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A STUDY AND ANALYSIS SIX-SIGMA METHODOLOGIES IN MANUFACTURING INDUSTRIES

Deepak Bhardwaj[1], Dr. B. Kumar[2]

[1]Research Scholar, Dept of Mechanical Engineering, Sunrise University, Alwar(Rajasthan)
[2] Professor, IEC, Greater Noida (UP)

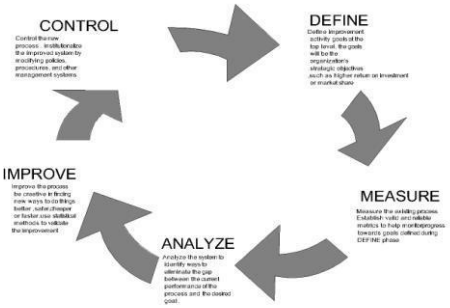
ABSTRACT

In today's highly competitive scenarios the markets are becoming global & economic conditions are changing fast. Customers are more quality conscious & demand for high quality product at competitive prices with product variety and reduced lead-time. Companies are facing tough challenge to respond to the needs of customer while keeping manufacturing & other related costs down .The companies are striving for their very survival. Companies can cut down their costs by reducing the production of defective parts. I used 6 sigma methodologies called DMAIC in the manufacturing industries for the production data analysis to improve the productivity by reducing the defect rate and improving the quality of the product.

RESEARCH/DESIGN/METHODOLOGY

A. DMA IC Roadmap

The DMA IC roadmap is extremely versatile. It has been used to improve performances in companies in virtually every industry and in every department within other companies. From manufacturing and maintenance to marketing and human resources, DMAIC (Define, Measure, Analyse, Improve and Control) is a proven discipline for improving processes. However, the Six Sigma DMAIC roadmap also can help in a company's effort to establish a strategic plan for its business. Developing a strategy is critical for establishing business direction. A great deal of work goes into developing strategy and it is regularly reviewed by the company executives. The DMAIC roadmap can help executives establish a disciplined process for creating and executing these strategies.



DMAIC Cycle

Purpose: 6 sigma methodologies called DMAIC in the manufacturing industries for the production data analysis to improve the productivity by reducing the defect rate and improving the quality of the product.

RESEARCH LIMITATIONS/IMPLICATIONS

The main hurdles in successful implementation of Six Sigma, in the views of researchers are, One organization's own management and employees, two active supplier participation and three active customers participation. Neither quality information nor the Six Sigma structured improvement procedure has a direct effect on product/service design or process management, but those two practices are found to have a significant effect on the Six Sigma focus on metric which in turn directly affects product/service design and process management (Linderman et al.2003, 2006).

Originality/value: The paper provides an theoretical attempt to adopt the concept of SIX SIGMA methodology in industries..

Introduction Six Sigma is a system of practices originally developed by Motorola to systematically improve processes by eliminating defects. The process was pioneered by Bill Smith at Motorola in 1986. Six σ is originally defined as a metric for measuring defects and improving quality. Development 1980s - US corporations began losing market share to Japanese, 1987 - Motorola pioneered the use of Six Sigma Bill Smith- "Father of Six Sigma" Bob Galvin-CEO of Motorola MAIC Process, 1995- General Electric Jack Welch, CEO of GE Created Six Sigma problem solving approach used today DMAIC Process

Tool used in 6 σ

• Process Flow Chart

What is done or being done

• Check Sheet / Tally Sheet

How Often it is done

• Histogram

What does variation look like?

• Graphs! Run Charts

Can the variations be represented in time series?

• Pareto Analysis

Which are the big problems?

• Cause and Effect Diagram

what causes the problem?

• Control Charts

Which Variation to control and how?

Philosophy

- Know what's Important to the Customer (CTQ)
- Reduce Defects (DPMO)
- Center around Target (Mean)
- Reduce Variation (Standard Deviation)

Six sigma conversion table

Table-1 ***SIGMA PROCESSES***

If you yield is :	Your DPMO is	Your Sigma is
30.9%	690,000	1.0
62.9%	308,000	2.0
93.3%	66,800	3.0
99.4%	6,210	4.0
99.98%	320	5.0
99-997	3.4	6.0

How Do we Arrive at Sigma?

