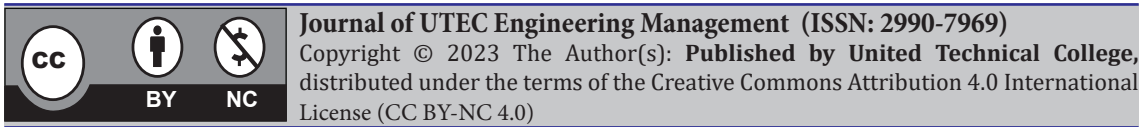


Comparative Assessment of Quality Management System in Selected Housing Construction Projects in Lalitpur District

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ABSTRACT

The objective of the study was to assess the quality management system applied in housing construction projects of Lalitpur district. General questionnaire survey on quality management system was done in ten housing developers. Detail assessment on quality management system was done only in two housing projects i.e. CE housing and Civil homes housing.

This research was based on key informant interview with project manager and site engineers, questionnaires survey with clients, consultants and contractors who were involved in building construction projects. Statistical tools mean value and relative importance index were used for the ranking of different quality methods.

The importance of the individual factor are calculated and ranked by their relative importance index (RII). Total Quality Management, Quality Management system and Quality control ranked highest respectively as a part of quality management process employed in the project. From the study, it was found that different stakeholders have different priorities and preferences. Clients give major priority to procurement of equipment and material. Consultants give main priority to recorded outcomes and achievement and contractors give management commitment and involvement as main priority. Training and education in quality, work improvement teams, customer expectations are found as important.

The outcome of this thesis will document the quality management system and will also assist to improve the quality system of housing construction in Lalitpur districts. Proper documentation regarding quality control should be maintained at site. For ensuring optimum quality management in housing projects, timely ISO audits system should be set up.

Keywords: Total Quality Management, ISO, housing, documentation, system

INTRODUCTION

Quality may be defined as the degree or standard or excellence of a product. In other word quality was generally defined as the characteristics of product or service that satisfies buyers stated or implied needs. According to ANSI/ASQC Standard A3-1987, Quality may be defined as “The totality of features and characteristics of a product or services which bear on its ability to satisfy stated or implied need”.

Quality may be expressed in terms of shape, size, strength, appearance, hardness, color, odor, location, position etc. It was true that concept of quality was subjective and difficult to define. Certain aspects of the quality can be identified. However; ultimately the judgment rests with the user. Quality doesn't happen by accident; concrete plan was needed for the achievement of the quality (Gopal,1995 :Battikha.M, 2000)

Quality can be defined as meeting the legal, aesthetic and functional requirements of a project. Law defines quality in terms of professional liability, a legal concept that requires all professionals to know their trade and practice it responsibly. According to Stasiowski and Burstein, this traditional definition of quality was based on such issues as how well a building blends into its surroundings, a building's psychological impacts on its inhabitants, the ability of a landscaping design to match the theme of adjacent structures, and the use of bold new design concepts that capture people's imaginations. In the construction industry, quality can be defined as meeting the requirements of the designer, constructor and regulatory agencies as well as the owner (Mishra, A. K., Gupta D, Aithal, P. S,2020; Clayton & Ferguson, 1988).

The concept of quality management was to ensure efforts to achieve the required level of quality for a product which was well planned and organized. From the perspective of a construction company, quality management in construction projects should mean maintaining

the quality of construction works at the required standard so as to obtain customers' satisfaction that would bring long term competitiveness and business survival for the companies (J.R.Patil, P. M. &, 2015). Further to this, the term quality management used in the construction industry was all encompassing and embedded in the phenomenon itself and are concepts such as quality control, quality assurance, quality improvement, quality standards etc. The authors revealed that the earliest form of formal quality management practices in construction can be traced back to ancient Greece and Italy.

Quality has remained in the forefront amongst factors used to determine the degree of success or failure of a project. This long term development has made it imperative for all parties involved in construction projects to strive at all times to produce commendable structures.

