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RESEARCH ARTICLE

SIXSIGMA - A STUDY.

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Abstract

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, disciplined use of facts and statistics analysis, and responsible approach to managing, improving and establishing new business, manufacturing and service processes.

Introduction:-

Six Sigma is the rigorous pursuit of the reduction of variation in all critical processes to achieve continuous and breakthrough improvements that impact the bottom line and/or top line of the organization and increase customer satisfaction. It is also the an organizational initiative designed to create manufacturing, service and administrative processes that produce a high rate of sustained improvement in both defect reduction and cycle time. Six Sigma is a comprehensive system for achieving, maintaining and maximizing business success. The basis of Six Sigma is a detailed knowledge of customer requirements, statistical analysis and ongoing efforts focused on optimizing business processes. Six Sigma consist of 6 important key:

i. Critical to Quality: Attributes most important to the customer
ii. Defect: Failing to deliver what the customer wants.
iii. Process Capability: What your process do.
iv. Variation: What the customer wants.
v. Stable Operations: Ensuring consistent, processes to improve what the customer sees and feels
vi. Design for Six Sigma: Designing to meet customer needs and process capability

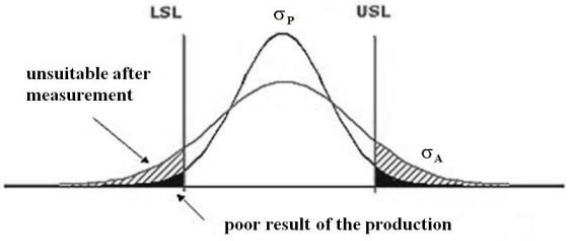

Figure 0-1 Measurement system Analysis

METHODOLOGY **OF IMPROVEMENT BY SIX SIGMA METHOD**

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Six Sigma is mainly based on understanding the customer needs and expectations, data and statistical analysis and an approach to managing, improving and creating new business, production and service processes. Six Sigma in particular focuses on:

Method of measuring quality, which allows you to compare different processes according to the achieved level SIGMA – variability of process.

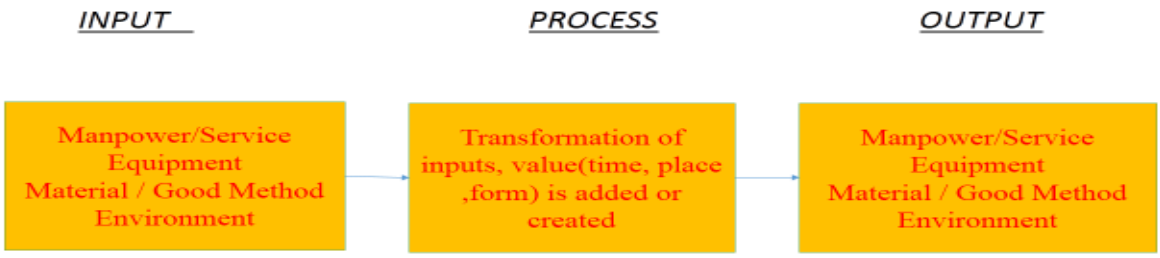


Figure 0-1 Basic Process

i. Project-oriented methodology for solving problems using statistical tools
ii. The quality improvement system, aimed at reducing errors and maintaining them at a low value.

Fundamental of Improving a processes and product

Definition: Process

A process is a collection of interacting components that transform inputs into outputs into inputs towards a common aim. The job of the management is to optimize the entire process towards its aim.

As shown in the figure II. 1 The output has "time value" if it is available when needed for user. Output has "place value" if it is available where needed by a user and output has form value if it is available in the form needed by a user.

Variation in a Process:

The distribution of measurements of the outputs from a process over time is called the "Voice of the Process (VoP)"

Feed Loops:

A feedback loop relates information about outputs from any stage back to other stage to make an analysis of the process.

