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# Quality Management in RCC Construction on Site using Quality Control Tool: Six Sigma

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**Abstract:**
The law of survival of fittest plays an important role in today's market due to the increase in competition. The pressure on construction enterprises for the market and competitors has increased due to the increasing requirements of customers towards quality assurance which require improvements in internal quality and keep close eye on quality control. The economic benefit largely depends on quality control in a business. Construction companies should pay more attention towards the principle of quality, and insist on quality standards.

**Keywords:** Quality, Quality Control, Quality Assurance, Quality Management, Six Sigma, Methodologies, Conclusion

## I. INTRODUCTION

Quality Control is very essential to build durable and efficient structures in the construction industry. Quality Control and Quality Assurance are very important to maintain the quality on site. Total Quality Management (TQM) is the concept widely used in the manufacturing industry but it also shows its importance in the construction industry. The strength of the structure is a random variable, it is necessary to exercise good quality control to minimize its variability.

## II. NEED FOR QUALITY MANAGEMENT

The need for quality management in construction is now widely accepted. Implementing the quality standard elements in the field, practically there will be lots of hurdles and most of the employers are very much interested and indulging themselves in this process but they don't get a proper way or benchmark to fix the standards. This study aims at analyzing the significance and importance of construction firms regarding implementation of Total Quality Management at all the levels of the Projects.

## III. NEED FOR SIX SIGMA

Six Sigma is a set of techniques and tools for process improvement. It was introduced by engineer Bill Smith while working at Motorola in 1986.Jack Welch made it central to his business strategy at General Electric in 1995. Today, it is used in many industrial sectors. Six Sigma seeks to improve the quality of the output of a process by identifying and removing the causes of defects and minimizing variability in manufacturing and business processes.

It uses a set of quality management methods, mainly empirical, statistical methods, and creates a special infrastructure of people within the organization, who are experts in these methods. Each Six Sigma project carried out within an organization follows a defined sequence of steps and has specific value targets, for example: reduce process cycle time, reduce pollution, reduce costs, increase customer satisfaction, and increase profits.

## IV. GENERAL CONCEPTS OF QUALITY

### A. What is quality?

Quality is defined as 'fitness to purpose', i.e. in terms of Construction it is providing a building which provides an appropriate quality for the purpose for which it is intended. The price to be paid for a building is a reflection of the expectations of quality.

### B. Quality Assurance

QA is a way of preventing mistakes or defects in manufactured products & avoiding problems when delivering solutions or services to customers. QA is applied to physical products in pre-production to verify what will be made meets specifications & requirements & during manufacturing production runs by validating lot samples meet specified quality control. QA is also applied to software to verify that features & functionality meet business objectives & that code is relatively bug free prior to shipping or releasing new software products & versions. Two principle included in quality assurance are: "Fit for Purpose", the product should be suitable for the intended purpose & "Right first time", mistakes should be eliminated. QA includes management of the quality of raw materials, assemblies, products & components, services related to production & management, production & inspection.

### C. Quality Control

Quality control is a formal systematic process designed to ensure that expected quality standards are achieved during scoring, equating, and reporting of test scores. Important elements to be checked during a quality control are as follows.

- To produce a building that satisfies the client.
- To produce a building where quality is related to the price.

- To produce a building in which sufficient time is allowed to obtain the desired quality.

## V. TOTAL QUALITY MANAGEMENT

### A. Introduction

Today, India is the second fastest growing economy in the world. The Indian construction industry is an integral part of the economy and a conduit for a substantial part of its development investment, is poised for growth on account of industrialization, urbanization, economic development and people's rising expectations for improved quality of living. To be competitive in today's market, it is essential for construction companies to provide more consistent quality and value to their owners/customers.

### B. Principles of TQM

The principles of Total Quality Management (TQM) provide a means for achieving quality in the construction process. The improvement of quality requires that every member of the organization embrace the principles of continuous improvement. Total Quality Management is a customer-oriented approach that stresses the effective use of people. Total Quality management also emphasizes the application of quantitative methods and process improvement techniques to continually improve products and services. Total Quality Management encourages innovation.

### C. Aims of TQM

The International Academy of the American Society for Quality has defined TQM as: The management approach of an organization centered on quality, based on the participation of all of its members and aiming at long-term success through customer satisfaction and benefits to all members of the organization and to society. The aims of TQM are to achieve customer satisfaction, cost effectiveness, and defect free work through a relentless pursuit of the "war on waste."

