Quality Management in Construction Projects

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Quality in Construction Projects

• Construction projects are constantly increasing in technological complexity.
• Electromechanical services constitute between 25% and 35% of the total cost of a building project, depending on what type of technologically advance services are required for the project.
• Quality management in construction projects is different from that in manufacturing.

• Quality in construction projects encompasses not only the quality of products and equipment used in the construction, but the total management approach to completing the facility per the scope of works to customer/owner satisfaction within the budget and in accordance with the specified schedule to meet the owner’s defined purpose.
• The **nature of the contracts** between the parties plays a dominant part in the quality system required from the project, and the responsibility for fulfilling them must therefore be specified in the project documents.

• The documents include plans, specifications, schedules, bill of quantities, and so on
• **Quality control** in construction typically involves ensuring compliance with minimum standards of material and workmanship in order to ensure the performance of the facility according to the design.
Quality meanings

• **Conformance** to established requirements has relevance and clarity.

• **Requirements** are contractually established characteristics of a product, process, or service.

• **A characteristic** is a physical or chemical property, a dimension, a temperature, a pressure, or any other specification used to define the nature of product, process or service.
• **Total quality management** is an organization wide effort centered on quality to improve performance that involves everyone and permeates every aspect of an organization to make quality a primary strategic objective.

• In case of construction projects, an organizational framework is established and implemented mainly by three parties: owner, designer/consultant, and contractor.

• Project quality is the result of aggressive and systematic application of quality control and quality assurance
• Quality of construction projects can be evolved as follows:
• 1. Properly defined scope of work
• 2. Owner, project manager, design team leader, consultant, and constructor’s manager are responsible to implement quality
• 3. Continuous improvement can be achieved at different levels as follows:
a. Owner—Specify the latest needs
b. Designer—Specification should include the latest quality materials, products, and equipment
c. Constructor—Use the latest construction equipment to build the facility
• 4. Establishment of performance measures
• a. Owner
  – i. To review and ensure that designer has prepared the contract documents that satisfy his needs
  – ii. To check the progress of work to ensure compliance with the contract documents
• **b. Consultant**
  
  i. consultant designer is to include the owner’s requirements explicitly and clearly define them in the contract documents
  
  ii. As a supervision consultant, supervise contractor’s work per contract documents and the specified standards

• **c. Contractor**—To construct the facility as specified and use the materials, products, and equipment that satisfy the specified requirements
• **5. Team approach**—Every member of the project team should know that TQM is a collaborative effort, and everybody should participate in all the functional areas to improve the quality. They should know that it is a collective effort by all the participants.

• **6. Training and education**—Both consultant and contractor should have customized training plans for their management, engineers, supervisors, office staff, technicians, and laborers.

• **7. Establish leadership**—Organizational leadership should be established to achieve the specified quality.
Types of contracting systems

1. Design/Bid/Build type Contracting System (Traditional Contracting System)
2. Design/Build type Contracting System
3. Project Manager type Contracting System
4. Construction Manager type Contracting System
5. Guaranteed Maximum Price
6. Build–Own–Operate–Transfer
7. Turnkey Contract
Conceptual Design

• The idea is conceived and given an initial assessment
• most critical to achieving outstanding project performance
• The conceptual phase includes
  – Identification of need by the owner, and establishment of main goals
  – Feasibility study, which is based on owner’s objectives
  – Identification of project team by selecting other members and allocation of responsibilities
  – Identification of alternatives
  – Financial implications, resources, based on estimation of life cycle cost of the favorable alternative
  – Time schedule
  – Development of concept design
Preliminary Design

• *It is schematic design.* The project is planned to a level where sufficient details are available for the initial cost and schedule.

• The central activity of preliminary design is the architect’s design concept of the owner’s objective, which can help make the detailed engineering and design for the required facility.
Preliminary design determines

• 1. General layout of the facility/building/project
• 2. Required number of buildings/number of floors in each building/area of each floor
• 3. Different types of functional facilities required such as offices, stores, workshops, recreation, training centers, parking, etc.
• 4. Type of construction such as reinforcement concrete or steel structure, precast, or cast in situ
• 5. Type of electromechanical services required
• 6. Type of infrastructure facilities inside the facilities area
• 7. Type of landscape
Detailed Design

