

# ASSESSMENT OF QUALITY PROBLEMS FOR HIGH RISE BUILDING PROJECTS- CASE STUDY

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*Abstract- Quality is one in every of the important factors within the success of construction comes. Quality of construction comes, furthermore as project success, are often considered the fulfilment of expectations of the project participants. Construction industry plays a crucial role within the development of any country. The development of construction industry depends on the standard of construction projects. The construction industry in India has been combating quality problems for several years. A major quantity of the budget is spent every year on infrastructure and different development projects. Since the quality outcomes of the projects don't seem to be per needed standards, faulty construction takes place. Consequently further investments are needed for removal of defects and maintenance work. This study presents the results of the investigation on assessment of quality problems in high-rise buildings. The objectives of the study are to identify the aspects of quality problems and assessment is made through a case study. The methodology for conducting the study involved literature review, data assortment and analysis of results using Pareto analysis 80-20 rule. The method of data assortment involved obtaining primary data from the respondents by conducting form surveys at the chosen building case studies. It's hoped that this study will provide some useful insight on the very important aspects of quality problems and provide remedial measures.*

**Keywords:** Quality control, High-rise buildings, Pareto analysis, Assessment of quality problems.

## I. INTRODUCTION

Construction industry plays a vital role within the development of any country. The event of construction industry depends on the standard of construction comes. Quality is one in every of the essential factors within the success of construction industry. Improvement within the quality of construction industry is connected with quality management within the project life cycle. Though quality management at each stage of project life cycle is very important however the standard management at the execution stage contributes considerably on final quality outcome of construction comes. The definition of quality depends on the purpose of read of the folks shaping it; some read it as "conformance to specification. Others read it as "performance to standards or price bought the worth. For construction firm quality is nothing however the satisfaction of consumers and fulfilling of their necessities among a nominative budget.

## II. NEED FOR STUDY

In other manufacturing industries are establishing the TQM system however in construction industry we have a tendency to cannot establish even QMS. The explanation behind is each construction project is exclusive and quality is ever changing factor i.e. quality change time to time, place to position. However several common activities in construction project just like the concrete work, Brick work, plastering, etc. are similar. In those common works are laid low with some major factors like quality of material, quality of manpower, construction detailing, concrete work, etc. during this study is extremely a lot of useful for ascertain the key factors and provides result with price of poor quality. This study is a lot of useful for making price minded quality awareness to low level construction companies.

## III. OBJECTIVE OF STUDY

1. To understand the concept of Quality control.
2. To identify the factors affecting the quality in high rise building.
3. To assess quality problems for high rise building through a case study.
4. To propose the recommendations and give findings of the quality control and management investigation framework.

## IV. DATA ANALYS FOR CASE STUDY

Researchers have adopted relative importance index for analysis of data and ranking major factors. The same method is adopted in this study and data collected from respondents are converted in five point scale and then the five point scale are transferred to relative importance index for each factor. These factors are ranked in order of importance based on the relative importance indices values. The relative importance index is calculated by using below formula:

Relative Importance Index (RII) =

$$\frac{\sum w}{A*N} \quad (1)$$

Where, W = weightage given to each factor by the respondents and ranges from 1 to 5,

A = highest weight (i.e. 5 in this case) and

N = total number of respondents

## V. PARETO ANALYSIS 80-20 RULE

The aim of the Pareto chart is to find out most significant factors among set of factors. In quality control, it represents the most common sources of defects. After obtaining Relative importance index for each factor, cumulative index and cumulative percentage of each factor is also determined. Thereafter draw the Pareto diagram in which Relative importance index are taken on primary axis as indicated by bar diagram in descending order and cumulative percentage of relative index are taken on secondary axis as indicated by line diagram in ascending order and also factors are taken on horizontal axis. Based on Pareto diagram interpret the result.

## VI. DATA COLLECTION

The study involve visiting a site of high rise building and conducting the case study. The case study is done by distributing respondent sheets to respondents and analysing the data for preparing the detail case study report. The case study is conducted at Undri, Pune. The site as G+14 building having 8 towers each of same floors.

## VII. DATA ANALYSIS

Total fourteen respondents have filled up the questionnaires for analysis of responses following steps are followed:

1. After getting of all fourteen responses, Total Score is determined based on rating scale (1-5). Calculation is shown in Table 1.

