Quality Management in the Design and Construction Phase: A Case Study

NAFEES AHMED MEMON*, QAZI MUHAMMAD MOINUDDIN ABRO**, AND FARIDA MUGHERI***

RECEIVED ON 09.04.2011 ACCEPTED ON 07.06.2011

ABSTRACT

Construction industry plays an important role in the development of any country. The development of construction industry depends on the quality of construction products and projects. Quality is one of the critical factors in the success of construction projects in Pakistan. 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 design and construction stage contributes significantly on final quality outcome of construction projects. This paper therefore highlights the importance of quality management in the design and construction phase. It presents the findings of two major cities in Pakistan and suggests some proactive measures for the improvement of quality in the design and execution phase of construction projects.

Key Words: **Quality Management, Project Life Cycle, Design and Construction Phase.**

1. INTRODUCTION

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 fulfillment of expectations (i.e. the satisfaction) of the project participants. The construction industry in Pakistan has been struggling with quality issues for many years [1]. 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 [2]. Quality of construction projects is linked with proper quality management in all the phases of project life cycle [3].

Design and construction are the two important phases of project life cycle which affect the quality outcome of construction projects significantly [4]. In a NEDO (National Economic Development Office), London survey aimed at improving methods of quality control for building works,

* Associate Professor, Department of Civil Engineering, Mehran University of Engineering & Technology, Jamshoro.
** Assistant Professor Mehran University Institute of Science, Technology & Development, Mehran University of Engineering & Technology, Jamshoro.
*** Lecturer, Department of Architecture, Mehran University of Engineering & Technology, Jamshoro.

it was found that "design" and "poor workmanship in the construction process" combined to form more than 90% of the total failure events [5]. This paper therefore, focuses on the quality management in the design and execution phase of construction projects. The aim of this paper is to highlight the importance of quality management in the design and execution phase of construction projects. In order to achieve that, a case study is designed for two major cities of Pakistan.

2. QUALITY MANAGEMENT IN THE DESIGN AND CONSTRUCTION PHASE

The cost, scheduling and performance problems can invariably be traced back to the problem of the quality of design, such as error, incompleteness, and lack of constructability. Since the cost of the design phase accounts for only about 3-10% of the project on average, most of the research into and discussion of the quality of construction projects have focused on the construction phase, and seldom on the design phase [2]. Design fees are often less than one percent of the life-cycle cost of a project, yet the design is one of the most important factors influencing the construction cost. Quality during the design phase has great impact on later expenditures [6-8]. Researchers and practitioners have acknowledged defective design as a major cause of contract claims and change orders during construction [9-10]. Proper quality management in the design process can reduce the rework and additional time spent by designers for rectification [11]. In the UK, the BRE (Building Research Establishment) found that 50% of errors in buildings had their origin in the design stage [5]. Quality in the design is a main issue in the construction industry of Pakistan. This issue is of major concern to many parties within the industry. The consultants involved in the design of construction projects are the main stakeholder closely associated with this issue.

Quality failures in construction have been estimated to cost the industry between 2 and 12% of construction turnover in rework alone. It is estimated that the cost of design deviation accounts for 9.5% of total project cost, while construction deviation accounts for 2.5% [12]. Low cost and speedy construction should not be achieved at the expense of the quality of the project. In fact, poor quality performance results in increased rework, which has significant cost and schedule implications [13]. In the UK, the BRE found that 40% of errors in buildings stemmed from the construction stage [5]. Cost, time and quality are conflicting goals under the current settings of the construction industry. A contractor has to attain the cost as budgeted, to meet the scheduled deadlines and to achieve the required quality level. However, whenever there is a choice among the three, quality always suffers [14]. Construction projects in Pakistan generally run over time and do not necessarily meet user expectations; and often require remedial works due to construction defects. One of the important factors contributing to the above mentioned problems is quality management in the construction phase. The contractors involved in the execution and management of construction projects are the main stakeholders associated with the issue of quality management in construction.