## VI. FORMATION OF QUALITY CIRCLE

### A. Introduction

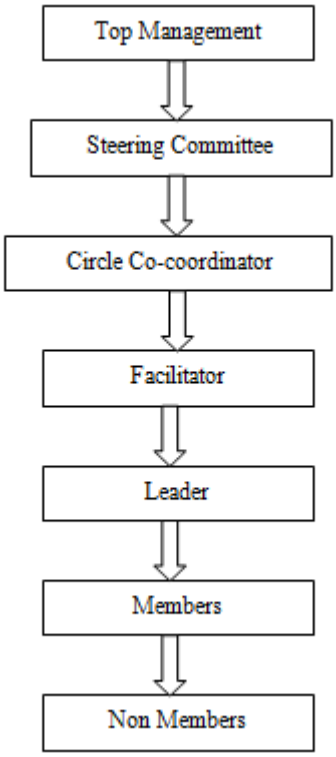
Quality Circles (QC) is a TQM method of utmost simplicity which can be easily adopted in this case. There have been no reported instances with regard to usage of QC in construction industry, while there has been an experimental study done on its usage in the American construction industry.

### B. Objectives of Quality Circle

To bring a change to the attitude of the employees. To facilitate the continuous improvement of the employees as well as the organization. To bring out the hidden potential of the employees and hence bring self-development to the employees. To develop team spirit within the employees resulting in zero conflict among the management and employees. To improve organizational culture.

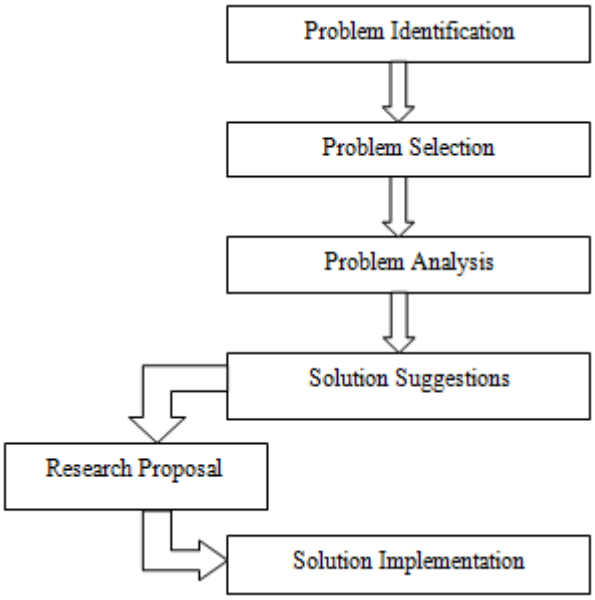
### C. Structure of Quality Circle

A circle is usually made up of 10 members who work together, which comprises of people who work in the office, middle level management personnel, supervisors and foremen. They meet for about an hour a week so as to identify, isolate, discuss and solve problems that they face such as quality and productivity issues.



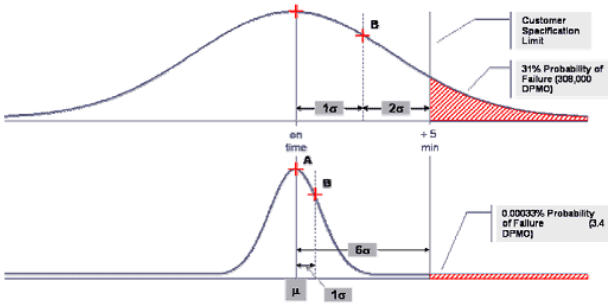

### D. Process of Quality Circle

As quality circles are a method of TQM, it is a process oriented method. Once the circles are formed, the facilitator imparts training onto the members. After their training is complete, a quality circle is ready to be implemented. The first step of the process is to identify the problem, the circle members meet on a regular basis and discuss about what the possible causes for a problem/problems. Next, they move on to ranking the problems or isolating the problem of greatest magnitude. They move on to further analyze the problem and discuss the possible solutions to them and rank or prioritize the most effective or efficient solutions. These suggestions are put forward to the management to be approved, on approval of which they would be implemented.