**Table 1: Total rating score calculation sheet**

| Main Factor          | Sub Factor   | Respondents |   |   |   |   |   |   |   |   |    |    |    |    |    | Total score |
|----------------------|--|-------------|---|---|---|---|---|---|---|---|----|----|----|----|----|-------------|
|                      |  | 1           | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |             |
| PLANNING             | Not study methodology of work                        | 5           | 5 | 4 | 5 | 4 | 5 | 5 | 4 | 5 | 5  | 5  | 4  | 5  | 5  | 66          |
|                      | Sequence of construction                             | 5           | 3 | 3 | 4 | 5 | 4 | 5 | 5 | 4 | 3  | 5  | 4  | 5  | 3  | 58          |
|                      | Inadequate information                               | 5           | 2 | 3 | 4 | 3 | 2 | 4 | 4 | 3 | 3  | 5  | 3  | 4  | 4  | 49          |
|                      | Inadequate project planning                          | 5           | 3 | 4 | 3 | 4 | 3 | 4 | 4 | 3 | 4  | 3  | 4  | 3  | 4  | 51          |
|                      | Lack of quality planning                             | 3           | 4 | 5 | 4 | 4 | 5 | 4 | 5 | 4 | 5  | 4  | 4  | 3  | 4  | 58          |
|                      | More paper work                                      | 2           | 2 | 3 | 3 | 3 | 2 | 4 | 1 | 3 | 3  | 4  | 3  | 5  | 4  | 42          |
| DESIGN               | Conformance to codes and standards                   | 5           | 5 | 3 | 2 | 3 | 1 | 3 | 3 | 2 | 2  | 4  | 1  | 2  | 2  | 38          |
|                      | Requirements for design                              | 5           | 5 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 4  | 4  | 4  | 4  | 4  | 56          |
|                      | Adherence to specification                           | 4           | 5 | 5 | 4 | 4 | 5 | 4 | 5 | 4 | 5  | 4  | 4  | 3  | 3  | 59          |
|                      | Change in design                                     | 4           | 5 | 2 | 3 | 4 | 3 | 4 | 3 | 4 | 3  | 4  | 3  | 4  | 3  | 49          |
|                      | Coordination and communication with design firm      | 5           | 5 | 4 | 3 | 3 | 4 | 4 | 3 | 3 | 2  | 4  | 4  | 3  | 3  | 50          |
|                      | Specification related to quality                     | 5           | 4 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2  | 2  | 3  | 3  | 3  | 39          |
|                      | Misinterpretation of drawing and specifications      | 5           | 3 | 3 | 4 | 4 | 4 | 2 | 2 | 3 | 3  | 3  | 3  | 2  | 4  | 45          |
| RULES AND REGULATION | Difficulties in obtaining work permit                | 3           | 1 | 2 | 2 | 3 | 3 | 1 | 1 | 2 | 1  | 2  | 3  | 1  | 2  | 27          |
|                      | Changes in government regulations and law            | 1           | 3 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | 3  | 1  | 2  | 2  | 3  | 29          |
|                      | Unfairness in tendering and bidding                  | 1           | 1 | 3 | 3 | 2 | 3 | 2 | 4 | 3 | 4  | 3  | 4  | 4  | 3  | 40          |
| MATERIALS            | Increase of Building material cost                   | 2           | 4 | 4 | 4 | 4 | 5 | 4 | 5 | 3 | 4  | 4  | 3  | 3  | 4  | 53          |
|                      | Availability of good quality construction materials  | 5           | 5 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 4  | 3  | 4  | 5  | 3  | 52          |
|                      | Material management system                           | 4           | 4 | 4 | 4 | 3 | 2 | 2 | 3 | 3 | 2  | 2  | 3  | 3  | 3  | 42          |
|                      | Cooperation between contractor and material supplier | 3           | 1 | 3 | 4 | 3 | 3 | 4 | 4 | 3 | 3  | 2  | 4  | 4  | 3  | 44          |
|                      | Testing and inspection of incoming materials         | 5           | 5 | 5 | 4 | 5 | 5 | 5 | 4 | 4 | 4  | 5  | 5  | 4  | 4  | 64          |
|                      | New construction materials                           | 5           | 3 | 3 | 3 | 2 | 4 | 1 | 3 | 3 | 4  | 4  | 3  | 3  | 3  | 44          |
|                      | Use of advance formworks                             | 5           | 4 | 4 | 3 | 3 | 3 | 4 | 3 | 2 | 4  | 3  | 3  | 4  | 3  | 48          |

|                       |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |
|-----------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|----|
| EQUIPMENTS            | Availability of equipment                             | 5 | 5 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 38 |
|                       | Equipment management system                           | 4 | 5 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 39 |
|                       | Good utilization of equipment                         | 4 | 4 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 38 |
| LABOUR                | Unskilled labour                                      | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 36 |
|                       | Income level and wages for labour                     | 4 | 4 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 39 |
|                       | Training courses for labour                           | 5 | 5 | 4 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 4 | 4 | 4 | 3 | 44 |
| EXECUTION             | Proper sampling and testing                           | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 5 | 4 | 5 | 5 | 5 | 64 |
|                       | Curing and deshuttering schedule                      | 5 | 5 | 4 | 4 | 3 | 4 | 4 | 4 | 4 | 5 | 4 | 5 | 4 | 5 | 60 |
|                       | Laboratory at site                                    | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 5 | 5 | 4 | 4 | 5 | 4 | 5 | 65 |
|                       | Observe regular schedule                              | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 2 | 4 | 4 | 52 |
|                       | Not maintain proper design mix                        | 5 | 1 | 4 | 5 | 4 | 5 | 5 | 5 | 4 | 5 | 5 | 4 | 5 | 5 | 62 |
|                       | Vibrator during pouring of concrete                   | 5 | 5 | 4 | 4 | 4 | 3 | 4 | 3 | 5 | 4 | 3 | 4 | 3 | 5 | 56 |
|                       | Improper construction technique                       | 4 | 5 | 3 | 3 | 3 | 3 | 4 | 2 | 3 | 3 | 4 | 3 | 3 | 2 | 45 |
|                       | Quality manual at site                                | 5 | 4 | 3 | 3 | 3 | 3 | 4 | 2 | 3 | 3 | 4 | 3 | 2 | 3 | 45 |
|                       | NDT performance                                       | 4 | 4 | 4 | 3 | 3 | 4 | 2 | 3 | 2 | 1 | 3 | 2 | 2 | 2 | 39 |
|                       | New construction technique                            | 4 | 5 | 3 | 2 | 3 | 3 | 4 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 44 |
| MANAGEMENT            | Implement quality control and assurance system        | 5 | 5 | 4 | 3 | 3 | 3 | 4 | 4 | 2 | 3 | 4 | 3 | 4 | 4 | 51 |
|                       | Implement a safety program                            | 5 | 5 | 3 | 4 | 3 | 3 | 4 | 4 | 3 | 2 | 3 | 4 | 4 | 4 | 51 |
|                       | Cost control system                                   | 5 | 5 | 3 | 3 | 3 | 4 | 2 | 3 | 2 | 1 | 3 | 2 | 2 | 2 | 40 |
|                       | Time schedule   | 5 | 5 | 4 | 3 | 3 | 4 | 4 | 4 | 5 | 2 | 4 | 3 | 3 | 3 | 52 |
|                       | Inadequate management support                         | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 4 | 4 | 4 | 2 | 3 | 3 | 50 |
|                       | External agency for quality testing                   | 4 | 5 | 4 | 3 | 4 | 3 | 4 | 4 | 3 | 4 | 3 | 4 | 3 | 4 | 52 |
|                       | Structural engineer suggestion during execution       | 5 | 5 | 4 | 3 | 3 | 4 | 4 | 3 | 3 | 2 | 4 | 4 | 3 | 3 | 50 |
|                       | Implementation of suggestion from various agencies    | 4 | 4 | 4 | 3 | 3 | 3 | 4 | 3 | 4 | 4 | 4 | 2 | 3 | 3 | 48 |
|                       | Implementation of materials used as per specification | 5 | 5 | 4 | 3 | 3 | 3 | 4 | 3 | 2 | 4 | 3 | 3 | 4 | 3 | 49 |
| SITE STAFF MANAGEMENT | Experience of site staff                              | 5 | 5 | 4 | 3 | 3 | 4 | 4 | 3 | 3 | 5 | 2 | 4 | 4 | 4 | 53 |
|                       | Lack of timely supervision and inspection             | 4 | 1 | 4 | 3 | 3 | 4 | 4 | 3 | 3 | 5 | 2 | 4 | 4 | 4 | 48 |
|                       | Coordination between the contractor and supervisor    | 4 | 4 | 5 | 4 | 3 | 4 | 4 | 4 | 3 | 3 | 4 | 3 | 4 | 4 | 53 |
|                       | Inadequate technical expert                           | 3 | 5 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 4 | 4 | 5 | 4 | 5 | 62 |
|                       | Review meeting with staff                             | 4 | 5 | 3 | 4 | 4 | 5 | 4 | 5 | 4 | 4 | 4 | 3 | 4 | 5 | 58 |
| FINANCIAL ISSUE       | Cash flow   | 5 | 3 | 4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 41 |

