Effectiveness of On-site Quality Audits in Reducing Construction Defects

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Abstract — The development industry has been scuffling with quality issues for several years, and therefore the cost to our economy is dramatic. The price could potentially be reduced significantly if the industry were to embrace the concept of quality assurance that has been used with great success by many other sectors of the economy. Building owners also have to be compelled to be educated on what's quality assurance so they'll begin using their voice to encourage adaptation of this approach to guard their investments and reduce the price of construction. Internal control (QC) and Quality Assurance (QA) represent increasingly important concerns for project managers. Defects or failures in constructed facilities may result in very large costs. Even with minor defects, re-construction is also required and facility operations impaired. Increased costs and delays are the result. Quality Assurance and internal control is an important a part of any construction process to boost the standard and uniformity of the project. The requirement for QA and QC in construction projects has increased considerably in recent times because of significant changes, advancements in technology and high expectation of the users. The QA and QC maintain uniformity in construction process and ensure more economical utilization of materials leading to significant reduction in cost to the users. The extra cost involved in QA and QC is directly proportional to the advantages. A technique has been developed for QA and QC in housing industry. The methodology accomplishes the required quality in construction process. Ultimately the presence of quality is vital. So generally we are able to define the standard in several ways as follows, Quality is conformance to requirements or specifications. Quality is fitness to be used. Quality is that the degree to which a collection of inherent characteristics fulfills requirements.

Keywords: Quality Assurance, Quality Control, Quality Audit, Construction, Internal Control

I. Introduction

The construction industry plays a fundamental role in economic development and societal progress by delivering essential infrastructure, residential facilities, commercial buildings, and public utilities. As one of the largest contributors to national economies worldwide, the industry significantly influences employment generation, urbanization, and sustainable development. However, modern construction projects have become increasingly complex due to advancements in technology, stringent regulatory requirements, diverse stakeholder involvement, and growing client expectations. This complexity often increases the likelihood of construction defects, project delays, cost overruns, and quality-related disputes, making quality management a critical success factor in construction project delivery [1].

Quality in construction is generally defined as the degree to which a completed project conforms to specified requirements, satisfies client expectations, and fulfills its intended purpose. The achievement of quality requires the integration of Quality Planning (QP), Quality Assurance (QA), and Quality Control (QC) throughout the project lifecycle. Quality Assurance focuses on preventing defects through systematic procedures, standards, and process improvements, while Quality Control emphasizes monitoring, inspection, testing, and verification to ensure compliance with established specifications and standards. Together, QA and QC form the foundation of an effective quality management system capable of delivering safe, durable, and cost-effective construction projects [2-4].

Despite considerable advancements in construction technologies and management practices, quality-related problems continue to challenge the industry globally. Studies have shown that construction defects remain among the most significant causes of project failure, leading to financial losses, reduced functionality, safety risks, legal disputes, and reputational damage. Research conducted by the Building Research Establishment (BRE) indicates that nearly 90% of building failures originate during the design and construction stages, while human factors, poor supervision, workmanship deficiencies, and inadequate quality management practices account for a substantial proportion of these failures. Defects may range from minor aesthetic imperfections to severe structural deficiencies that threaten the safety and serviceability of buildings and infrastructure [5, 6].

Traditionally, many construction organizations have adopted a reactive approach to quality management, addressing defects only after their occurrence. Such practices often result in expensive rework, schedule delays, contractual disputes, and increased project costs. Contemporary construction management philosophies advocate a proactive approach in which quality considerations are embedded throughout project planning, design, procurement, execution, and commissioning stages. Preventing defects at their source is considerably more effective and economical than correcting deficiencies after construction. Consequently, the industry has witnessed growing adoption of structured quality management systems (QMS), particularly those based on ISO 9001 standards and the Plan–Do–Check–Act (PDCA) framework, which emphasize continuous improvement, customer satisfaction, and process optimization [7].