3. RESULTS OF THE QUESTIONNARE SURVEY

Considering the significance of quality management in the design and construction stage, it is important to study this issue in the construction industry of Pakistan. In order to achieve this objectives a questionnaire survey was carried out in two major cities of Pakistan (i.e Hyderabad and Karachi). The main participants of the survey were design consultants and contractors. The study of design stage is based on the data collected from design consultants and the study of construction phase is based on the data collected from contractors. Total 75 Questionnaires were distributed to consultants and contactors. 58 companies responded to the questionnaire. Out of 58 respondents 33 were contractors and 25 were design consultants. The statistics of respondents, is depicted in Fig. 1.

3.1 Consultants' Response (Quality Management in the Design Phase)

- *Importance of Quality Management in the Design Stage of Project:* The results reveal that more than 50% of the respondents feel that quality management is very important in the design phase of project.

- *Contribution of Quality Management at the Design Stage:* As depicted in Fig. 2, 12 out of 25 respondents are of the opinion that quality management at the design stage may contribute up to 75% of the quality of the product/service.
- *Approximate Percentage of Design Errors Observed by Consultants During Design Phase of the Project:* 15 out of 25 companies observe 10% errors at the deign stage of the project. The results are presented in Fig. 3.
- *Approximate Percentage of Design Errors Reported by Contractors During Construction Phase of the Project:* 17 out of 25 consultants respond that 10% design errors are reported by the contractors during the execution stage of project.

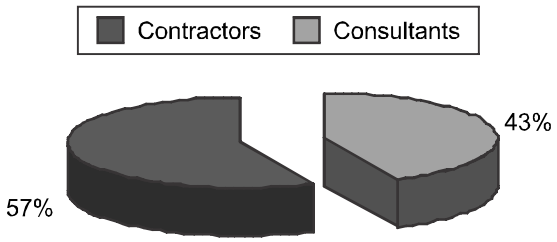

FIG. 1. PERCENTAGE OF RESPONDENTS

- *Proper Selection Criteria for the Employment of Designer:* 73 % of the respondents say that they have proper selection criteria for the employment of designer.
- *Level of Satisfaction of the Clients about the Projects Designed by Consultants:* 14 out of 25 companies observe that their clients are highly satisfied from the projects they have designed.
- *Need for Improvement in Quality Management during Design Stage:* 25% of the respondents feel that there is a need for improvement in their organization in quality management process during design stage of the project.
- *Quality Management System Already Implemented in the Organization:* Out of 25 respondents only 5 companies said they have implemented ISO, 3 companies said they have TQM where as the remaining 17 companies have no formal quality management system. The results are shown in Fig. 4.
- *Improvement in the Quality of Design After Implementing Formal Quality Management System:* 35 % of the companies, who have implemented formal QMS, say that quality in the