1- Identify the CTOs

"Critical to Quality" characteristics or the Customer Requirements for a product or Service

2- Define Defect Opportunities

Any step in the process where a Defect could occur in a CTQ

3- Look for Defects in a Products or Services

Count Defects or failures to meet CTQ requirements in all process steps

4- Arrive at DPMO

Defects per Million Opportunities

5- Convert DPMO to Sigma

Use the SIGMA TABLE

Table – 2

Sigma Level	DPMO
2	308,537
3	66,807

4	6,210
5	233
6	3.4

Origin of Six Sigma

Motorola the company that Invented Six Sigma

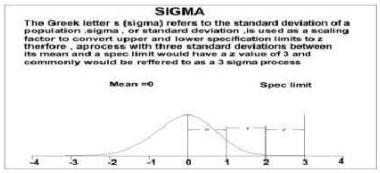
- The term "Six Sigma" was coined by Bill Smith, an engineer with Motorola
- Late 1970s - Motorola started experimenting with problem solving through Statistical analysis
- 1987 - Motorola officially launched it's Six Sigma program

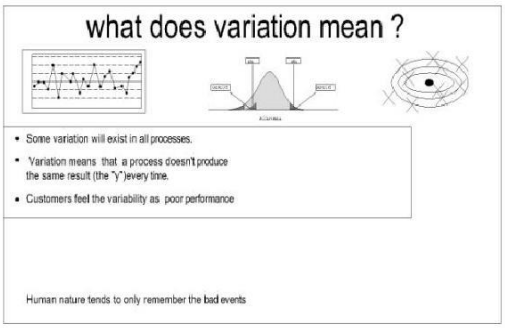
Concept of SIX SIGMA

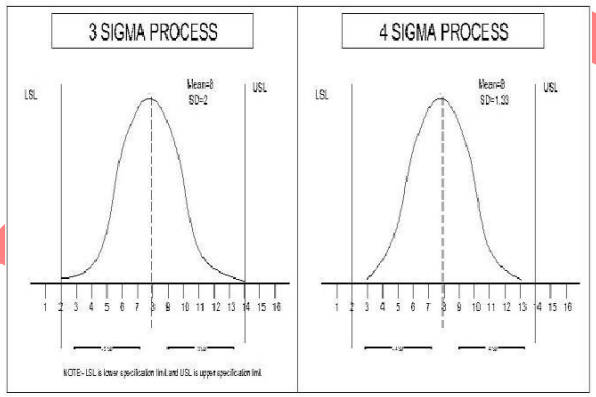
"Sigma" means standard deviation and therefore Six Sigma means six standard deviations. The objective of Six Sigma is only 3.4 defects (or errors) out of every million defect opportunities. This translates into 99.99966% perfection. Since most private manufacturing companies in Vietnam are currently around Three Sigma or even lower in some cases, a process improvement project using Six Sigma principles may initially aim at Four Sigma or Five Sigma, which would nonetheless result in significant defect reduction. Mekong Capital's Introduction to Six Sigma An important clarification is that Six Sigma measures defect opportunities and not defective products.

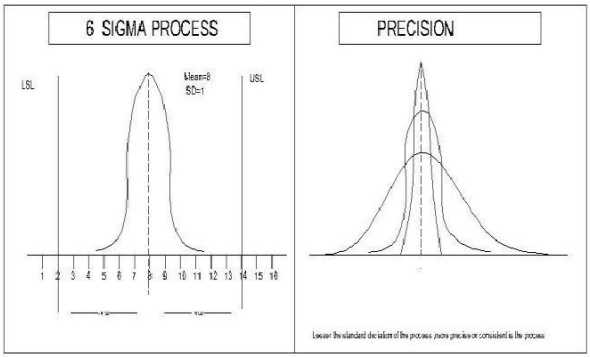
Meaning of a Sigma process

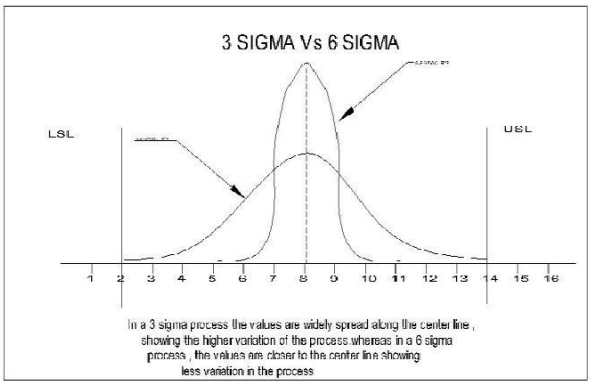
From a sigma process we come to know that at what distance, in terms of the standard deviation, the specification limits are placed from the target value.