The concept of Total Quality Management (TQM) has further strengthened quality initiatives in construction by promoting organization-wide participation in continuous improvement efforts. TQM focuses on customer satisfaction, process standardization, waste reduction, teamwork, leadership commitment, and employee involvement. By integrating quality principles into every organizational activity, TQM enables construction firms to enhance productivity, reduce defects, and achieve long-term competitiveness. Nevertheless, the successful implementation of quality management systems remains a challenge in many developing economies due to limited awareness, inadequate training, insufficient management commitment, and misconceptions regarding the costs associated with quality programs [8].

A crucial component of construction quality management is the role of technical inspectors. These professionals serve as the frontline guardians of quality by ensuring that construction activities comply with approved designs, regulatory requirements, contractual obligations, and industry standards. Their responsibilities include conducting site inspections, verifying material quality, assessing workmanship, reviewing documentation, monitoring compliance, and recommending corrective actions whenever deviations are identified. Technical inspectors act as an essential link between designers, contractors, project managers, regulatory authorities, and clients, thereby facilitating effective communication and accountability throughout the construction process [8-9].

Beyond their preventive role, technical inspectors also contribute significantly to dispute resolution and legal proceedings associated with construction defects. Their inspection reports, observations, and certifications often provide critical evidence in claims, arbitration, and litigation cases. In many jurisdictions, inspector certifications are required before project approvals, occupancy permits, and final handovers can be granted. This dual function of quality oversight and legal accountability highlights the strategic importance of technical inspectors in ensuring project success and protecting stakeholder interests [8-10].

Recent advancements in digital technologies have created new opportunities to enhance construction quality management. Technologies such as Building Information Modeling (BIM), automated inspection systems, drones, artificial intelligence, data analytics, and digital quality management platforms enable more accurate monitoring, real-time decision-making, and predictive identification of potential quality issues. These innovations support the transition from traditional inspection-based approaches toward data-driven quality assurance systems capable of improving project performance and reducing defects [10].

Despite these developments, challenges such as fragmented communication, inadequate stakeholder coordination, resource constraints, time pressures, and inconsistent regulatory enforcement continue to hinder effective quality management implementation. Therefore, there is a growing need to examine the effectiveness of quality control measures, quality assurance systems, and technical inspection practices in preventing construction defects and improving project outcomes [10].

This study aims to investigate the significance of quality assurance and quality control practices in construction projects, with particular emphasis on defect prevention and the role of technical inspectors. By examining the causes of construction defects, evaluating quality management methodologies, and analyzing the responsibilities and challenges faced by technical inspectors, the study seeks to provide insights that can support improved project performance, enhanced safety, reduced costs, and greater stakeholder satisfaction. Ultimately, strengthening quality management frameworks and inspection systems will contribute to the delivery of sustainable, resilient, and high-quality construction projects.

II. METHODOLOGY

This study adopted a mixed-method research approach combining quantitative and qualitative techniques to investigate the effectiveness of quality assurance (QA), quality control (QC), and technical inspection practices in preventing construction defects. The research employed a cross-sectional survey design complemented by semi-structured interviews, document analysis, and an extensive literature review to obtain comprehensive insights into quality management practices within the construction industry.

A. Research Design

The quantitative component of the study was based on a structured questionnaire survey administered to construction professionals working in construction companies across Maharashtra. The survey targeted engineers, project managers, site supervisors, quality control personnel, technical inspectors, and other construction professionals possessing a minimum of five years of site experience and involvement in completed construction projects. Both purposive and convenience sampling techniques were employed to select respondents with relevant expertise while ensuring efficient data collection within available time and resource constraints.

B. Data Collection

Primary data were collected through face-to-face interviews and electronically distributed questionnaires. The questionnaire consisted of three sections. Section A gathered demographic and professional background information of respondents. Section B focused on identifying and ranking the major causes of poor quality in construction projects, including poor material quality, poor workmanship, inadequate design and specifications, poor supervision, time constraints, unsuitable machinery, and budget limitations. Section C examined factors contributing to poor construction material quality and deficiencies in QA/QC processes.