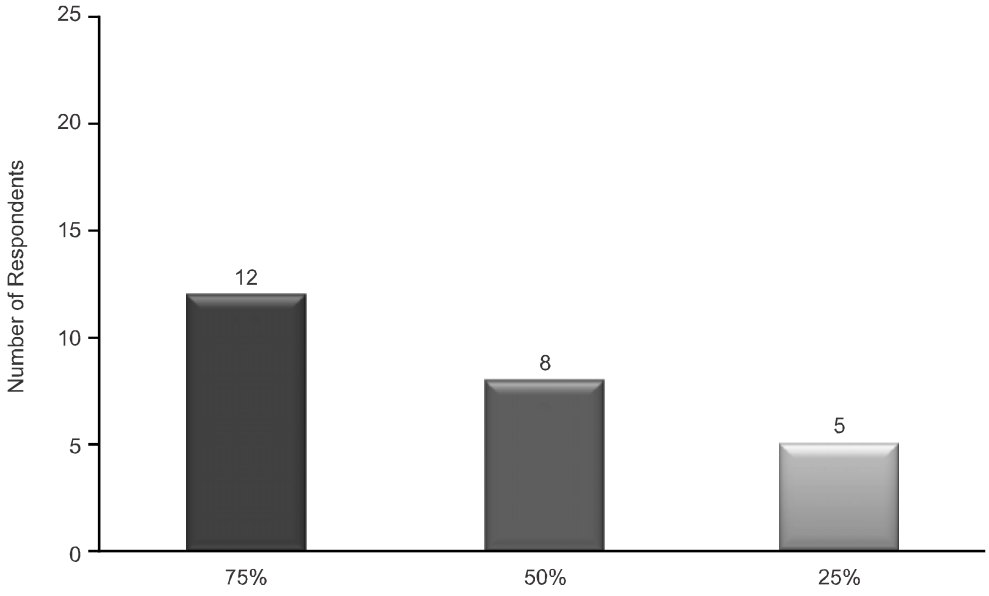

FIG. 2. CONTRIBUTION OF QUALITY MANAGEMENT AT THE DESIGN STAGE

design has improved after implementing formal quality management system.

- *Future Plan to Implement, Change or Modify Quality Management System:* As shown in Fig. 5, majority of the respondents is satisfied with their existing quality management procedures and only few have the plan to modify or change their existing quality management procedures.

3.2 Contractors' Response (Quality Management in the Construction Phase)

- *Importance of Quality Management in the Construction Phase of Project:* As depicted in Fig. 6, the results reveal that majority of the contractors (17 out of 33) is of the opinion that quality management is 'very important' in the construction phase of project.

