

Impact of Quality Change Management on Project Performance in Civil Engineering Projects in India

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Abstract: - One of the primary objectives of quality management is to eliminate non-conformance, which can be achieved through effective project oversight and supervision. High standards of quality not only enhance productivity but also help reduce costs, ultimately strengthening an organization's competitive advantage. This study aims to investigate the impact of quality management practices on the performance of construction projects within the Indian industry. Numerous researchers have sought to identify factors influencing construction project outcomes. In this study, a structured questionnaire was distributed to a diverse group of industry professionals, including architects, engineers, consultants, developers, and researchers. A total of 152

valid responses were collected. Respondents were asked to rate various aspects of quality's influence on project performance using a five-point Likert scale. To prioritize the factors, the Relative Importance Index (RII) was calculated for each element. Factor analysis revealed three main components that together explained 62% of the observed variance. The findings indicate that the most significant project aspects affected by quality management are the rate of rework, overall project performance, cost, safety, labor productivity, and profitability, with RII scores of 0.85, 0.82, 0.78, 0.76, 0.75, and 0.74, respectively.

Key-Words: - Construction Management; Quality Assurance; Construction Sector; Factor Analysis; Construction Productivity; Relative Importance Indices.

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1 Introduction

The construction industry is experiencing continual transformation driven by advancements in technology, diversified funding mechanisms, and evolving development methodologies. Modern construction projects are characterized by a heightened level of complexity and require project teams to navigate unprecedented challenges and frequent changes. This dynamic environment underscores the importance of examining how quality management practices impact project efficiency and overall performance. In today's In a competitive market, organizations face increasing pressure to deliver innovative solutions more rapidly and cost-effectively. While there is a strong emphasis on reducing expenses and accelerating project timelines, these priorities can sometimes lead to compromises in product quality. Therefore, maintaining high standards of quality remains crucial to achieving project success and sustaining a competitive advantage. The quality of work done is not being accepted by the quality department. Now, you need to do the rework for the same work, which requires time and cost, and the delivery time will be delayed. As there is a clause in the contract regarding the delivery of the project, the organization cannot afford to delay the project, [1].

The primary objective of organizations in the construction sector is to fulfill the expectations of both shareholders and clients. Customers often invest significant resources in their desired projects, and their continued engagement depends largely on the delivery of quality outcomes. When organizations fail to meet client expectations regarding quality, it is unlikely that clients will choose to work with the same developer in the future, [2], [3], [4], [5], [6], [7], [8]. Research indicates that approximately 85% of quality-related issues in construction projects stem from inadequate commitment by top management and project teams, [1], [9], [10]. Quality deficiencies often necessitate rework, which in turn escalates both project costs

and timelines. The responsibility to mitigate cost and schedule overruns due to poor quality typically falls on the project manager. Subpar project performance can lead to a range of negative outcomes, as illustrated in Figure 1.

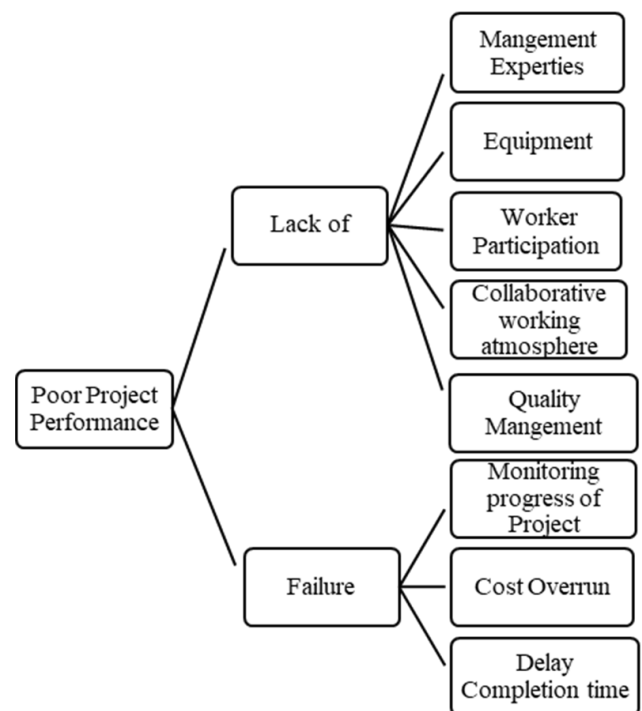


Fig. 1: Poor project performance leads to
Source: Created by the authors

To address these challenges, it is crucial for quality managers to establish robust systems and procedures, and to ensure that both senior management and all project stakeholders are well-informed about these protocols. Educating the project team on the significance of quality is essential, as it keeps project managers vigilant throughout all phases of construction. Ultimately, maintaining quality is a collective responsibility of the project team, and effective quality policies are vital in preventing issues that could compromise