|            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |
|------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|----|
|            | Political hindrances                      | 4 | 1 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 3 | 3 | 2 | 1 | 3 | 33 |
|            | Non delay of interim payment              | 4 | 1 | 3 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 1 | 2 | 2 | 29 |
| CORRUPTION | Building without approved drawing         | 1 | 1 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 1 | 2 | 2 | 29 |
|            | Approval of technically deficient drawing | 3 | 1 | 3 | 3 | 2 | 2 | 3 | 3 | 1 | 1 | 2 | 3 | 3 | 3 | 33 |
|            | Undocumented construction                 | 2 | 1 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 3 | 2 | 2 | 1 | 1 | 26 |

2. Afterwards, Relative Importance Index for each factors are calculated by using Relative importance index (RII) Method. A calculation is shown in Table 2.

Table 2: Relative Importance Index Calculation sheet

| Main Factor          | Sub Factor  | Respondents |   |   |   |   |   |   |   |   |    |    |    |    |    | Total score | RII  |
|----------------------|---|-------------|---|---|---|---|---|---|---|---|----|----|----|----|----|-------------|------|
|                      |   | 1           | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |             |      |
| PLANNING             | Not study methodology of work                       | 5           | 5 | 4 | 5 | 4 | 5 | 5 | 4 | 5 | 5  | 5  | 4  | 5  | 5  | 66          | 0.94 |
|                      | Sequence of construction                            | 5           | 3 | 3 | 4 | 5 | 4 | 5 | 5 | 4 | 3  | 5  | 4  | 5  | 3  | 58          | 0.82 |
|                      | Inadequate information                              | 5           | 2 | 3 | 4 | 3 | 2 | 4 | 4 | 3 | 3  | 5  | 3  | 4  | 4  | 49          | 0.7  |
|                      | Inadequate project planning                         | 5           | 3 | 4 | 3 | 4 | 3 | 4 | 4 | 3 | 4  | 3  | 4  | 3  | 4  | 51          | 0.72 |
|                      | Lack of quality planning                            | 3           | 4 | 5 | 4 | 4 | 5 | 4 | 5 | 4 | 5  | 4  | 4  | 3  | 4  | 58          | 0.81 |
|                      | More paper work                                     | 2           | 2 | 3 | 3 | 3 | 2 | 4 | 1 | 3 | 3  | 4  | 3  | 5  | 4  | 42          | 0.61 |
| DESIGN               | Conformance to codes and standards                  | 5           | 5 | 3 | 2 | 3 | 1 | 3 | 3 | 2 | 2  | 4  | 1  | 2  | 2  | 38          | 0.54 |
|                      | Requirements for design                             | 5           | 5 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 4  | 4  | 4  | 4  | 4  | 56          | 0.8  |
|                      | Adherence to specification                          | 4           | 5 | 5 | 4 | 4 | 5 | 4 | 5 | 4 | 5  | 4  | 4  | 3  | 3  | 59          | 0.84 |
|                      | Change in design                                    | 4           | 5 | 2 | 3 | 4 | 3 | 4 | 3 | 4 | 3  | 4  | 3  | 4  | 3  | 49          | 0.7  |
|                      | Coordination and communication with design firm     | 5           | 5 | 4 | 3 | 3 | 4 | 4 | 3 | 3 | 2  | 4  | 4  | 3  | 3  | 50          | 0.71 |
|                      | Specification related to quality                    | 5           | 4 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2  | 2  | 3  | 3  | 3  | 39          | 0.55 |
|                      | Misinterpretation of drawing and specifications     | 5           | 3 | 3 | 4 | 4 | 4 | 2 | 2 | 3 | 3  | 3  | 3  | 2  | 4  | 45          | 0.64 |
| RULES AND REGULATION | Difficulties in obtaining work permit               | 3           | 1 | 2 | 2 | 3 | 3 | 1 | 1 | 2 | 1  | 2  | 3  | 1  | 2  | 27          | 0.38 |
|                      | Changes in government regulations and law           | 1           | 3 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | 3  | 1  | 2  | 2  | 3  | 29          | 0.4  |
|                      | Unfairness in tendering and bidding                 | 1           | 1 | 3 | 3 | 2 | 3 | 2 | 4 | 3 | 4  | 3  | 4  | 4  | 3  | 40          | 0.57 |
| MATERIALS            | Increase of Building material cost                  | 2           | 4 | 4 | 4 | 4 | 5 | 4 | 5 | 3 | 4  | 4  | 3  | 3  | 4  | 53          | 0.75 |
|                      | Availability of good quality construction materials | 5           | 5 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 4  | 3  | 4  | 5  | 3  | 52          | 0.74 |
|                      | Material management system                          | 4           | 4 | 4 | 4 | 3 | 2 | 2 | 3 | 3 | 2  | 2  | 3  | 3  | 3  | 42          | 0.6  |