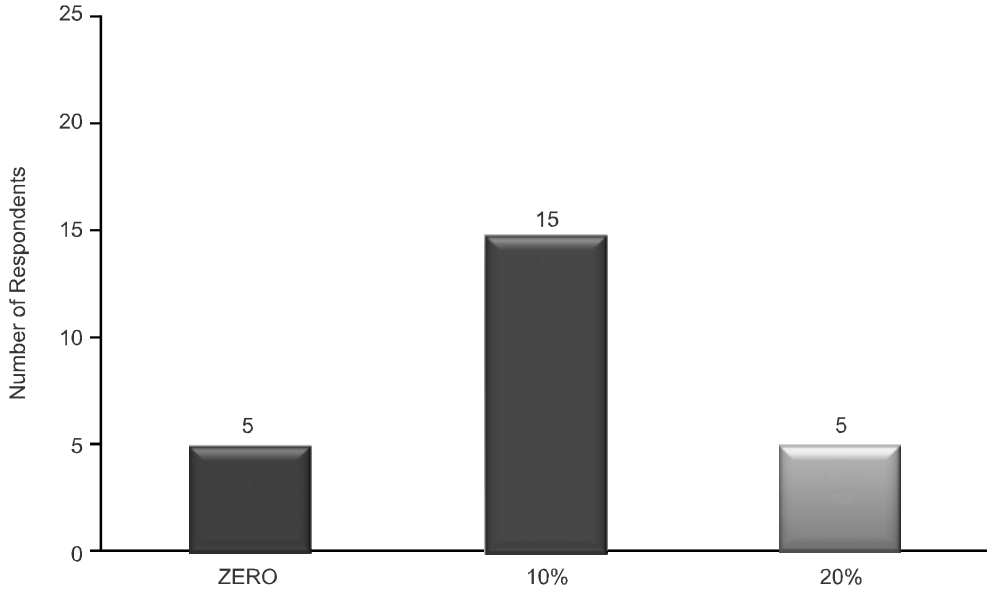

FIG. 3. APPROXIMATE PERCENTAGE OF DESIGN ERRORS OBSERVED BY THE CONSULTANTS DURING DESIGN STAGE

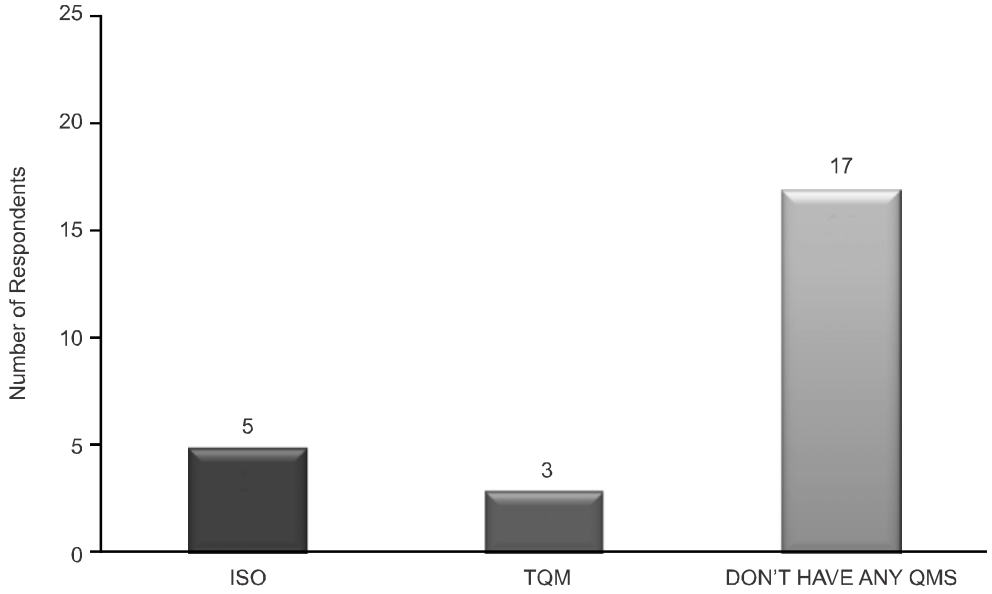

FIG. 4. QUALITY MANAGEMENT SYSTEM ALREADY IMPLEMENTED IN THE ORGANIZATION

- *Contribution of Quality Management in the Construction Phase:* 17 out of 33 respondents feel that quality management in the construction phase of project may contribute up to 75% of the quality of the product/service. The results are presented in Fig. 7.
- *Proper Selection Criteria in the Organization for the Employment of Project Site Staff:* 95% of the contractors say that they have proper selection criteria in their organization for the employment of project site staff.
- *Compliance with Rules and Regulation of Pakistan Engineering Council for Employment of Engineers:* 91% of the respondents say that their organization comply with the rules and regulations of Pakistan engineering council for the employment of engineers.

