

Study of Quality Management in Construction Industry

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Abstract- Construction industry plays an important role in the development of any country. The development of construction industry depends on the quality of construction projects. Quality is one of the critical factors in the success of construction projects. Improvement in the quality of construction projects is linked with quality management in the project life cycle. Although quality management at every stage of project life cycle is important but the quality management at the execution (construction) stage contributes significantly on final quality outcome of construction projects. This project mainly focuses the importance and factors that affects the quality management in the execution (construction) phase. The project also includes visiting of some construction companies and conducts the questionnaire survey, then analyse the difficulties (major factors) and the cost variance due to quality defect in quality management and suggests some proactive measures for the improvement of quality in the execution phase of construction projects.

I. INTRODUCTION

1.1 GENERAL

Quality is one of the critical factors in the success of construction projects. Quality of construction projects, as well as project success, can be regarded as the fulfilment of expectations (i.e. the satisfaction) of the project participants. The construction industry in India has been struggling with quality issues for many years. A significant amount of the budget is spent each year on infrastructure and other development projects. Since the quality outcomes of the projects are not according to required standards, faulty construction takes place. Consequently additional investments are required for removal of defects and maintenance work. A construction project in its life span goes through different phases. The main phases of a project can be described as: conceptual planning, feasibility study, design, procurement, construction, acceptance, operation and maintenance.

Quality of construction projects is linked with proper quality management in all the phases of project life cycle. Design and construction are the two important phases of project life cycle which affect the quality outcome of construction projects significantly. In a NEDO (National Economic Development Office), London survey aimed at improving methods of quality control for building works it was found that "design" and "poor workmanship in the construction process" combined to form more than 90% of the total failure events. This paper therefore, focuses on the quality management in the execution phase of construction projects. The aim of this paper is to highlight the importance of quality management in the execution phase of construction projects.

During the last decades construction industry has been heavily criticized for its performance and productivity in relation to other industries. With the turn of the new millennium, it appears that the construction industry is going through an intense period of introspection, which is exacerbated by increased technological and social change. These changes are altering the tempo of the environment within which construction operates. Moreover, such changes extensively affect the way business is carried. No organization operating in the construction industry, whether large or small, private or public, can afford to ignore its changing environments if it is to survive.

Many of the management practices used to support construction organizations are being challenged. The industry's clients are moving forward. Clients demand improved service quality, faster buildings and innovations in technology. It is no accident that the construction industry has turned to the manufacturing sector as a point of reference and source of innovation. Successful concepts derived from manufacturing, such as Total Quality Management (TQM), Reengineering and Lean (or Just-in-Time) Production, are being adopted and integrated into the construction industry. Implicitly, the successful implementation of these concepts is heavily dependent on a culture of teamwork and cooperation at both intra- and inter-organizational levels in construction.

Quality Management has increasingly been adopted by construction companies as an initiative to solve quality problems and to meet the needs of the final customer, if ever an industry needed to take up the concept of QMS (Quality Management System) in the construction industry. However, implementing QMS principles in construction industry is particularly difficult because of the many parties involved.

In this thesis I first present a short review of the literature on quality management in construction industry. Secondly, we focus on the problem defining quality in construction. I use data from my studies on quality in construction industry to illustrate the problem of defining quality and also discuss with some contractors. Third, we focus on problems with implementing quality management in construction industry. Using those data, I form some the questionnaire for quality survey. Fourth, from the survey I can easily predict the major factor affecting the quality of construction. Fifth, the founded major factor affects the organization in terms time, cost and reputation. Finally the research result shows the cost and time for insufficient quality. Then conclude the research with giving some suggestion to the organization.

1.2 OBJECTIVES OF STUDY

QMS places emphasis on prevention, not correction. The goal which works that is 100% free of errors, free of accidents, and 100% free of waste. The aim of the project is to do things right at the first time, eliminating waste and rework. To achieve this, it is necessary to focus on "processes." A process is a task or a series of tasks. A process might be the vibration of fresh concrete, the fabrication of structural concrete, the preparation of a drawing, or a way in which the project manager acts with a client and with other members of the projects .

