete the project in years})$$

At minimum, the PPI should exceed 2 to ensure a return on investment. Initially one can find many projects with PPI greater than 4 thus making it somewhat easier to realize savings.

Six Sigma Tools

The six sigma methodology incorporates numerous tools. The unique and useful six sigma tools include: KANO'S model to capture customer critical requirements, SIPOC (Suppliers, Inputs, Process, Outputs, and Customers), statistical software for analysis, and Multi-vari analysis for identifying a predominant family of variation or inconsistencies, planned experimentation, and the 4P model to sustain gains. The following table summarizes simple yet powerful tools in the DMAIC methodology:

Phase	Tools
Define	Pareto, process map, Kano's Analysis, SIPOC, CTQ, Project charter
Measure	Cost of quality, DPU, DPMO, Sigma level, Average Range, Standard Deviation
Analyze	Root cause analysis, FMEA, Scatter plot, Visual correlation
Improve	Comparative and full factorial experiments
Control	Process thinking (4P model), Review, Control charts, Scorecard

While utilizing various six sigma tools, the dogma of statistics discourages many practitioners. In most cases in the manufacturing industry (as well as in the service and software areas), a lot of statistics need not be used. Actually by utilizing some commonly-used tests for evaluating process improvement (using the mean or variance, for example), we have extracted the most likely statistics and presented them here in a simplified form.

Six sigma Measurements

The three commonly used measurements are DPU (Defects / errors per unit), DPMO (Defects per million opportunities), and sigma level. The DPU is a unit or the output level measurement. DPMO is the process level measurement, and sigma is a business level measurement. Sigma provides a common theme for the organization and requires a lot of improvement to show a positive change.

The customer cares for DPU, the process engineer needs to know DPMO, and the business needs to know the sigma level. All of these measurements can be used to communicate performance expectations and progress throughout an organization.

The most commonly –used measurement driving improvement in an organization must be DPU. The DPU is converted into DPMO based on the process or product complexity, and the DPMO is transformed into the sigma level for establishing a common performance measurement across all functions in an organization.

Executive understanding of six -sigma

The most critical factor in making a Six Sigma corporate initiative successful is the passionate commitment of leadership. However, passionate commitment must come with the correct understanding of the intent of Six Sigma and with effective executive support of the initiative. To create passionate commitment, leadership must learn certain tools and skills. These tools and skills are listed in table.

Table incorporates 10 tools an executive must become familiar with in order to actively participate in the Six Sigma initiative. With the help of these key executive tools, executives can steer their Six Sigma initiative in the right direction to achieve bottom line results. Otherwise, the Six Sigma implementation will staggeringly crash to the ground.

STRATEGY TOOLS OF SIX -SIGMA

Tool/ Concept	When (Application)
Employee recognition	To inspire dramatic improvement and employee innovation.
Process Thinking	Helps understand business processes and how to lead them for improvement
Six-sigma business scorecard	Learning to achieve improvement in performance and profitability.
Management Review	Monthly feedback to the management team for necessary adjustment to achieve growth and profitability.
Statistical Thinking	Helps in determining degree of adjustment or type os action to be taken.
Six-sigma overview	Decision making, specifically when committing to six-sigma
Pareto principle	When deciding about what to work on first
Process mapping	Identifies disconnects in the business and opportunity for improvement.
Cause and Effect Analysis	Identifies the root cause(s) of problems and remedial actions.
Rate of Improvement	Achieves dramatic process improvement by reducing waste and achieving profitability.

Six Sigma Ideologies

An organization makes the commitment to implement six -sigma. One of the commonly-asked questions is about its effect on the corporate culture. People talk about cultural change, resistance to change, decision making, and Institutionalizing six- sigma. The following table shows the extent of transformation needed at the thinking level in order for six-sigma in various aspects of business organization, to become a way of doing work for achieving excellence and happy customers.

Six- sigma thinking in various aspects

ASPECT	SIX-SIGMA IDEAIOLGY
Management	Quality and time
Manufacturability	Robust design
Variable research	Design of experiments
Process adjustment	Statistical controls
Problem solving	Process based
Focus	Process
Behavior	Proactive
Suppliers selection	Process capability
Decision making	Facts based
Design	Reproducibility
Goal setting	Reach out and stretch
People	Asset and solution
Improvement	Optimization

SIX-Sigma is a methodology, as well as a strategy, to achieve superior performance to become best in class in everything.

