



Research Paper

SIX SIGMA APPROACH: APPLICATION, BENEFITS AND SCOPE

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Six Sigma is an approach that improves quality by analyzing data with statistics. In recent years there has been a significant increase in the use and development of the Six Sigma Approach. This paper reviews some related literatures to describe application, benefits and scope. Understanding of the six sigma method allows organizations to better support their strategic directions, and increasing needs for coaching, mentoring, and training. The Six Sigma method is a complex and flexible system of achieving, maintaining and maximizing the business success. Six Sigma is based mainly on understanding the customer needs and expectation, and responsible approach to managing, improving and establishing new business, manufacturing and service processes.

Keywords: Six Sigma, Quality, Future Research

INTRODUCTION

Six Sigma refers to a process in which the range between the mean of a process quality measurement and the nearest specification limit is at least six times the standard deviation of the process, shown as Figures 1 and 2. The quality management approaches, including Statistical Quality Control, Zero Defects and Total Quality Management, have been key features for many years, while Six Sigma is one of the more recent quality improvement initiatives to gain popularity and acceptance

in many industries. Since its initiation at Motorola in the 1980s, many companies including GE, Honeywell, Sony, Caterpillar, and Johnson Controls have adopted Six Sigma and obtained substantial benefits. Six Sigma is a long-term program. It won't work well without full commitment from upper management.

In recent years, interest from the academic community has increased very fast. Therefore, it is the best time to have an extensive review on the related literatures.

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Figure 1: Illustration of Centered 3 Sigma

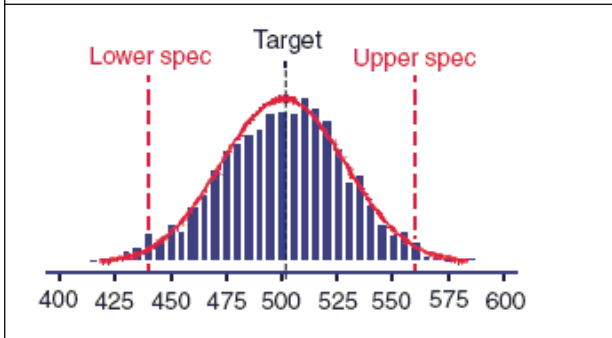
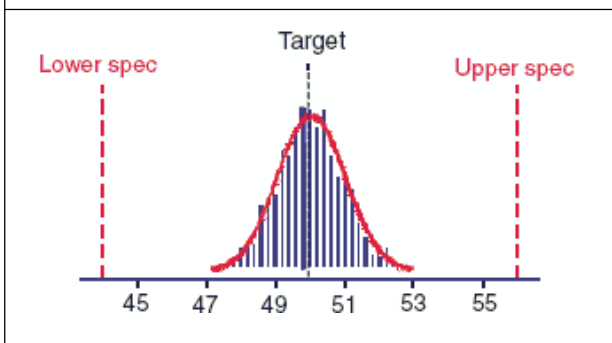


Figure 2: Illustration of Six Sigma process



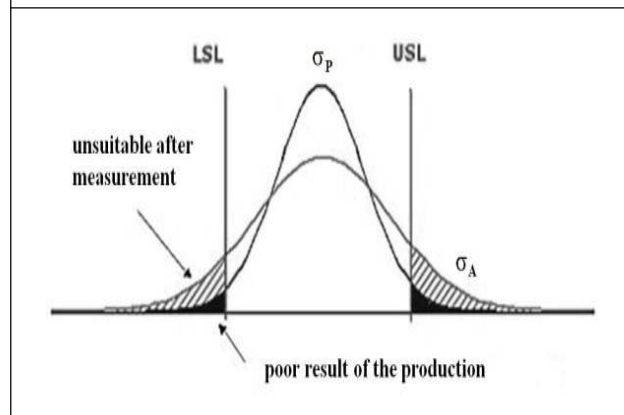
Six Sigma Methods

Six Sigma is based on six basic principles that help the implementation of Six Sigma method to production companies or service industries. Six Sigma uses the base tools to improve the quality of products and processes as Measurement System Analysis (MSA), IPO Diagram (Input-process-output), Cause-and-Effect diagram (CE), Histogram, Pareto diagram, Define, Measure, Analyze, Improve, Control (DMAIC), Run chart, Control chart, Scatter diagram, Regression Analysis, Designing of Experiments (DOE), Failure Mode and Effect Analysis (FMEA), Standard Operating Procedure (SOP) and Quality Function Deployment (QFD).