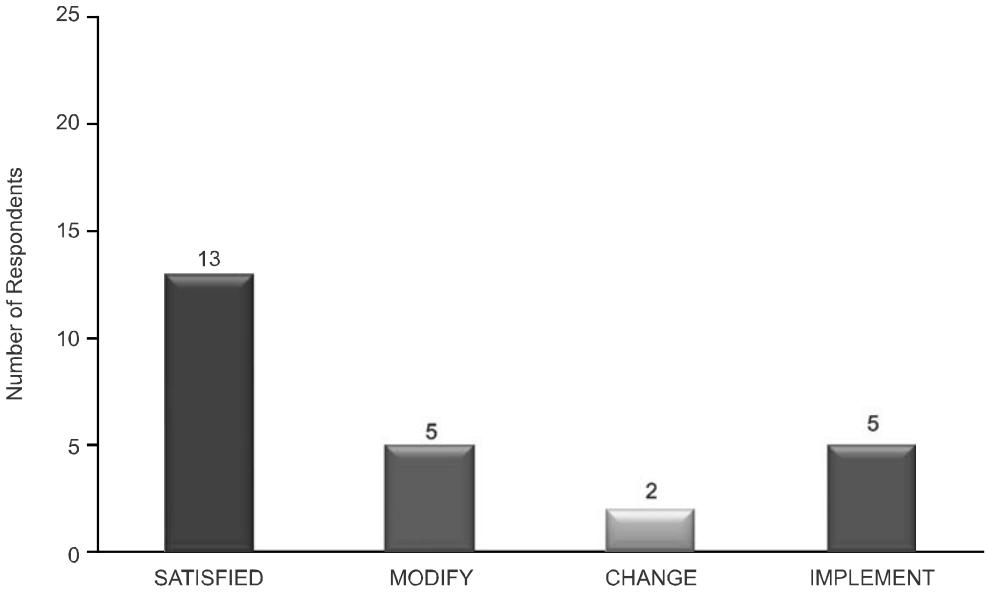

FIG. 5. FUTURE PLAN TO IMPLEMENT, CHANGE OR MODIFY QUALITY MANAGEMENT SYSTEM

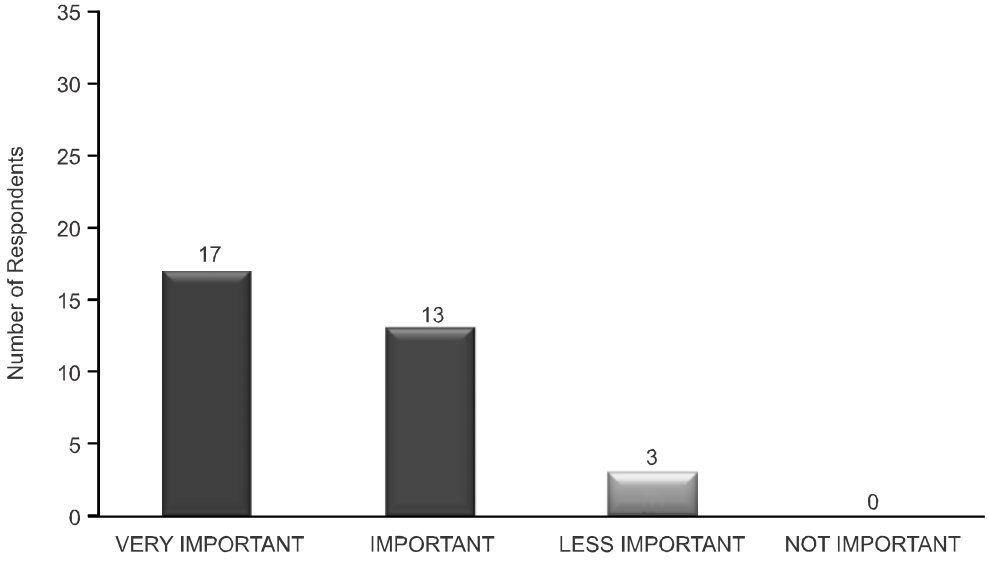

FIG. 6. IMPORTANCE OF QUALITY MANAGEMENT IN THE CONSTRUCTION PHASE OF PROJECT

- *Main Objective of Quality Management Activities in the Execution of Project:* 15 out of 33 contractors apply quality management activities to get the work passed by the consultants, where as 12 say that quality management activities are aimed to satisfy their clients.
- *Material Testing from Approved Laboratories:* 93% contractors respond that they carry out testing of materials from approved laboratories.
- *Feedback from Clients about the Level of Satisfaction of Service/Product Quality:* 90% of the respondents do not get feed back form their clients about their product/service quality.
- *Response to Complaints to Improve the Quality and Bring Changes in Quality Management Policy:* Only 13% of the respondents attend complaints of the clients and adopt changes for improvement in quality management policy.
- *Quality Management System in the Organization:* Out of 33 companies, 5 companies say that they have implemented ISO and 3 companies say TQM, whereas 25 companies have no formal quality management system. The results are shown in Fig. 8.
- *Effect of Implementing Quality Management System in the Organization:* The companies who have implemented the formal QMS, are of the opinion that present QMS is advantageous for them.
- *Future Plan to Implement, Change or Modify Quality Management System:* As shown in Fig. 9, 40% of the respondents say that they intend to modify or change the existing system, 25% say that they will implement quality management system in near future, whereas 35% companies say they do not need any formal quality management system. The results reveal that a significant percentage of companies are still not accepting any formal quality management system to be implemented in their organization.
- *Clients' Satisfaction about Service/Product Quality:* 95% of the respondents are of the opinion that their clients are satisfy from their product/service quality.