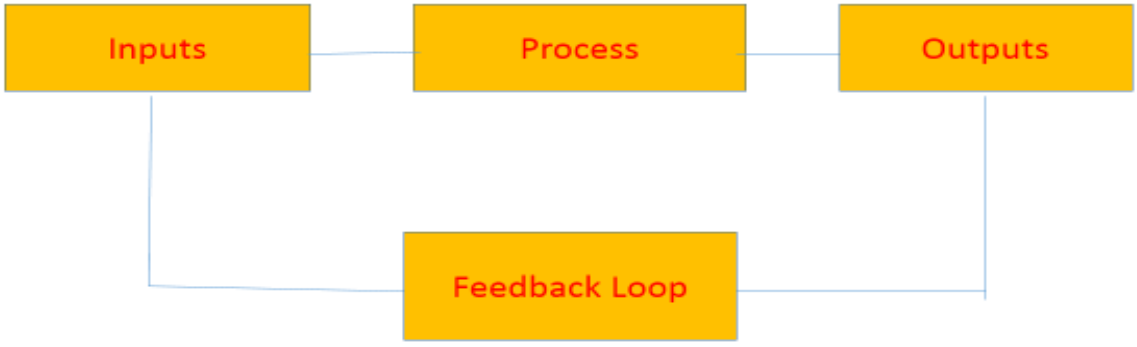


Figure 0-2 Feedback Loop

Definition of Quality:[1]

Quality means "conformance to valid customer requirement. As long as an output fell within acceptable limits around the desired value or target value. It was deemed conforming good, or acceptable.

A. The Design for Six Sigma (DFSS) Model

The design of six sigma consist of 11 phases mention as below:

i. Define Phase

a. Develop the business case.
b. Compute the benefits of the six sigma project.
c. Asses the risk to the project's success.
d. Activate the PD team.
e. Finalize the project objective.
f. . Pass the define phase tollgate review.

ii. Input to the Define Phase:

The input to the define phase are notification to the leader from the executive committee. The project highlight for the attention in the organizational dashboard and will have a high weighted average importance score from the organizational six sigma project priority matrix.

iii. Develop the Business Case

Preparing a business case to identify its location on the organizational dashboard and to show its priority on the organizational project priority matrix.

iv. Preparing the Opportunity Statement:

The opportunity statement describes the current and desired states of the problem, opportunity, or objective in clear, concise and measurable terms.

v. Develop the Initial Project Objective:

It includes the product, service or process being designed, the relevant market segment and the measure of success, direction, target and deadline.

vi. Develop the Project Scope:

A Multi – Generation Product Plan (MGPP)

It is a method that is used to view the entire picture of a project. It addresses the more significant strategic and tactical issues.

vii. Develop the Project Plan:

A Gantt is a scheduling tool. It is a bar chard chart that plots tasks and subtasks against time. Start and end dates can be scheduled for each task and subtask. Finally the milestone and resources relevant to a task or subtask are indicated on the Gantt chart.

viii. Develop the Document Control System.

It is needed to manage design changes when individual and sub – teams are working concurrently on a six sigma project.

ix. Assess the Benefits of the Six Sigma Project

It has both soft benefits and had benefits. Soft benefits include improving quality and morale and decreasing cycle time. Hard benefits include increasing revenues or decreasing cost. This guesstimate will be refined through iterative learning over the life of the project.

x. Assess the Risk to the Project's Success:

There are many reasons that can affect the risk of a step in a project or of an entire project.

xi. Finalize the Project Objective.

B. Measure Phase

In this stage team members obtain a clear and concise understanding of the needs and wants of the market for a design.

The measure phase consist of 11 phases mention as below:

i. Market Segmentation:[1]

It is a process of dividing market into homogeneous subset of the customer such that the customer in any subset will respond similarly to a marketing mix established for them and differently from the customers in another subset.

ii. Finding Cognitive images with Kano Surveys

Kano survey embrace a set of market research tools used for three purpose:

a. To improve existing products, services, or processes
b. To create major new features for existing product, service or process.

c. To invent and innovate an entirely new product, service or process.

iii. Convert Cognitive Images into CTQs with Quality Function Deployment:
Quality function development (QFD) is a method used to build the demands of customers into product and/or service features, characteristics and specifications as well as to develop process equipment, methods and control system.