|            |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |      |
|------------|--|---|---|---|---|---|---|---|---|---|---|---|---|---|---|----|------|
|            | Cooperation between contractor and material supplier | 3 | 1 | 3 | 4 | 3 | 3 | 4 | 4 | 3 | 3 | 2 | 4 | 4 | 3 | 44 | 0.62 |
|            | Testing and inspection of incoming materials         | 5 | 5 | 5 | 4 | 5 | 5 | 5 | 4 | 4 | 4 | 5 | 5 | 4 | 4 | 64 | 0.91 |
|            | New construction materials                           | 5 | 3 | 3 | 3 | 2 | 4 | 1 | 3 | 3 | 4 | 4 | 3 | 3 | 3 | 44 | 0.62 |
|            | Use of advance formworks                             | 5 | 4 | 4 | 3 | 3 | 3 | 4 | 3 | 2 | 4 | 3 | 3 | 4 | 3 | 48 | 0.68 |
| EQUIPMENTS | Availability of equipment                            | 5 | 5 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 38 | 0.54 |
|            | Equipment management system                          | 4 | 5 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 39 | 0.55 |
|            | Good utilization of equipment                        | 4 | 4 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 38 | 0.54 |
| LABOUR     | Unskilled labour                                     | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 36 | 0.51 |
|            | Income level and wages for labour                    | 4 | 4 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 39 | 0.55 |
|            | Training courses for labour                          | 5 | 5 | 4 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 4 | 4 | 4 | 3 | 44 | 0.62 |
| EXECUTION  | Proper sampling and testing                          | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 5 | 4 | 5 | 5 | 5 | 64 | 0.91 |
|            | Curing and deshuttering schedule                     | 5 | 5 | 4 | 4 | 3 | 4 | 4 | 4 | 4 | 5 | 4 | 5 | 4 | 5 | 60 | 0.85 |
|            | Laboratory at site                                   | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 5 | 5 | 4 | 4 | 5 | 4 | 5 | 65 | 0.92 |
|            | Observe regular schedule                             | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 2 | 4 | 4 | 52 | 0.74 |
|            | Not maintain proper design mix                       | 5 | 1 | 4 | 5 | 4 | 5 | 5 | 5 | 4 | 5 | 5 | 4 | 5 | 5 | 62 | 0.88 |
|            | Vibrator during pouring of concrete                  | 5 | 5 | 4 | 4 | 4 | 3 | 4 | 3 | 5 | 4 | 3 | 4 | 3 | 5 | 56 | 0.8  |
|            | Improper construction technique                      | 4 | 5 | 3 | 3 | 3 | 3 | 4 | 2 | 3 | 3 | 4 | 3 | 3 | 2 | 45 | 0.64 |
|            | Quality manual at site                               | 5 | 4 | 3 | 3 | 3 | 3 | 4 | 2 | 3 | 3 | 4 | 3 | 2 | 3 | 45 | 0.64 |
|            | NDT performance                                      | 4 | 4 | 4 | 3 | 3 | 4 | 2 | 3 | 2 | 1 | 3 | 2 | 2 | 2 | 39 | 0.55 |
|            | New construction technique                           | 4 | 5 | 3 | 2 | 3 | 3 | 4 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 44 | 0.62 |
| MANAGEMENT | Implement quality control and assurance system       | 5 | 5 | 4 | 3 | 3 | 3 | 4 | 4 | 2 | 3 | 4 | 3 | 4 | 4 | 51 | 0.72 |
|            | Implement a safety program                           | 5 | 5 | 3 | 4 | 3 | 3 | 4 | 4 | 3 | 2 | 3 | 4 | 4 | 4 | 51 | 0.72 |
|            | Cost control system                                  | 5 | 5 | 3 | 3 | 3 | 4 | 2 | 3 | 2 | 1 | 3 | 2 | 2 | 2 | 40 | 0.57 |
|            | Time schedule  | 5 | 5 | 4 | 3 | 3 | 4 | 4 | 4 | 5 | 2 | 4 | 3 | 3 | 3 | 52 | 0.74 |
|            | Inadequate management support                        | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 4 | 4 | 4 | 2 | 3 | 3 | 50 | 0.71 |
|            | External agency for quality testing                  | 4 | 5 | 4 | 3 | 4 | 3 | 4 | 4 | 3 | 4 | 3 | 4 | 3 | 4 | 52 | 0.74 |
|            | Structural engineer suggestion during                | 5 | 5 | 4 | 3 | 3 | 4 | 4 | 3 | 3 | 2 | 4 | 4 | 3 | 3 | 50 | 0.71 |

|                              |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |      |  |
|------------------------------|--|---|---|---|---|---|---|---|---|---|---|---|---|---|---|----|------|--|
|                              | <b>execution</b>   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |      |  |
|                              | <b>Implementation of suggestion from various agencies</b>    | 4 | 4 | 4 | 3 | 3 | 3 | 4 | 3 | 4 | 4 | 4 | 2 | 3 | 3 | 48 | 0.68 |  |
|                              | <b>Implementation of materials used as per specification</b> | 5 | 5 | 4 | 3 | 3 | 3 | 4 | 3 | 2 | 4 | 3 | 3 | 4 | 3 | 49 | 0.7  |  |
| <b>SITE STAFF MANAGEMENT</b> | <b>Experience of site staff</b>                              | 5 | 5 | 4 | 3 | 3 | 4 | 4 | 3 | 3 | 5 | 2 | 4 | 4 | 4 | 53 | 0.75 |  |
|                              | <b>Lack of timely supervision and inspection</b>             | 4 | 1 | 4 | 3 | 3 | 4 | 4 | 3 | 3 | 5 | 2 | 4 | 4 | 4 | 48 | 0.68 |  |
|                              | <b>Coordination between the contractor and supervisor</b>    | 4 | 4 | 5 | 4 | 3 | 4 | 4 | 4 | 3 | 3 | 4 | 3 | 4 | 4 | 53 | 0.75 |  |
|                              | <b>Inadequate technical expert</b>                           | 3 | 5 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 4 | 4 | 5 | 4 | 5 | 62 | 0.88 |  |
|                              | <b>Review meeting with staff</b>                             | 4 | 5 | 3 | 4 | 4 | 5 | 4 | 5 | 4 | 4 | 4 | 3 | 4 | 5 | 58 | 0.82 |  |
| <b>FINANCIAL ISSUE</b>       | <b>Cash flow</b>   | 5 | 3 | 4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 41 | 0.58 |  |
|                              | <b>Political hindrances</b>                                  | 4 | 1 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 3 | 3 | 2 | 1 | 3 | 33 | 0.47 |  |
|                              | <b>Non delay of interim payment</b>                          | 4 | 1 | 3 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 1 | 2 | 2 | 29 | 0.41 |  |
| <b>CORRUPTION</b>            | <b>Building without approved drawing</b>                     | 1 | 1 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 1 | 2 | 2 | 29 | 0.41 |  |
|                              | <b>Approval of technically deficient drawing</b>             | 3 | 1 | 3 | 3 | 2 | 2 | 3 | 3 | 1 | 1 | 2 | 3 | 3 | 3 | 33 | 0.47 |  |
|                              | <b>Undocumented construction</b>                             | 2 | 1 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 3 | 2 | 2 | 1 | 1 | 26 | 0.37 |  |