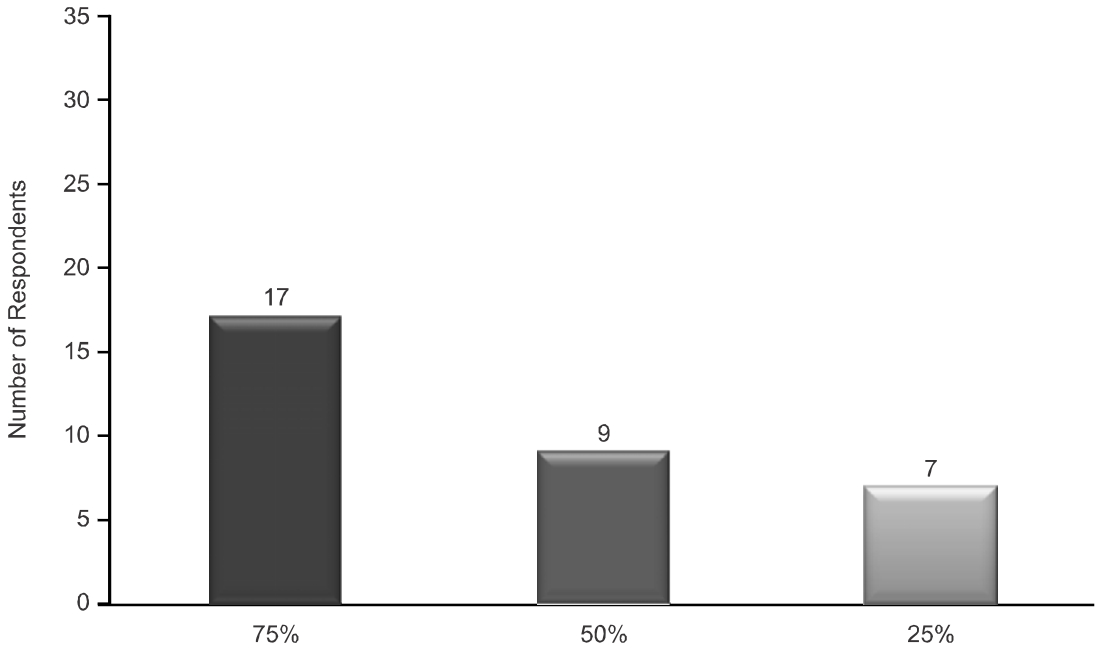

FIG. 7. CONTRIBUTION OF QUALITY MANAGEMENT IN THE CONSTRUCTION PHASE OF PROJECT

- *Organizations' Own Satisfaction about their Service/Product Quality during Construction Phase:* 87% contractors are satisfied from their product/service quality which they are providing to their clients, whereas 13% are not satisfied, which is a sign that these companies are looking for improvement in their service/ product quality.

- *Employees' Level of Satisfaction about the Facilities Provided to Them:* 18 out of 33 respondents feel that their employees are satisfied from the facilities they are being provided by the company, whereas 8 contractors feel that their employees are not satisfied and 7 contractors do not know about the level of satisfaction of their employees.