iv. Select Final Set of CTQs:
Team members select the final set of CTQs to be designed into the product, service or process. These decisions require a benefit/cost analysis of each cognitive feature.

v. Develop and Validate a Measurement System for the CTQs
It promotes understanding between people by putting communicable meaning into words.
Validity means that the measurements gathered reflect the right operational definitions represented in the project.

vi. Develop a Design Scorecard
The purpose of a design scorecard is to formally state critical parameters in the voice of the customer and the predicted vive of the process.

vii. Plan to Manage the Risk
Team member input the CTQs and CTFs into a Failure Mode and Effect Analysis (FMEA). FMEA is a tool used to identify, estimate, propertied and reduce the risk of failure in CTQs and CTPs.

viii. Revise the Project Objective, if necessary
PDT members update the project objective at this point based on any new information that has come to light due to the measure phase of the DMADV model

ix. Conduct Tollgate Review
It consist of three important parameter:
a. Market successfully segmented.
b. Market strategy selected.
c. Type of Kano survey selected.

C. Analyze Phase

PD team members use the analyze phase of the DMADV model to generate and investigate alternative high – level design concepts for the critical parameters. With nominal values and tolerances, developed in the measuring phase. Further the set of alternative designs are compared and studied to identify the best design to move forward into the design phase of the DMADV model

i. Inputs of the Analyze Phase:
a. Prioritized list of CTQs, part features, service steps etc.
b. Nominal values and specification limits for CTQs, part features, service step etc.
c. Design scorecard for CTQs, part features, service step etc.
d. Report on the status of existing patents and trademarks.

ii. Generate High – Level Design Concept for Critical Parameters
Identify the level of effort required in design concept generation to understand time frames and resources required by the project.

iii. Investigate Alternative Design Concepts for Each Critical Parameter
Three simple rules can be used to eliminate less – worthy design concepts.
a. Eliminate all "show - stopper" concept- extremely negative aspect associated with them.
b. Combine the concepts from different designs to create fewer designs with better features.
c. Eliminate concepts that don't fit with the organization's mission.

iv. Create a Limited Set of Potential High – Level Design Concepts
Select 2 or 3 highest ranked alternative design concepts from matrix for further testing and development.

v. Assess the Risk of the BEST Design Concept
Risk systematically and continuously identifies and quantifies risk elements in design concepts at tollgates and prevents from occurring through risk abatement programs, it also communicates risk to management.

vi. Optimize the Total Life Cycle Cost (TLCC)
It identifies and quantifies all aspects of cost associated with: development, creating, producing, using and disposing of a product, service, or the process in the field

vii. Develop a Process Model for the Best Design
There are three types of model:

a. Descriptive – used to describe the "what is" condition of a product, service or the process.

Profit = Revenue – Cost

$E = mc^2$

b. Predictive – Are used to predict future events.

Demand=a – b (Unit Price) + Error

Sales= f (version of the service, promotional budget for the service, channels of distribution used for the service) + Error

viii. Transfer High – Level Design to Process Owner with Design Scorecards

Purpose of a design scorecard is to formally state critical parameters (CTQs, part features CTPs etc.) in the voice of the customer and the predicted voice of the process.

ix. Analyze Phase Tollgate Review

D. Design Phase

It will used various tools and methods to predict the sigma level of the detailed design. After a design phase build and pilot test a prototype of the product, service, or process under study. Team will develop plans for full – scale production of the production or delivery of the service.

i. Inputs of the Design Phase
   a. A high level design
   b. A set of design scorecards for the best high – level design.

ii. Constructing a Detailed Design
Team members move from a high – level design to a detailed design by moving from general CTQs to high – level CTPs to detailed CTPs. (e.g. Dimensions, brand name etc.)

iii. Create a Comprehensive set of Detailed CTPs. CTPs need to be developed for the following aspects of product, service or process being designed by team member.

iv. Operational Define each Detailed CTP
An operational definition contains three parts:
   a. Criterion to be applied to an object or group.
   b. A test of the object or group
   c. Decision as to whether the object or group met the criterion.