project outcomes. Failure to uphold quality standards not only affects current project performance but can also result in loss of future business opportunities and reputational damage, [11], [12], [13], [14], [15], [16]. The literature identifies several recurring problems in construction project performance, including budget overruns, delays, unsafe working conditions, poor quality, and client dissatisfaction, [17], [18], [19], [20], [21], [22].

The construction industry must recognise and address the elements that influence project success or failure to enhance overall project outcomes. Many studies have been carried out over the years to identify these crucial elements, which fall into the following categories:

I. Using standardised management frameworks and procedures [23], [24], [25] is the first step in project management techniques.

II. Internal Project Factors: Characteristics like project size, complexity, type, and inherent nature, [26], [27], [28], [29], [30], [31], [32].

III. External Factors: The effects of the social, political, technological, and economic spheres, [1], [6], [9], [26], [27], [28], [29], [30], [32], [33], [34], [35].

IV. Procurement Strategies and Supply Chain Management: Approaches to sourcing, logistics, and overall supply chain coordination, [36], [37], [38], [39], [40], [41], [42], [43].

V. Organizational Culture: The influence of company culture on project execution and team dynamics, [20], [44], [45], [46], [47].

The construction sector can improve project performance, guarantee client satisfaction, and uphold a solid reputation in the market by methodically addressing these concerns.

1.1 Total Quality Management

As consumer expectations are getting higher regarding goods and services, the total quality management shows the integration of quality to meet customer demands, [48], [49], [50].

For the reduction of wastage generation from product manufacturing, a total quality management-driven industry mitigates this hurdle by making sure all initial steps are taken very carefully. Because of these practices, project performance and accuracy increased with the help of total quality management, [49], [51], [52], [53].

Completion of the project on time and with higher accuracy is the result of the successful implementation of total quality management in steps

like design of the product, manufacturing process, cost, and feedback analysis. With the use of such techniques, the total capability of goods and services can be enhanced drastically, and hence increase customer-positive feedback responses.

The main component of total quality management is performing the mentioned steps regularly. This can be achieved by individuals with experience and expertise. A philosophical view enhances the first-time driven response continuously, [24], [54], [55], [56], [57].

Some of the major elements in total quality management are timely practices, modification in ongoing projects, continuous focus, cost cutting, dedicated team members, following standards related to manufacturing, and optimization of all steps.

Core Principles of TQM:

- i. Management Commitment
 - Planning
 - Execution
 - Monitoring
 - Corrective Action
- ii. Employee Empowerment
 - Training
 - Performance Evaluation
 - Feedback
 - Recognition
- iii. Continuous Improvement
 - Quality in place
 - Cross-functional process
 - Attain, sustain, improve
- iv. Customer Focus
 - Supplier management
 - Don't compromise quality

1.2 Continuous Improvement

The goal of continual improvement at all organisational levels, from planning and design to decision-making, is a core component of Total Quality Management and performance. This strategy places a strong emphasis on improving procedures, training staff, and using technology to boost output. TQM promotes organisations to expand their capabilities rather than only concentrating on improving results, which ultimately produces better outcomes. The idea acknowledges that failures frequently result from faulty procedures or insufficient systems rather than from human error. Organisations can consistently decrease errors and inefficiencies by addressing these underlying causes, [18], [58], [59], [60].

Key Mechanisms for Error Prevention:

- Putting mistake-proofing strategies (poka-yoke) into practice to avoid mistakes
- Identifying problems early on with source inspections to lessen their effects
- Stopping activities to fix persistent issues and enhance procedures.

Benefits of Implementing TQM:

- Improved ability to adjust to changes in the market and legal requirements
- Enhanced operational effectiveness and productivity
- Enhanced market value and reputation of the company
- Defects, waste, and related expenses decreased
- Increased profitability and value for shareholders
- Increased client satisfaction
- Encouragement of innovation and ongoing process enhancement.

TQM is a holistic management philosophy that promotes long-term success in construction projects, not merely a collection of procedures, thanks to this approach.