STATEMENT OF THE PROBLEM

There are several issues about the delivery of product in construction industry in Nepal. Most of the issues are concerned with the quality of their product. With inefficient or nonexistent quality management procedures, significant expenditures of time, money, and resources are wasted on construction projects (Rounds and Chi, 1985 as cited in Battikha, 2002). A number of measures like monitoring, inspections, rewarding better companies, etc. have emerged as a means to fix such problems. In addition, the lack of quality due to deficient construction quality management was detected through nonconformance to established requirements. In construction, non-conformance occurs when the finished state of a project and its components deviate from the established requirements then quality degrades from specification. Quality-related problems during construction can be projected on the operating life of the finished project. To a contractor, non-conformance can yield penalties as well as cost time burdens for re-work, which can convert into productivity loss (Battikha M. , 2000). It was generally observed that despite comprehensive quality control

provisions in the contract documents, achieving quality in construction of building was becoming challenging day by day. Research work on quality management system applied in housing construction in Lalitpur district was very limited. From the past experiences and the available documents it has been noted that the building constructions are suffering from quality management issues somehow similar to Adhikari, N., Mishra, A. K., & Aithal, P. S., 2022.

This study was expected to know about the quality management document maintained at site for quality product. It would also attempt to reveal how quality management systems are established in project procurement and what kind of tests are been performed at site for maintaining the quality of work. The findings are expected to be valuable in future projects.

It would help customer to know further about quality management system applied in construction projects. It would benefit construction housing developer to improve quality in future projects. It would give ideas about over side agency how their regulation requirements are followed by developer.

OBJECTIVE

The main objective of this research was to study about the quality management system in housing construction.

METHODOLOGY

The research approach adopted in this study comprises of both qualitative and quantitative approach. This research involves questionnaire survey from which statistical data were collected in respect with the study objective. Key Informant Interview & Questionnaire survey is the main instruments used.

Study Area

After the devastating earthquake April 2015, demand of housing were increased. There are huge numbers of housing developers. Ten housing developers were taken for general questionnaire survey. Out of ten only two housing developers were taken for detailed study. Study area was limited on Lalitpur district only. Mainly the study focuses on Quality system during construction in the housing construction projects and how were they used in construction project.

Study Population

This research includes housing construction projects in Nepal. It was impossible to conduct all construction company. The population consists of 34 housing developers in Kathmandu.

Sample Size

For the research and fulfilling the objectives questionnaire survey was carried out with the various employees of the sample of developers companies. Out of 34 housing developers only 10 company have selected for questionnaire survey. Total of 40 responses were taken from selected company which was shown in table 1.

Table 1: List of Housing Companies

S.N.	Sample	No. of Responses Received		
		Clients	Consultants	Contractors
1	CE Construction Pvt. Ltd.	3	2	4
2	Civil Homes Pvt. Ltd.	3		
3	CM Developers Pvt. Ltd	3	2	
4	CD Developers Pvt. Ltd.	2		
5	Classic Developers	2		
6	The Comfort Housing Pvt. Ltd.		3	4

S.N.	Sample	No. of responses received		
		Clients	Consultants	Contractors
7	Shivam Developers	2		
8	CG Properties			3
9	Greenhill City Pvt. Ltd.			4
10	Brihat Investment Pvt. Ltd.		3	
	Sub-Total	15	10	15
	Total	40		

Collection of Data

Primary data were collected through survey questionnaire with clients, consultants and contractors.

Primary Data

The primary data were collected from questionnaire survey. As in many development related researchers, specific checklists were provided. The major techniques of primary data collection was:

Schedules/Questionnaire

An interview checklist was developed to collect people's perception. Understanding and view regarding the quality management aspect of the building project. The questionnaire was related with which practices for quality management system are adopted in the Building construction projects (J.Jido, 1996; Lakshmi, R., 2015; R.Stroh, Z. a., 1999; Quinnell, R. M. a. P., 2010; Mishra, 2020 Adenuga, O. A., 2013; Ardit, D., 1998; Burati, J. L. et al., 1992; Battikha, M., 2002; Chin Keng, Tan et al. 2011; Jha et al. 2007; Mishra, A. K., Gupta D, Aithal, P. S., 2020; Khadka, S. et al., 2021).

- Practices for quality management system adopted in the Building construction projects.
- Achieving quality on projects
- Ranking of twenty elements of ISO standard
- Quality control measure

Key Informant Interview (KII)

Interview with the site project manager, site engineer, store keeper and supervisors were taken were taken from Civil homes phase IV and CE Housing. It was done by snowball sampling.

Secondary Data

The Secondary data was collected from the following sources:

- Documents and reports of CE construction and Civil Homes.
- Quality Assurance plan (QAP) of two companies.
- Guidelines provided by DUDBC for construction of building published by MoUD CLPIU 2017 followed by continuous literature review.

Data Analysis

All the data and information collected from the primary sources were analyzed by comparing and contrasting the situation. The collected data are presented on the basis of quality and nature of data. The qualitative data are presented to develop the logic sequential whereas the quantitative data are presented in table, figure and percentage.