MEASUREMENT SYSTEM ANALYSIS

Diffusion of the watched commodities' parameter can be connected by the commodity itself or the system of measuring. The system of measuring is made by operator, benchmark and the method of measuring. Measurement System Analysis (MSA) is a tool for the evaluation of accuracy and advisability of the measuring system. It goes with testing or measuring the chosen parameter by the operator. It monitors the influence of repeatability and reproducibility of the total variance. The goal of MSA is to estimate how the system of measuring contributes to the total variance of watched parameter. Most of the time, analysis of the measurement system is used in the phase of Measurements.

Figure 3: Measurement System Analysis



Tolerance = USL – LSL (area of matching values for the customer),

LSL - Lower Specification Limit,

USL - Upper Specification Limit,

$\sigma^2 A$ (absolute) = $\sigma^2 P$ (of product) + $\sigma^2 M$ (of measurement system),

σ^2 – variance

ANALYSIS OF THE CAUSES AND CONSEQUENCES

CE is a tool to solve problems through finding the cause of their occurrence. It helps to find all possible causes, to split causes into categories and organize their relationships and impact on output, and to identify opportunities for improvement. In general, these categories are commonly known as 7 M causes:

- Man -people, job;
- Methods and mechanics, process;
- Machine – machines, equipment;
- Measurement;
- Management - system of organization and management;
- Material; and
- Mother Nature - environment.

HISTOGRAM

Histogram is a perfect tool for visualization of the frequency of the watched phenomenon in process. It is a bar chart made from number of categories, showing their splitting. Customer tolerance can be added (LSL, USL) to watched process.

PARETO DIAGRAM

Pareto diagram is a bar chart for discrete data, indicating the frequency of non digital data. These categories are arranged in descending order. The tool that allows determining the impact of input factors to an endpoint.

DMAIC

It is the common option for the model of improving the process based on Deming's circle Plan-Do-Check-Act (PDCA). DMAIC is in the Six Sigma methodology being used as

the standard routine for planning and implementation of the project.

Reported benefits of implementing six sigma:

MANUFACTURING SECTOR

Motorola was the first organization to use the term six sigma in the 1980s as part of its quality performance measurement and improvement program. Six sigma has since been successfully applied in other manufacturing organizations such as General Electric, Boeing, DuPont, Toshiba, Seagate, Allied Signal, Kodak, Honeywell, Texas Instruments, Sony, etc. The reported benefits and savings are composed and presented from investigating various literatures in six sigma.

FINANCIAL SECTOR

In recent years, finance and credit department are pressured to reduce cash collection cycle time and variation in collection performance to remain competitive. Typical six sigma projects in financial institutions include improving accuracy of allocation of cash to reduce bank charges, automatic payments, improving accuracy of reporting, reducing documentary credits defects, reducing check collection defects, and reducing variation in collector performance .

Bank of America (BOA) is one of the pioneers in adopting and implementing six sigma concepts to stream-line operations, attract and retain customers, and create competitiveness over credit unions. It has hundreds of six sigma projects in areas of cross-selling, deposits, and problem resolution. BOA reported a 10.4% increase in customer satisfaction and 24% decrease in

customer problems after implementing six sigma . American Express applied six sigma principles to improve external vendor processes, and eliminate non-received renewal credit cards. The result showed an improved sigma level of 0.3 in each case. Other financial institutions including, GE Capital Corp, JP Morgan Chase, and SunTrust Banks are using six sigma to focus on and improve customer requirements and satisfaction .

HEALTHCARE SECTOR

Six sigma principles and the healthcare sector are very well matched because of the healthcare nature of zero tolerance for mistakes and potential for reducing medical errors. Some of the successfully implemented six sigma projects include improving timely and accurate claims reimbursement, streamlining the process of healthcare delivery, and reducing the inventory of surgical equipment and related costs .

The radiology film library at the University of Texas MD Anderson Cancer Center also adopted six sigma and improved service activities greatly .Also in the same institution’s outpatient CT exam lab, patient preparation times were reduced from 45 min to less than 5 min in many cases and there was a 45% increase in examinations with no additional machines or shifts .