3. Based on Relative Importance Index, rearrangement of factors is done in descending order. The factors are ranked in order of importance based on Relative Importance Index. It is shown in Table 3.

**Table 3: Ranking based on Relative Importance Index**

| Sr.No. | Factor name                                 | Relative importance index | Rank |
|--------|---|---------------------------|------|
| 1      | Not study methodology of work               | 0.94                      | 1    |
| 2      | Laboratory at site                          | 0.92                      | 2    |
| 3      | Testing and inspection of incoming material | 0.91                      | 3    |
| 4      | Proper sampling and testing                 | 0.91                      | 3    |
| 5      | not maintaing proper design mix             | 0.88                      | 4    |
| 6      | Inadequate technical expert                 | 0.88                      | 4    |
| 7      | Curing and deshuttering schedule            | 0.85                      | 5    |
| 8      | Adherence to specifications                 | 0.84                      | 6    |
| 9      | Sequence of construction                    | 0.82                      | 6    |
| 10     | Review meeting                              | 0.82                      | 6    |

|    |   |             |           |
|----|---|-------------|-----------|
|    | <b>with staff</b>   |             |           |
| 11 | <b>Lack of quality planning</b>                               | <b>0.82</b> | <b>6</b>  |
| 12 | <b>Requirement for design</b>                                 | <b>0.8</b>  | <b>7</b>  |
| 13 | <b>vibrator during pouring of concrete</b>                    | <b>0.8</b>  | <b>7</b>  |
| 14 | <b>increase building material cost</b>                        | <b>0.75</b> | <b>8</b>  |
| 15 | <b>Experience of site staff</b>                               | <b>0.75</b> | <b>8</b>  |
| 16 | <b>Coordination between the contractor and supervisor</b>     | <b>0.75</b> | <b>8</b>  |
| 17 | <b>availability of good quality construction materials</b>    | <b>0.74</b> | <b>9</b>  |
| 18 | <b>Observe regular schedule</b>                               | <b>0.74</b> | <b>9</b>  |
| 19 | <b>Time schedule</b>  | <b>0.74</b> | <b>9</b>  |
| 20 | <b>external agency for quality testing</b>                    | <b>0.74</b> | <b>9</b>  |
| 21 | <b>Inadequate project planning</b>                            | <b>0.72</b> | <b>10</b> |
| 22 | <b>Implement Quality control and quality assurance system</b> | <b>0.72</b> | <b>10</b> |
| 23 | <b>Implement a safety program</b>                             | <b>0.72</b> | <b>10</b> |
| 24 | <b>Structural engineer suggestion during execution</b>        | <b>0.71</b> | <b>11</b> |
| 25 | <b>Coordination and communication with design firm</b>        | <b>0.71</b> | <b>11</b> |
| 26 | <b>Inadequate management support</b>                          | <b>0.71</b> | <b>11</b> |
| 27 | <b>Inadequate information</b>                                 | <b>0.7</b>  | <b>12</b> |
| 28 | <b>Change in design</b>                                       | <b>0.7</b>  | <b>12</b> |
| 29 | <b>Implementation of material used as per specifications</b>  | <b>0.7</b>  | <b>12</b> |
| 30 | <b>Use of advance formwork</b>                                | <b>0.68</b> | <b>13</b> |
| 31 | <b>Implementation of suggestion from various agencies</b>     | <b>0.68</b> | <b>13</b> |
| 32 | <b>Lack of timely supervision</b>                             | <b>0.68</b> | <b>13</b> |
| 33 | <b>Misinterpretation of drawing and specifications</b>        | <b>0.64</b> | <b>14</b> |
| 34 | <b>Improper construction technique</b>                        | <b>0.64</b> | <b>14</b> |
| 35 | <b>Quality manual</b>   | <b>0.64</b> | <b>14</b> |

|    | at site  |      |    |
|----|--|------|----|
| 36 | Cooperation between contractor and material supplier | 0.62 | 15 |
| 37 | New construction material                            | 0.62 | 15 |
| 38 | Training courses for labour                          | 0.62 | 15 |
| 39 | New construction technique                           | 0.62 | 15 |
| 40 | More paper work                                      | 0.6  | 16 |
| 41 | Material management system                           | 0.6  | 16 |
| 42 | Cash flow  | 0.58 | 17 |
| 43 | unfairness in tendering and bidding                  | 0.57 | 18 |
| 44 | Cost control system                                  | 0.57 | 18 |
| 45 | Specification related to quality                     | 0.55 | 19 |
| 46 | Equipement management system                         | 0.55 | 19 |
| 47 | Income level and wages for worker                    | 0.55 | 19 |
| 48 | NDT performance                                      | 0.55 | 19 |
| 49 | Conformace to codes and standard                     | 0.54 | 20 |
| 50 | Availability of equipement                           | 0.54 | 20 |
| 51 | Good utilization of equipment                        | 0.54 | 20 |
| 52 | Unskilled labour                                     | 0.51 | 21 |
| 53 | Political hinderances                                | 0.47 | 22 |
| 54 | Approval of technically deficient drawing            | 0.47 | 22 |
| 55 | Building without approved drawing                    | 0.41 | 23 |
| 56 | Non delay of interim payment                         | 0.41 | 23 |
| 57 | Changes in government rules and regulatuions         | 0.41 | 23 |
| 58 | Difficulties in obtaining work permit                | 0.38 | 24 |
| 59 | Undocumented construction                            | 0.37 | 25 |

4. Draw a line diagram for Ranking of quality control measure based on importance of Relative Index shown in Figure. 1
5. After obtaining importance based Relative importance index for each factor, cumulative index and cumulative percentage of each factor is determined by using Pareto Analysis 80 – 20 Rule. Calculation is shown in Table 4.



