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# "Use of Six Sigma methodologies for Road construction work: A Research"

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***Abstract***— Six Sigma was produced in 1980's in assembling industry and wound up famous as process improvement technique. Albeit Six Sigma has been executed in the assembling and different administrations businesses, it is still moderately another idea in the road construction industry. This paper incorporates the nitty gritty technique of Six Sigma. The market study about need of process improvement is done especially to know ideas of quality, cost, efficiency, profitability time, consumer loyalty and utilization of Six Sigma inside road construction enterprises and a contextual investigation on how Six Sigma can be actualized on construction work of an open working to limit deformities and along these lines to enhance quality of work.

Especially Six Sigma can give a broader quality idea, point by point execution estimation, composed and repeatable execution improvement. Six Sigma is discussable inside construction setting because of contrasts of assembling and construction industry. Taking everything in thought, clearly Six Sigma has a great deal keeping in mind the end goal to quicken crucial and social difficulties construction industry needs.

***Keywords***— Six Sigma, Road Construction Industry, Quality Control, Process improvement, DMAIC, DPMO.

## I. INTRODUCTION

Construction administration and innovation are the two key components impacting the improvement of the construction industry. The profitability of the construction industry worldwide has been declining in the course of recent years. One methodology for enhancing the process is utilizing Six Sigma ideas in construction. Six Sigma is a quality improvement method in light of insights was utilized right off the bat by Motorola in 1980s by Bill Smith of Motorola to diminish cost, increment quality by enhancing process and decrease the generation time. It got little attention until late 1990s. Six Sigma results the use of another type of administration procedure to construction. When all is said in done, six sigma ventures are simpler to oversee, more secure, finished sooner, and cost less and are of better quality. Sigma inside construction setting turns into a fascinating exploration question thinking about quality, execution and administration perspectives. Six Sigma is a quantitative methodology for improvement with the objective of constraining imperfections from any process, extraordinarily a numerical objective of 3.4 deformities for every million chances (DPMO). Six Sigma is purportedly less demanding to apply than numerous other quality administration programs since it gives data about the change required and the projects to execute the change. The methodology it utilizes is a five stage improvement process: Define Measure, Analyze, Improve and Control (DMAIC). This process is profoundly coordinated with the general objectives of the association and in that capacity, requires top down usage. Six Sigma is more exceptional, centered and detail than some other quality improvement procedures.

### 1.1 Purpose and Objective of the Research -

1. To examination the Six Sigma idea
2. To check the familiarity with process improvement (Six Sigma) in showcase.
3. Applying DMAIC system of Six Sigma procedure on road construction work.
4. Compare Six Sigma esteem consequences of standard strategy for working and Six Sigma philosophy.

### 1.2 Scope of the investigation -

Six Sigma can be actualized in various sorts of construction undertakings and site condition, for example, Industrial and private ventures, transportation, water, control plant, structure, and so on. That is the reason; this investigation will endeavor to cover site and office based activities of construction venture. Considering the mindset contrasts between different temporary workers, manufacturers, advisors, venture directors, site and office engineers, it is essential to mirror their thoughts and points of view about process improvement.

## II. RELATED WORK

- Harry and Schroeder (2000), who are the key designers and defenders of the Six Sigma program at Motorola, characterized Six Sigma as "a restrained technique for utilizing amazingly thorough information gathering and measurable examination to pinpoint wellsprings of mistakes and methods for killing them."[1]
- Snee (2000) demonstrated that "Six Sigma ought to be a vital methodology that works over all processes, items, organization capacities and industries."[2]
- Chowdhury (2001) clarified that Six Sigma speaks to a factual measure and an administration theory that trains workers how to enhance the manner in which they work together, experimentally and generally, and how to keep up their new execution level. It gives order, structure, and an establishment for strong basic leadership in light of straightforward statistics.[3]
- Pande et al. (2000) characterized Six Sigma as (1) a method for estimating processes, an objective of close flawlessness spoken to by 3.4 deformities for each million chances (DPMO) ; and all the more precisely, (2) a thorough and adaptable framework for accomplishing, managing, and augmenting business achievement. It is extraordinarily determined by a nearby comprehension of client needs, trained utilization of certainties, information, and factual examination, and constant thoughtfulness regarding overseeing, enhancing, and reevaluating business processes.[4]
- Pande and Holpp (2002) characterized Six Sigma as (1) a factual proportion of the execution of a process or an item; (2) an objective that ranges close flawlessness for execution improvement; and (3) an arrangement of administration to accomplish enduring business initiative and world-class performance.[5]

