Study of Quality Management System in Construction

AnupW S[1], Arun Kumar H[2], SNA Saqhi[3]

[1]*Asst Professor, Civil Engineering Department, Manipal Institute of Technology, Karnataka, India*
[2]*Post graduate student, Civil Engineering Department, Manipal Institute of Technology, Karnataka, India*
[3]*Asst Vice President, Civil Engineering Department, The Prestige Group, Karnataka, India*

Abstract-*Construction players have realized the importance of Quality management System in construction. This is an exploratory research conducted primarily to give insight about quality practices, tools, techniques, management commitment towards quality implementation in construction projects. It also explores the issues faced during the implementation of Quality Management Systems. The research uses a qualitative questionnaire approach to gather data. A case study which substantiates the questionnaire is conducted using content analysis method. Conclusions are drawn based on the results of the analysis and the case study data. Suitable suggestions on how to overcome the issues of implementation of QMS has been made by consulting the experts through an unstructured interview.*

Key Words: Quality Management System (QMS), Management Responsibility, Relative Importance Index (RII)

1. INTRODUCTION

Globally, construction industry is one of the largest contributors to the Gross Domestic Profit (GDP) of any country. The construction projects has increased rapidly in the recent years, reflecting the interest of private and public sector investing more funds into property development. As the investment has increased the expectation of quality product has also increased.

Now quality management has become an integral part of construction. Acknowledging the quality issues in construction and increasing demand for quality products, specific regulations to the implementation of the Quality Management Systems have been framed. ISO 9001 standards were set up for this purpose.

1.1Quality Management System

The results of a survey on Quality in construction by FIDIC has clearly indicated that the failure in construction quality is a big problem worldwide [1]. In order to attract customers, ISO certification has become a trend in most industries including construction industry. According to ISO organisation, 178 Countries are ISO members, 3335 technical bodies are responsible for standards development and 1.1 million certificates are issued across 178 Countries and Economics [2]. By the end of the year 2013, nearly 37,958 organisations in India had adopted ISO 9001 certification. The QMS which is being implemented are based on the ISO 9000 series of standards. ISO 9001 is one such standard [6] .The important clauses in ISO 9001 for quality implementation are quality management system, management responsibility, resource management, product realization and measurement, analysis and improvement. Quality Management in construction project means maintaining the construction quality to the desired level of the customer [3].

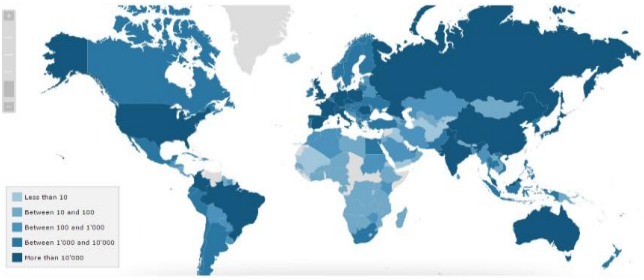

Figure 1: World distribution of ISO 9001 certificates in 2013

1.2 ISO Quality Standards

Failure in the quality of construction is the biggest failure of the project. ISO 9000 series of standards were developed to overcome these problems. ISO 9001 is one such standard followed in the construction which helps in QMS implementation [4]. Quality Assurance, Quality Control, Quality Plan and quality improvement are the terms associated with quality management. Quality systems is defined as the organizational structure, procedures, processes and resources needed to implement quality management [5]. ISO 9001 specifies certain set of quality system requirements which has to be followed to meet customer satisfaction.

