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Evaluating the factors affecting Quality of Residential projects in Construction Industry

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ABSTRACT
Quality is one of the most important parameter for the success of any construction activity in an organization. The need for achieving Quality in the building project is of prime importance throughout the life cycle of the project to conform to the specified standards and meet the expectations of the customers. In this study factors influencing quality were analyzed to highlight their significance. Data analysis includes comparisons of ranking of factors using severity, frequency and importance indexes. The reliability of data was calculated using SPSS. The degree of importance of the subfactors influencing the quality of the building project were identified which was further used in ranking the main factors. The findings of the study indicate that Design, Finance and Labor are the most critical main factors affecting Quality. Site layout was found to be the least critical. Among the subfactors frequent design changes, Interference of political parties, Overtime working hours on a regular basis, Scarcity of labor force and Scarcity of good quality construction materials were the 5 most critical subfactors affecting Quality.

Keywords

Quality, critical quality factors, SPSS, importance index

1. INTRODUCTION

Quality has become a very popular subject in recent years due to conceptual changes in industry. The Project Management Triangle or also known as the Iron Triangle expresses the Triple Constraint of time, cost and quality that must be managed in project (Atkinson, 1999). Each constraint of this triangle is connected and moving one point of the triangle will impact the other two points. However for the majority of projects time and cost are considered as the main factors and Quality is generally taken for granted and inadequate attention is given to this parameter.

Over the years there have been several definitions of Quality. The British Standard Institution defines quality as "the totality of features and characteristics of a product or service that bear on its ability to satisfy stated and applied needs" (McCabe, 2014). Another definition of quality is "Uniformity of the product characteristics or delivery of a service around a nominal or target value" (El-Sawah, 1998). In its simplest form Quality can be defined as 'meeting the needs of the customers' or 'compliance with customer satisfactions'. *Construction project quality* is the fulfillment of the owners needs per conditions specified in contract document within a budget and specified schedule to satisfy the owners/user requirements per defined scope of work (Nokulunga, et al., 2017)

Various attempts have been made by researchers and field practitioners to determine the critical quality factors in building construction projects. According to (Arditi, et al., 1998) the drawings and specifications given to the contractor provide technical information on materials, performance of the construction facility, and quality requirements and consequently affect the quality of constructed facility. Researchers observed that design related factors found to be more crucial influencing quality of construction management (Oyedele, et al., 2003) .These are acceptable to all the parties of construction such as planners, engineers, architects and quantity surveyors. In addition to this the skills and experience of the contractor and supervision staff showed the highest score among the sub-factors influencing quality. (Femina, et al., 2016)
However to measure overall quality of project by considering the performance of different sections in the organizations is not repeated so far. Therefore the aim of this study was to identify various factors affecting

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the quality performance of construction projects and to rank them by importance index. Various factors that affect the process quality in each phase of the construction project were surveyed and the findings of the study were discussed.

2 METHODOLOGY

From the literature review survey, it was observed that several factors are responsible for project quality and their nature varies from project to project. In the present study ten factors were identified which influence Quality these are Design, Contract, Material, Labor, Equipment, Environment, Site layout, Execution, Financial Issues, and Political. Further each factor is divided into sub-factors as shown in Table no 1. Further these factors are divided into 46 sub categories to investigate the details of main factor affecting Quality. (Table 1)

Table 1: Factors influencing Quality of a building project

Sr. No.	Main factors	Sub factors	Sub factors
1.	Design	a) Adequacy in pre design and project meetings b) Frequent design change c) BOQ	d) Coordination e) Time for approval f) Scope of work g) Design specifications
2.	Contract	a) Cooperation between the parties in contract b) Conflict between parties involved in contract	c) Method of dispute resolution in contract d) Conditions of contract
3.	Material	a) Communication between the contractor and vendor b) Availability of construction materials c) Storage system	d) Site laboratory facility e) Results of third party testing of materials
4.	Labour	a) Skill of labors b) Training for labors c) Daily Wages	d) Working time e) Availability of labor f) Labor union
5.	Equipment	a) Condition of equipments b) Availability	c) Equipment maintenance d) Breakdown of machinery
6.	Environment	a) Natural disaster b) Unfavorable site conditions c) Pollution on site	
7.	Site layout	a) Organization structure b) Access at site c) Entry and exit at site	d) Location of storage e) Temporary office
8.	Execution	a) Work method instructions b) Communication c) Coordination	d) Safety on site e) Decision making
9.	Political	a) Instability in governance b) Change in housing rule c) Interference of political parties	
10.	Financial	a) Working capital b) Inflation	c) Cash flow d) Overhead expense

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2.1 Questionnaire Survey-

In order to obtain the information pertaining to the factors discussed above, different questions were designed in such a manner that responses can be easily recorded in the appropriate format and the data can be analyzed. The questionnaire consists of three sections-

Section One: Respondent's information (Company profile).

