Managing Quality in Oil and Gas Construction

Debdutta Mallik
ASNT Level 3 Trainer / Technical Consultant
Velosi (M) Sdn Bhd
No 6-2 Jalan PJS 8/2 Mentari Business Park
Bandar Sunway, 46150, Petaling Jaya, Selangor, Malaysia
d-mallik@velosi.com, debduttamallik@yahoo.co.in

ABSTRACT

Onshore/Offshore construction is backbone of Oil & Gas industry as well as for nation’s economy. Quality management system has been a major player in construction projects for last few decades mainly in Oil & Gas sector. The development of construction industry depends on the quality of construction projects. Quality is one of the critical factors in the success of construction projects. Improvement in the quality of construction projects is linked with Total Quality Management in the project life cycle. Adopting this system ensures safety and integrity of the complete project construction in compliance set Standard & Specification. This paper deals with various aspects of Total Quality Management system which can be followed for execution of an Onshore/Offshore construction project.

Keywords: quality management, quality control, quality assurance, construction, safety

1.0 Introduction

Quality is one major factor behind success of any project. A suitable Total Quality Management system can ensure the same. Quality of construction projects is linked with proper quality management in all the phases of project life cycle. Quality Management has increasingly been adopted by construction companies as an initiative to solve quality problems and to meet the needs of the final customer. Compared to manufacturing and service industry, the construction industry is more complex involving many labor skills, different materials, and complex technical and management skills. Since the work is normally carried out in open, uncertain weather conditions to a certain extent affects the progress of construction. Quite often, the construction overshoots the target date and also exceeds the budget estimate.

Using a TQM approach, the causes of the defects can be scientifically analyzed and remedial measures taken to ensure the safety in construction. The mindset of the employee has to be changed from one of only monitoring to one of continually looking for improvement. Total quality management in construction ensures quality and productivity. It is basically a way of thinking about the concept, visualization and achievement of goals.
### 2.0 Overview of Total Quality Management:

**Evolution of Total Quality Management: TQM Timeline & History of TQM**

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>1920s</td>
<td>Some of the first seeds of quality management were planted as the principles of scientific management swept through U.S. industry. Businesses clearly separated the processes of planning and carrying out the plan, and union opposition arose as workers were deprived of a voice in the conditions and functions of their work. The Hawthorne experiments in the late 1920s showed how worker productivity could be impacted by participation.</td>
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<tr>
<td>1930s</td>
<td>Walter Shewhart developed the methods for statistical analysis and control of quality.</td>
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<tr>
<td>1950s</td>
<td>W. Edwards Deming taught methods for statistical analysis and control of quality to Japanese engineers and executives. This can be considered the origin of TQM. Joseph M. Juran taught the concepts of controlling quality and managerial breakthrough. Armand V. Feigenbaum’s book Total Quality Control, a forerunner for the present understanding of TQM, was published. Philip B. Crosby’s promotion of zero defects paved the way for quality improvement in many companies.</td>
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<td>1960s</td>
<td>Shigeo Shingo: Mistake Proofing A. Fiegenbaum: Total Quality Control</td>
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<td>1968</td>
<td>The Japanese named their approach to total quality companywide quality control. It is around this time that the term quality management systems arises. Kaoru Ishikawa’s synthesis of the philosophy contributed to Japan’s ascendancy as a quality leader.</td>
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<td>1970s</td>
<td>Shift from QA to Strategic Approach of Quality</td>
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<td>1986</td>
<td>Motorola developed Six Sigma approach</td>
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<td>1990s</td>
<td>TPS: Toyota Production System (Lean Six Sigma)</td>
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<td>2000 onwards</td>
<td>TQM is the name for the philosophy of a broad and systemic approach to managing organizational quality. Quality standards such as the ISO 9000 series and quality award programs such as the Deming Prize etc specify principles and processes that comprise TQM.</td>
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2.1 Some Fundamental Concepts

We usually think of “Quality” in terms of an excellent product or service that fulfils or exceeds our expectations. These expectations are based on the intended use and its cost. According Dale Besterfield (Quality Control, A Practical Approach, 7th edition, 2004).

Quality can be expressed as: \( Q = \frac{P}{E} \)

Where: 
- \( Q \) = Quality
- \( P \) = Performance
- \( E \) = Expectation.

If \( Q \) is greater than 1.0, then the customer has a feeling of great satisfaction about the product or service rendered. The determination of \( Q \) is based on perception, with the contractor determining performance and the customer determining expectations. The customer expectations are continually becoming more demanding.