The statistical method used for analyzing the data can be briefly explained as: Relative importance Index suggested by Fagbenle et al., 2004 was used as shown in equation 1 followed by Adhikari, N., Mishra, A. K., & Aithal, P. S., (2022) and Mishra, A. K., Jha, A. (2019).

$$RII = \frac{\sum W}{A \times N} \dots\dots\dots(1)$$

Where,

W is the mentioned scale for rating a factor by the respondents that ranges from 1 to 5

A is the highest weight in the scale

N is the total number of respondents

Here $W = 1N1 + 2N2 + 3N3 + 4N4 + 5N5 /$

$$(N1 + N2 + N3 + N4 + N5)$$

Where N1..... N5 are the frequencies of respondents in 5 point Likert scale

Summary of Research Methodology

To achieve the desired objective of research, various method of analysis were done. For this detail of research activity was mentioned at table 2.

Table 2: Research Matrix

SN	Objectives	Data Sources	Methodology	Analysis
1.	To assess the quality management practice at housing construction.	Literature review, Project manager’s and other employee’s experience.	Questionnaire Survey, Key Informant Interview	Assessment of quality management practices at housing construction.

RESULT AND DISCUSSION

Quality management system assessed at site.

During research and interview with the technical person involved in the two projects civil homes and CE Housing, different method of quality management adopted in the construction were found and how this were assess at construction site were studied. The twenty elements of ISO were listed and how these twenty elements were assessed at site were shown in table 3. During the research regarding the quality management accessibility at the site it was found that the quality control flowchart were prepared at CE housing before the construction started as shown in appendix D. In Civil homes, quality

control flowchart were not made which effect in the sequence of work. While comparing the ISO twenty element in CE housing and civil homes identification and traceability & servicing were lagging. Both the housing CE housing and civil homes seems to follow the twenty ISO element. CE housing maintained ISO documents more systematically than civil homes. In Civil homes, quality system were not maintained properly and control of customer supplied product were not done. All construction work given to petty contractor, so that process control were lagging. In CE housing, it seem to follow all ISO element but elements like training to employee were not done properly.

Table 3: ISO Twenty Element Executed at Construction Site

Elements	CE Housing	Civil Homes
Management Responsibility	Quality policy were made before the project start. Organization chart were made.	Quality manual ,Organization chart
Quality System	Quality system of this housing maintained work Monitoring card like RCC work card, Sanitary work, Electrical work monitoring card, handover monitoring card separately.	Detail monitoring card not there.
Contract Review	Contract document were made including all specification and contract was signed by customer.	Overall Contract review were made & Contract for the customer were made separately.

Elements	CE Housing	Civil Homes
Design Control	Design of houses was provided from designer CE services and structure from CE engineering solutions ,it was control from the respective department	Overall design were done by Civil International consultant.
Design Control	Design of houses was provided from designer CE services and structure from CE engineering solutions ,it was control from the respective department	Overall design were done by Civil International consultant.
Document and Data Control	All the documents were maintained at site. Details of ISO document were maintained at site regularly and systematically.	All the documents were maintained at site. Each building record kept separately regarding their drawing, test report, inspection card etc.
Purchasing	All the material were purchased from procurement department	Separate procurement department of the company handle all the item needed at site.
Control of Customer Supplied Product	All the material that were specified in the contract were brought by company & others than mentioned in contract brought by client.	No any control of customer supplied product.
Identification and Traceability	Non compliance	Non compliance
Process Control	Each and every process of construction were supervised by engineer .With the approval of site engineer work can proceed. Only finishing work were given to separate contractor. Separate Checklist for brickwork and plaster work were provided to supervisor for quality control.	All the work done by contractor and process control was lagging.
Inspection and Test Status	To check the quality of RCC work, Cube test of each building were done at site. Different material test were also done at site like soil content of sand .Cube test of each house were done each house one footing RCC, one from Column RCC and one from Slab RCC record were maintained .	Quality of construction material were test at quarry and other test like Cube test were done at their own lab. Each houses cube test were done. Only slab RCC test were taken into account.
Control of Non-conforming Product	Non-conforming product were identified and vendor were informed about it officially.	Each and every lot of material were inspected and if found any problem the material were put in hold and reject the non-conforming material.