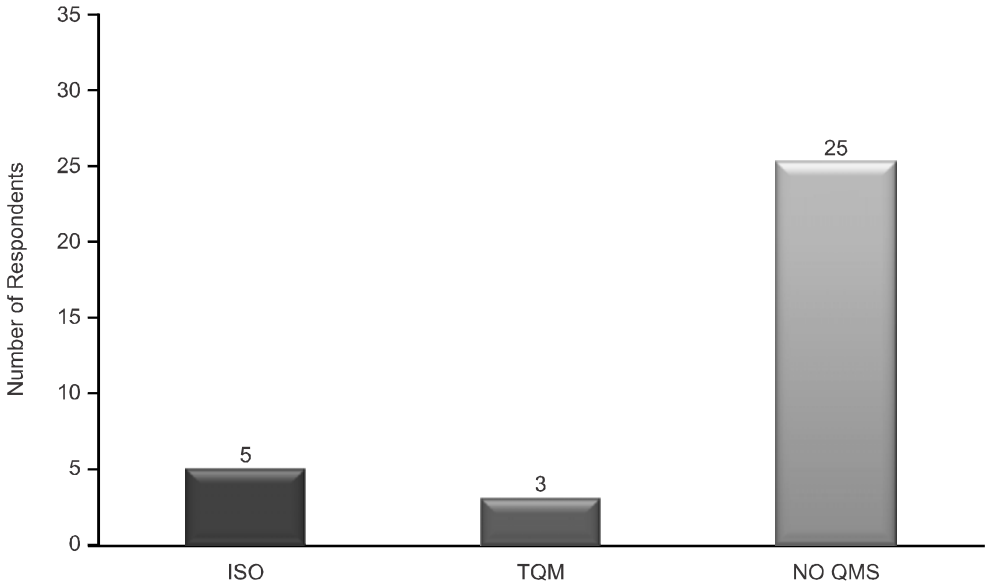

FIG. 8. QUALITY MANAGEMENT SYSTEM IN THE ORGANIZATION

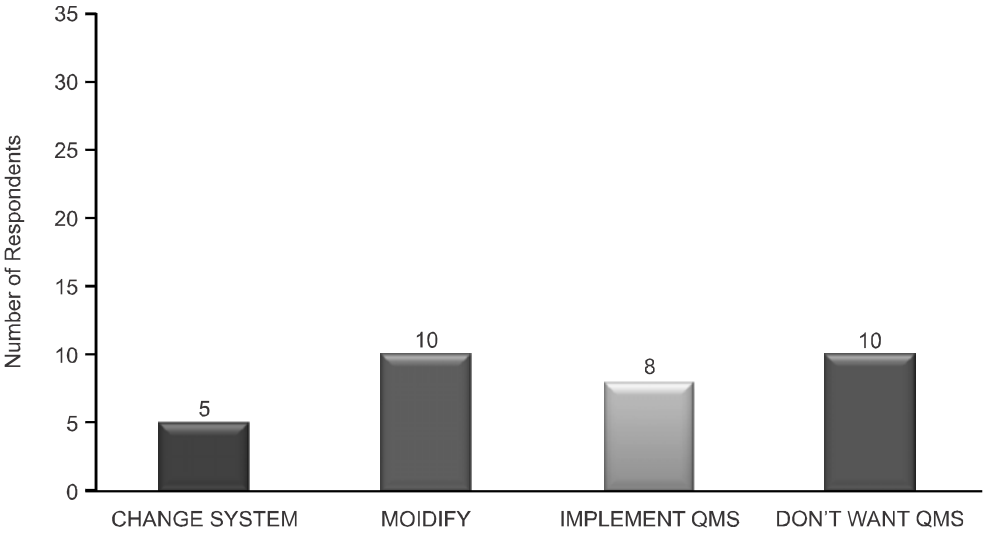

FIG. 9. FUTURE PLAN TO IMPLEMENT, CHANGE OR MODIFY QUALITY MANAGEMENT SYSTEM

4. DISCUSSION

4.1 Quality Management in the Design Phase

- Majority of the consulting organizations is of the opinion that management of quality is very important at the design stage of project. This supports the fact that construction project is actually the outcome of design and if the design is of poor quality, the outcome will remain affected no matter how good is the execution of project.
- The consultants observe some design errors at the design stage of project and some design errors are also reported by contractors during the execution of project. This leads to the result that more emphasis should be given to improve the quality in the design phase.
- Although most of the respondents say that they have proper selection criteria for the employment of designer but the actual situation of the industry seems to be different. The employment of technical staff in construction organizations is affected by some other factors; political influence being the most important factor in that scenario.
- Majority of the respondents say that their clients are satisfied from the level of service provided in the design and only few feel that there is a need for improvement in the quality management process at design stage.
- Majority of the companies have no formal QMS in place which leads to the fact that the companies are reluctant in the adoption of modern quality management practices.
- Most of the consultants, who have the formal QMS in place, are satisfied with their existing QMS set-up and only few intend to change or modify it. This observation leads to the conclusion that many consulting organization are reluctant in adopting change or continuous improvement.

4.2 Quality Management in the Construction Phase

- Majority of the contractors is of the opinion that management of quality is very important at the execution stage of project. This leads to the fact that no matter how good design it is, but if the quality is not managed properly in execution, the quality of design will not be advantageous.
- Most of the respondents say that quality management at execution stage contributes significantly to the quality of the product/service. This observation leads to the result that after proper quality of design, the emphasis should also be given to the quality of material, equipment and workmanship.
- Majority of the contractors say that they have proper selection criteria for the employment of project site staff and they comply with the regulation of Pakistan Engineering Council for the employment of engineers but the actual scenario of the construction industry of Pakistan is different.
- Most of the contractors focus just on the objective to get the work passed by the consultants whereas only few aim to satisfy the client and meet their own organizational goals.
- Majority of the contractors say that they carry out testing of materials from approved laboratories. But the observation of different projects in Pakistan seems to be different. The use of materials mostly lacks to the required standards and testing from approved laboratories.
- Majority of the respondents do not get feed back form their clients about their product/service quality and only few contractors attend complaints of their clients and adopt changes for improvement in quality management policy.
- Majority of the contractors have no formal QMS in place. The few, who have implemented a formal QMS, are satisfied and observe that it is advantageous for their organization.