The main objective of this study is to create the quality awareness to the construction company especially small scale industries. Because all the literature and statistics shows that small scale construction industries not that much aware of QMS (Quality Management System). Whenever the Quality Management System is implemented we can easily minimize the wastage of material, cost overrun, wastage of time, etc... Specifically, the aims and objectives of this research project are to:

1. Investigate the adoption and implementation of QMS in the construction industry.

2. Determine the major factors that are mostly affecting the quality of construction during the construction particularly in execution phase.

3. To create the quality awareness to the low level construction organisations.

4. To minimize the indirect cost of the project and also reduce the wastage of materials, time, money, manpower, etc.

1.3 SCOPE OF STUDY

This project proposes to investigate the adoption and implementation of QMS in the construction industry and develop a "measurement methodology" of construction processes for customer satisfaction and continuous improvement. The main concept of this research project will be to identify "what" processes can be measured and "how" to measure them. To identify the above objectives, literature search, questionnaires and interviews will be used. The tools used in the measurement will be one or several of the "Tools of Total Quality" such as control and run charts, cause and effect diagrams, flowcharts, check sheets, Pareto diagrams, and histograms. For the local construction industry, this project has the potential of demonstrating benefits of using TQM in their organizations. This will be carried out by showing that quality improvement efforts can be quantified, measured, and analyzed - thereby showing the construction company to continuously improve in products and services to meet and even exceed customer needs.

In India especially Tamilnadu lack in quality management so creating awareness about quality management is more important. This thesis creates some awareness about major factor affect the construction quality and cost of poor quality. Another important of this thesis is comparing the quality management between high level companies and low level companies.

1.4 NEED FOR STUDY

In other manufacturing industries are establishing the TQM (Total Quality Management) system but in construction industry we cannot establish even QMS (Quality Management System). The reason behind is every construction project is unique and quality is ever changing factor i.e. quality change time to time, place to place. But many common activities in construction project like the concrete work, Block work, plastering, etc.

In those common works are affected by some major factors like quality of material, quality of manpower,

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construction detailing, concrete work, etc. in this thesis is very much helpful for find out the major factors and give result with cost of poor quality. This thesis is more helpful for creating cost oriented quality awareness to low level construction companies.

1.5 TERMINOLOGIES

This part includes the terminologies used in quality management system. These definitions place a major role in quality management because researcher's definitions are the basic. From the basic we can understand about quality management.

1.5.1 Quality

ISO 8402 defines quality as the degree of excellence in a competitive sense, such as reliability, serviceability, maintainability or even individual characteristics.

We usually think of "quality" in terms of an excellent product or service that fulfils or exceeds our expectations. These expectations are based on the intended use and its cost.

According Dale Besterfield (Quality Control, A Practical Approach, 7th edition, 2004), Quality can be expressed as:

$$Q = P / E$$

Where: Q = Quality
P = Performance
E = Expectation

If Q is greater than 1.0, then the customer has a feeling of great satisfaction about the product or service rendered. The determination of Q is based on perception, with the contractor determining performance and the customer determining expectations. The customer expectations are continually becoming more demanding.

1.5.2 Quality Systems

Quality systems refer to the organizational structure, process, resource and procedure needed to implement quality management.

1.5.3 Quality Assurances

Quality assurance is the planned and systematic activities implemented within quality system and demonstrated, as needed, to provide adequate confidence that an entity will fulfil requirements for quality.

Quality assurance is evaluating the overall project performance on a regular basis to provide a confidence that the project will satisfy the relevant quality standards.

The primary function of quality assurance is to obtain completed construction that meets all contract requirements. Assurance is defined as a degree of certainty. Quality assurance personnel continually assure or make certain that the contractor's work complies with contract requirements.

1.5.4 Quality Control

Quality Control is the monitoring of specific project results to determine if they comply with the relevant quality standards and identifying ways to eliminate causes of unsatisfactory performance.

