Development of an Internal Quality Audit (IQA) System for Construction Projects

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***Abstract*- Development of an Internal Quality Audit (IQA) System for Construction Projects aims to enhance quality management practices in the construction industry through the creation of a robust and systematic audit framework. The construction sector frequently faces challenges related to quality control, leading to increased costs and project delays. This project seeks to address these issues by developing an IQA system tailored to the specific needs and complexities of construction projects A pilot implementation was conducted on a sample construction project to test the efficacy of the proposed system. The audit results demonstrated a significant improvement in identifying quality issues early, leading to enhanced adherence to project specifications and standards. The system's effectiveness was measured by reductions in rework, cost overruns, and project delays, as well as improved stakeholder satisfaction This project contributes to the construction industry by providing a practical tool for internal quality assurance, facilitating more rigorous and efficient quality control processes. The developed IQA system is expected to improve overall project quality, reduce errors, and enhance operational efficiency. Future work will focus on refining the system based on feedback from ongoing implementations and exploring its adaptability to various types of construction projects.**

I. INTRODUCTION

In the construction industry, ensuring the highest standards of quality is crucial for the successful completion of projects.

Type of audit

- Internal Quality Audit (IQA)
- External Quality Audit
- Supplier or Vendor Quality Audit
- Compliance Audit
- Process Audit
- Product Quality Audit
- System Audit
- Follow-up Audit
- Management Audit
- Late Department/Engineer Approval of Contractor Submittals-Audit

II. OBJECTIVE

The primary objective of this study is to develop a comprehensive and effective Internal Quality Audit (IQA) system tailored for construction projects, with the aim of addressing key quality management challenges in the industry. By focusing on improving the internal auditing process, the study seeks to enhance the overall quality assurance framework in construction projects, ensuring that they meet the required standards, remain within budget, and are completed on time. A disconnected auditing process often leads to inefficiencies, delayed corrective actions, and poor communication between project teams. This objective focuses on creating a system where quality audits are embedded within the overall project management framework, facilitating immediate action and alignment with the project's timeline and budget.

III. METHODOLOGY

The methodology for developing the Internal Quality Audit (IQA) system for construction projects followed a structured approach that encompassed requirements gathering, system design, software development, testing, and evaluation. The overall goal was to design a system that would streamline and standardize the quality auditing process, improve efficiency, and ensure real-time tracking of compliance with quality standards. Below is a detailed breakdown of the

methodology

- Requirements Gathering
- System Design
- Development Phase

REQUIREMENTS GATHERING

The first step involved collecting detailed requirements from key stakeholders in construction projects to ensure the IQA system would meet the practical needs of the users.

SYSTEM DESIGN

Based on the requirements gathered, the design phase focused on creating a detailed architecture and user interface for the IQA system

DEVELOPMENT PHASE

The testing phase aimed to ensure that the system met the functional, performance, and security requirements before full-scale implementation. After testing the system, the next phase focused on evaluating its effectiveness and gathering feedback from users to make necessary improvements. A pilot project was selected to test the system in real-world conditions. The pilot project involved a construction site where the IQA system was implemented for one of the quality audit stages (e.g., material procurement or safety audit). After testing the system, the next phase focused on evaluating its effectiveness and gathering feedback from users to make necessary improvements.

IV. RESULTS AND DISCUSSIONS

By This study has addressed these critical issues by proposing the development of an Internal Quality Audit (IQA) system that offers a structured, standardized approach to monitoring and improving quality across the construction lifecycle. The key findings and contributions of this research include:

- **Designing a standardized IQA** framework: A flexible yet comprehensive IQA system that can be customized for various types and sizes of construction projects, ensuring consistency in quality audits across the industry.
- Identifying key quality control areas: By focusing on high-risk areas (such as materials, workmanship, safety compliance, and design adherence), the IQA system can more effectively pinpoint and address quality issues before they escalate.

1. CASE 1 EMPIRICAL TESTING AND VALIDATION OF THE IQA FRAMEWORK

The Project Engineer (PE) of various functions shall conduct the inspections and witness the tests through their departments. QA/QC Engineer shall remain responsible for all Quality Assurance and acceptance requirements of the project and will directly report to the PE or Team Leader (Quality Control). QA Engineer will provide all necessary assistance to the P.E or TL (QC) regarding recommendation to acceptance of all raw, manufactured, mixed materials used in the project on achieving the minimum acceptance levels as per the technical specifications in the contract agreement and relevant I.S codes. The PE is responsible for keeping the Consultant Team Leader informed as to progress of the work and the manner in which it is being done, and also to call the attention to any non-compliance with the drawings or specifications. He is not authorized to approve or accept any portion of the work, or to issue instructions contrary to the plans, specifications, and Contract Agreement (CA). The PE to reject unsatisfactory workmanship; defective materials and issue instructions to the Contractor of any work that is being improperly performed in terms of the Contract Agreement.

CASE 2: INVESTIGATING THE IMPACT OF IQA ON PROJECT SUSTAINABILITY

All materials included in the construction works for which quality control tests are specified, and for which approval by the PE or QA/QC Engineer has been previously given, are to be inspected and checked for acceptability in accordance with the Specifications requirements. Any of the completed construction works in which unapproved and/ or untested and/ or unaccepted materials are incorporated without approval or written permission from the PE or QA/QC Engineer is deemed performed at the Contractor's risk and is considered as unacceptable and unauthorized.