• Detailed design involves the process of successively breaking down, analyzing, and designing the structure and its components so that it complies with the recognized codes and standards of safety, and performance while rendering the design in the form of drawings and specifications that will tell the contractors exactly how to build the facility to meet the owner’s need.
• The design professional can help ensure project quality through several activities, including:
  – Developing a scope of services that meet the owner’s requirements and the project goals and objectives
  – Developing a design activity plan for the project
  – Defining project design guidelines
  – Estimating accurately the hours of effort and costs involved in achieving a quality design
  – Building flexibility into the design activity plan to allow for changes and future project development, as well as associated budget and schedule revisions
  – Developing a realistic schedule with appropriate milestones to confirm progress
  – Monitoring design progress constantly
Detail Design of the Works

- Architectural Design
- Concrete Structure
- Elevator Works
- HVAC Works
- Fire Protection System
- Plumbing Works
- Drainage System
- Electrical System
- Fire Alarm System
- Telephone/Communication System
- Public Address System
- Audiovisual System
- Security System
- Landscape & External Works
- Furnishings/Furniture
• Regulatory/Authorities’ Approval
• Contract Documents and Specifications
• Shop Drawing and Materials Submittals
Samples

• The contractor has to submit (if required) the samples from the approved material to be used for the work.

• The samples are mainly required to:
  – Verify color, texture, and pattern
  – Verify that the product is physically identical to the proposed and approved material
  – Comparison with products and materials used in the works
Contractor’s Quality Control Plan (CQCP)

• The contract documents specify the details of the contents of the Quality Control Plan (QCP) to be prepared by the contractor for the construction project;

• The plan has to be submitted to the consultant for approval.
The following is the outline for preparation of a QCP:
1. Purpose of the QCP
2. Project description
3. Site staff organization chart for quality control
4. Quality control staff and their responsibilities
5. Construction program and subprograms
6. Schedule for submission of subcontractors, manufacturer of materials, and shop drawings
7. QC procedure for all the main activities such as
   – a. Procurement (direct bought out items)
   – b. Off-site manufacturing, inspection, and testing
   – c. Inspection of site activities (checklists)
   – d. Inspection and testing procedure for systems
   – e. Procedure for laboratory testing of material
   – f. Inspection of material received at site
   – g. Protection of works
8. Method statement for various installation activities

9. Project-specific procedures for site work instructions, and remedial notes

10. Quality control records
11. List of quality procedures applicable to project in reference to the company’s quality manual and procedure
12. Periodical testing procedure for construction equipment and tools
13. Quality updating program
14. Quality auditing program
15. Testing
16. Commissioning
17. Handover
18. Site safety
Construction

• Construction is the translation of the owner’s goals and objectives into a facility built by the contractor as stipulated in the contract documents, plans and specifications within budget and on schedule.

• The construction phase consists of various activities such as mobilization, execution of work, planning and scheduling, control and monitoring, management of resources/procurement, quality, and inspection
Management Resources/Procurement

• The contractor is responsible for engaging subcontractors, specialist installers, and suppliers; and arranging for materials, equipment, construction tools, and all types of human resources.

• Workmanship is one of the most important factors to achieve quality in construction; therefore, it is the construction workforce be fully trained and have full knowledge of all the related activities to be performed during the construction process.
Quality Control

• On the construction site, inspection and testing are carried out in three stages during the construction period to ensure quality compliance

• 1. During the construction process. This is carried out with the checklist request submitted by the contractor for testing ongoing work before proceeding to the next step.
• 2. Receipt of subcontractor or purchased material or services. The contractor submits a material inspection request to the consultant upon receipt of material.

• 3. Before final delivery or commissioning and handover.
Contractor’s Quality Control Plan

• The contractor’s quality control plan (CQCP) is the contractor’s everyday tool to ensure meeting the performance standards specified in the contract documents.
• The CQCP is the documentation of the contractor’s process for delivering the level of construction quality required by the contract.
• It is a framework for the contractor’s process for achieving quality construction
• The CQCP does not endeavor to repeat or summarize contract requirements.
• It describes the process that the contractor will use to ensure compliance with the contract requirements.
• Based on contract requirements, the contractor prepares his quality control plan and submits it to the consultant for approval.
• This plan is followed by the contractor to maintain project quality.
• The contractor’s quality control plan is prepared based on the project-specific requirements as specified in the contract documents.