Both ANSI (American National Standards Institute) and ISO define quality control as the operational technique and activity; for example, providing a means to control and measure the characteristics of a material, structure, component, or system that are used to fulfil requirements for quality.

1.5.5 Quality Management

Quality management refers to all activities of overall management functions, especially top management leadership, that determine quality policy objectives and responsibilities for all members of the organization.

1.5.6 Total Quality Management (TQM)

Total quality management is the management approach of an organization, which concentrates on quality based on the participation of its members and aims at long-term success through satisfaction and benefits to all members of the organization and society.

1.5.7 Quality planning

Quality Planning is identifying which quality standards are relevant to the project and determining how to satisfy quality standards.

1.6 QUALITY IMPROVEMENT TECHNIQUES

Total Quality Management mainly demands a process of continued improvement aimed at reducing variability. An organization wishing to support and develop such a process needs to use quality management tools and techniques. It is prudent to start with the more simple tools and techniques. These are Check-sheet, Check list, Histogram, Pareto

Diagram, Cause-and-Effect Diagram (Fishbone Diagram), Scatter Chart and Flowchart.

1.6.1 Check-sheet

Check-sheet is used to record events, or non-events (non-conformances). They can also include information such as the position where the event occurred and any known causes. They are usually prepared in advance and are completed by those who are carrying out the operations or monitoring their progress. The value of check-sheet can be retrospective analysis, so they help with problem identification and problem solving.

1.6.2 Checklist

Checklist is used to tell the user if there is a certain thing, which must be checked. As such, it can be used in the auditing of quality assurance and to follow the steps in a particular process.

1.6.3 Histogram

Histogram provides a graphical representation of the individual measured values in a data set according to the frequency of occurrence. It helps to visualize the distribution of data and there are several forms, which should be recognized, and in this way they reveal the amount of variation within a process. It should be well designed so that people who carry out the operation can easily use them.

1.6.4 Pareto Analysis

It is a technique employed to prioritize the problems so that attention is initially focused on those, having the greatest effect. It was discovered by an Italian economist, named Vilfredo Pareto, who observed how the vast majority of wealth (80%) was owned by relatively few of the population (20%). As a generalized rule for considering solutions to problems, Pareto analysis aims to identify the critical 20% of causes and to solve them as a priority.

1.6.5 Cause and Effect Diagram (Fishbone Diagram)

Cause and Effect Diagram, which was developed by Karo Ishikawa, is useful in breaking down the major causes of a particular problem. The shape of the diagram looks like the skeleton of a fish. This is because a process often has a multitude of tasks footing into it, any one of which may be a cause. If a problem occurs, it will have an effect on the process, so it will be necessary to consider the whole multitude of tasks when searching for a solution.

1.6.6 Scatter Diagram

The relationship of two variables can be plotted in the scatter diagrams. They are easy to complete and obviously linear pattern reveals a strong correlation.

1.6.7 Flowcharts

Flow chart is used to provide a diagrammatic picture using a set of symbols. They are used to show all the steps or stages in a process project or sequence of events. A flowchart assists in documenting and describing a process so that it can be examined and improved. Analysing the data collected on a flowchart can help to uncover irregularities and potential problem points.

1.6.8 Statistical analysis

Statistics is the study of the collection, organization, analysis, interpretation and presentation of [data](#). It deals with all aspects of data, including the planning of data collection in terms of the design of [surveys](#) and [experiments](#).

1.6.9 PDCA cycle

PDCA is an iterative four-step management method used in business for the control and continuous improvement of processes and products. It is also known as the Deming circle/cycle/wheel, Shewhart cycle, control circle/cycle, or plan-do-study-act. Another version of this PDCA cycle is OPDCA. The added "O" stands for observation

1.6.10 Pilot survey

A brief preliminary survey, often using a small, convenience sample, conducted to test the survey instruments and data collection method before the project details are finalized and the larger, formal survey conducted.

