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FACTORS AFFECTING IMPLEMENTATION OF QUALITY MANAGEMENT SYSTEMS IN CONSTRUCTION PROJECTS - A STUDY

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Abstract: Quality management systems are being operated in some sectors in India. But it is rare to meet this system in construction industry. There are many hindrances that make it difficult to apply the system effectively due to the nature of construction and therefore no objective way to measure the effectiveness of this system exist in construction industry. Objective of this study is to evaluate the critical factors that affect the quality management system on quality improvement and performance in construction projects. It also aims to evaluate the effectiveness of quality management system (QMS) in construction projects. Finally, it proposes an implementation framework for quality management in construction projects. Data Will be collected and analysed using statistical techniques with the help of appropriate software. The factors included are project background aspects, general quality aspects and standard code representing aspects. All the above factors will be subjected to descriptive analysis, and regression analysis. The critical factors obtained through the above said analysis will be validated with the critical factors obtained by the various previous researchers. Regression equations have been proposed to identify the strongest predictor among the independent variable which have cause and effect relationship on dependent variable. The study brings out the underlying critical factors which are responsible for the implementation of quality management in construction projects. Also, suitable recommendations and suggestions for effective quality management system for construction projects will be presented.

Index Terms - Quality management system QMS, general quality aspect, standard quality aspect, construction projects, critical factors, regression modelling.

I. INTRODUCTION

Construction industry is a pillar of economy for every country including India. It is time bound and employs huge resources of men, material, and machinery. As a result, it contributes to a massive growth of the country's economic development. The technical break through has greatly influenced the construction industry. Construction sector has undergone severe cycle changes day by day. Construction contributes to the growth of many related industries such as manufacturing of construction material, cement, pipes, sanitary wares, tiles, ready mix concrete, etc. Besides from being an important asset that generates profit to the country, construction encourages the development of human resources and generates more employment than other industrial sectors.

Considering the significance of construction, it is necessary to identify major issues affecting the efficiency of this sector. The poor state of technology adopted by the construction industry in many countries as well as fragmented relation between construction cost and time delay which in turn affects the quality. Many clients now-a-days are dissatisfied with contractors' performance in terms of keeping to the quoted price and the time of delivering a final product of required quality. Now-a-days, management of construction companies is focusing on quality issue on a competitive edge. Delivering projects that satisfied client requirement has become a main priority to maintain business relationships and hence the construction industry should develop standards during every stage to deliver satisfactory outputs.

I. LITERATURE REVIEW

Garvin (1984) explained the phenomenon of quality as an integrated with multifaceted interests of process and product stakeholders. The author introduced five different views about quality as transcendent quality, product-based quality, user-based quality, manufacturing based quality and value-based quality.

Suleiman and Steven (1998) conducted a study on Mexico manufacturing industry to identify the critical organizational factors that are essential to have successful implementation of Total Quality Management and concluded that employee's' training, performance evaluation based on quality outcomes, and reward for quality ideas not only facilitate the implementation of TQM but also have significant effect on cost and profit.

Alira (2005) prioritized the knowledge role in defining the success of quality management programs in the organizations and suggested a new approach of quality management practices as deep quality concept (DQC) that defined the way to acquire the essential knowledge for realizing the productive performance outcomes of quality management efforts.

Yang (2006) investigated the relationships between HRM practices and TQM practices, the relationships between HRM practices and quality performance and the effect of HRM practices on the implementation of TQM. The results of the study on the effect of various HRM practices on individual TQM practices show that the implementation of HRM has a positive and significant effect on the performance of TQM except the practice of 'employee relations', which has tiny influence on all TQM practices.

Sharma (2006) performed an empirical study to establish the quality management dimensions and contextual factors which contribute significantly in enhancing organizational performance in Queensland business by incorporating quality management programs like TQM, IS0 9000, and both TQM and ISO 9000, simultaneously. The author replicated same 12 quality management factors suggested by Powell (1995) as comprehensive dimensions of a complete quality management program.