### 2.1 SIX SIGMA METHODOLOGY: DMAIC

The standard Six Sigma procedure comprises of five stages: Define Measure, Analyze, Improve and Control (DMAIC). It successions the means that are fundamental to accomplishing results and briefs as takes after:
(1)Define: this stage is to characterize the necessities of clients, the extent of processes to be examined. Undertaking targets at that point set in view of the client's prerequisites.

(2)Measure: distinguish the key measurements, conceivable components that influence the key measurements, the information gathering plan, and execute the arrangement of information accumulation. And furthermore to begin with investigate the causes that consequence of variety.

(3)Analyze: Analyze the information gathered and the process to decide the main drivers of the issue that should be made strides.

(4) Improve: check the relationship of key underlying drivers that influenced the variety of the key measurements. At that point, point the key factors and create answers for enhance the process or generation apparatuses. Plot them on a little scale to decide whether they emphatically enhance the process execution, Successful improvement techniques are then actualized on a more extensive scale. Consequences of process changes are measured.

(5)Control: create and execute a control intend to guarantee that execution improvement re-mains at the coveted level. The process must be observed to avert anomalous changes happened.

### 2.2 DPMO

The sigma idea of estimating surrenders was begun by Motorola in the mid 1980s as an approach to build up a widespread quality metric that connected paying little heed to item multifaceted nature or dissimilarities between various. items or processes. Higher sigma esteems show better items or processes with less quantities of deformities per unit of item or administration. Items delivered at a Six Sigma level of quality work for all intents and purposes deformity free by definition, with just 3.4 imperfections for each million chances (DPMO) as appeared in Table-1. Through Six Sigma, each quantifiable can be thought about on a similar stage through changing over yields or DPMO to sigma level, regardless of how unique they might be. The association should simply to set out rules in deciding quantifiable amid execution.

**Table-1: Basic Six Sigma Conversion Table**

| Basic Sigma Conversion Table | | |
|---|---|---|
| Yield=Percentage of items without defects | Defects per million opportunities (DPMO) | Sigma Level |
| 30.9 | 690 000 | 1 |
| 69.2 | 380 000 | 2 |
| 93.3 | 66 800 | 3 |
| 99.4 | 6 210 | 4 |
| 99.98 | 320 | 5 |
| 99,9997 | 3.4 | 6 |

## III. CASE STUDY

**A) Market overview about need of process improvement**:

To know need of process improvement in advertise the study is taken of 60 individuals inside construction setting at Dhule and adjacent zones (Maharashtra). The inquiries with respect to quality, cost, efficiency, profitability time, consumer loyalty and need of Six Sigma are asked and normal evaluations are computed and appeared as graphical portrayal demonstrated as follows;.