Figure 1: Ranking of quality control measure factor

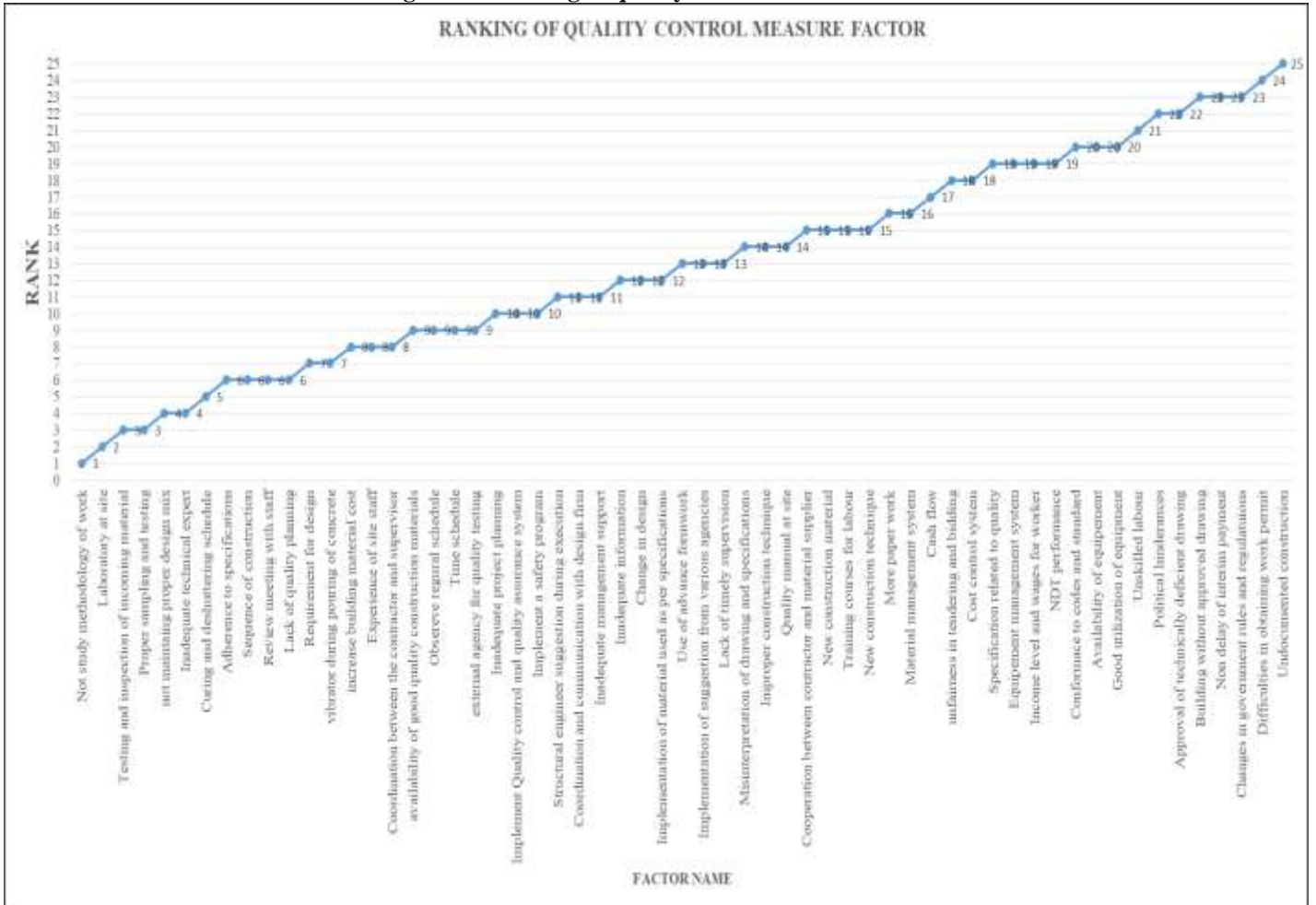


Table 4: Pareto analysis calculation sheet

| Sr.No. | Factor Name                                 | Relative Importance Index | Cummulative Index | Cummulative Percentage |
|--------|---|---------------------------|-------------------|------------------------|
| 1      | Not study methodology of work               | 0.94                      | 0.94              | 2.38%                  |
| 2      | Laboratory at site                          | 0.92                      | 1.86              | 4.72%                  |
| 3      | Testing and inspection of incoming material | 0.91                      | 2.77              | 7.03%                  |
| 4      | Proper sampling and testing                 | 0.91                      | 3.68              | 9.34%                  |
| 5      | Not maintaing proper design mix             | 0.88                      | 4.56              | 11.57%                 |
| 6      | Inadequate technical expert                 | 0.88                      | 5.44              | 13.80%                 |
| 7      | Curing and deshuttering schedule            | 0.85                      | 6.29              | 15.96%                 |
| 8      | Adherence to specifications                 | 0.84                      | 7.13              | 18.09%                 |
| 9      | Sequence of construction                    | 0.82                      | 7.95              | 20.17%                 |
| 10     | Review meeting with staff                   | 0.82                      | 8.77              | 22.25%                 |
| 11     | Lack of quality planning                    | 0.82                      | 9.59              | 24.34%                 |
| 12     | Requirement for design                      | 0.8                       | 10.39             | 26.37%                 |
| 13     | Vibrator during pouring of concrete         | 0.8                       | 11.19             | 28.40%                 |