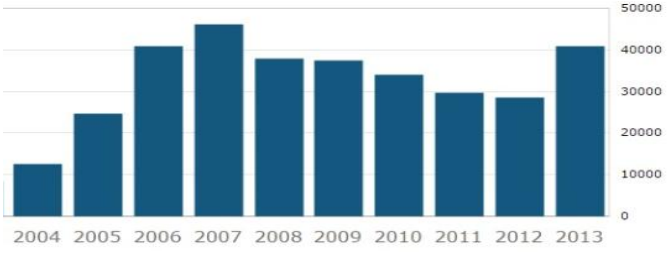

Figure 2: Evolution of ISO certificates in India

X-axis denotes the year and the Y-axis denotes the number of certifications in India. Considerable research has been conducted on QMS implementation within construction projects globally as well as in India .Most of the recent research are conducted on the advantages and disadvantages of implementation of QMS. Limited researches have been carried out on the issues faced during the implementation of QMS. The debates whether QMS is suitable for construction industry will never end.

The paper provides an exploratory view of quality management practices followed in construction and also the issues faced during the implementation of QMS. Suggestions for the improving the implementation will be made based on the research outcomes.

2. OBJECTIVE

The study focuses on –

- The prevailing quality practices followed in the local construction projects and management commitment towards quality implementation.
- Problems encountered while implementing quality management systems.

3. RESEARCH METHODOLOGY

A detailed extensive literature review was carried out and an unstructured interview with the experts was conducted to know the tools, techniques and also the issues faced while implementing QMS. The experts had a minimum of 20 years of experience and were well versed in quality implementation in construction industry.

A questionnaire was framed based on the literature review and expert discussion. The questions were grouped under the different clauses of ISO 9001 standards.

The questionnaire was distributed to the respondents having minimum 3 years of experience in the company. They were given with a ranking scale from 1 to 5 with 1 being strongly disagree and 5 being strongly agree.

The sample size was calculated using Z-score test assuming 90% confidence interval, 20% standard deviation and 10 % marginal error.

$$\text{Sampling size} = \frac{z^2 * standard\ deviation * (1 - standard\ deviation)}{(Margin\ of\ error)^2}$$

The value of z depends on the confidence interval. The resultant sampling size was 45. Since the response rate is too low among civil Engineers, 54 questionnaires were distributed out of which 45 responses were collected. The Respondent's organizations were ISO certified companies with minimum of 400 employees. Cronbach's Alpha test was done to check the reliability of the questionnaire for the first 10 responses. The alpha value was 0.879 comparing with the standards it was acceptable. Proper validation of the questionnaire was carried out and suitable changes required were done.

Statistical analysis was carried out using SPSS to rank the factors. Correlation test was carried out between the factors. One sample t-test was conducted to check the hypothesis.

To substantiate the questionnaire, a case study was conducted. The quality documents of two projects were studied. Both the projects were of a single client but different contractors based in Bangalore, Karnataka. Using Content Analysis method, the results were tabulated and are shown below.

4. RESULTS AND DISCUSSIONS

Around 70 percent of the respondents think that ISO 9001 certifications are required as a marketing tool and also to improve the overall quality of the project. The quality tools and techniques adopted by the companies based on their responses are tabulated. All the companies had specific quality plan for every project.

	Companies									
Tool/Techniques	1	2	3	4	5	6	7	8	Total	%
Benefit/cost analysis	✓	✓		✓	✓	✓	✓	✓	7	88
Benchmarking	✓	✓	✓			✓			4	50
Flowcharting	✓	✓	✓			✓	✓	✓	6	75
Design of Experiments				✓		✓			2	25
Quality Auditing	✓	✓	✓	✓	✓	✓	✓	✓	8	100
Pareto analysis								✓	1	13
Inspection	✓	✓	✓	✓	✓	✓	✓	✓	8	100
Scatter Diagram				✓			✓		2	25
Brainstorming			✓		✓	✓			3	38

Table 1: Tools and Techniques of Quality in 8 companies

4.1 Relative Importance Index Analysis

Descriptive Statics was carried on the two groups separately. The first group was the management responsibility and resource allocation where the respondents would rate their top management based on certain factors. Top management were the quality heads and the people who have the authority to prepare quality policies.