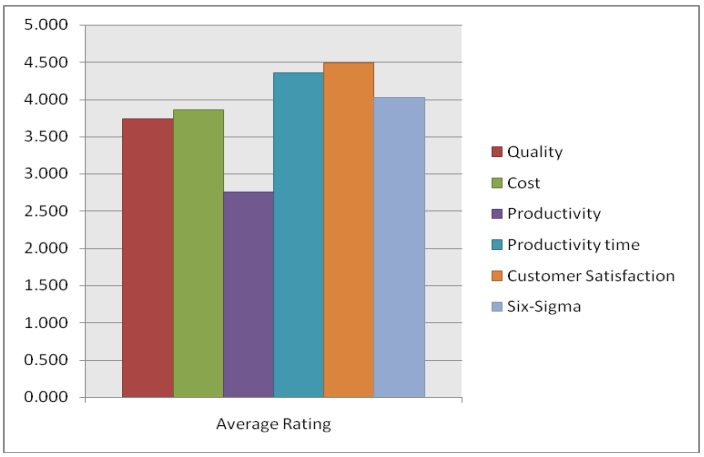


**Fig.1 Market survey about need of process improvement in construction**

**B) Applying Six Sigma for Four laning undertaking of NH-6 from Fagane-Songarh Expressway:**

A case of how Six Sigma might be connected for enhancing the quality of construction of " Four laning undertaking of NH-6 from Fagane-Songarh Expressway" is presently portrayed. It containing complete 141 km

remove from Fagane (Maharashtra) to songarh (Gujarat). Among that 5 km on left of camp area and 5 km on right of camp area are chosen for examine. An agenda is set up for four layers of road construction i.e. Subgrade, Sub Base, Base course, Wearing course arrangement work, which covers different focuses whose quality should be checked. The agenda as appeared in table is readied. The information is filled in the agenda for 5 km on left half of camp area i.e. prior to use of Six Sigma. the one which affirms to guidelines more than 85% are set apart as "√" else standards' identity's underneath 85% are set apart as "×". The quantity of "×" drives 'o' abandons and the aggregate number of checks prompts openings. To repeat, the building components related with inside completions are most noticeable to the stripped eye. It is important to decrease the frequency of deformities related with quality of road so as to wipe out the quantity of grievances identifying with poor execution of road by clients and to diminish the quantity of mishaps because of low quality of road. For this reason following parts are chosen as unmistakable zones.

**i. Regular method of Four laning project of NH-6 from Fagane-Songarh Expressway: For 5 km on Left**

| WEARING COURSE | STEPS OF ROAD CONSTRUCTION | | | |
|---|---|---|---|---|
| | FOR SUBGRADE PREPARATION | FOR SUB BASE COURSE | FOR BASE COURSE | FOR WEARING COURSE |
| CLEANING & GRUBBING OF SITE | × | ✓ | × | ✓ |
| LEVELING OF SURFACE | ✓ | ✓ | ✓ | ✓ |
| WATER SPREADING | ✓ | ✓ | ✓ | ✓ |
| QUALITY OF MATERIAL USED | ✓ | ✓ | ✓ | ✓ |
| MATERIAL TESTING & SAMPLING | ✓ | ✓ | ✓ | ✓ |
| PARTICLE SIZE OF MATERIAL | ✓ | × | ✓ | ✓ |
| MIX PROPORTION | ✓ | ✓ | ✓ | ✓ |
| SPREADING OF MATERIAL/MIX | × | ✓ | ✓ | ✓ |
| THICKNESS OF LAYER | ✓ | × | ✓ | ✓ |
| NUMBER OF PASSES COMPLETED BY ROLLER | × | × | × | × |
| DESIRED COMPACTION VALUE | × | × | × | ✓ |
| CBR VALUE | ✓ | ✓ | ✓ | ✓ |
| PROVISION OF PRIMER COAT | - | - | - | ✓ |
| PROVISION OF DRAINAGE LAYER | - | - | × | - |
| TEST ON BITUMEN | - | - | ✓ | × |
| TOLERANCE FOR TOP OF LAYER | ✓ | ✓ | ✓ | ✓ |
| PROVISION OF CAMBER | - | - | ✓ | ✓ |
| NO. OF DEFECTS | 04 | 04 | 04 | 02 |
| NO. OF CHECKS | 13 | 13 | 16 | 16 |
| TOTAL NUMBER OF DEFECTS | | 14 | | |
| TOTAL NUMBER OF CHECKS/OPPORTUNITIES FOR DEFECTS | | 58 | | |

**Calculations for Sigma value:**

The DPMO (defects per million opportunities) formula is used:

DPMO= (No. of defects) / (No. of opportunities*No. of units)*1,000,000

The DPMO relating to the internal finishes of building A unit recently completed by Contractor was then calculated based on the data collected and presented in Table1.