1.7 COMPANY IDENTIFICATION

Companies for questionnaire survey are mainly classified in to 3 types according to their cost. They are high level, middle level, and low level companies.

- High level companies their project cost is more than 100 crore,
- Middle level companies project cost ranges from 5 to 100 crore, and
- Low level company's project cost less than 5 crore.

The high level companies are located in Chennai, Bangalore areas and The middle and low level companies are located in Coimbatore, tiruppur, erode areas.

1.8 IMPORTANCE OF QUALITY CONTROL IN CONSTRUCTION

Quality Control (QC) in construction is the process of verifying that the project is built to plan, that the tolerances allowable by industry standard and engineering practices have been met or bettered, and that the finished project (and all phases to get there) meet with the quality standards of the architect, engineer, owner, and general contractor. On construction projects there are dozens of subcontractors, all of which have specific responsibilities. Superintendents and project managers try to maintain high quality standards but they can't be everywhere at once. Required inspections by cities and counties (as well as other jurisdictions, depending on the project) help to ensure safety and code issues. In addition, a good general contractor or developer will have on staff a QC person, someone who is responsible for going through the building or project, ensuring compliance, and maintaining an on-going list of corrective items that must be accomplished before the contractor who installed it is paid or leaves the job. QC technicians generally keep a very detailed binder, separated by areas/rooms/phases of the project with notes of items that must be either verified or corrected, with sign-off as each is accomplished. This binder becomes part of the project record and is an important element to completing the project on time and with expected quality maintained.

1.9 FACTORS AFFECT QUALITY OF CONSTRUCTION

1. Limitation of Finance: This was the main factor of construction and in every type of work where contractor had to plan for financial payment to eliminate the risk because it might affect the project.
2. Limitation of Communication: Construction site sometimes was located in rural areas or far away from the community. It might be a cause which affected transportation causing difficulty and delay, therefore it was a limitation that contractor had to consider.
3. Limitation of Labour and Wage: In many different local areas, the problem related to labour such as lack of skilled labour, complex work, not being able to find labour might occur, which might be causes of work difficulty, delay and low quality.
4. Limitation of Weather: Weather was one of several important limitations because it sometimes cannot be prevented such as flooding, storm, etc.

5. Limitation of Building Plan and Construction Detail: Problems of building plan and construction detail were found such as drawing not clear, drawing mistake, so they also became big problems in construction.

6. Limitation of Material and Equipment: Some construction works might use special machines or equipment which contractor had to study carefully regarding performances, suitability for work and prepare enough equipment for each work.

7. Limitation of Time: Some construction works had to be completed within a time limit such as in cases of urgent works. They caused limitation of work planning and they also caused other management problem. Therefore, contractor had to carefully consider this issue.

8. Limitation of Construction Methodology: Construction works in some areas could not be performed by regular method because there were buildings around construction site, so the contractor had to find new methods that were suitable to construct and sometimes used specialist engineer when some construction works were in step of construction.

9. Limitation of Rule or Regulation: This problem also greatly affected construction such as problem from traffic which had an effect on transportation, problem of labour hiring, problem of building construction regulation, etc.

10. Training Policies: Looking into the general training policy, the ISO 9001 registered companies have more concern on the training of their employees than the non-registered ones. They not only pay for the course fees, but also allow them to receive training during working hours. For non-registered companies, the company may reimburse the course fees but employees have to attend training sessions outside of working hours. Moreover, regular training programmes on technical and computer knowledge were commonly provided in many companies. The most popular training programme organized by ISO 9001 registered companies was Quality Knowledge.

11. Lack of co-ordination among departments: Co-ordination is very important for project successful. Because co-ordination between the departments is failed that may leads to wrong execution or may affect the sequence of work. For example consider the MEP (Mechanical Electrical Plumbing) department not properly co-ordinate with execution team, now execution team done the plastering work before plumbing works are not done due to lack of co-ordination. Here definitely rework required so automatically quality is misplaced.