Oztas et al., (2007) reported the differences and uniqueness of the construction industry from other industries (e.g., a long time for project completion; human relationships generally formed once; difficulty in defining quality standards and feedback relating to the construction processes) make it difficult for construction companies to implement quality management system, which can be fragmented and slow in their attempts at quality improvement. The author concluded that, fact that the construction industry has historically been reluctant to deal with changes is reflected in slower implementation of ISO 9001 especially in developing countries.

Hosseinalidehghan et al., (2014) enumerated the application of total quality management in small and medium size construction projects. The author proposed a framework for the implementation of quality management in construction industry. The findings on critical success factors and primary barriers indicated that top management commitment followed by customer satisfaction were the most critical success factors in implementing total quality management in construction projects. Top management involvement to improve ways of performing task and primary focus were the main barriers in total quality management implementation process.

All the facts discussed above led the researcher to a fact that everything on paper, when put into execution, encountered practical difficulties and the ground reality is an important issue to be addressed. It is necessary to identify those factors that need to be monitored real time during the progress of the project, make necessary remedial measures to overcome the factors that are responsible for the implementation of quality management in construction projects. Hence it is imperative to identify the critical factors to be monitored in the real time management of construction projects. Present study analyzes effectiveness of QMS by taking project background aspects, general quality aspects and standard code representing aspects as key factors.

II. RESEARCH METHODOLOGY

This study has adopted a descriptive research design. This study is quantitative in nature, as it uses quantitative techniques such as descriptive analysis, regress analysis to analyse the data collected interpret the results. Structured questionnaire was used for collecting the data. The questionnaire survey acted as an important data collection tool to analyze the quality in construction projects. Professionals and experts with more than 20 years of experience in construction projects such as project engineers, quality engineers, safety engineers and site engineers in construction projects were consulted for data collection and gaining information from their experience. The identified factors for quality from literature survey were scrutinized with the experts to the present work situation and their opinions and suggestions were incorporated to improve the questionnaire.

III. DATA COLLECTION

A structured survey questionnaire was used for collecting primary data. The survey questionnaires were sent to the respondents by-hand, postal and courier and through e-mail. The types of projects involved in this survey are multi-storied corporate/commercial buildings, residential buildings, and industrial buildings. The project cost varied from 1crore to 100 crores. The private sector has been considered in this survey. Four months' time duration were taken for collecting and processing the data. The data for the present study was collected from 260 respondents like quality engineer, project manager, site engineer and construction engineers and the data have been analysed using statistical techniques of Descriptive analysis and Inferential analysis. The factors included under the project background aspect, general quality aspects and standard code representing quality aspects are those which are to be studied carefully so that no detail is omitted at the project planning stage. The factors define the concept of the project and detailed to be obtained in the preparation of a feasible project schedule

IV. RESULTS AND DISCUSSION

Descriptive analysis involves the calculation of the measures of central tendency, the mean, measures of variability and the standard deviation. These two are useful to determine the central tendencies and dispersion of the variables selected for the study.

IV.I Project Background Aspects

From the analysis of factors under project background aspects ten factors were identified as most important. Out of ten factors following two aspects higher significance, "The contractor should maintain the time management on tender submission with more knowledge on labour and material cost," "The project engineer must be aware of quality management with codes and specifications."

Sl.No.	Project Background Aspects Factors	MEAN	STANDARD DEVIATION	SIGNIFICANCE VALUE
1	Time management on tender submission	4.801	0.400	0.0137
2	Knowledge about labour and material cost	4.788	0.409	0.0383
3	Awareness about quality management	3.731	0.443	0.0380
4	Knowledge about codes and specifications	3.865	0.811	0.0238

Table 1: Most Important Factors Identified under Project Background Aspects

IV.II General Quality Aspect

This study has analyzed 92 aspects representing Standard Code of Construction projects with respect to Quality implementation. From ANOVA analysis following factors under General Quality Representing Aspects were identified as Significant with values less than 5%.