All sampling and quality control testing, as well as check tests to verify quality of materials, are to be got conducted by the Contractor in the laboratory set up in his own field laboratory. The testing shall be got carried out under the supervision of the PE or QA/QC Engineer. However, the Contractor is responsible to provide necessary labor tools and transport for the

purpose of sampling by the laboratory staff. The kind(s) of test(s) and frequency of testing should conform to the Minimum Quality Control Testing Requirements of the Technical Specifications /PWD/CPWD Guidelines. Sampling and Testing should be in accordance with the relevant IS methods. Tests are to be reported on proper forms.

- Make sure that the drawing and specifications are complete and convey a clear understanding of the scope of the project.
- Treat seriously and respond in writing to clarifications and other correspondence from the Contractor during the tender phase.
- Be prudent and cautious in accepting alternatives offered by contractors to the scope of work included in the Contract.
- Correct ambiguities and inconsistencies when discovered during the tender phase by issuing addenda, even if it means extending the date for submission of tenders.

ARTICLE 1: DOCUMENATION

Upon completion of the project, check on the defects if any pointed out by the client and give notice to the contractor for rectification of the defects. There are several documents to be prepared and submitted to the client. The following should be checked with the client as the project nears completion:

- All contract documents including approved revised estimate, if any.
- Additional agreement, if any.
- Documents for approval of additional items.
- All GFC drawings.
- As-built drawings.
- Materials source approval.
- Calibration reports of equipment.
- Quality Control Documents.
- Final completion reports including inventory reports and snag lists.
- Guarantee Bonds for specialized works.
- All relevant records properly indexed to facilitate dealing with further Arbitration/Court cases, if any.
- Closing certificate.

Although the final documentation is to be submitted at the end of the construction period, they have to be prepared as the work progresses, and finalized when works are nearing completion.

which he has requested in writing. Such language is often interpreted to include the late approval of submittals, shop drawings, work drawings, etc. Many delay claims can be avoided by the Department/Engineer's prompt review and return of Submittals.

- Be mindful of constructive notice of delays.
- Enforce the requirement that the Contractor make every effort to avoid or mitigate delays.
- The Department's active involvement in review and monitoring the Contractor's construction schedule can often provide critical information which the Department can use to work with the Contractor to avoid or mitigate delays.
- Note that the burden of proof of delays rests with the Contractor. Investigate the Contractor's given reasons for delays.
- Evaluate carefully the Contractor's schedule or programme for conducting the works to ensure its reasonableness and compliance with the Contract.
- Acceptance of the Contractor's schedule by the Department entitles the Contractor to measure delays to the work against this approved schedule. Therefore, caution should be taken to ensure that the schedule is reasonable prior to its approval.
- Be mindful of concurrent Contractor-caused delays in determining the Contractor's entitlement to additional compensation for extensions of time.

ARTICLE 2. PAYMENT CERTIFICATES

Claims Avoidance Notes:

- Require Engineer to process Contractor's applications for payment and issue Payment Certificate, within a reasonable time frame.
- Establish effective system within Department for processing Payment Certificates in a timely fashion
- Limit time available for review and approval by each section within the Department (i.e., Q.S., accounts, etc.).

Remember that the 45 days specified in Article 6 includes time required by the Finance Department to check the certificate and process payment.

ARTICLE 3, INSPECTION TESTING PLAN

Records to be maintained for mandatory tests & QAP.

- Checklist for pour card.
- Moisture Content

- Design Mix Report
- Dry Density Test on Formation/Embankment.
- Third Party Testing Report.
- Request for Information
- Material approval Request
- Material inspection Request
- Materials source approvals
- Gradation of FA&CA
- Aggregate impact value
- Flakiness and Elongation index (FI & EI)
- Fine aggregate Silt content & bulkage.
- Materials invoices and MTC's
- Water source approval
- Lab equipment's / Apparatus Calibration
- Reports

Mandatory registers to be maintained.

- Site order book
- Inspection Register
- Cube Test Register
- Drawing Register
- Hindrance Register
- Cement Register
- Steel Register
- Inward Register
- Outward Register
- Weather Register
- Gradation for CA&FA Aggregate register
- Material Receipt register
- Planning and execution records register
- Obsolete drawing record register
- Pile log register.
- Drawing issue register

List of Mandatory Tests for building works

- Water
- Cement
- Coarse and fine aggregates
- Concrete-nominal mix.
- specifications of these schedules to obtain the types of information the Department can best utilize to monitor construction.
- Study the schedule requirements of the contract and recognize the schedule's benefit to the Department in monitoring the progress of the work, anticipating problems, avoiding and mitigating delays and defending claims.

VI. CONCLUSION

The construction industry is characterized by its complexity, diverse stakeholders, and the need for precise execution across multiple phases. Quality assurance (QA) and quality control (QC) are fundamental to ensuring that construction projects are completed successfully, meeting client requirements, regulatory standards, and safety protocols. However, despite the existence of various quality management systems (QMS), many construction projects still face challenges related to inconsistent quality, cost overruns, delays, and safety issues. These challenges often stem from a lack of effective internal auditing mechanisms, insufficiently trained auditors, and poorly integrated quality control processes

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