2 Literature Review

The factors that influence the success of construction projects have been the subject of much recent research, with numerous studies providing thorough theories and empirical assessments.

After evaluating earlier studies that were published in prestigious construction publications, [24] created a conceptual framework for Critical Success Factors (CSFs) in building projects. Project-related elements, human-related factors, external environment, project management activities, and project procedures are the five divisions into which their analysis divided the primary factors affecting project success. This categorisation is consistent with more general research that finds cost, time, quality, and management to be essential factors in assessing project results.

[61] looked into the reasons behind schedule overruns in the Indian construction industry in relation to project delays. They found 45 characteristics and emphasised major causes of delays, including poor contracts, poor planning, insufficient site coordination, lack of commitment, ineffective site management, communication breakdowns, and ambiguous project scope, using a combination of questionnaires and interviews. Their

regression study also showed that low productivity, rework because of quality problems, sluggish client decision-making, and architects' resistance to change were all significant predictors of project delays.

[62] examined the relationship between quality management and profitability by analyzing firms recognized by the Brazilian National Quality Award over ten years. Their study, which utilized both parametric and non-parametric statistical methods, demonstrated that organizations implementing quality management practices achieved superior profitability and work performance compared to those without such systems. However, the authors noted limitations related to sample size and the specific profile of the firms studied.

Additional research in construction management has underscored the link between quality management systems and financial performance, [11], [53], [63], [64], [65]. Rules and regulations associated with the principle of Deming that focus on decreasing uncertainty always remain foundational in this field. In 2005, researchers also analysed how Supply Chain Management (SCM) improves total quality management with a focus on the analysis of the just-in-time concept and noted its major points in efficiency in the operational and performance field. Combining all three entities, the strategy can be enhanced at a very drastic rate and finally yield positive feedback and less waste generation, which will enhance the decision-making capability.

The mentioned research focused on the positive success rate of the product and not only included parameters such as time, quality, and time duration, but also focused on the management process, communication, and satisfaction of stakeholders.

[59] identified and examined the following factors: Just in Time (JIT), which emphasises effective supply management, a seamless material flow, and a strong commitment to on-time delivery. Total Quality Management (TQM) places a strong emphasis on product design, a commitment to quality, and suppliers' ability to fulfil strict requirements. To enhance effectiveness, SCM has been improved, which has proved crucial for chain-wide operations. Also, merging the protocols resulted in streamlined and positive operations.

The results show that specific cultural orientations—like contractor commitment, worker orientation, and goal alignment among project participants—are essential for improving participant satisfaction and project success as a whole. In particular, learning and adaptation within the project environment were linked to trust and shared aims,

whilst a cooperative attitude and strong contractor commitment were linked to higher labour productivity, [20]. Important aspects of project organisational culture were highlighted by the study, such as worker orientation, contractor commitment, empowerment orientation, cooperative orientation, reliance, and goal alignment.

But the study clearly recognized its shortcomings, especially with relation to the makeup of the sample. The results may not have been as generalisable as they might have been because the bulk of respondents (85%) were contractors. Furthermore, the very small sample size raises the possibility that more extensive insights could be obtained from future studies with a more varied participant base. The literature has extensively examined how Total Quality Management (TQM) affects project performance. [34] emphasised that, via improved cooperation and collaboration, the application of TQM concepts can promote continuous improvement and improve project outcomes.

Putting quality of product first is the main component of achieving total quality management. To ensure this and customer satisfaction, the minimization of expenses is necessary. This will result in defining a quality standard and a positive customer satisfaction rate.

Achieving ongoing quality improvements requires empowering and involving every employee in the company. By improving work processes and staff competencies via training and benchmarking, a dedication to ongoing development is guaranteed. TQM also goes outside the company by incorporating other vendors and clients, fostering a team-based approach to quality.

Person factors—knowledge, skills, abilities, and motivation—have a direct impact on performance and results, making them essential to TQM's success.

An atmosphere that fosters quality initiatives is also greatly influenced by system elements, such as human enhancers and system needs. These components work together to create a thorough framework for attaining excellence in quality management, [55].

For effective quality management, TQM frameworks frequently take into account both systemic (such as organizational demands and supporting systems) and individual-level (such as knowledge, skills, and motivation) elements.

In construction projects, striking a balance between quality, money, and time is crucial, according to [66]. According to their study, maintaining the necessary degree of quality at every

stage of the project is essential for overall success, even when higher quality can be attained at a larger cost or over a longer period of time. Defects can be reduced and a more seamless transition to project commissioning can be achieved by implementing effective quality management from the very beginning, such as during project inception, design, and constructability reviews.

