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Study on Concept of Six Sigma DMAIC Methodology

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Abstract**—***Six Sigma, a statistical measure of variation is used for improving business process. Implementation of Total Quality Management (TQM) is possible by using Six Sigma which targets 99.99927% defect free manufacturing. Six Sigma DMAIC methodology is meant of Define, measure, Analysis, Improve and Control. DMAIC is a problem solving process which may resolve the issues of defects or failures, deviation from target, time over run, cost over-run etc. DMAIC reduces variation by identifying the key requirements tasks and standard tools for utilize and tackle the problem. This paper contains a study on Six Sigma DMAIC methodology for improvement of existing problem in construction.*

Keywords—Six Sigma, DMAIC, Total Quality Management, DPMO, Analyze, Problem.

I. INTRODUCTION

The development of Construction industry is highly influenced by two main factors which are construction management and technology. The completion of a project with stipulated time and cost as per required standards and specifications, waste minimize, efficient use of resources are the objectives of construction industry. For the improvement of Productivity, quality management has been introduced worldwide. Quality Management is defined as any approach used to achieve and sustain a high-quality output confirming to requirements and meeting customer satisfaction. The Total Quality Management (TQM) focuses on quality which became a comprehensive management strategy. Total quality Management is embedded on quality awareness at each step of production work or service.

Total Quality Management has evolved as a strategic approach in most of the manufacturing and service operations to respond to the challenges posed by competitive business world. Six Sigma is a quality tool which is used as a problem solving methodology, centered around defect reduction and variation management executed in the form of a disciplined, data driven and time bound approach and is provided by the top management in an organization. The methodology explained here is Six Sigma DMAIC, a five step improvement process as Define, Measure, Analyze, Improve and Control.

II. SIX SIGMA

Six Sigma is a quality improvement technique based on statistics was used firstly by Bill Smith of Motorola in 1980s, who defined the concept as organized common sense to decrease cost, increase quality by improving process and reduce the production time. The concept of Six Sigma has been generated from Standard Normal Distribution which is a statistical distribution, illustrated by symmetrical bell shaped curve. Six Sigma is having statistics and management perspective. In the statistical approach mean is the arithmetic average of a process data set and standard deviation is the spread around the mean. Sigma can also be explained as the capability of the process to produce defect free work. Sigma is an index, which is used to describe the degree of dispersion for the output of a random set of data or process.

Six Sigma is a quantitative approach for improvement with the major objective being elimination of defects from any process, specially a numerical goal of 3.4 defects per million opportunities (DPMO). The graphical representation of six sigma levels is shown in Fig No 1. The curve of six sigma levels represents the total population by infinite series of segments in its both directions. Sigma symbolize the deviation from mean. In this curve shows the lower and upper limits as six times the standard deviation from the central line of mean.

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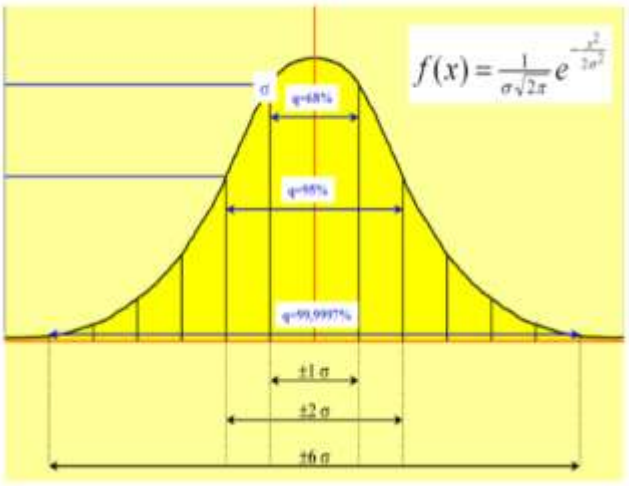

FIGURE 1. Graphical Representation of Levels of Six Sigma

In this curve the range between -6σ and +6σ is the considerable part which covers 99.9997% of the population. Table No 1 shows the rate of defects per million opportunities and yield in different sigma levels.In fact, the Six Sigma represents the quality level in six sigma management method, there is only 3 or 4 faults in 1000000 opportunities in sigma quality level.