In simplified terms, **Quality Control** concerns the operational means to fulfill the quality requirements, while **Quality Assurance** aims at providing confidence in this fulfillment, both within the organization and externally to customers and authorities.

**Quality management** includes quality control and quality assurance, as well as the additional concepts of quality policy, quality planning and quality improvement. Quality management operates throughout the quality system. These concepts can be extended to all parts of an organization.

**Total quality management** brings to these concepts a long-term global management strategy and the participation of all members of the organization for the benefit of the organization itself, its members, its customers and society as a whole. Basically Quality Management System emphasis on prevention, not correction.

### 3.0 Total Quality Management Principles: The 8 Primary Elements of TQM

Total quality management can be summarized as a management system for a customer-focused organization that involves all employees in continual improvement. It uses strategy, data, and effective communications to integrate the quality discipline into the culture and activities of the organization. Many of these concepts are present in modern Quality Management Systems, the successor to TQM. Here are the 8 principles of total quality management:

#### 3.1. Customer-focused

The customer ultimately determines the level of quality. No matter what an organization does to foster quality improvement—training employees, integrating quality into the design process,
upgrading computers or software, or buying new measuring tools—the customer determines whether the efforts were worthwhile.

### 3.2. Total employee involvement

All employees participate in working toward common goals. Total employee commitment can only be obtained after fear has been driven from the workplace, when empowerment has occurred, and management has provided the proper environment. High-performance work systems integrate continuous improvement efforts with normal business operations. Self-managed work teams are one form of empowerment.

### 3.3. Process-centered

A fundamental part of TQM is a focus on process thinking. A process is a series of steps that take inputs from suppliers (internal or external) and transforms them into outputs that are delivered to customers (again, either internal or external). The steps required to carry out the process are defined, and performance measures are continuously monitored in order to detect unexpected variation.

### 3.4. Integrated system

Although an organization may consist of many different functional specialties often organized into vertically structured departments, it is the horizontal processes interconnecting these functions that are the focus of TQM.

Micro-processes add up to larger processes, and all processes aggregate into the business processes required for defining and implementing strategy. Everyone must understand the vision, mission, and guiding principles as well as the quality policies, objectives, and critical processes of the organization. Business performance must be monitored and communicated continuously.

Every organization has a unique work culture, and it is virtually impossible to achieve excellence in its products and services unless a good quality culture has been fostered. Thus, an integrated system connects business improvement elements in an attempt to continually improve and exceed the expectations of customers, employees, and other stakeholders.

### 3.5. Strategic and systematic approach

A critical part of the management of quality is the strategic and systematic approach to achieving an organization’s vision, mission, and goals. This process, called strategic planning or strategic management, includes the formulation of a strategic plan that integrates quality as a core component.
3.6. Continual improvement

A major thrust of TQM is continual process improvement. Continual improvement drives an organization to be both analytical and creative in finding ways to become more competitive and more effective at meeting stakeholder expectations.

3.7. Fact-based decision making

In order to know how well an organization is performing, data on performance measures are necessary. TQM requires that an organization continually collect and analyze data in order to improve decision making accuracy, achieve consensus, and allow prediction based on past history.

3.8. Communications

During times of organizational change, as well as part of day-to-day operation, effective communications plays a large part in maintaining morale and in motivating employees at all levels. Communications involve strategies, method, and timeliness.

To be successful implementing TQM, an organization must concentrate on the eight key elements:

1. Ethics.
2. Integrity
3. Trust.
4. Training.
5. Teamwork.
7. Recognition.
8. Communication.
4.0 Quality Management Tools

Total Quality Management mainly demands a process of continued improvement aimed at reducing variability. An organization wishing to support and develop such a process needs to use quality management tools and techniques. It is prudent to start with the more simple tools and techniques.

Here follows a brief description of the basic set of Total Quality Management tools. They are:

- Pareto Principle
- Scatter Plots
- Control Charts
- Flow Charts
- Cause and Effect, Fishbone, Ishikawa Diagram
- Histogram or Bar Graph
- Check Lists
- Check Sheets

4.1 Pareto Principle

The Pareto principle suggests that most effects come from relatively few causes. In quantitative terms: 80% of the problems come from 20% of the causes (machines, raw materials, operators etc.); 80% of the wealth is owned by 20% of the people etc. Therefore effort aimed at the right 20% can solve 80% of the problems. Double (back to back) Pareto charts can be used to compare ‘before and after’ situations. General use, to decide where to apply initial effort for maximum effect.
4.2 Scatter Plots

A scatter plot is effectively a line graph with no line - i.e. the point intersections between the two data sets are plotted but no attempt is made to physically draw a line. The Y axis is conventionally used for the characteristic whose behavior we would like to predict. Use, to define the area of relationship between two variables.