A need for committed management with major steps mentioned, continuous improvement, and collaboration of all stakeholders is necessary to prevent failure of total quality management and decrease the remanufacturing of the product, and hence, finally result in quality-based outcomes.

The financial consequences of poor quality in construction are substantial. [67] reported that rework in commercial building projects can account for approximately 5% of direct costs. In 2007, the U.S. construction industry incurred an estimated \$62 billion in direct costs due to rework, out of a total industry expenditure of \$1.246 trillion. Previous studies have estimated that quality-related costs can reach up to 20% of total construction. For industrial construction, direct rework costs may be as high as 12% of total project costs, [67].

Deming's quality management theory underscores the importance of reducing process variability and ensuring conformance to specifications, which leads to higher productivity, cost savings, and enhanced competitive advantage. Quality in construction is typically evaluated across several dimensions, including performance, reliability, conformance, durability, serviceability, aesthetics, and perceived value, [67].

This analysis highlights the interconnected roles of organizational culture and quality management in achieving successful construction project outcomes, while also drawing attention to the significant economic impact of poor quality within the industry.

2.1 Cost of Quality

Prevention Costs: These are incurred to avoid internal or external non-conformance in the contractor's activities. They include activities such as planning, training, and process control, all aimed at ensuring quality from the outset.

Appraisal Costs: These costs arise from the contractor's efforts to inspect, collect data, and evaluate processes. They encompass testing and equipment, system control, and surveys to verify compliance with quality standards.

Internal Failure Costs: These costs result from the contractor's unsatisfactory outcomes before the owner accepts the building specifications. Examples

include scrap, rework, expediting, and the need for additional materials due to errors or inefficiencies.

External Failure Costs: These costs occur due to defects or poor quality identified after the owner has accepted the building. They include warranty claims, litigation expenses, and damage to the contractor's brand image, all of which can have long-term repercussions.

Together, these cost categories highlight the importance of proactive quality management to minimize expenses and maintain standards throughout the construction process.

Many researchers attempted to graphically depict the cost of quality. [67] developed one such graph shown in Figure 2.

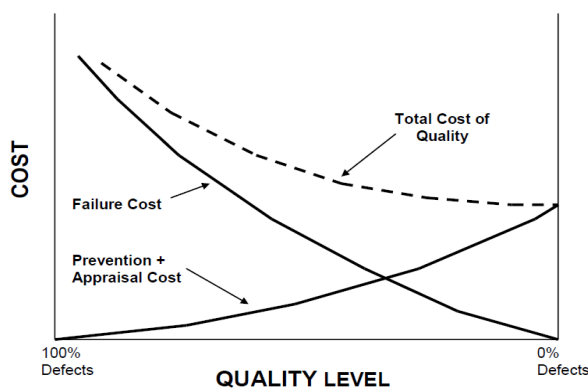


Fig. 2: Cost Versus Quality level

Source: [67]

We have selected the different attribute for analysis as shown in Table 1.

2.2 Research Objectives

1. To identify key quality management attributes that influence construction project performance.
2. To evaluate the extent to which these quality management attributes affect the outcomes of construction projects.

3 Research Methodology

This study adopted a mixed-methods approach, beginning with an extensive review of existing literature and consultations with industry experts to pinpoint quality management factors relevant to project performance. Insights from these preliminary steps informed the development of a structured questionnaire, tailored to assess the impact of quality management practices within the Indian construction sector.

Initially, a survey was conducted to test the framework and questionnaire for their effectiveness.

After analyzing all the responses from the pilot study framework, the framework has been modified and made ready for full-scale deployment. Afterwards, the final questionnaire was distributed among the selected participants mentioned in the data collection section of this work.

Participants were asked to rate the quality management influence using a five-point Likert scale, where 1 indicated 'No Impact' and 5 represented 'Very High Impact', [124]. The data collected were subjected to rigorous statistical analysis, including the Relative Importance Index (RII), reliability assessment, Kaiser-Meyer-Olkin (KMO) test, and factor analysis, to ensure robustness and validity of findings.

4 Data Collection

4.1 Respondent Profile

A random sampling has been performed in the Indian context for individuals, engineers, workers, academicians, specialists, and laborers working in different manufacturing industries for this study. An average of 8 years among all the participants selected has been maintained, which proves their knowledge and expertise in the field.