Elements	CE Housing	Civil Homes
Corrective and Preventive Action	Corrective and preventive action taken into account after meeting with higher level.	Not found this corrective and preventive action taken into account.
Handling ,Storage, Packaging, Preservation and Delivery	Separate store were there for cement storage.	Proper handling was not found at site.
Control of Quality Records	Each houses separate structure work monitoring card, finishing item supervision card, electrical work, sanitary were maintained and site .Documentation were done systematically.	Only House detail were found to be kept at site including changes and RCC work record. Others record regarding quality was not there.
Internal Quality Audits	ISO audit were done internally by internal people within organization & once in a year external audit were done by external auditor expertise.	Audit were done once in three month by expertise.
Training	Training were provided only to project managers yearly.	Training need identification was done & according to their need training provide to contractors, others technical personnel.
Servicing	Non-compliance	Non-compliance
Statistical Techniques	Techniques like WIP forecasting, material and manpower management was done at CE housing.	It was lacking resulting in impact to daily progress and turnover of the project.

Ranking of practices for quality management system in building construction.

Questionnaire survey was done to find out the effective quality system. As shown in table 4 client give main priority to Totally Quality Management

and Consultants and contractors give Quality Management System as main priority. Overall Total Quality Management ranked 1st scoring RII .0.659 ,Quality Management System ranked 2nd and Quality control ranked 3rd.

Table 4: Ranking of practices for quality management system in building construction

Quality System	Clients		Consultants		Contractors		Overall	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Total Quality Management	0.613	1	0.75	2	0.613	3	0.659	1
Quality Management System	0.480	4	0.8	1	0.653	1	0.644	2
Quality Control	0.587	2	0.625	3	0.613	3	0.608	3
Quality Improvement	0.533	3	0.575	5	0.653	1	0.587	4
Quality Assurance	0.480	4	0.6	4	0.613	3	0.564	5

Achieving Quality in Housing Project

Questionnaire survey was done with clients, consultants and contractors and find out better quality management practices for achieving quality in projects .As per table 5. Clients give major priority to procurement of equipment & material, Consultants give main priority

to recorded outcomes and achievement and contractors give management commitment & involvement as main priority. Training and education in quality, work improvement teams, Customer expectations are some important practices.

Table 5: Achieving Quality in Housing Projects

Quality System	Clients		Consultants		Contractors		Overall	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Management commitment and involvement	0.800	6	0.75	4	0.800	1	0.783	2
Customer Expectation	0.833	3	0.75	4	0.783	2	0.789	1
Recorded outcomes and achievements	0.767	11	0.8	1	0.750	8	0.772	5
Benchmarking	0.800	6	0.75	4	0.767	3	0.772	5
Desirable Results	0.783	9	0.7	12	0.750	8	0.744	10
Work improvement teams	0.817	4	0.7	12	0.767	3	0.761	7
Training and Education in quality	0.850	2	0.725	8	0.750	8	0.775	4
Reward System/Incentives	0.783	9	0.725	8	0.717	12	0.742	11
Data and Information	0.800	6	0.7	12	0.667	16	0.722	13
Procurement of equipment and material	0.883	1	0.7	12	0.767	3	0.783	2
Levels of output or productivity	0.817	4	0.65	16	0.667	16	0.711	14
Profitability	0.700	19	0.65	16	0.683	14	0.678	18
Mission statement, vision and values	0.717	16	0.65	16	0.683	14	0.683	17
Short-term view	0.750	12	0.525	19	0.733	11	0.669	19
Measurement of Outcomes	0.750	12	0.75	4	0.767	3	0.756	8
Innovation and creativity	0.750	12	0.725	8	0.767	3	0.747	9
Safe Work Procedures(SWPs)	0.717	16	0.8	1	0.700	13	0.739	12
Contractor ISO 9000 series certification	0.733	15	0.775	3	0.583	19	0.697	15
Designer ISO 9000 series certification	0.717	16	0.725	8	0.633	18	0.692	16

Ranking of the Twenty Elements of ISO Standard

As per table 6 questionnaire survey ,Clients ranked quality system as main priority,consultants ranked corrective and preventive action as a priority and contractors Identification and traceability as a main priority.

Overall process control ranked first whereas calibration ranked as last as shown in table. Control of non-conforming product ranked second and Inspection and test status ranked third.