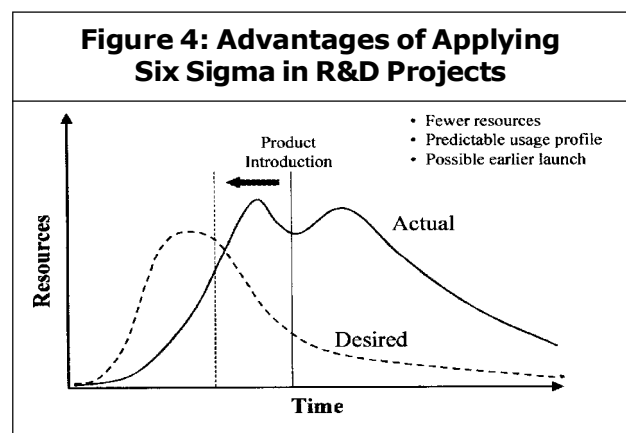
ENGINEERING AND CONSTRUCTION SECTOR

In 2002, Bechtel Corporation, one of the largest engineering and construction companies in the

world, reported savings of \$200 mn with an investment of \$30 mn in its six sigma program to identify and prevent rework and defects in everything from design to construction to on-time delivery of employee payroll. For example, six sigma was implemented to streamline the process of neutralizing chemical agents, and in a national telecommunications project to help optimize the management of cost and schedules .

RESEARCH AND DEVELOPMENT SECTOR

The objectives of implementing six sigma in R&D organizations are to reduce cost, increase speed to market, and improve R&D processes. To measure the effectiveness of six sigma, organizations need to focus on data-driven reviews, improved project success rate, and integration of R&D into regular work processes. One survey noted that as of 2003 only 37% of the respondents had formally implemented six sigma principles in their R&D organization reported that the development and manufacturing of the new prototype at W R Grace (Refining Industry) was cut to 8-9 months from 11-12 months by implementing



the DFSS process. Figure 4 shows the conceptual benefits and improvement of implementing six sigma in R&D projects.

FUTURE OF SIX SIGMA

Six sigma is likely to remain as one of the key initiatives to improve the management process than just being remembered as one of the fads. The primary focus should be on improving overall management performance, not just pinpointing and counting defects. Researchers and practitioners are trying to

integrate six sigma with other existing innovative management practices that have been around to make six sigma method even more attractive to different organizations that might have not started or fully implemented the six sigma method. Integrating and comparing principles and characteristics of six sigma with Total Quality Management, Human Resource Functions, Lean Production, ISO 9000 , ISO 9001, the capability maturity model are all part of the quality community’s effort to maximize the positive effect of the six sigma method.

Table 1: Reported Benefits and Savings From Six Sigma in Manufacturing Sector

Company/Project	Metric/Measures	Benefit/Savings
Motorola (1992)	In-process defect levels	150 times reduction
Raytheon/aircraft integration systems	Depot maintenance inspection time	Reduced 88% as measured in days
GE/Railcar leasing business	Turnaround time at repair shops	62% reduction
Allied signal (Honeywell)/laminates plant in South Carolina	Capacity Cycle time Inventory On-time delivery	Up 50% Down 50% Down 50% Increased to near 100%
Allied signal (Honeywell)/bendix IQ brake pads	Concept-to-shipment cycle time	Reduced from 18 months to 8 months
Hughes aircraft’s missiles systems group/wave soldering operations	Quality/productivity	Improved 1,000%/improved 500%
General electric	Financial	\$2 billion in 1999
Motorola (1999)	Financial	\$15 billion over 11 years
Dow chemical/rail delivery project expenditures	Financial	Savings of \$2.45 million in capital
DuPont/Yerkes plant in New York (2000)	Financial	Savings of more than \$25 million
Telefonica de espana (2001)	Financial	Savings and increases in revenue 30 million euro in the first 10 months
Texas instruments	Financial	\$ 600 million
Johnson and Johnson	Financial	\$ 500 million
Honeywell	Financial	\$1.2 billion

CONCLUSION

The fundamental idea of six sigma is that if performance is improved, quality, capacity, cycle time, inventory levels, and other key factors as reduction waste, energy sources and environment will also improve. Thus, when these factors are improved, both the provider and the customer experience greater satisfaction in performing business transactions.

Successful implementation and growing organizational interest in six sigma method have been exploding in the last few years. It is rapidly becoming a major driving force for many technology-driven, project-driven organizations. Factors influencing successful six sigma projects include management involvement and organizational commitment, project management and control skills, cultural change, and continuous training.

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