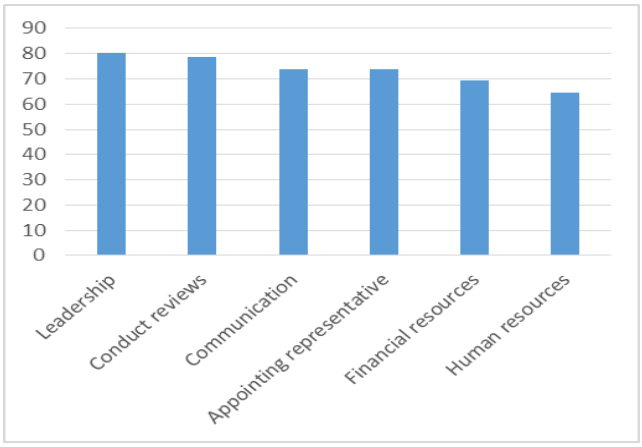

Figure 3: RII values for Management Responsibility

As the figure suggests most of the top management are good in leadership where they set all the quality policies and procedures. They are also good in conducting reviews and appointing representatives but they lag in communication with the subordinates regarding quality and also in resource allocation.

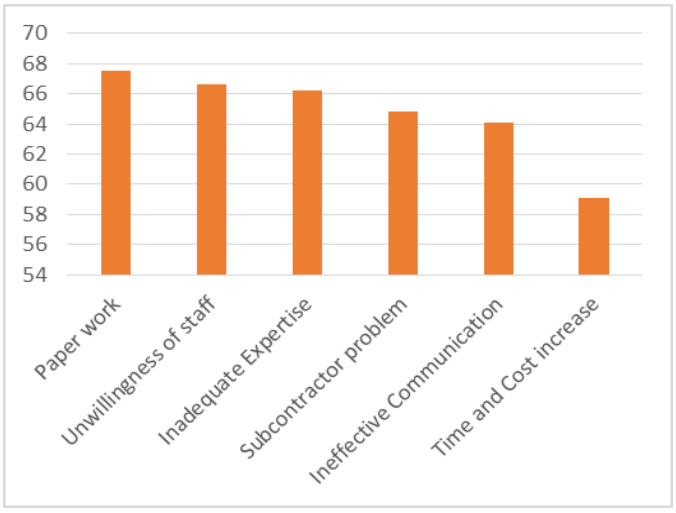

Figure 4: RII values for Issues while implementing QMS

Out of the top six issues faced during the implementation of QMS the respondents feel that too much of paper work is the biggest hurdle in QMS implementation. The unwillingness of the employees to adopt QMS and inadequate technical expertise are other major issues.

4.2 Correlation Analysis

The bivariate Pearson's correlation analysis was conducted between the factors using SPSS. This test was again conducted under two groups. The management responsibility factors had moderate correlation and the issues had weak correlation. The top three correlation factors are shown in the graph.

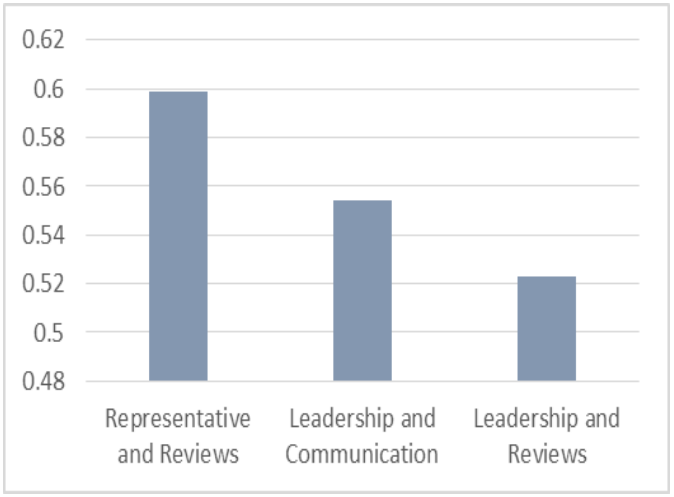

Figure 5: Correlation values for Management Responsibility factors

The top three correlation values of problems faced during implementation of QMS are shown in the graph.