Table 6: Ranking Twenty Elements of ISO Standard

Quality System	Clients		Consultants		Contractors		Overall	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Management Responsibility	0.817	2	0.65	17	0.767	5	0.744	11
Quality System	0.850	1	0.725	12	0.717	13	0.764	6

Quality System	Clients		Consultants		Contractors		Overall	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Design Control	0.767	7	0.75	8	0.767	5	0.761	7
Document and Data Control	0.817	2	0.775	5	0.717	13	0.769	4
Purchasing	0.750	10	0.65	17	0.733	11	0.711	16
Control of Customer Supplied Product	0.683	17	0.675	16	0.767	5	0.708	17
Identification and Traceability	0.733	11	0.75	8	0.817	1	0.767	5
Process Control	0.800	4	0.8	3	0.750	10	0.783	1
Inspection	0.800	4	0.725	12	0.683	20	0.736	12
Calibration	0.600	19	0.575	19	0.733	11	0.636	20
Inspection and Test Status	0.700	15	0.825	2	0.800	2	0.775	3
Control of Nonconforming Product	0.767	7	0.775	5	0.800	2	0.781	2
Corrective and Preventive Action	0.717	13	0.85	1	0.700	16	0.756	8
Handling, Storage, Packaging, Preservation and Delivery	0.700	15	0.725	12	0.767	5	0.731	14
Control of Quality Records	0.767	7	0.775	5	0.717	13	0.753	9
Internal Quality Audits	0.717	13	0.75	8	0.700	16	0.722	15
Training	0.733	11	0.7	15	0.767	5	0.733	13
Servicing	0.617	18	0.575	19	0.800	2	0.664	19
Statistical Techniques	0.600	19	0.8	3	0.700	16	0.700	18

Quality Control Methods

In this questionnaire about quality control method adopted as shown in table 7, clients ranked Method "set procedures to quality control" as a main priority, whereas consultant ranked Quality of workmanship in all

construction activities as main priority and contractor ranked "do proper sampling and test" as 1st priority. But overall Do proper sampling and test as 1st rank.

Table 7: Quality Control Methods

Quality System	Clients		Consultants		Contractors		Overall	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Study duties and responsibilities	0.800	3	0.73	8	0.800	7	0.775	6
Coordination with project purchase department	0.783	5	0.73	8	0.883	3	0.797	5
Do proper sampling and testing	0.867	2	0.83	2	1.000	1	0.897	1
Set procedures to quality control	0.900	1	0.78	6	0.900	2	0.858	2
Follow prescribed curing & de shuttering schedules	0.717	9	0.75	7	0.817	5	0.761	9
Quality of workmanship in all construction activities	0.783	5	0.9	1	0.833	4	0.839	3

Quality System	Clients		Consultants		Contractors		Overall	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Quality control laboratory at site	0.800	3	0.83	2	0.783	8	0.803	4
Maintain sequence of construction	0.733	7	0.8	5	0.783	8	0.772	7
Report of non-conformity to quality standards	0.733	7	0.83	2	0.750	11	0.769	8
Recording changes	0.667	11	0.68	11	0.768	10	0.703	11
Site progress review meeting with staff	0.717	9	0.73	8	0.817	5	0.753	10

CONCLUSION

Quality management system at CE housing was done systematically. Quality control flowchart were made and construction work was done systematically as per flowchart. But in civil homes as per KII and site visit it was found that quality were maintained but systematic documentation were not maintained as per ISO standards.

The quality system used at site in accordance to the twenty elements of ISO was found to be implemented in both projects. But the element identification and traceability was non-compliance to both CE housing and Civil housing. Element calibration was non-compliance in Civil housing. Among twenty elements also, CE housing had major elements maintained and followed in sites whereas in Civil homes although preliminary guidelines were followed, regular follow up and updating was lacking.

According to the questionnaire survey with clients, consultants and contractors regarding quality management practices, Quality management system ranked first scoring RII of 0.659 and Total Quality Management system ranked second with score 0.644 followed by quality control with score 0.608 and Quality improvement with the score 0.587. In findings

the governing factors for ISO twenty elements, process control ranked first, Control of non-conforming product ranked second, Inspection and test status ranked third.

Questionnaire survey was done with clients, consultants and contractors and find out better quality management practices for achieving quality in projects. Different opinion of stakeholders was found. In Overall Customer expectations ranked first, Management commitment and involvement & procurement of equipment and material ranked second.

Quality management was duly affected by the quality of material used. So the test was done at CE housing at site lab and results obtained were given priority in the study. At civil homes cube test result was presented which was done at their own separate lab and records were marked. The test results of quality control were also taken into study and was found that tests were performed insitu as well as to the standard labs mentioned by contract and clients. The study and analysis of the reports showed that the tests like compressive strength test, sieve analysis for gradation of material etc. were intermittently performed in CE housing whereas in Civil homes, it was done at quarry and test performed only upon request.

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