12. Other Limitations: Such as cooperation of each party that is related to construction project.

2. METHODOLOGY

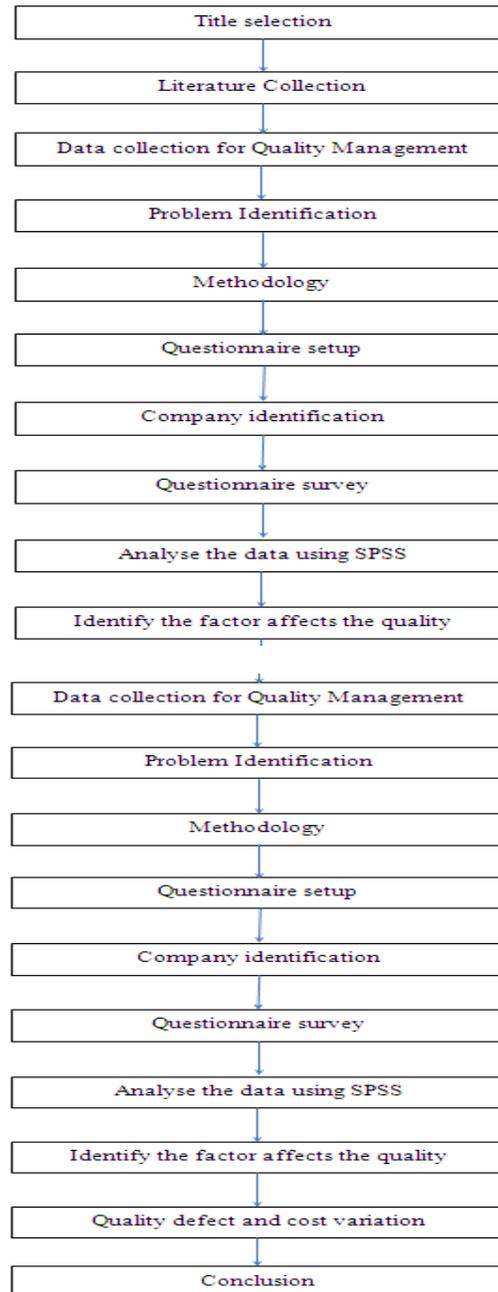
2.1 GENERAL

From the literature survey it had been learnt concluded there are many issues about quality in construction industry. Due to time constraint for the project, the descriptive survey method is to be adopted, whereas other methods may take long duration. Several methods for collecting information from the industry were evaluated from various literatures.

The following steps are carried out in the project. These are

- After title conformation relevant literatures were collected. From the literature the problem and issues were identified.
- Framing the questionnaires based on the analysis from the various people of construction industry, literature review.
- Group the companies based on the methodology
- Conduct the questionnaire survey in pre-defined companies
- Analysis the data using SPSS software
- Find out the factors that affects the quality of construction
- Calculate the cost variance for quality defect
- Conclusion

2.2 METHODOLOGY



3. DESIGN OF QUESTIONNAIRE

4.

A questionnaire was designed to study more about the quality management practices in the construction industry and ways to improve quality in construction works. The questionnaires were prepared with reference of literature reviews and field persons like contractors, engineers, project managers and consultant. Because field people are very well know about, what are all the factors affecting the quality majorly.

Questionnaires are mainly focused on the execution part particularly superstructure. Because the quality of construction is majorly misplace in execution part. Questionnaire mainly divided into five main categories. These are column work, beam work, slab work, brick or block work and plastering work.

Lot of factors affecting the construction quality but in this project I only focuses on major factors like concreting work (concrete quality, pouring of concrete, compaction, curing, etc.), man power, material quality, equipment quality, detailing, etc.