All the factors had positive correlation which means that as one factor increases, the other factor also increases and vice versa.

Figure 6: Correlation values for issues while implementing QMS

4.3 Hypothesis Testing

Non parametric one sample test was used for hypothesis testing. Nonparametric tests are useful for testing whether group means or medians are distributed the same across groups. Initially we had considered 90 percent Confidence Interval (CI) for the study. In hypothesis testing with 90 percent CI, the significance level should be below 0.1(i.e. 10percent). Hence when the sample was analyzed for hypothesis one sample test all values should rejection of

null hypothesis which signifies that all values are below 0.1. This clears the hypothesis testing.

5. CASE STUDY

To substantiate the questionnaire survey, a case study was conducted, the quality documents of two projects were studied. Both the projects were of a single client but different contractors located in Bangalore. Using Content analysis technique all the inputs, mechanisms, and output were tabulated. The quality details were analyzed and tabulated .The tabulations were done under the quality clauses of ISO 9001. The analysis was carried out based on the inputs, mechanisms, control measures and the output.

Project 1 is located in Bangalore. The whole work was contracted to a single contractor. The quality plans were set up separately for that specific project. The tabulations were done under the quality clauses of ISO 9001. The analysis was carried out based on the inputs, mechanisms, control measures and the output.

Project 1					
Unit of Analysis	**General**	**Management Responsibility**	**Resource Allocation**	**Product Realisation**	**Measure,Analyse and Improve**
Input	Documentation Reqirements,Project Quality Plan	Quality Planning and Objectives,Quality Policy,Responsibility,authority and Communication	Training Plan,Contract document,Inputs from all the site	Planning Records and Schedule Records, BOQ,Customer Documents,Master List of Submittals	Method Statements, Contract Documents,Master List of Inspection and Test plans,QMS
Mechanism/Representative	Senior Manager,Vice Presidents,Quality Meetings	Senior Management, Management Review	Recruitment,Quality Manager,Project incharge,Planning Engineer,HR	Schedule Management,Planning Engineer,QC Engineer	Management Representative,QC Engineer,Marketing department
Control	Control of Record and Documents,Master list of Codes/standards ,Project QMS	QMS,Agenda and Minutes of management review meeting	Trianing and Evaluation record for workman,MOM of the meeting.Induction Training	Monthly Quality Statements,Reconciliation Statements,MIS, Internal Communication, Test certificates for materials,Benchmarks of Project,Control and Monitoring of Equipments	CustomerSatisfaction Report, Customer Feedback,Customer Complaints,Internal and External Audits,Site work methods,Audit progress, Quality Ratings
Output	Master list of Quality records and controlled copy	Progress in quality,Work programme,Audit plan	Trianing Records,Certifications	Project Completion Report, Action Plan,General Photographs,PM's Report,Maintenance Report.Submittals,Customer Communication, Delivery Report	Product Quality assessments and Causes of non compliance,Continual Improvement Records , Corrective and Preventive Action Reports.

Table 2: Content analysis of Project A

The information from the referred quality documents were arranged according to functional hierarchy.

Project 2 is also located in Bangalore. The whole work was contracted to a single contractor and then subcontracted. Even in this case the quality plans were set up separately for that specific project.