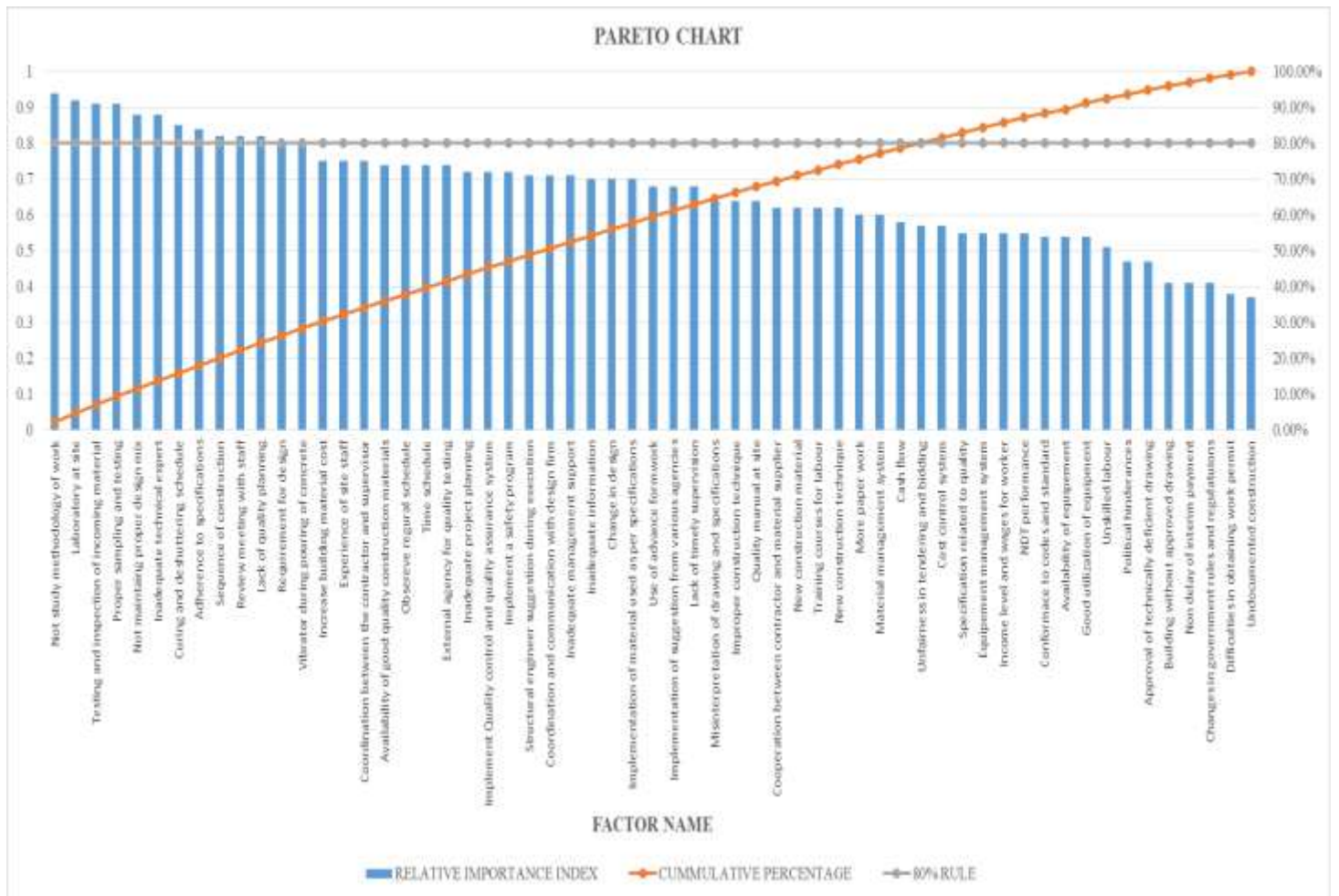
|    |  |      |       |        |
|----|--|------|-------|--------|
| 14 | Increase building material cost                        | 0.75 | 11.94 | 30.30% |
| 15 | Experience of site staff                               | 0.75 | 12.69 | 32.20% |
| 16 | Coordination between the contractor and supervisor     | 0.75 | 13.44 | 34.11% |
| 17 | Availability of good quality construction materials    | 0.74 | 14.18 | 35.98% |
| 18 | Observe regular schedule                               | 0.74 | 14.92 | 37.86% |
| 19 | Time schedule  | 0.74 | 15.66 | 39.74% |
| 20 | External agency for quality testing                    | 0.74 | 16.4  | 41.62% |
| 21 | Inadequate project planning                            | 0.72 | 17.12 | 43.45% |
| 22 | Implement Quality control and quality assurance system | 0.72 | 17.84 | 45.27% |
| 23 | Implement a safety program                             | 0.72 | 18.56 | 47.10% |
| 24 | Structural engineer suggestion during execution        | 0.71 | 19.27 | 48.90% |
| 25 | Coordination and communication with design firm        | 0.71 | 19.98 | 50.71% |
| 26 | Inadequate management support                          | 0.71 | 20.69 | 52.51% |
| 27 | Inadequate information                                 | 0.7  | 21.39 | 54.28% |
| 28 | Change in design                                       | 0.7  | 22.09 | 56.06% |
| 29 | Implementation of material used as per specifications  | 0.7  | 22.79 | 57.84% |
| 30 | Use of advance formwork                                | 0.68 | 23.47 | 59.56% |
| 31 | Implementation of suggestion from various agencies     | 0.68 | 24.15 | 61.29% |
| 32 | Lack of timely supervision                             | 0.68 | 24.83 | 63.02% |
| 33 | Misinterpretation of drawing and specifications        | 0.64 | 25.47 | 64.64% |
| 34 | Improper construction technique                        | 0.64 | 26.11 | 66.26% |
| 35 | Quality manual at site                                 | 0.64 | 26.75 | 67.89% |
| 36 | Cooperation between contractor and material supplier   | 0.62 | 27.37 | 69.46% |
| 37 | New construction material                              | 0.62 | 27.99 | 71.04% |
| 38 | Training courses for labour                            | 0.62 | 28.61 | 72.61% |
| 39 | New construction technique                             | 0.62 | 29.23 | 74.18% |