Section Two: Questions regarding to what extent the quality concept is understood in the company.

Section Three: Respondent's rank of the factors affecting quality. This section aims to find out the degree of importance of the various factors affecting quality.

The respondents were asked to rate the severity of each factor on how badly it affects the quality of a building project on a five point Likert scale, where 1 represents no impact, 2 represents less impact, 3 represents moderate important, 4 represents high impact and 5 represents severe impact. The respondents were also asked to rate the frequency of occurrence of each factor of a building project on a five-point Likert scale ranging from 1 to 5, where 1 represents not frequent and 5 represents extremely frequent.

2.2 Data Analysis

The importance index of each sub-factor is determined by multiplying the severity index and frequency index of each factor. The main factors are then ranked by taking the averages of importance indexes of corresponding sub factors.

The data was analyzed using the following methods:

1. Reliability of data obtained to test the internal consistency of the scale used for measuring the factors using SPSS

2. Ranking of the factors affecting Quality using severity, frequency and importance indexes.

2.3 Reliability analysis-

The Cronbach alpha of internal consistency reliability in the Statistical Package for Social Sciences (SPSS) was used. The alpha has a reliability coefficient which varies from 0 to 1; the higher the alpha the greater the internal consistency of reliability. The alpha should be greater than 0.7.

2.4 Ranking of the Main factors and sub factors-

Severity index, frequency index and importance index was used to rank the severity, frequency and importance of each factor respectively. All these indexes are derived according to the formula described by (Chan, et al., 2002) & (Kometa, et al., 1994)for relative importance index. The indexes are expressed mathematically as follows:

$$\textit{Severity Index} = \left(\frac{\sum s}{N}\right) * 100\% \quad \text{.....Equation no 1}$$

$$\textit{Frequency Index} = \left(\frac{\sum f}{N}\right) * 100\% \quad \text{.....Equation no 2}$$

$$\textit{Importance Index} = \left(\frac{\sum s}{N}\right) * 100\% \quad \text{.....Equation no 3}$$

Where s and f represents severity and frequency rating respectively ranging from 1 to 5; S and F are the highest severity and frequency rating respectively, that is 5; and N is the total number of responses for that particular factor.

3 RESULTS AND DISCUSSION

In order to rank the factors affecting Quality, all the sub factors were analyzed individually by calculating their degree of importance. The result of the Cronbach alpha for this data is 0.79 which is significant and thus ensured the reliability of the scale.

3.1 Ranking of Main factors-

The Main factors that affect quality were ranked according to importance index (Table 2). Those factors that were identified as very important by the respondents are discussed in this section.

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Table 2: Ranking of the main factors

Sr. No	Main factors affecting Quality	Importance index
1	Design	33.65
2	Financial	33.50
3	Labour	33.39
4	Material	31.87
5	Environment	31.77
Sr. No.	**Main factors affecting Quality**	**Importance index**
6	Political	31.42
7	Equipment	29.78
8	Execution	29.08
9	Contract	27.98
10	Site layout	27.52

With respect to the degree of importance of the main factors Design, Financial and Labour related factors are the top three most critical factors having significant impact on the Quality of a residential project as shown in Table 2. The National Economic Development Office (NEDO, 1987) also determined that two thirds of inadequate qualities on construction sites were due to design inefficiencies. Research undertaken by Building Research Establishment (BRE, 1982) in UK has shown that slightly more than fifty per cent of construction faults were caused by design deficiencies. Thus it can be said that design related factors have great influence in achieving quality of building projects.

Financial factors such as inadequate working capital may lead to using low quality materials as well as unskilled labors and this will have a significant impact on the construction quality. The contractors pay more attention to complete the works on schedule and control the overhead costs to finish within budget than to achieving quality in construction.