Project 2					
Unit of Analysis	**General**	**Management Responsibility**	**Resource Allocation**	**Product Realisation**	**Measure,Analyse and Improve**
Input	Quality policies and Objetcives,PQP	Authorities, Objectives and communication	Trianing Plan and procedures, Awareness among employees,Competencies,Employement programmes	Planning and schedule records Quality designs and Customer requirements documents	Contract documents,Baseline Schedule, Standards,Master list of checklists
Mechanism/Representative	Quality Manager, Steering committee, Process incharge	Cash flow technique, Senior Manager , Management Representative at site,Deputy General Managers	HR policies, Recruitment,Quality Manager, Planning Engineer	Schedule, Design of Experiments, Laboratory manual, QA/AC Engineer	Customer feedback,Marketing representative,Maintenance Engineer, QC Engineer
Control	Process mapping model,Minutes of Meetiing,Control of records and documents	Agenda and Minutes of Meeting of management review meeting	Skill sets, Evaluation records,Incentives, Variable pay	Monthly/Weekly quality statements,MIS, Test certificates,Control and monitoring checklists	Internal and external auditing,Customer feedback, Comparison statements,Quality ratings from customers,Audit progress
Output	Master list of quality records,Formats and controlled documents	Detailed Procedure, Work Programme,Standard Operating procedures and external audit	Employee's records of training,qualification and skill records	Project Completion report, mainteneance report,Delivery confirmation,Project manager's report, relevant checklists	Quality assessment reports,Continual improvement reports,Corrective action reports, Non compliance reports

Table 3: Content analysis of Project B

Delphi Technique was adopted to make suggestions on how to overcome the issues faced during quality implementation. The experts had a minimum 25 years' experience in construction and were quality policy makers for their respective firms. The experts were not the respondents of the questionnaire.

6. CONCLUSIONS

The success of QMS doesn't completely depend upon setting policies and maintaining documents. Though the top management are very good in leading the changes and setting policies, without proper communication and control of processes, the desired quality cannot be achieved in construction. If there is no proper monitoring

and control, The ISO certification just becomes a marketing tool rather than a QMS implementation tool.
The importance of Quality Representative at site has to be communicated to the lower management.
There is a perception that QMS implementation increases paper work. The unwillingness of the employee to adopt QMS and inadequate technical expertise are other major factors faced during the implementation of QMS. Most of the quality issues faced elsewhere are relevant in local context. The correlation values are higher for appointment of representatives and Conducting reviews in case of management factors. Subcontractors work and inadequate technical expertise has greater correlation in issues in implementation of QMS.
From the case study, every project has a specific quality plan. Though the same client is developing the property, they still follow separate project Quality Plans (PQP). Proper resource allocation with specific roles and responsibilities are pre-defined for every project. But they lack in monitoring of resources. Quality audits, progress reports, schedule etc. are used for quality control. Quality audits and experiments designed are traditional methods for quality control.
Customer feedback is received and suggestions for future improvement. Though ISO 9001 has established standards, the procedures and policies change for every project based on the requirements.

7. SUGGESTIONS

According to the results obtained from the research most of the employees believe that implementation of QMS increases paper work and thus unwillingness to implement it has increased.
Competence, training and awareness has to be developed in the organization and should be given importance.
Proper training has to be provided to the employees and the importance of implementing QMS has to be communicated in order to change their perception about quality.
A monitor and control model has to be set up during the planning stage which has be followed by the quality representatives.
Adequate technical expertise has to be provided through training and certifications in quality management. Research and development has to be encouraged in quality department. Proper communication regarding the quality failures has to be made to the top management.
Documentation should not be a burden to the employees. A proper control of the documents should be pre-defined.
A skilled quality team in every firm is very useful to achieve quality products. Recognition and awards in quality departments has to be developed same as in safety department. Rework has to be reduced in order to reduce time and cost overrun.

7. REFERENCES

[1]. Rumane A. R (2011), Quality management in construction projects (Industrial innovation series), CRC press, Boca Raton.
[2]. Liu, A. M. M. (2003). The quest for quality in public housing projects: A behavior-to-outcome paradigm. Construction Management and Economics, 21, 147-158.
[3]. Landin, A. (2000). ISO 9001 within the Swedish construction sector. Construction Management and Economics, 18, 509-518.
[4]. http://www.iso.org/iso/iso-survey, 11-05-2015, 3 PM.
[5]. ISO 8402:1994 Quality management and quality assurance.
[6]. IS/ISO 9001(2008): Quality Management Systems – Requirements, Bureau of Indian standards.