Warning: There may appear to be a relationship on the plot when in reality there is none, or both variables actually relate independently to a third variable.

4.3 Control Charts
Control charts are a method of Statistical Process Control, SPC. (Control system for production processes). They enable the control of distribution of variation rather than attempting to control each individual variation. Upper and lower control and tolerance limits are calculated for a process and sampled measures are regularly plotted about a central line between the two sets of limits. The plotted line corresponds to the stability/trend of the process. Action can be taken based on trend rather than on individual variation. This prevents over-correction/compensation for random variation, which would lead to many rejects.

4.4 Flow Charts

Pictures, symbols or text coupled with lines, arrows on lines show direction of flow. Enables modeling of processes; problems/opportunities and decision points etc. Develops a common understanding of a process by those involved with no particular standardization of symbology.

4.5 Cause and Effect, Fishbone, Ishikawa Diagram
The cause-and-effect diagram is a method for analyzing process dispersion. The diagram's purpose is to relate causes and effects. Three basic types: Dispersion analysis, Process classification and cause enumeration. Effect = problem to be resolved, opportunity to be grasped, result to be achieved. Excellent for capturing team brainstorming output and for filling in from the 'wide picture'. Helps organize and relate factors, providing a sequential view. Deals with time direction but not quantity. Can become very complex. Can be difficult to identify or demonstrate interrelationships.

4.6 Histogram or Bar Graph

A Histogram is a graphic summary of variation in a set of data. It enables us to see patterns that are difficult to see in a simple table of numbers. Can be analyzed to draw conclusions about the data set.

A histogram is a graph in which the continuous variable is clustered into categories and the value of each cluster is plotted to give a series of bars as above. The above example reveals the skewed distribution of a set of product measurements that remain nevertheless within specified limits. Without using some form of graphic this kind of problem can be difficult to analyze, recognize or identify.

4.7 Check Sheets

A Check Sheet is a data recording form that has been designed to readily interpret results from the form itself. It needs to be designed for the specific data it is to gather. Used for the collection of quantitative or qualitative repetitive data. Adaptable to different data gathering situations. Minimal interpretation of results required. Easy and quick to use. No control for various forms of bias - exclusion, interaction, perception, operational, non-response, estimation.

4.8 Check Lists

A Checklist contains items that are important or relevant to a specific issue or situation. Checklists are used under operational conditions to ensure that all important steps or actions have been taken. Their primary purpose is for guiding operations, not for collecting data. Generally used to check that all aspects of a situation have been taken into account before action or decision making. Simple, effective.
5.0 Quality Management System in Onshore/Offshore Construction

Every Quality Management plan is project specific. Outline of a typical plan for pipeline construction in line with ISO: 9001 is given below:

1. Preparation of Quality Policy which clearly defines the goal of the organization which shall be followed by all persons involved in the project.
2. Quality Manual: A suitable project specific quality manual need to be generated in line with requirement of reference code and standards, which will address the followings:
   a. Specified Level of Quality—Materials and Workmanship
   b. Document and Record Control
   c. Management and Staff Responsibilities, Approving authorities.
   e. Process Control(Preparatory phase, Initial phase and Follow-up phase)
   f. Inspection and Testing
   g. Control of Nonconforming Work and Materials
   h. Control of Inspection, Measuring and Testing Equipment
   i. Project Materials Certification
   j. Audit requirements and its frequencies
   k. Safety, health & environment

6.0 Conclusion

Benefit of Total Quality Management is endless. Implementation of Total Quality Management System in any offshore project will make it more productive & cost effective. The major benefits of TQM in terms of cost savings include elimination of non-confirmation & repetitive work, elimination of waste costs and reject products, elimination of repairs and reworks, reduced warranty and customer support costs, process efficiency leading to improved profit per product or service & fiscal discipline through elimination of unnecessary steps and wasteful expenditure and improved customer satisfaction.

TQM also frees up management time from redressing problems and directs management time and effort to increase production extend the range of products & improve existing products.

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