Six Sigma Innovations:

Innovation appears to be very much aligned with the intent and expectation of any corporate six -sigma. When emphasizing innovation to achieve six sigma results, one must consider creating a culture for innovation. Innovative ideology must become an integral part of the six sigma initiative and must, therefore, be integrated through implementation and recognition. Every employee in a corporation is capable of being innovative. Bringing out the ability to achieve significant improvement is an expectation that leadership must establish and seek. The intellectual participation of employees must be a leadership mantra. All good leaders see potential in their employees and exploit it as the only way to achieve sustained improvement. Innovations begin with intellectual involvement of employees through ideas. The process of effective implementation and success has been far from satisfactory.

Effective leaders must possess the following four skills to produce a lot of improvement quickly:

- 1) Time management:** A lake of time management skills stalls the execution of any planned activity. Projects planned behind schedule because people like to work on

convenient things instead of important things .people think they are busy but are unable to see any progress.

- 2) **Process thinking:** process thinking relates to the 4P model of the process excellence. The prepare stage is where we identify the inputs necessary to perform the process well. The perform stage is where we take steps to perform tasks involved in a process. The perfect stage is where we compare the process output with the target value. Finally, the progress stage involves learning from the root cause analysis of deviation from the target
- 3) **Statistical thinking:** statistical thinking requires an understanding of random and assignable variation. The random variation is uncontrollable, while the assignable variation occurs because of a specific action. Statistical thinking allows leaders to make a decision based on the understanding of the nature of variation.
- 4) **Innovative thinking:** innovative thinking implies doing things differently. In order to practice innovative thinking, one must possess the process knowledge, be able to experiment with the various possibilities, and see beyond the obvious by stretching the solution to achieve breakthrough improvement. If an organization plans to benefit from a six-sigma initiative over the long term, its leaders must institutionalize innovative thinking throughout the organization.

Incorporating innovation:

While preparing to launch six sigma initiatives, expect to make a significant improvement in performance based on the innovative thinking. Concepts of incremental improvement must be discouraged, because they lead to mediocre solutions and prevent people from realizing the full potential of the initiative. The leadership most identifies and assimilates innovation in to a company's values by determining corporate believes and tactics and creating an environment for innovation. Leaders must also define innovation in the organizational context and develop a corporate strategy for achieving the innovate success. Leaders should establish the expectation and recognition for innovation from employees at all levels. Innovation strategies should include training; communication of expectations and objectives; delineation of the roles of executives, managers and employees; intellectual property management, and commercialization of innovative products or services. Starting innovation at personal level, one can look into the following traits practiced by most innovators:

- A quick system level understanding to speed up the creativity process.
- Unique and thoughtful ways to overcome obstacles or get around constraints.
- The ability to optimize a solution while exploiting many constraints.
- Commitment to the change in paradigm.

Six-Sigma Implementation Plan:

Six-sigma approach is to implement a corporate performance measurement system. An effective scorecard is implemented with inputs such as corporate performance measurements, departmental measurements, a frequent performance reviews, and periodic communication with stakeholders. A well implemented scorecard is a prerequisite to sustain the six-sigma initiative over a long term. Besides the scorecard the leadership must sustain the six-sigma initiative with some exciting changes, energy and activities. The following table provides a good frame work for understanding and implementing the six-sigma initiative well in the organization.

Implementation plan

NEEDS FOR SIX-SIGMA INITIATIVE	PROCESS STEPS
<ul style="list-style-type: none"> • Leadership education • Drivers for six-sigma • Market position • Business opportunities analysis • Qualified resources • Competitive assessment and awareness • Corporate performance 	Commit to six-sigma
<ul style="list-style-type: none"> • Prioritized list of projects • Executive team training • Strategy for implementing six-sigma • Resources for training and mentoring • Measurement of success • Organization chart 	Planning for six-sigma
<ul style="list-style-type: none"> • Corporate performance measurement model • Departmental measurements • Performance review process and frequency • Performance commitment with stakeholders 	Implement performance measurement system for the six-sigma initiative
<ul style="list-style-type: none"> • Competitive compensation information • Commitment to reward and recognize excellence • Commitment to communicate consequences of poor performance • A fair and objective performance review system 	Establish a six-sigma performance driven compensation system
<ul style="list-style-type: none"> • Successful completion projects with significant savings • Innovative solution • Extraordinary effort and results • Recognition process 	Recognize success

<ul style="list-style-type: none"> • Qualified candidates for black belt expertise • Project mentors from successful project teams • Lessons learned 	Develop internal expertise and resources
<ul style="list-style-type: none"> • Scorecard • Continual assessment and renewal 	Monitor and sustain improvement

Conclusion

Six- sigma is designed to accelerate improvement using an integrated and comprehensive approach with an extensive tool. The most important aspect of six-sigma is its ability to channel corporate energy into continually creating value and intellectually engaging employees by challenging them for dramatic improvement. Expecting innovative solutions will lead to innovative employees. Organizations recruit knowledgeable people but are often unable to exploit their knowledge, which is a huge waste with no salvage value.

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