SIGMA
The Greek letter s (sigma) refers to the standard deviation of a population .sigma , or standard deviation ,is used as a scaling factor to convert upper and lower specification limits to z. therfore , aprocess with three standard deviations between its mean and a spec limit would have a z value of 3 and commonly would be reffered to as a 3 sigma process
Mean =0
Spec limit
-4 -3 -2 -1 0 1 2 3 4


what does variation mean ?
Some variation will exist in all processes.
Variation means that a process doesn't produce the same result (the "y") every time.
Customers feel the variability as poor performance
Human nature tends to only remember the bad events


3 SIGMA PROCESS
LSL
Mean=8
SD=2
USL
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
NOTE- LSL is lower specification limit and USL is upper specification limit
4 SIGMA PROCESS
LSL
Mean=8
SD=1.33
USL
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16


6 SIGMA PROCESS
LSL
Mean=8
SD=1
USL
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
PRECISION
Lower the standard deviation of the process ,more precise or consistent is the process


3 SIGMA Vs 6 SIGMA
LSL
USL
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
In a 3 sigma process the values are widely spread along the center line , showing the higher variation of the process whereas in a 6 sigma process , the values are closer to the center line showing less variation in the process

1 DMA IC Roadmap

The DMA IC roadmap is extremely versatile. It has been used to improve performances in companies in virtually every industry and in every department within other companies. From manufacturing and maintenance to marketing and human resources, DMAIC (Define, Measure, Analyze, Improve and Control) is a proven discipline for improving processes.

The Define Phase

The Define stage sets the blueprint for the strategy. Executives define the current status of the company and how it is presently operating as well as the current market or economic situation. Externally, the voice of the customer needs to be confirmed. Political, economic, social and technical trends (sometimes referred to as PEST analysis) are recognized and the strength and weaknesses of the competition are established.

The Measure Phase

A company's performance is best measured quantitatively. As in business improvement projects, the Measure phase confirms the current baseline operation. During this stage, data is gathered to show how the company is tracking.

The Analyze Phase

Careful analysis of the business and the market will help leadership determine the best strategy for the company. Opportunities, threats, strengths and weaknesses, which are validated with data from the measure stage, are analyzed in detail.

The Improve Phase

Strategy needs to be continuously improved as customer, economic and technical factors change. After analyzing how the V's are affected by the company's X's leaders utilize the information to either modify strategy or stay the course with the existing strategy.

The Control Phase

It is important to closely monitor and manage company performance against strategy.

This is to ensure the company follows the path that leadership wants to take.

GENERAL TOOL USED

D-Define Phase: Define the project goals and customer (Internal and external) deliverables.

Define Customers and	Project Charter

Requirements (CTQs)	
Develop Problem Statement, Goals and Benefits	Process Flowchart
Identify Champion, Process Owner and Team	SIPOC Diagram
Define Resources	Stakeholder Analysis
Evaluate Key Organizational Support	DMAIC Breakdown Work structure
Develop Project Plan and Milestones	CTQ Definitions
Develop High Level Process Map	Voice of Customer Gathering

M-Measure Phase: Measure the process to determine current performance; quantify the problem

Define Defect Opportunity, and Metrics Unit	Process Flowchart
Detailed Process Map of Appropriate Areas	Collection Data Plan/ Example
Develop Data Collection Plan	Benchmarking
Validate the Measurement System	System Measurement Analysis/ Gage
Collect the Data	R&R
Begin Developi Y=f(x)	Voice of the

ng Relationship	Customer Gathering
Determine Process Capability and Sigma Baseline	Process Sigma Calculation

A- Analyze Phase: Analyze and determine the root cause(s) of the defects.

Define Performance Objectives	Histogram
Identify Value / Non-Value Added Process Steps	Pareto Chart
Identify Sources of Variation	Time Series/ Run Chart
Determine Root Cause(s)	Scatter Plot
Determine Vital Few x's, Y=f (x)Relationship	Regression Analysis
	Cause and Effect/ Fishbone Diagram
	5 Whys

SCOPE OF FUTURE WORK

There is lots of work that we can do in this context. We can apply the DMAIC in other Quality system like inventory control, Lean manufacturing, etc. I have apply this in the manufacturing industry in which we have taken the mass production system like bottling Manufacturing plant. The work done was on trial version, so in future I will be explore the remaining tool like Failure mode & Effect analysis (FMEA), Design of experiment(DOE) , Hypothesis testing ,and Multivariate analysis I will try to get the full version so our work will be more effective. I have found that this can be extended at the design level also so in near facture I will use six sigma not at process level but for product design.

Now days the six sigma is also used in service industry as used by ICICI bank and hotel industry. Minitab will also be effective in service industry case also but in these industries the data analysis is quite common with the help of six sigma methodology and using the Minitab as the data analysis tool. Future exploration is become more important because the job

scenario in India itself. In near future I will apply the Minitab software with the help of six sigma for more challenging problems. Another dimension of future work will be cost and benefit analysis. Major cost factor Involves in training, men's hours and the consultant fees etc. Data say that out return on investment (ROT) is more than 70%. Also the break even period is very short. So work to be explore in near future are

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