The questionnaire utilized both ranking scales and a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Secondary data were obtained through an extensive review of journal articles, books, technical reports, industry publications, construction defect records, inspection reports, and relevant legal documents.

In addition, semi-structured interviews lasting approximately 45–60 minutes were conducted with selected technical inspectors and construction professionals. These interviews explored inspection procedures, defect identification practices, quality management challenges, and the role of inspectors in dispute resolution.

C. Data Analysis

Quantitative data were analyzed using the Statistical Package for Social Sciences (SPSS). Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize respondent characteristics and survey responses. The Total Evaluation Score (TES) method was applied to rank the causes of poor construction quality. The TES was calculated using:

$$TES = \Sigma(W_i \times A_i)$$

where Wi represents the assigned weight for each rank and Ai denotes the number of respondents selecting that rank.

The Relative Importance Index (RII) was employed to evaluate the significance of factors contributing to poor material quality using the following formula:

$$RII = \Sigma W / (A \times N)$$

where W is the weight assigned by respondents, A is the highest possible weight (5), and N is the total number of respondents.

Correlation and regression analyses were further conducted to examine relationships between inspection practices, quality management variables, and defect occurrence. Qualitative data obtained from interviews and document reviews were analyzed using thematic analysis. Emerging themes related to quality management practices, inspection effectiveness, defect prevention, and legal responsibilities were identified and interpreted. Triangulation was subsequently employed to compare and validate findings from quantitative and qualitative sources.

D. Ethical Considerations

Ethical principles were strictly observed throughout the study. Participants were informed about the objectives of the research and provided informed consent before participation. Confidentiality and anonymity were maintained by removing personal identifiers from all collected data. Access to research data was restricted to the research team, and all digital records were securely stored using password-protected and encrypted systems.

III. Results and Discussion

A. Results

The study collected responses from construction professionals involved in quality management, technical inspection, and project supervision activities. The demographic analysis revealed that 67.3% of the respondents were male, while 32.7% were female. The majority of respondents (36.4%) belonged to the 26–30 years age group, and most possessed a Bachelor's degree (67.3%), indicating a relatively young and educated workforce actively engaged in construction quality management.

The findings identified structural cracks, waterproofing failures, and electrical code violations as the most frequently occurring construction defects. Structural cracks were primarily associated with improper curing practices and workmanship deficiencies, while waterproofing defects were commonly detected during finishing works. Electrical defects mainly involved inadequate grounding, overloaded circuits, and improper cable installations. Material-related nonconformities such as unauthorized substitutions, missing test certificates, and incomplete documentation were also observed, particularly during material delivery inspections and pre-construction audits.

Strategy	**Key Components**	**Outcome**
Skilled Workforce Training	Certification programs, ongoing education, safety training	Improved competency and reduced errors
Effective Supervision	Regular inspections, checklists, performance tracking	Early defect detection and correction
Quality Management Systems	ISO 9001, documented processes, audits, accountability	Standardized quality and continuous improvement

Table 1: Summary of Workmanship Excellence Strategies

Analysis of inspection practices indicated that the majority of inspections were conducted during foundation and superstructure stages, whereas inspections during finishing and handover stages were comparatively limited. Statistical analysis revealed a significant relationship between the phase of inspection and defect detection ($p < 0.01$). Defects were more likely to be identified when inspections were conducted during critical construction phases.