DPMO= (No. of ‘‘X’’ in the data collection sheet)/ (No. of opportunities of defects*No. of units) *1,000,000

DPMO= (14)/ (58*1)*1,000,000=241379

Based on the sigma conversion table in Table-1, the equivalent sigma for 241379 DPMO was approximately 2.2σ and according to belt holders it was decided that 2.2σ was not acceptable where quality of internal finishes is concerned. So a decision was made to apply Six Sigma on Building B which is identical to building A to improve the quality of work.

ii. **Applying Six Sigma methodology for Four laning project of NH-6 from Fagane-Songarh Expressway: For 5 km on Right**

| WEARING COURSE | STEPS OF ROAD CONSTRUCTION | | | |
|---|---|---|---|---|
| | FOR SUBGRADE PREPARATION | FOR SUB BASE COURSE | FOR BASE COURSE | FOR WEARING COURSE |
| CLEANING & GRUBBING OF SITE | ✓ | ✓ | ✓ | ✓ |
| LEVELING OF SURFACE | ✓ | ✓ | ✓ | ✓ |
| WATER SPREADING | ✓ | ✓ | ✓ | ✓ |
| QUALITY OF MATERIAL USED | ✓ | ✓ | ✓ | ✓ |
| MATERIAL TESTING & SAMPLING | ✓ | ✓ | ✓ | ✓ |
| PARTICLE SIZE OF MATERIAL | ✓ | × | ✓ | ✓ |
| MIX PROPORTION | ✓ | ✓ | ✓ | ✓ |
| SPREADING OF MATERIAL/MIX | ✓ | ✓ | ✓ | ✓ |
| THICKNESS OF LAYER | ✓ | ✓ | ✓ | ✓ |
| NUMBER OF PASSES COMPLETED BY ROLLER | ✓ | ✓ | ✓ | ✓ |
| DESIRED COMPACTION VALUE | × | ✓ | × | ✓ |
| CBR VALUE | ✓ | ✓ | ✓ | ✓ |
| PROVISION OF PRIMER COAT | - | - | - | ✓ |
| PROVISION OF DRAINAGE LAYER | - | - | ✓ | - |
| TEST ON BITUMEN | - | - | ✓ | × |
| TOLERANCE FOR TOP OF LAYER | ✓ | ✓ | ✓ | ✓ |
| PROVISION OF CAMBER | - | - | ✓ | ✓ |
| NO. OF DEFECTS | 01 | 01 | 01 | 00 |
| NO. OF CHECKS | 13 | 13 | 16 | 16 |
| TOTAL NUMBER OF DEFECTS | | | 03 | |
| TOTAL NUMBER OF CHECKS/OPPORTUNITIES FOR DEFECTS | | | 58 | |

**Calculations for Sigma value:**

DPMO= (03)/ (58*1)*1,000,000=51724
Based on the sigma conversion table in Table-1, the equivalent sigma for 55000 DPMO was approximately 3.31σ

**Remark:** By comparing both the above processes we get the increase of 1.11σ in building B by application of DMAIC technique of Six Sigma methodology.

## IV. CONCLUSION

1. The market study demonstrates that, there is a urgent need of process improvement where the quality idea is concerned.
2. Although Six Sigma is a generally new quality activity in the road construction industry, the aftereffects of this contextual analysis demonstrate that it very well may be actualized and can limit the imperfections.
3. By looking at the standard strategy for working for road construction work of 5 km on Left half of camp area with DMAIC procedure of Six Sigma system connected for 5 km on Right half of camp area, we get the expansion of 1.11σ on Right half of Camp area.

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