A total of 370 participants were selected for the questionnaire. After three follow-up reminders over two months, a total of 152 fully completed and valid responses were received, resulting in a response rate of 41%. Respondents rated the impact of quality management on different dimensions of project performance using a Likert scale ranging from 1 ('No Impact') to 5 ('Very High Impact'), as defined in [125].

4.2 Reliability Analysis

To analyse the consistency in survey data, analysis and examination of reliability have been performed. Alpha of Cronbach has been used to evaluate the coefficient of reliability, and the value falls between 0 and 1. It was found that a value above 0.5 is best for questionnaire-based research, [10], [126]. This study resulted in the value of 0.81, which shows that the results and data yielded are consistent and reliable. The reliability is pertinent in his work and aligned with the discussion and conclusion of this paper further the reliability analysis of the study based on number of samples and attributes is shown in Table 2.

Table 1. Reliability analysis for the study [10], [126]

Cronbach's alpha value	No of attributes	No of samples
0.816	17	152

Source: Created by the authors

4.3 Relative Importance Index

Individuals rated the quality management on the basis of a five-point Likert scale and enhanced the survey data, [127]. These variables were ranked and prioritised using the Relative Importance Index (RII), which was determined by taking into account both the frequency of replies and the related Likert scale scores, and the attributes are further summarized in table 3. This method made it possible to pinpoint the characteristics that had the biggest impact on project performance.

$$R_{ii} = \frac{\sum_0^1 r * n_r}{5N} \quad (1)$$

R = Rating on Likert scale

n_r = Number of respondents given rating r

N = Total respondents

4.4 Impact of Quality on Rate of Rework

Rework emerged as the most affected aspect of project performance, with the highest RII value of 0.89. Substandard work is typically rejected by both owners and management, failing to meet customer expectations and potentially compromising the safety of future occupants. Poor quality necessitates corrective actions, leading to increased material usage and waste generation. Conversely, adherence to high-quality standards substantially reduces the incidence of rework, thereby enhancing client satisfaction and minimizing unnecessary resource expenditure.

4.5 Impact of Quality on Project Performance

Project performance, as a holistic measure, was also found to be strongly influenced by quality management, with an RII score of 0.88. High-quality execution reduces the need for future repairs and defect management, contributing to greater satisfaction among stakeholders, including clients, owners, and management teams. Superior construction quality not only bolsters profitability and market reputation but also results in fewer maintenance issues during the building's operational phase, thereby improving long-term project outcomes.

4.6 Impact of Quality on Cost

Quality management has a direct impact on project costs, reflected by an RII score of 0.85. Studies have shown that rework can account for approximately 5% of direct costs in commercial construction projects, [67]. In 2007, the U.S. construction industry incurred an estimated \$62 billion in rework-related expenses out of a total expenditure of \$1.246 trillion. Quality-related costs can constitute up to 20% of overall project costs [67], with industrial projects experiencing rework costs as high as 12% of total costs, [67]. These costs are typically categorized into prevention and appraisal costs (associated with good quality) and internal and external failure costs (resulting from poor quality), [67].

4.7 Impact of Quality on Safety

Safety is another critical dimension influenced by quality management, with an RII value of 0.85. The safety of both construction workers during project execution and occupants' post-completion is closely tied to the quality of workmanship. Deficiencies in quality increase the likelihood of failures and accidents, whereas robust quality practices reduce such risks. Numerous case studies attribute building failures to inadequate quality control and a lack of commitment to quality management systems by project teams and contractors.

4.8 Impact of Quality on Labour Productivity

Labour productivity, with an RII score of 0.82, is significantly enhanced by effective quality management. A safer workplace, increased morale, and encouragement for employees through awards and recognition are all benefits of high standards. Employees feel safer and more motivated when quality management systems and assurance plans are correctly implemented, which increases productivity and efficiency on the job site. Furthermore, decreased rework and failure rates lead to increased profitability and project success in general. The performance of construction projects is impacted by quality management in many ways, and this analysis emphasises how important it is for reducing rework, keeping costs under control, guaranteeing safety, and increasing productivity.

4.9 Impact of Quality on Profitability

With a Relative Importance Index (RII) score of 0.76, profitability is another important aspect of construction project success that is influenced by quality management. By minimising non-

conformance, the required quality can be attained, which lowers related expenses like internal and external failure costs (associated with bad quality) and appraisal and prevention costs (considered costs of excellent quality). The savings from less material waste and rework typically outweigh the cost of putting in place a strong quality control system. This association is supported by empirical data, which indicates that businesses that implement quality management methods regularly report increased profitability and enhanced productivity, [16].