No.	Question	Average Index	Mode	Rank
1	Project scope can match with the project proposal and compliance with contract specifications	3.38	3	11
2	Being effective in quality assurance process and project audits	3.65	4	3
3	Product defect rate decreases	3.27	3	12
4	Quality awareness improvements and understanding the quality objectives in the organization	3.78	4	1
5	Non-conformities decrease	3.43	3	9
6	Product and service quality improvement	3.49	3	7
7	Contribution to achieving defined objectives for the project in construction	3.4	3	10
8	Accuracy and presentation of the work by improving quality assurance and control	3.46	3	8
9	Increased effectiveness and efficiency in meeting the organization's quality objectives	3.54	4	5
10	Improved capability to project scope statement, requirements documentation, and project plan	3.38	3	11
11	Enhanced involvement of people in improvement activities	3.68	4	2
12	Consistent outcomes, measured and monitored to approach expected level of quality	3.51	4	6
13	Defining procedures that identifies current practices are obsolete or inefficient	3.62	4	4
14	QMS Procedures ensure corrective action is taken whenever defects occur	3.49	3	7
	Total	3.51	4	---

Notes: Level of the effectiveness QMS on: 5 = Strongly Agree (4.51 – 5.00), 4 = Agree (3.51 – 4.50), 3 = Neutral (2.51 - 3.50), 2 = Disagree (1.51 - 2.50), 1 = Strongly disagree (< 1.50).

Table 2: Descriptive statistics analysis regarding the effectiveness of QMS on quantity/Scope

No.	Question	Average Index	Mode	Rank
1	To effectively resolve problems of construction project without changes on the amount of project budget	3.35	3	8
2	Business outputs are tracked and measured, which means areas of waste and duplication can be identified and eliminated.	3.65	4	4
3	Optimized cost on communication and follow-up of assigned tasks to construction project resources cheaper and easier	3.49	3	6
4	Increased ROI and profit can be caused reduction of cost	3.57	4	5
5	Optimizing performance can reduce expenses by efficient process management and resources	3.9	4	2
6	Lower production costs because of fewer nonconforming products, less rework, lowered rejection rates, streamlined processes and fewer mistakes	3.46	3	7
7	Realizing the defects earlier and are corrected at a lower cost	4	4	1
8	A well-managed supply chain can reduce expenses	3.76	4	3
	Total	3.65	4	****

Notes: Level of the effectiveness QMS on: 5 = Strongly Agree (4.51 – 5.00), 4 = Agree (3.51 – 4.50), 3 = Neutral (2.51 - 3.50), 2 = Disagree (1.51 - 2.50), 1 = Strongly disagree (< 1.50).

Table 3: Descriptive statistics analysis regarding the effectiveness of QMS on Projects costs

The regression analysis further demonstrated a statistically significant negative relationship between inspection frequency and defect occurrence ($p < 0.05$). Projects subjected to more frequent inspections experienced fewer construction defects, highlighting the effectiveness of continuous quality monitoring. Moreover, ANOVA results indicated significant differences in legal dispute outcomes based on the completeness and quality of inspection reports ($p = 0.009$). Projects supported by comprehensive inspection documentation exhibited greater legal clarity and improved dispute resolution outcomes.

Survey results showed that 56.4% of respondents considered existing quality control measures to be effective or very effective, while 43.6% reported experiencing project delays due to quality-related issues. Only 27.3% of organizations conducted regular quality audits, whereas 32.7% never performed audits, suggesting opportunities for improvement in quality management practices.

The Relative Importance Index (RII) analysis identified inadequate quality control activities (RII = 0.79) as the most significant contributor to poor material quality. This was followed by lack of clarity in QA/QC procedures (RII = 0.77) and insufficient guidance regarding the timing and frequency of quality inspections (RII = 0.75).

Regarding Quality Management Systems (QMS), respondents reported positive impacts on project performance. Customer satisfaction received the highest mean score (3.86), followed by cost performance (3.65), project time performance (3.61), and quality/scope management (3.51). These findings indicate that QMS implementation contributes positively to overall project success.