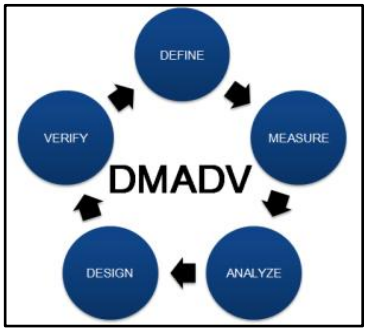
## VII.INTRODUCTION TO SIX SIGMA

Six Sigma is new, emerging, approach to quality assurance and quality management with emphasis on continuous quality improvements. The main goal of this approach is reaching level of quality and reliability that will satisfy and even exceed demands and expectations of today's demanding customer. A term Sigma Quality Level is used as an indicator of a process goodness. Lower Sigma quality level means greater possibility of defective products, while, higher Sigma quality level means smaller possibility of defective products within process. The Six Sigma concept has derived from statistical distribution known as "*standard normal distribution*" illustrated by symmetrical bell-shaped curve. *"Theoretically this bell-shaped curve has been extensively studied and has been proven very useful as numerous natural continuous phenomena seem to follow it or can be approximated by it."1* The curve represents the total "*population*" (whatever is measuring) by the infinite series of segments in its both directions. Each segment has been named "*Sigma*" which symbolize by "σ" (Greece letter) and is deviation from "*mean*" (μ: average or peak of the bell - shaped curve) in Statistical terms . The considerable part of the curve is the range between− 3σ and +3σ due to covering 99.73% of the population where as Six Sigma considers the range between−6σ and +6σ which covers 99.9997% of the data. The contraction of the curve illustrates that the main population is cumulatively around average and in specification limits which presents the excellence performance.




## VIII. METHODOLOGIES OF SIX SIGMA

### A. DMIAC




#### 1) Define

The main objective of this stage is to outline the borders of the project. Stakeholders agree on the parameters that will define the project. Scope and budgetary items, as well as customer needs, are aligned with project goals. Team development takes place as the project begins to take shape.

#### 2) Measure

The main objective is to collect data pertinent to the scope of the project. Leaders collect reliable baseline data to compare against future results. Teams create a detailed map of all interrelated business processes to elucidate areas of possible performance enhancement.

#### 3) Analyze

The main objective is to reveal the root cause of business inefficiencies. Analysis of data reveals areas where the implementation of change can provide the most effective results. Groups discuss ways that the data underscores areas ripe for improvement.

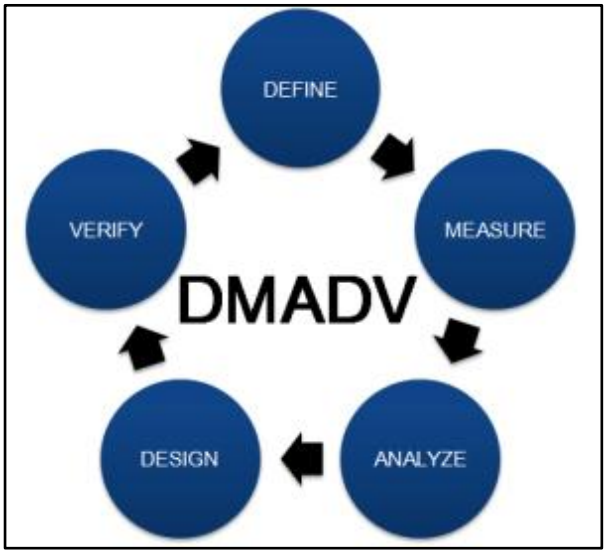
#### 4) Improve

The main objective at the end of this stage is to complete a test run of a change that is to be widely implemented. Teams and stakeholders devise methods to address the process deficiencies uncovered during the data analysis process. Groups finalize and test a change that is aimed at mitigating the ineffective process. Improvements are ongoing and include feedback analysis and stakeholder participation.

#### 5) Control

The objective of the last stage of the methodology is to develop metrics that help leaders monitor and document continued success. Six Sigma strategies are adaptive and on-going. Adjustments can be made and new changes may be implemented as a result of the completion of this first cycle of the process. At the end of the cycle, additional processes are either addressed or the initial project is completed.

### B. DMADV




The application of DMADV is used when a client or customer requires product improvement, adjustment, or the creation of an entirely new product or service. The application of these methods is aimed at creating a high-quality product keeping in mind customer requirements at every stage of the game.

#### 1) Define

Project leaders identify wants and needs believed to be considered most important to customers. Wants and needs are identified through the historical information, customer feedback, and other information sources. Teams are assembled to drive the process. Metrics and other tests are developed in alignment with customer information.