5 Different Factors Affecting Quality Management

A useful statistical method for simplifying data is factor analysis, which groups similar characteristics into underlying constructs according to their covariance. To find the key elements affecting quality management, this method has been frequently applied in construction management research, [1], [56], [125]. The survey data in this study were subjected to Varimax rotation and principal component analysis. Three unique components were chosen for additional examination since their Eigenvalues were greater than one. The combined contribution of these three factors to the overall variance is depicted in Figure 3, both as a percentage of the total and with precise values. This analytical approach enables a clearer understanding of the primary drivers of quality management effectiveness within construction projects, facilitating targeted improvements and strategic decision-making.

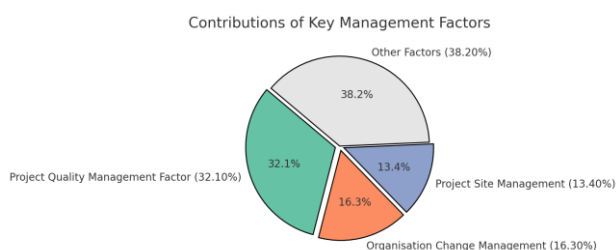


Fig. 3: Overall contribution of all three attributes
Source: Created by the authors

The combined influence of these three factors accounts for a total variance of 62%, identifying them as the most influential factors in line with previous research findings. The first factor, related to project quality management, explains a variance of 32.1%. This factor includes the following attributes: the impact of quality on reducing rework, improving project performance, affecting costs, and

the role of employee training in managing and controlling quality in construction projects. Additionally, quality is noted to increase labor productivity, improve the quality performance of construction projects by prioritizing quality over price in supplier selection, and enhance profitability. The respective factor loadings for these attributes are 0.515, 0.75, 0.72, 0.825, 0.51, and 0.56. Figure 4 illustrates the variations in factor loadings associated with project quality management.

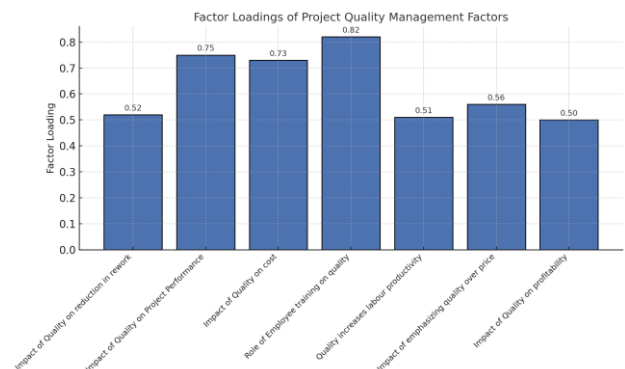


Fig. 4: Variation in factor loading based on of the project quality management factor
Source: Created by the authors

The second factor, organizational change management, accounts for a variance of 16.3%. It includes attributes such as the impact of quality on safety, the influence of organizational culture on project quality performance, the role of effective quality assurance, the effect of management commitment, the contribution of effective safety programs, and the competency of project management. The factor loadings for these attributes are 0.53, 0.49, 0.54, 0.47, 0.62, and 0.409, respectively. Figure 5 presents the variations in factor loadings associated with organizational change management.

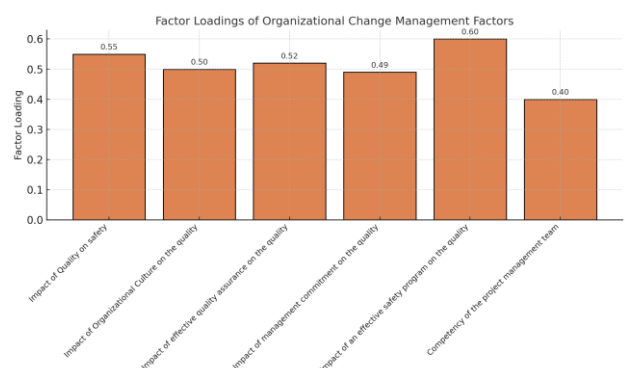


Fig. 5: Variation in factor loading based on organizational change management
Source: Created by the authors

The third factor, project site management, accounts for a variance of 13.6%. This factor encompasses attributes such as the impact of continuous improvement in quality management on the performance of the construction project, the influence of the site's physical environment on quality performance, the competency of subcontractors on project performance, and the effect of site management and supervision staff on project outcomes. The factor loadings for these attributes are 0.6, 0.52, 0.481, and 0.56, respectively. Figure 6 illustrates the variations in factor loadings related to project site management.