• The plan outlines the procedures to be followed during the construction period to attain the specified quality objectives of the project while fully complying with the contractual and regulatory requirements.
Content of The CQCP

• 1. Introduction
• 2.0 Description of project
• 3.0 Quality control (QC) organization
• 4.0 Qualification of QC staff
• 5.0 Responsibilities of QC personnel
Content of The CQCP

• 6.0 Procedure for submittals
  – 6.1 Submittals of subcontractor(s)
  – 6.2 Submittals of shop drawings
  – 6.3 Submittals of materials
  – 6.4 Modification request
  – 6.5 Construction program
Content of The CQCP

• 7.0 Quality control procedure
  – 7.1 Procurement
  – 7.2 Inspection of site activities (checklists)
  – 7.3 Inspection and testing procedure for systems
  – 7.4 Off-site manufacturing, inspection, and testing
  – 7.5 Procedure for laboratory testing of material
  – 7.6 Inspection of material received at site
  – 7.7 Protection of works
  – 7.8 Material storage and handling
Content of The CQCP

• 8.0 Method statement for various installation activities
• 9.0 Project-specific procedures
• 10.0 Quality control records
• 11.0 Company’s quality manual and procedures
• 12.0 Periodical testing
• 13.0 Quality updating program
• 14.0 Quality auditing program
• 15.0 Testing, commissioning, and handover
• 16.0 Health, safety, and the environment (HSE)
5S for Construction Projects

- 5S is a systematic approach for improving quality and safety by organizing a workplace.
- It is a methodology that advocates.
- What should be kept
- Where it should be kept
- How it should be kept
- 5S is a Japanese concept of housekeeping having reference to five Japanese words starting with letter S.
5S for Construction Projects

• 1. Sort
• Determine what is to be kept in the open and what under shed
• Allocate area for each type of construction equipment and
• Machinery
• Allocate area for electrical tools
• Allocate area for hand tools
1. Sort

- Allocate area for construction material/equipment to be used/
- installed in the project
- Allocate area for hazardous, inflammable material
- Allocate area for chemicals, paints
- Allocate area for spare part for maintenance
2. Set in order

• Keep/arrange equipment in such a way that their maneuvering/movement shall be easy
• Vehicles are to be parked in the yard in such a way that frequently used vehicles are parked near the gate
• Frequently used equipment/machinery to be located near the workplace
• Set boundaries for different type of equipment and machinery
• Identify and arrange tools for easy access
• Identify and store material/equipment per relevant division/section of contract documents
2. Set in order

• Identify and store material in accordance with their usage per construction schedule
• Determine items that need special conditions
• Mark/tag the items/material
• Display route map and location
• Put the material in sequence per their use
• Frequently used consumables to be kept near workplace
• Label drawers with list of contents
• Keep shuttering material at one place
• Determine inventory level of consumable items
3. Sweeping

- Clean site on daily basis by removing
- – Cut pieces of reinforced bars
- – Cut pieces of plywood
- – Left-out concrete
- – Cut pieces of pipes
3. Sweeping

- Cut pieces of cables and wires
- Used welding rods
- Clean equipment and vehicles
- Check electrical tools after return by the technician
- Attend to breakdown report
4. Standardize

- Standardize the store by allocating separate areas for material used by different divisions/sections
- Standardize area for long lead items
- Determine regular schedule for cleaning the work place
- Make available standard toll kit/box for a group of technicians
4. Standardize

- Make every one informed of their responsibilities and related area where the things are to be placed and are available
- Standardize the store for consumable items
- Inform suppliers/vendors in advance the place for delivery of material
5. Sustain

• Follow the system until the end of project
• The contractor is responsible for providing all the resources to build the project/facility. These resources are mainly.
• 1. Manpower
• 2. Construction equipment, machinery, and tools
• 3. Material to be used/installed in the project
• 4. Consumables
• The following points have to be considered while planning the layout for storage of construction material:

• 1. Construction documents specify the minimum number of construction equipment, machinery, and tools to be made available at the construction site during the construction process.
• 2. Materials to be used/installed in the project are documented in the bill of quantity (BOQ) or bill of material (BOM), and contract drawings and documents.

• 3. Consumables are required by the contractor to fabricate/install/assemble the equipment/panel/material.
• The 5S program helps
• Reduce time to search equipment, tools, material, and consumables
• Improve activity timing
• Increase space for storage
• Improve safety
• Organize the workplace