B. Discussion

The findings reinforce the critical role of quality control and technical inspection in preventing construction defects and enhancing project outcomes. The predominance of structural, waterproofing, and electrical defects confirms previous studies that identified workmanship deficiencies, inadequate supervision, and poor material quality as major causes of construction failures. The significant relationship between inspection frequency and defect reduction demonstrates that proactive inspection strategies are more effective than reactive corrective measures.

The results further highlight the importance of technical inspectors as both quality assurance professionals and key contributors to dispute resolution processes. Comprehensive inspection records not only facilitate defect prevention but also provide valuable evidence during legal proceedings. This finding extends existing literature by emphasizing the dual technical and legal responsibilities of inspectors.

The study also demonstrates the value of structured Quality Management Systems in improving customer satisfaction, reducing project costs, minimizing delays, and strengthening organizational performance. However, the relatively low frequency of quality audits observed among respondents suggests that many organizations still rely on informal quality control practices rather than systematic quality management approaches.

The RII analysis indicates that deficiencies in QA/QC procedures and inadequate inspection activities remain significant challenges. Therefore, construction organizations should strengthen quality management frameworks, enhance workforce training, and increase inspection frequency throughout all project stages, particularly during finishing and handover phases. Furthermore, the integration of emerging technologies such as Building Information Modeling (BIM), drones, digital inspections, and real-time data analytics can significantly improve defect detection, documentation accuracy, and decision-making processes.

Overall, the findings confirm that effective quality control measures, supported by competent technical inspectors and robust quality management systems, are essential for reducing construction defects, improving project performance, and achieving sustainable construction outcomes.

IV. Conclusions

The construction industry plays a pivotal role in economic development and infrastructure growth; therefore, maintaining high standards of quality is essential for ensuring project success, structural safety, client satisfaction, and long-term sustainability. This study examined the importance of quality control measures, quality management systems (QMS), and the role of technical inspectors in preventing construction defects and improving project performance. The findings revealed that construction defects such as structural cracks, waterproofing failures, electrical code violations, and material nonconformities remain significant challenges affecting project quality, costs, and timelines.

The results demonstrated that effective quality control practices significantly contribute to reducing defect occurrence and improving overall project outcomes. Statistical analyses confirmed that inspection frequency and timing have a substantial influence on defect detection and prevention. Projects subjected to regular inspections experienced fewer defects, while comprehensive inspection documentation enhanced legal clarity and facilitated dispute resolution. These findings reinforce the critical role of technical inspectors as both quality assurance professionals and key contributors to construction compliance and legal accountability.

The study further identified poor workmanship, inadequate quality control activities, insufficient supervision, and poor material quality as the primary causes of construction defects. The Relative Importance Index analysis highlighted inadequate QC implementation, unclear QA/QC procedures, and insufficient inspection schedules as major contributors to the use of substandard materials and quality failures. Additionally, the findings revealed that Quality Management Systems positively influence customer satisfaction, cost control, project completion time, and overall project quality, demonstrating the value of structured quality management frameworks in construction projects.

The research also emphasizes that quality control should not be viewed merely as a regulatory obligation but rather as a strategic management function that creates value throughout the project lifecycle. Organizations that prioritize quality through effective planning, continuous monitoring, employee training, and stakeholder collaboration are better positioned to deliver projects that meet performance requirements while minimizing rework, delays, and financial losses.

As construction projects become increasingly complex and technology-driven, the adoption of innovative tools such as Building Information Modeling (BIM), drones, artificial intelligence, real-time data analytics, and digital inspection systems offers significant opportunities to strengthen quality management practices. Furthermore, the active involvement of technical inspectors from project planning through post-construction stages can significantly enhance defect prevention and risk mitigation.

In conclusion, achieving excellence in construction quality requires an integrated approach involving robust quality management systems, competent technical inspectors, skilled workforce development, effective communication, strong leadership commitment, and continuous improvement practices. By fostering a culture of quality and accountability, construction organizations can significantly reduce defects, improve project performance, enhance stakeholder confidence, and contribute to the development of safer, more durable, and sustainable built environments.

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