Fig. 6: Project Site Management: Factor Loadings
Source: Created by the authors

The analysis was conducted on all three characteristics, and the results are summarized in Table 4. The findings indicate that management commitment had the smallest loading factor impacting project quality performance, while employee training in quality management and control in construction projects exhibited the highest loading factor. The maximum observed factor loading was 0.825, whereas the minimum was 0.47. Additionally, attributes related to project site management showed the least influence, accounting for the smallest percentage of explained variance at 13.6%. In contrast, the elements associated with project quality management demonstrated a significantly higher impact, with the largest percentage of explained variance at 32.1%.

6 Discussion and Conclusion

The construction industry is at a crossroads, requiring fundamental shifts in its approach to quality. As [67] suggests, the sector must transition from allocating resources toward addressing quality non-conformance to investing in quality conformance. This shift also involves moving beyond mere compliance with quality standards and focusing on achieving genuine quality performance

outcomes. [128] further emphasizes that increased investment in prevention and appraisal activities can significantly reduce the costs associated with internal and external failures. The findings from various studies indicate that while the costs of prevention and appraisal (conformance costs) are predictable and manageable, the costs arising from failures (non-conformance costs) are often unpredictable and can escalate rapidly. Moreover, many researchers agree that the visible costs of non-conformance represent only a fraction of the total hidden costs, which may include lost future business and reputational damage. [16] highlight that intangible costs, such as loss of reputation, can be substantial and difficult to quantify. Effective project management and control are essential to minimize non-conformance and its associated costs. As Crosby famously stated, "Quality is free; what costs money are the actions that result from not doing things right the first time."

A review of the literature consistently demonstrates the positive impact of quality management on project performance. For example, the implementation of Total Quality Management (TQM) has been linked to continuous improvement, enhanced teamwork, and superior project outcomes [124]. Firms that have adopted quality management frameworks report higher profitability and improved operational performance, [16], [20]. Additionally, integrating Supply Chain Management (SCM) with a strong commitment to quality has been shown to further enhance project results, [20]. Key drivers of project success identified in the literature include worker orientation, contractor commitment, and alignment of project goals, [20], [129]. These factors, combined with effective training, organizational culture, robust quality assurance plans, continuous improvement initiatives, and a safe physical environment, create a foundation for successful quality management implementation, [46]. Investing in prevention and appraisal not only reduces failure costs but also supports the development of a proactive quality culture.

This study is based on 152 valid responses collected through a structured questionnaire, with participants rating the impact of quality management on various aspects of construction project performance using a five-point Likert scale. Analysis using the Relative Importance Index (RII) revealed that the most affected aspects are rate of rework (RII = 0.85), project performance (0.82), cost (0.78), safety (0.76), labour productivity (0.71), and profitability (0.67). The factors most critical for implementing an effective quality management system include employee training (RII = 0.75),

organizational culture (0.74), a comprehensive quality assurance plan (0.71), continuous improvement (0.68), safety programs (0.65), and the physical environment of the project site (0.63). By focusing on these factors, construction organizations can enhance their quality management systems and, consequently, improve project performance.

7 Limitation

While this study provides valuable insights, it is not without its limitations. The research relied on self-reported data from industry professionals, and the scope was limited to perceptions of project performance and factors influencing it. The study did not capture real-time data from ongoing projects, which may limit the generalizability of the findings. Additionally, the results are directly influenced by the experience and perspectives of the respondents, which may introduce bias.

Future research should aim to gather empirical data from active construction projects and explore the practical challenges of implementing quality management systems across a broader range of contexts. Expanding the sample size and diversity of respondents could also enhance the robustness of the findings. Despite these limitations, the results of this study provide a foundation for further investigation and practical improvements in quality management practices within the Indian construction industry.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

The authors wrote, reviewed and edited the content as needed and verifies that none utilised artificial intelligence (AI) tools were used. The authors take full responsibility for the content of the publication.