No	General Quality Aspect Factors	Significance Value
	MANAGEMENT	
1	A Qualified manager to be employed.	0.0579
2	The manager should have experience in the concerned field.	0.0740
3	He should posses adjustable quality with attendants.	0.0190
4	He should be capable of doing test in the absence of any technicians.	0.0160
	CALIBRATION	
1	Before the commencement of work, every instrument must be calibrated.	0.0160
2	Whenever the meter and instrument are disturbed, it should be recalibrated.	0.0230
	INSPECTION	
1	Superior checking is necessary for design and fabrication.	0.0320
2	While superior checking the design norms, site condition, latest techniques should be kept in mind.	0.0080
	FINAL APPROVAL	
1	The consultant engineer should approve every product by their test.	0.0030
2	The client management has to witness the test and scrutinize the result.	0.0440
	DESIGN QUALITY MANAGEMENT	
1	The design of fabrication must be approved.	0.0100
2	The pouring of concrete should be approved by design authority.	0.0010
3	The calibrated instrument should be kept carefully against shock.	0.0160

IV.III Standard Code Representing Aspects

This study has analyzed 92 aspects representing Standard Code of Construction projects with respect to Quality implementation. From ANOVA analysis following factors under Standard Code Representing Aspects were identified as Significant with values less than 5%.

No	PRODUCT QUALITY	Significance Value
F66.	The schedule for the product quality checks should be available and checks should be don as per schedule	0.010
F67.	Product Quality Rating scores consistent since inspection of site and greater than 70%	0.010
	CUSTOMER SATISFICATION	
F77.	The project should have a customer complaint register, updated & reviewed	0.010
F78.	All the customer complaints should be segregated and responded within stipulated time(examine proof)	0.010
F80.	Is there any unresolved complaints at the time of assessment the ratio to be noted	0.010
	QUALITY MANAGEMENT SYSTEM	
F86.	Company has to make the Staff understand the essence of QMS document	0.010
	WORK METHODS	
F98.	Necessary training to be provided for staff & workmen for the work procedures establishe	0.010
F99.	Work procedures / Instructions should be available with concerned Engineer / Area	0.010
F100.	The work must be done as per the stated method statement and checked at different stages	0.010
	CONSTRUCTION SCHEDULE	
F105.	The Master schedule to be updated & monitored every month	0.010
F106.	The set goals have to stretch the employees	0.010
	CONTRACT REVIEW AND MANAGEMENT	
F118.	The site should have control on Contract document	0.010
	QUALITY CONTROL	
F139.	You must inspect the incoming material standard	0.010
F140.	You have to soak the brick in water atleast 1hour before using	0.010

IV.IV Regression Analysis

Stepwise multiple regressions of extracted underlying factors with the dependent variables were done and the obtained regression equations are as follows.

Regression Model 1: Management = 2.206 (Constant) + 0.259 (Manager should be capable of doing test in the absence of technicians) 0.132 (Every apparatus should be capable to withstand the specimen resistance) 0.254 (Must be aware of the principle of the machine and specimen).

Regression Model 2: Final approval = 2.989 (Constant) 0.157 (The norms and standards should be followed) 0.152 (Every item should be rechecked by superior authorities).

Regression Model 3: Inspection = 3.759 (Constant) 0.050 (Whenever the meter and instrument are disturbed, it should be recalibrated) 0.331 (Must be aware of the principle of the machine and specimen) 0.118 (Every apparatus should be capable to withstand the specimen resistance).