v. Validate the Measurement System for Each
A valid measurement system is a prerequisite for valid decision making.

vi. Conduct a Capacity Analysis
It is a technique used to study the resource requirements and statistical foe each detailed CTP in selected configurations of the detailed design.

vii. Perform a FMEA of the Detailed CTPs
Use Failure Modes and Effects Analysis to identify, estimate, prioritize and reduce the risk of failure of the detailed CTPs in the design through the development of action.

viii. Constructing Detailed Design Scorecards
Create scorecard for the detailed CTPs flowed – down from the CTP and CTQ scorecards in the measure and analyze phase.[1]

ix. Prepare a Control and Verification Plan
Create a smooth transition between themselves and the operations and sales department.

x. Conduct Design Phase Tollgate Review

E. VALIDATE PHASE

It is all about transforming the fully functioning service, product or process based on the design to the process owner and diffusing the innovation to all relevant stakeholders of the design throughout the organization's interdependent system of stakeholders. It is the final phase of the DMADV model

The Dmaic Model for Improvement:-

The relationship between the voice of the customer, the voice of the process and the DMAIC model is explained in Figure III – 1

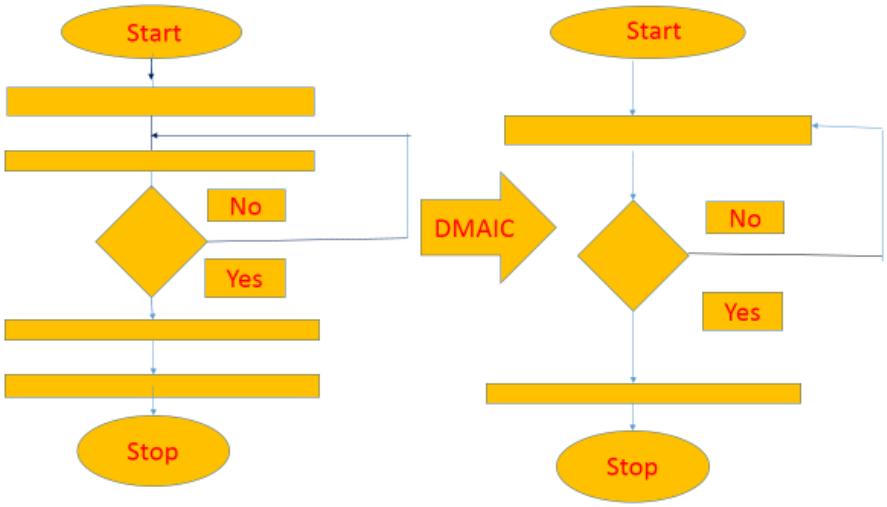


Figure 0-1 Relationship between the VoC, VoP and the DMAIC Model

DMAIC stands for -[3]

D – Define: Define phase of six sigma project involves identifying the quality characteristics that are critical to customers (called CTQs).

i. M – Measure: Measure phase involves operationally defining the CTQs, conducting studies of the validity of the measurement system of the CTQ(s), collecting baseline data for the CTQs, and establishing baseline capabilities for CTQs.[2]

ii. A – Analysis: Analysis phase involve identifying input and process variables that affect each CTQ (called Xs) using process maps or flowchart, creating a cause and effect matrix etc.

iii. I – Improve: Improve phase involves designing appropriate experiments to understand the relationships between the Xs & MNVs that impact the CTQs, generating the actions needed to implement optimal levels of critical Xs that minimize spread in CTQs and conducting pilot's tests of processes with Xs with optimal set of their level.

iv. C – Control: Control phase involves avoiding potential problems in Xs set with risk management and mistake proofing, standardizing successful process change, controlling the critical Xs, developing process control plans for the critical Xs, documenting the control plans and turning over the control plan to the process owner.