#### 2) Measure

The second part of the process is to use the defined metrics to collect data and record specifications in a way that can be utilized to help drive the rest of the process. All the processes

needed to successfully manufacture the product or service are assigned metrics for later evaluation. Technology teams test the metrics and then apply them.

**3) Analyze**

The result of the manufacturing process (i.e. finished product or service) is tested by internal teams to create a baseline for improvement. Leaders use data to identify areas of adjustment within the processes that will deliver improvement to either the quality or manufacturing process of a finished product or service. Teams set final processes in place and make adjustments as needed.

**4) Design**

The results of internal tests are compared with customer wants and needs. Any additional adjustments needed are made. The improved manufacturing process is tested and test groups of customers provide feedback before the final product or service is widely released.

**5) Verify**

The last stage in the methodology is continuous. While the product or service is being released and customer reviews are coming in, the processes may be adjusted. Metrics are further developed to keep track of continuous customer feedback on the product or service. New data may lead to other changes that need to be addressed, so the initial process may lead to new applications of DMADV in subsequent areas.

## IX. TQM VS SIX SIGMA

### A. Integration

In Total Quality Management framework, quality is not sufficiently connected with the strategy and performances; a team that is responsible for quality improvement is autonomous and separated both from the top managers, as well as from the process executives. Six Sigma process management, process improvement and measurement are seen as the daily responsibility of all employees, and above all operational managers and direct executives of business processes; this concept enables that the quality and costs, as well as their relationship, become an integral part of work of each employee.

### B. Leadership

When it comes to quality, quality leaders are managers who are committed to quality improvement, advocate for quality improvement, and take measures to raise the quality of the business to the next, higher level; however, if top management support is missing, and they express scepticism for the ideas of leaders, these ideas may remain exactly that, just ideas, with no possibility for implementation; in such enterprises, where top managers' support is missing, quality improvement is only temporary assignment the ideas of leaders are only the prelude or introduction to quality improvement process , because Six Sigma implies that top managers must understand the necessity of change, and the necessity of quality improvement for continuity of successful business; only with the support of top managers, ideas of leaders and other employees can become a reality.

### C. Quality

The objective of Total Quality Management is primarily to stabilize the level of quality, not improve it. The message that Six Sigma promotes includes continuous improvement of enterprise, focusing on customers, process management and process improvement.

### D. Goal:

The goal that is promoted by Total Quality Management is usually expressed as "achieving or surpassing customers' requirements"; however, as customers' requirements are subject to change, meeting customers' needs today, does not assure their satisfaction in the future. Six Sigma defines a challenging, ambitious goal, which is expressed as "providing zero-defects"; this goal is very clear, since it is defined as defects rate or correctness rate, which should be around 99.99966%

### E. Attitude

The team charged for Total Quality Management creates a "quality policy" and takes care that business processes are realized in accordance with this policy; quality policy is defined without consulting the direct executives of the processes, but they are forced to comply it; due to that, direct executives are often alienated from the defined quality policy. Six Sigma involves the expertise of employees for performing specific activities, particularly in terms of their adaptation to changing conditions, and not only in terms of mechanical application of technical guidelines, programs or policy; employees are given the authority to perform work in a way they think is the best, but they must always have in mind the fact that the results of their work reflect the results of the enterprise as a whole.

## X. CONCLUSION

Defects are usually explained as measurable characteristics of the process or process output that do not suit the needs of the customers' or the standard or specification. The Six Sigma concept differs from the Total Quality Management precisely when it comes about the attitude on defects and variations. Bearing in mind the features of the Six Sigma concept, and comparing it to Total Quality Management, it can be said that it is more comprehensive and more appropriate for modern environment. For successful implementation of this concept, managers must have a clear vision and must present it to all employees how it could become their vision, too. Also, the enterprise must strive to attract and hire the best people in a given field. In addition, it is desirable to define clearly the values and principles (business culture), because they have to connect employees at all levels. This means that all employees need to respect the other employees, regardless of whether they are in inferior or superior relationships. It is important to develop leadership, because managers are usually good at coping with a complex, but stable phenomena, while the role of leaders is prominent in the field of innovation. Therefore, it is necessary to develop a commitment to change among the employees. Thus, although the essence of both approaches is that improvements must not be haphazard, but systematic and well thought out, and then successfully implemented in order to provide effects, these concepts have some differences. Moreover, all differences go in favor of the Six Sigma concept, and this is confirmed by its increasing presence in the global economy. Latest survey results show that enterprises in Serbia understand the importance of the implementation of this concept for competitiveness improvement

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