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APPENDIX

Table 1. Selected attributes for analysis

<i>Attributes codes</i>	<i>Attributes selected for the study</i>	<i>References</i>
A1	Role of quality management in reducing project rework	[68], [69], [70]
A2	Influence of site conditions on project quality outcomes	[71], [72], [73]
A3	Effect of quality practices on overall project effectiveness	[74], [75], [76], [77]
A4	Contribution of quality standards to workplace safety	[78], [79], [80], [81], [82]
A5	Influence of continual quality improvement on construction project performance	[83], [84], [85], [86]
A6	Effect of subcontractor expertise on project delivery and success	[87], [88], [89], [90]
A7	Role of site leadership and oversight in ensuring project performance	[91], [92], [93]
A8	Effectiveness of quality assurance processes in achieving desired quality standards	[94], [95], [96], [97]
A9	Enhancement of labor productivity through quality-focused practices	[98], [99], [100], [101]
A10	Relationship between quality practices and cost efficiency in projects	[102], [103], [104], [105]
A11	Importance of workforce training in maintaining quality control within construction	[70], [106], [107]
A12	Influence of organizational values and culture on project quality outcomes	[100], [108], [109], [110]
A13	Role of comprehensive safety programs in supporting project quality goals	[80], [111], [112]
A14	Effect of quality-driven strategies on overall profitability	[113], [114], [115]
A15	Consequences of prioritizing quality over cost in supplier selection on project outcomes	[91], [116], [117], [118]
A16	Impact of leadership commitment on the successful implementation of quality standards	[69], [119], [120]
A17	Capability of the project management team in ensuring project excellence	[121], [122], [123]

Source: Created by the authors

Table 3. The impact of a quality management system on different aspects of construction project performance, [127]

Attributes code	Total responses	Total score	RII	Attribute name
A1	152	637	0.85	Influence of quality practices on minimizing project rework
A3	152	622	0.82	Contribution of quality management to overall project performance
A10	152	592	0.78	Effect of quality standards on project cost optimization
A4	152	577	0.76	Role of quality measures in enhancing construction safety
A11	152	570	0.75	Significance of employee training in improving quality management and control in construction
A12	152	563	0.74	Effect of organizational culture on project quality outcomes
A8	152	539	0.71	Role of robust quality assurance mechanisms in achieving quality project outcomes
A9	152	538	0.71	Effect of quality implementation on enhancing labor productivity
A15	152	532	0.70	Influence of prioritizing quality over cost in supplier selection on construction quality
A16	152	524	0.69	Contribution of managerial dedication to achieving project quality standards
A5	152	516	0.68	Effect of ongoing quality improvement initiatives on construction project success
A13	152	509	0.67	Relationship between safety programs and quality achievements in construction
A14	152	509	0.67	Influence of quality practices on project profitability
A2	152	494	0.65	Effect of on-site physical conditions on construction quality performance
A6	152	478	0.63	Role of subcontractor expertise in determining overall project outcomes
A7	152	471	0.62	Influence of site management and supervision on project execution and performance
A17	152	467	0.62	Proficiency of the project management team in driving successful outcomes

Source: Created by the authors

Table 4. Influence of factor loading on attributes as per the percentage of variance explained

Attribute/variable name	Factor loading	Percentage of variance explained
Project quality management factor		32.1%
Influence of Quality on Minimizing Rework	0.515	
Effect of Quality Practices on Overall Project Performance	0.75	
Contribution of Quality Management to Cost Efficiency	0.72	
Significance of Employee Training in Quality Control for Construction Projects	0.825	
Enhancement of Labor Productivity through Quality Implementation	0.51	
Impact of Prioritizing Quality over Cost in Supplier Selection on Construction Quality	0.56	
Relationship between Quality Standards and Project Profitability	0.49	
Organisation change management		16.3%
Influence of Quality Management on Workplace Safety	0.53	
Effect of Organizational Culture on Project Quality Outcomes	0.49	
Role of Robust Quality Assurance in Enhancing Project Quality	0.54	
Impact of Management Commitment on Achieving Quality Standards	0.47	
Contribution of Effective Safety Programs to Project Quality Performance	0.62	
Proficiency of the Project Management Team in Delivering Quality Outcomes	0.409	
Project site management		13.6%
Effect of Continuous Quality Improvement on Construction Project Performance	0.6	
Influence of Site Physical Environment on Project Quality Outcomes	0.52	
Impact of Subcontractor Competency on Overall Project Performance	0.481	
Role of Site Management and Supervision in Enhancing Project Delivery	0.56	
Total Variance Accounted for by Quality Management Factors		62.0%

Source: Created by the authors