TABLE 1

YIELD	DPMO	SIGMA LEVEL
30.9	690000	1
69.2	308000	2
93.3	66800	3
99.4	6210	4
99.98	320	5
99.9997	3.4	6

Overview of Sigma Levels, DPMO and Yield

Six Sigma implementation is mainly done with sub-methodologies like DMAIC and DFSS or DMADV or IDDOV methodologies. DMAIC process is Define, Measure, Analyze, Improve and Control and DMADV is Design, Measure, Design, and Verify.

III. SIX SIGMA DMAIC METHODOLOGY

The DMAICis a problem solving process which is deeply integrated with the overall goal of the organization which follows the phases Define, Measure, Analyze, Improve and Control. Figure 2 shows the stages of DMAIC methodology. DMAIC is the core tool used in Six Sigma for the improvement, optimization and stabilization of business processes and business and is referred to a data driven improvement cycle.

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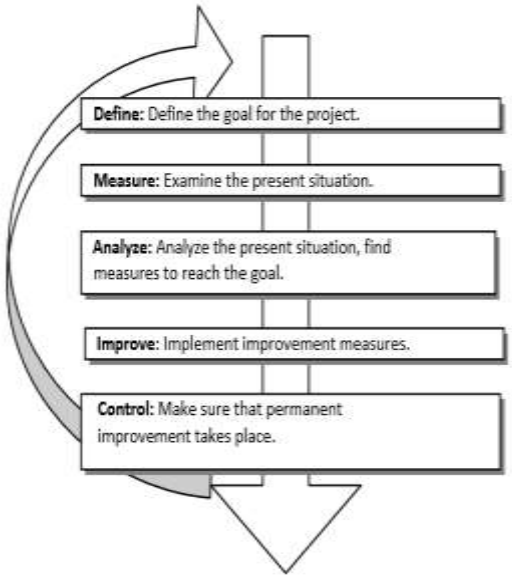

FIGURE 2 : The DMAIC Methododlogy

3.1 DEFINE

The first step of DMAIC method is necessary to define the requirements of the customer and any thing that do not meet that requirements known as defects , define project goal of the project and identify the critical to quality characteristics of the process. The steps in this phases are Define Customers and Requirements, Develop Problem Statement, Goals and Benefits, Identify Champion, Project owner and Team, Define resources, Develop Project Plan. The tools and Techniques used in this phase are as follows:

- IPO Diagram
- Project Charter
- Process Flow chart
- SIPOC Diagram
- Stake Holder Analysis
- DMAIC Work Breakdown Structure
- CTQ Definitions
- Voice of the Customer Gathering

3.2 MEASURE

In this step of DMAIC measurement of performance of the existing process and its deviation from actual requirements are taken with the objective of measuring enough data or information from the process under development. The steps of measue phase are Define defect, opportunity, Unit and Metrics, Detailed Process map of appropriate areas, Develop DATA Collection Plan, Validate the measurement system, Collect the data etc. The tools used are given below:

- Process Flow Chart
- Data Collection Plan/Example

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- Bench Marking
- Measurement system Analysis
- Voice of the Customer Gathering
- Process Sigma Calculation
- Pareto Charts
- Histograms

3.3 ANALYASE

In this stage the study and analysis of the collected data has carried out to find out the causes of defects and unsatisfactory performance. As team collected different set of dada by different people, they may decide to adjust the data collection plan to include additional information. By this, the team analyse both the data and the process and verify the root causes of wastes and defects. The steps which follows in analyze phase is listed as define performance objectives, Identify value/ non value added process steps, Identify sources of variation, Determine root causes etc.