COLUMN WORK

1. Does the column marking is affect the quality?
Yes no sometimes
2. Is there any kind of problem arise due to insufficient reinforcement?
Yes no sometimes
3. Is there any kind of quality problem arise due to poor design?
Yes no sometimes
4. Is there any kind of quality problem arise due to improper shuttering work?
Yes no sometimes
5. Does the improper cover block placement affect the quality of column?
Yes no sometimes
6. Is there any kind of quality problem arise due to manpower in site?
Yes no sometimes
7. Is there any kind of quality problem arise due to equipment used in site?
Yes no sometimes
8. Does the poor quality of concrete is affect the quality of column?
Yes no sometimes

9. Is there any kind of quality problem arise due to compaction of concrete?
Yes no sometimes

10. Is there any kind of quality issue arise due to improper curing of column?
Yes no sometimes

BEAM WORK

11. Is there any kind of problem arise due to insufficient reinforcement?
Yes no sometimes
12. Is there any kind of quality problem arise due to shuttering work?
Yes no sometimes
13. Does the poor cover block placement is affect the quality of beam?
Yes no sometimes
14. Is there any kind of quality problem arise due to manpower in site?
Yes no sometimes
15. Is there any kind of quality problem arise due to equipment used in site?
Yes no sometimes
16. Does the poor quality of concrete is affect the quality of beam?
Yes no sometimes
17. Is there any kind of quality problem arise due to compaction of concrete?
Yes no sometimes
18. Is there any kind of quality issue arise due to curing of beam?
Yes no sometimes

SLAB WORK

19. Does the reinforcement is not providing as per reference drawing?
Yes no sometimes
20. Is there any kind of quality problem arise due to shuttering work?
Yes no sometimes
21. Does poor cover block placement affect the quality?
Yes no sometimes
22. Is there any kind of problem arise related to electrical lining?
Yes no sometimes
23. Is there any kind of quality problem arise due to manpower in site?

Yes no sometimes
24. Is there any kind of quality problem due to equipment used in site?

Yes no sometimes
25. Does the quality of concrete is affect the quality of slab?

Yes no sometimes
26. Is there any kind of quality problem due to compaction of concrete?

Yes no sometimes
27. Is there any kind of quality issue due to curing of slab?

Yes no sometimes

BLOCK WORK

28. Does any kind of quality problem due to improper drawing study?

Yes no sometimes

29. Does the right angle marking is affect the quality of block work?

Yes no sometimes

30. Does the starter course lying is affect the quality of block work?

Yes no sometimes

31. Does the proportion of mortar mix is affect the quality?

Yes no sometimes

32. Is there any kind of problem due to poor quality of brick or block?

Yes no sometimes

33. Is there any kind of problem arise due to not wetting the brick or block before lying?

Yes no sometimes

34. Is there any kind of quality problem due to manpower in site?

Yes no sometimes

35. Is there any kind of problem due to not pointing of joints?

Yes no sometimes

36. Is there any kind of quality issue due to curing of wall?

Yes no sometimes

PLASTERINGWORK WALL PLASTERING

37. Is there any kind of fault due to improper button marking fixing?

Yes no sometimes

38. Does mortar proportion affect the quality?

Yes no sometimes

39. Is there any kind of quality problem due to manpower in site?

Yes no sometimes

40. Is there any kind of quality issue due to curing of surface?

Yes no sometimes

CEILING PLASTERING

41. Is there any kind of problem arise due to not hacking the surface before plastering?

Yes no sometimes

42. Is there any kind of fault due to improper button marking fixing?

Yes no sometimes

43. Does thickness of plastering affect the quality?

Yes no sometimes

44. Does the mortar proportion affect the quality?

Yes no sometimes

45. Is there any kind of quality problem due to manpower in site?

Yes no sometimes

46. Is there any kind of quality issue due to curing of surface?

Yes no sometimes

4. CONCLUSION

The result of this thesis will expose the main factors which affect the construction quality and also increase in cost of construction due to quality defect. This study will create the quality management awareness to all level construction companies especially small scale companies. From this thesis we get the major factors and issues which affects the construction quality and that create a chance for find out the remedial measure. This thesis is useful for minimize the material wastage, workmanship wastage, time wastage and indirect cost. Then increase the customer satisfaction and company reputation.