|       |  |      |       |         |
|-------|--|------|-------|---------|
| 40    | More paper work                              | 0.6  | 29.83 | 75.71%  |
| 41    | Material management system                   | 0.6  | 30.43 | 77.23%  |
| 42    | Cash flow                                    | 0.58 | 31.01 | 78.70%  |
| 43    | Unfairness in tendering and bidding          | 0.57 | 31.58 | 80.15%  |
| 44    | Cost control system                          | 0.57 | 32.15 | 81.59%  |
| 45    | Specification related to quality             | 0.55 | 32.7  | 82.99%  |
| 46    | Equipement management system                 | 0.55 | 33.25 | 84.39%  |
| 47    | Income level and wages for worker            | 0.55 | 33.8  | 85.78%  |
| 48    | NDT performance                              | 0.55 | 34.35 | 87.18%  |
| 49    | Conformace to codes and standard             | 0.54 | 34.89 | 88.55%  |
| 50    | Availability of equipement                   | 0.54 | 35.43 | 89.32%  |
| 51    | Good utilization of equipment                | 0.54 | 35.97 | 91.29%  |
| 52    | Unskilled labour                             | 0.51 | 36.48 | 92.58%  |
| 53    | Political hinderances                        | 0.47 | 36.95 | 93.78%  |
| 54    | Approval of technically deficient drawing    | 0.47 | 37.42 | 94.97%  |
| 55    | Building without approved drawing            | 0.41 | 37.83 | 96.01%  |
| 56    | Non delay of interim payment                 | 0.41 | 38.24 | 97.05%  |
| 57    | Changes in government rules and regulatuions | 0.41 | 38.65 | 98.09%  |
| 58    | Difficulties in obtaining work permit        | 0.38 | 39.03 | 99.06%  |
| 59    | Undocumented construction                    | 0.37 | 39.4  | 100.00% |
| TOTAL | 39.40  |      |       |         |

6. Draw the Pareto diagram in which Relative importance index are taken on primary axis as indicated by bar diagram in descending order and cumulative percentage of relative index are taken on secondary axis as indicated by line diagram in ascending order and also factors are taken on horizontal axis. It is shown in Figure 2.

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Figure 2: Pareto chart



### VIII. ANALYSIS OF CASE STUDY:

1. Questionnaires are circulated among fourteen respondents project of a Construction company out of which fourteen respondents of project of a construction company has responded. Rate of response is 100% which may be considered to be good for data analysis. After examine the data of responses of respondents the following findings have been mentioned in detail.
2. In this study, identifying the major factors faced in building construction project is based on collecting information from different respondent and also finding their sequences from Relative Importance Index method for quality control measure used in Building construction project.
3. In this research, Pareto Analysis tool has been used to identify the major factors for quality control measure. Before implement quality tools firstly identify the sequence of the major factor by using Relative Importance Index method.
4. From this research, by adopting Pareto Analysis 80-20 Rule found that 80% quality problem measure or improve by implementing 20 major factors on site. Further 20 % quality problem improve by implementing remaining factors.
5. The case study research includes interviews, discussions with construction managers, detailed study of project documents and contracts. Company has own quality assurance plan and maintain quality as per contract.
6. In this research, Relative Importance Index and Pareto analysis has been introduced for interpretive the quality factor to improve the quality of Group Housing Residential Apartment project.

### IX. DISCUSSIONS:

1. As per Pareto analysis it is found that factors like not study methodology of work, laboratory at site, Testing and inspection of incoming material, Proper sampling and testing, not maintaing proper design mix, Inadequate technical expert, Curing and deshuttering schedule, Adherence to specifications, Sequence of construction, Review meeting with staff, Lack of quality planning, Requirement for design, vibrator during pouring of concrete, are the factors that have to be implemented to avoid quality defects.
2. These factors contribute 80% of problems. According to Pareto these 20% of the problem can be improved by implementing 80% of the remaining problems.
3. The Company has its own quality assurance/control manual which is not seen most of the construction companies in India.
4. Moreover the Company has provided Assistant supervisor to each technical person appointed on site.
5. The Company is handling its 2nd project in infrastructure. The company is one of the leading companies in Pune having high reputation in infrastructure projects.
6. For quality inspection the company has its own laboratory which maintains and checks quality of material at every phase.
7. The company has appointed a third party inspection for checking quality at every phase.

## X. CONCLUSIONS

1. To achieve the quality on the construction projects, first is to identify the factors which affect the quality of construction work and then adopt suitable precautions that are applicable to avoid them.
2. Quality Control or assurance ought to be enforced throughout the planning and construction stage to avoid defects and mistake, therefore quality of building mustn't be restricted solely to a selected person but to the responsibilities of all parties concerned in construction.
3. The construction method relies on cooperation instead of personal aggressiveness which is able to enhance a high quality building and borderline value of maintenance within the future.
4. There should be Quality Control committee at the construction site of High Rise Building so that controlling should be maintained.
5. In the construction site, finance is not available from time to time so that sub-standard materials are used for items of construction work.
6. In the construction site, numerous defects occurs due to lack of supply of material. This drawback occurs for large projects because of material is simply offered by one provider as a result provider has low stock of material.
7. Various problems occur because of work force in High Rise building. Workforce have lack of information, lack of confidence and lack of motivation for the work they are doing. By not adopting correct methodology for a few things of work for high Rise Building. To avoid these Quality issues, providing training programmes is mandatory.
8. In order to achieve better Quality work, adopt some programmes such as total quality management, quality assurance, quality control and quality circle in the organization.

## XI. ACKNOWLEDGEMENT

It gives me an immense pleasure and satisfaction to present this paper which is the result of unwavering support, expert guidance and focused direction of my guide come HOD Prof. Dr. Pankaj P. Bhangale, Department of Civil Engineering, SSGBCOET, Bhusawal. His constant intellectual support in the form of his innovative ideas is of valuable guidance. His expert suggestions and scholarly feedback had greatly enhanced the effectiveness of this work. The success of this paper has throughout depended upon an exact blend of hard work and unending cooperation and guidance, extended to me by the supervisors at our college.

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