Design of Six Sigma Tools and Methods [4]:-

Over the years, companies have included numerous tools into the Six Sigma approach to make them more effective and to eliminate possible gaps after its application. Such toolsets include statistical and analytical tools both from industrial engineering and operations research fields. In this instance, these tools enrich the practical and industrial approach with a stronger theoretical basis to achieve a better equipment and resources utilization. There are many tools and techniques for Six Sigma implementation used in various phases of DMAICmethodology. In addition many of the tools/techniques used in the implementation of Six Sigma were referred and categorized by phase of define-measure-analyze-improve-control (DMADC) which they are used. [1]

i. Brainstorming

It is the technique to elicit a large number of ideas from a group using their collective thinking power. It involves between 3 and 2 people, with 5 or 6 people being the optimal group size. The brainstorming session should be a closed – door meeting to prevent distractions. Seating should be arranged in a U – shape or circle to promote the flow of ideas among group member.

ii. Affinity Diagram

It is used to organize verbal and pictorial data consisting of facts, opinions, intuition, and experience into natural cutlers that bring out the latent structure of the problem under study.

iii. Cause and Effect Diagram and Matrix

It is the tool used to organize the possible factors (CTPs or Xs) that could negatively impact the stability, center, spread and shape of a CTQ. It is also known as fishbone or Ishikawa diagram.

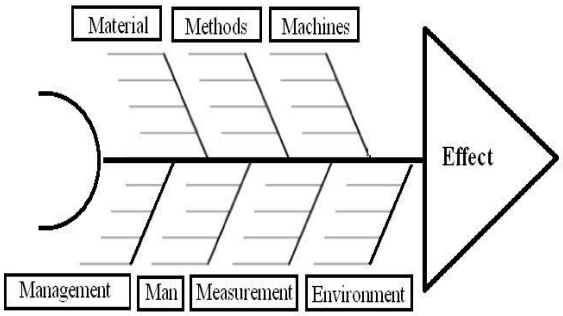


Figure 0-1 Cause & Effect Diagram

It helps to find all possible causes, to split causes into categories and organize their relationships and impact on output, and to identify opportunities forimprovement. In general, these categories are commonly known as 7M causes:

a. Man -people, job;
b. Methods and mechanics, process;
c. Machine – machines, equipment;
d. Measurement;
e. Management - system of organization and management;
f. Material;

vi Cheek Sheet

These are used in Six Sigma projects to collect data on CTPs (Xs) and CTQs in a format that permits efficient and easy analysis by team member. There are three types of cheek sheets:

a. Attribute Cheek Sheet

It is used to gather data about defects in a process. The logical way to collect data about a defect is to determine the number and percentage of the defect generated by each cause.

Figure 0-1 attribute Cheek Sheet

Type of Defect	Frequency	Percentage
Improper use of English language	2	2.9
Rude Response	3	4.3
Call took too much time	30	42.9
Didn't know answer to the question	25	35.7
Total		

a. Measurement Check Sheet

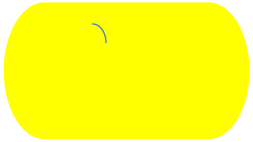
Gathering data about a product, service, or process also involves collecting information about measurement such as cycle time, temperature, size, length, weight and diameter. These data are best represented on a frequency distribution on a measure check sheet.

Table IV- 3 Measurement Check Sheet of Cycle Times

Cycle Time	Tally	Frequency
5 < 10	1111 1111 1111 1111...	36
10 < 15 minutes	1111 1111	178
15 < 20 minutes	…….	233
20 < 25 minutes	…….	53
Total		

b. Defect Location Cheek Sheet

Another way to gather information about defects in a product or design is to use a defect location check sheet. It is a picture of a product or design on which an inspector indicates the location and nature of a defect.



i. Stratification

Stratification is a procedure used to describe the systematic subdivision of a data set. It can be used to break down a problem to discover its root causes and set into motion appropriate corrective actions.

ii. Gantt Chart

It is a simple scheduling tool that plots tasks and sub – tasks has been created for a six sigma project, then responsibilities can be assigned for each task.

Table IV - 2 Generic Gantt Chart

Tasks	Responsibility	Timeline (Month)						Comments
Task 1		J	F	M	A	S	O	
Subtask 1a								
ST 1b								
T 2								
T 3								
ST 3a								
ST 3b								

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.

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