Labour factors such as due to the unavailability of skilled labors the use of unskilled labors is done by the contractor thus affecting the quality of work on a considerable level. Many firms are concerned that lack of skilled workforce will negatively affect quality. Also overtime working hours reduces the productivity of labors and result in poor construction quality. Thus proper training to labors, strong coordination and motivation between labour level and managerial level will improve the performance of the project thus improving the Quality.

Material, Environment, Political and Equipment related factors have a moderate impact on the Quality. Thus the contracting firms should develop its own overall management system that contains materials management system, equipment management system and labors management system. These systems will ensure that most quality elements be achieved.

Contract and Site layout related factors have the least impact on the Quality with a degree of importance less than 28.

3.2 Evaluation of ten most critical sub factors-

The critical sub factors that affect quality were ranked according to their importance index (Table 3). The ten sub factors that were identified as very important by the respondents are discussed in this section.

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Table 3: Ten most critical sub factors influencing Quality

Rank	Sub Factors	Corresponding Main factor	Importance index
1	Frequent design change	Design	40.18
2	Interference of political parties	Political	38.48
3	Working time for Labors	Labour	38.07
4	Availability of Labors	Labour	38.00
5	Availability of Materials	Material	37.37
6	Pollution on site	Environment	36.66
7	Late confirmation & approval on design	Design	36.60
8	Overhead expenses	Financial	34.94
9	Skill of Labors	Labour	34.94
10	Results from third party testing of materials	Material	34.10

Results of study shows that frequent design change is weighed the highest degree of importance by the respondents. Design changes & rework are unavoidable in construction projects and are a major cause of project delays and cost overruns. As every construction project passes through a no. of design changes during project lifecycle it is necessary to establish the relationship and consequences of design changes beforehand. The second most critical factor found out was Interference of political parties. It is a major factor that raises the costs, lowers the quality. Also the projects allocated to contractors having connection with the political parties are both more expensive to construct and more likely to fail subsequent quality inspections. The third critical sub factor is working time for Labors. Scheduling of longer work days than a standard eight-hour work day lowers work output and efficiency through physical fatigue and poor mental attitude. Quality thus suffers with increased overtime working hours and decreased productivity.

3.3 Evaluation of ten least critical sub factors-

As suggested by Vilfredo Pareto, all the factors are not equally important and the least important factor can be handled by lower level manager in order to achieve quality of project. In the present study, ten such least significant factors were identified and their important indexes as shown in Table 4.

Table 4: Ten least critical factors influencing Quality

Rank	Sub Factors	Corresponding Main factor	Importance index
1	Entry and Exit to site	Site layout	23.23
2	Natural disaster	Environment	25.21
3	Labor union	Labour	25.56
4	Communication between the contractor and vendor	Material	26.13
5	Work instructions	Execution	26.68
6	Conditions of contract	Contract	26.76
7	Provision for temporary office	Site layout	27.30
8	Access to the site area	Site layout	27.52
9	Availability of equipments and machines	Equipment	27.69
10	Instability in governance	Political	27.89

Results indicate that Entry/Exit on site is identified to be the least critical by the respondents when it comes to Quality. Natural disaster, Strike by the Labour force, Poor communication between the contractor and vendor are also found to be least critical. Quality of the building project is least affected by this factors yet this factors cannot be neglected.

4 CONCLUSION

Quality is the most commonly used word by the construction practitioners but mostly misrepresented. Quality is not about the cost but quality is all about planning, design and maintaining safety during Execution without adversely affecting the Environment. The present research is focused on evaluating the overall quality of project by considering various aspects such as Organization structure, Site layout, Material management system and Execution of work. The present study is an essential first step towards highlighting the major issues that need attention to improve the quality of building construction projects. Findings of this study demonstrate that there are several factors influencing quality in construction project but all are not equally significant and therefore they are categorized according to their degree of importance. Highly important factors can be taken care by top level management while least important factors can be controlled by middle managerial level in order to achieve quality of construction project. More efforts are still needed to investigate ways to formulate management systems (policies and procedures) to handle each factor individually. Hence to achieve overall quality of construction project it is necessary to design suitable organization structure and derive an effective quality management program for implementation and monitoring of quality.

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