The tools used in this stage is given as,

- SWOT Analysis
- PESTEL Analysis
- Overall Equipment effectiveness
- TRIZ
- Innovative Problem Solving
- Control Charts
- Histogram
- Pareto Chart
- Scatter Plot
- Time Series/Run Chart
- Regression Analysis
- Cause and Effect/Fishbone Diagram
- Five Whys
- Process Map Review an Analysis
- Statistucal Analysis
- Hypothesis Testing (Continuous and Discrete)
- Non-normal data Analysis

3.4 IMPROVE

Elemination of the defects is done in this stage to improve the process.Identify the ways to destroy the existing problem and develop the potential solution. The steps in the improvement phase are perform design of experiments, Develop potential solutions, define operating tolerences of potential solutions, validate potential improvement by piolet studies, correct/reevaluate potential solution.

Tools used to implement this phase are as follows

- Brain Storming
- Mistake Proofing
- Design of Experiments
- Pugh Matrix
- QFD/ House of Quality
- Affinity Diagram
- Nominal Group Technique
- SMED
- Five S
- Value stream mapping

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- Failure Modes and Effects Analysis (FMEA)
- Simulation Software
- Mind Mapping
- Forece Field Diagram

3.5 CONTROL

Control phase helps to ensure the rectification of the problems which create the variations in the desired outputs. In this stage, measuring the performance of the new process under a controlled plan to control the quality level of the process is carried out. Control phase can be considered as the mini version of project management. The steps of Control phase are Define and validate Monitoring and Control System, Develop Standards and Procedures, Implement Statistical Process Control, Determine process capability, Develop Transfer Plan,Handoff to Process owner, Verify Benefits, Cost savings, Avoidance, Profit, Growth, Close project,Finalize documentation, Communicate to business, celebrate.

The tools used in this phase are given below.

- Process Sigma Calculation
- Control Charts
- Cost saving calculations
- Control Plan
- GANTT Chart
- Activity Diagram
- Radar

IV. CASE STUDY

A case study was conducted on a residential building in which six sigma principles were applied to internalfinishing work (tiling works) to enhance the quality of the existing process. A defect assessment sheet was prepared inwhich the possible defects that might occur in tiling works was listed. The assessment was done for each item, the onewhich met the standard requirement is marked as right mark else it is marked as 'X' and NA indicates that the item is notapplicable. The total number of defects, total number of opportunities for defects in each assessment sheets is calculated and the yield is evaluated as follows:

DPMO = No. of 'X' in data assessment sheet x 1000000
No. of opportunities of defects x No. of units

Based on DPMO, using sigma conversion table the sigma level is calculated. Here the value od DPMO was 27449.32and sigma was 3.37. Yield was 95.76%. Then by using the DMAICprocedure of Six sigma the quality of the ongoing process is improved.

In this paper the following tools are used in each stage of DMAIC methodology,

Define - SIPOC (Suppliers Input Process Output Customer)
Measure –Pareto chart
Analyze – Cause and Effect diagram
Improve – Brainstorming (Recommendation for corrective action)
Control – Control plan

One of the major challenges faced by the construction firms is to deliver the product within the stipulated time without compromise in Quality. Execution of works with the Standard Quality requirements reduces rework and hence the cost for it. There are various factors which have high impact on construction quality. These factors must be identified as early as possible so that quality can be improved. In this paper tiling work of a residential building has been studied and sigma level has been evaluated. DMAIC methodology has been implemented based on Six Sigma principles which give a systematic framework to identify the impact of defects, their root causes and ways to reduce them. DMAIC can be helpful to increase quality and quantity at the same time and it will affect technical and financial success of project considerably. Briefly, Six Sigma, as a quality initiative, that aims to reduce defects and variations in processes using statistical measurements, process design and quality control analysis in order to increase (external/internal) customer satisfaction.

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V. CONCLUSION

Six Sigma is a performer indicator and process improver, a quality tool used in the industries. The main techniques of Six Sigma are DMAIC and DMADV. The improvement technique DMAIC is applied by five main phases which are Define, Measure, Analyze, Improve and Control and their tools discussed in this paper. This method gives systematic approach to identify and improve the current process which must be modified. This is helpful to reduce and eliminate variation which cause defect, to meet the quality standards also improve the quality and customer satisfaction.

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