Regression Model 4: Calibration = 3.537 (Constant) 0.126(Every apparatus should be capable to withstand the specimen resistance) 0.318 (Must be aware of the principle of the machine and specimen)

Regression Model 5: Quality Assurance = 2.390 (Constant) 0.120(The schedule for the product quality checks should be available and checks should be done as per schedule) 0.244 (The site team use systematic methods/ tools with data to analyze quality problems) 0.167 (The site must report Customer complaints in monthly quality report)

Regression Model 6: Customer Satisfaction =0.768 (Constant) + 0.466 (The project follows a written organizational policy to implement quality assurance) 0.210 (The site team use systematic methods/ tools with data to analyze quality problems) 0.123 (The schedule for the product quality checks should be available and checks should be done as per schedule.

The following QMS factors were found to be the strongest predictors exhibiting cause and effect relationship with more number of dependent variables (Management, Final Approval, Inspection, Calibration, Quality Assurance, Customer Satisfaction) in general quality aspect.

1. Manager should be capable of doing test in the absence of technicians.
2. Whenever the meter and instrument are disturbed, it should be recalibrated.
3. Each item must be approved by the quality manager.
4. The following extracted factors were the strongest predictors exhibiting cause and effect relationship with a greater number of dependent variables in standard code representing aspect.
5. The site must report Customer complaints in monthly quality report.
6. The project follows a written organizational policy to implement quality assurance.

V. CONCLUSION

The critical factors which are likely to affect the implementation of total quality management in construction projects have been identified. They are grouped under three categories based on their significance as highly critical, significant, and less significant.

The highly critical factors are to be given top priority in the real time monitoring. The significant factors are also to be addressed with equal importance. The less significant factor should not be neglected but given due importance. With all these aspects properly addressed at the appropriate stage of the project, project can be successfully completed within the stipulated time. The critical factors identified reveal that the quality management team members have a crucial role to play. The site engineers otherwise known as engineers also have an equal role to play.

From the questionnaire survey the under lying critical factors in implementing the quality management in construction projects were identified and given below.

i. Lack of experience in the implementation of the quality management system.

ii. Extreme reliance upon the traditional methods of construction management.

iii. Natural negative attitude towards new approach.

iv. Trickle down process where when large organisations implementing the quality management system the subcontractors or suppliers have to go along, was not materialised.

v. Misconception of the QMS; for example, QMS mandates a higher level of product quality, QMS tend to major on bureaucracy, paperwork, administrative cost and loss of innovative opportunity, and In general all those factors were due to the failure to understand the concept of the quality management system, lack of positive view of the significant benefits that a quality management.

System can bring to the construction projects and lack of capability and skill to implement the QMS.

VI. RECOMMENDATIONS

- Although top management might not need to oversee the daily operations of the quality management system, they are required to establish the quality policy and the quality objectives, conduct management reviews, ensure availability of resources, and communicate the importance of meeting customer requirements and any applicable regulatory mandates.
- Top management must be involved during the development, as well as the implementation, review and analysis, of the quality management system for maintenance and continuous improvement.
- All levels of management should ensure that all services provided, and related activities are planned, implemented, controlled and monitored. All levels of management must be responsible for identifying and facilitating the communication of problems and take action to resolve them.
- Construction projects must clearly define every role of quality management and staff for effective internal communications, controlling both each other and the work to be carried out.
- The importance of providing the quality working culture in the construction industry is however undeniable as it will unconsciously change the mentality of the construction community towards a quality working culture. Therefore, steps should be taken to initiate the change.
- Enforce a regulation to construction companies and consulting firms to implement the QMS, thereby, they might not have choice rather than to practice the quality system in their projects and consequently the QMS will become part of their

profession. For those who disregard the requirement, may be blocked from participating in any tender or undertaking any consulting services.

- Frequent Training and Seminars: It is evident that training can constructively make a rapid change to the perception of the QMS and a rapid development of the skill to implement the QMS. Thus, the developers in the public and private sectors should play their role to promote training to the project managers, the consultants, and the contractors.
- Increase Audit Frequency: To ensure the smooth run of the implementation of the QMS, auditing must be carried out frequently. Inconsistency in auditing will lead to lost control over performance and the quality of the work, resulting in failure to accomplish the work in time and to the specification.

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