- Some companies intend to implement a formal QMS in future, whereas few look for change or modification. There are still many respondents who are not accepting the adoption of formal QMS in their companies.
- Significant number of respondents is of the opinion that their clients are satisfy from their product/service quality.
- Majority of contractors is satisfied from their product/service quality which they are providing to their clients, whereas few are not satisfied, which is a sign that these companies are looking for improvement in their service/product quality.
- Many respondents feel that their employees are satisfied from the facilities they are being provided by the company, whereas few contractors feel that their employees are not satisfied and some contractors do not know about the level of satisfaction of their employees.

7. CONCLUSION

The results of the survey clearly indicate that both consultants and contractors realize the importance of quality management in the design and construction phase of project. However, there is lack of quality management procedures in the design and construction process. Consequently the quality of design and construction is affected. Poor quality in design and construction affects the maintenance cost and level of service of the project. Therefore this paper concludes that the consultants and contractors should take some proactive measures in order to improve the quality in the design and execution phase of construction projects.

8. SUGGESTIONS

Based on the results of survey, discussion and conclusion given in the preceding sections, some proactive measures are suggested in order to improve the quality in the design and execution phase of construction projects.

(i) More attention should be paid by the consultants/designers on the quality in design stage of the project. If the design is of poor quality the outcome will remain affected, no matter how good is the execution of project.

(ii) The contractors should focus on the quality management process in the execution stage of the project. If the quality is not managed properly in the execution stage, the quality of design will not be advantageous.

(iii) Consultants should adopt proper selection criteria for the employment of the designer.

(iv) Contactors should follow the proper selection criteria for the employment of project site staff and comply with the rules and regulations of Pakistan Engineering Council for the employment of engineers.

(v) The main objective of the contractors should be to satisfy the quality criteria according to clients needs in order to meet the organizational goals.

(vi) The contractors should carry out testing of materials from approved laboratories.

(vii) The consultants and contractors should get the feed back from their clients to evaluate their level of service in design and construction. The feed back will provide necessary information for improvement in the quality of design and construction.

(viii) The consultants and contractors should implement formal quality management system in order to improve quality management in the design and execution phase of the construction projects. The implemented system should be modified or updated according to the current industry requirements.

(ix) Employees are the internal customers of the organization. If the employees are not satisfied with the benefits and facilities provided by the employer, it is difficult to obtain proper quality of work and satisfy the external customers. Therefore the organizations should pay proper attention to the needs and satisfaction of their employees.

(x) The results presented in this paper are based on the questionnaire survey from consultants and contractors of two major cities of Pakistan. However, this kind of study should be carried out at the global level in order to highlight the importance of proper quality management procedures in the design and execution phase of construction projects.

ACKNOWLEDGEMENTS

The authors are thankful to Prof. Dr. Ghous Bux Khaskheli, Dean, Faculty of Architecture & Civil Engineering, Mehran University of Engineering & Technology, Jamshoro, Pakistan, for his cooperation in the completion of this study. The authors also acknowledge the contribution of Engr. Abdul Waheed and his team members in the collection of this data from different organizations.

REFERENCES

[1] Khan, A.H., Azhar, S., and Mahmood, A., "Quality Assurance and Control in the Construction of Infrastructure Services in Developing Countries: A Case Study of Pakistan", First International Conference on Construction In Developing Countries' Advancing and Integrating Construction Education, Research & Practice, Karachi, Pakistan, August 4-5, 2008.

[2] Raykun, R.T., and Yaw-Guang, L., "On the Quality of Construction Engineering Design Projects: Criteria and Impacting Factors", International Journal of Quality & Reliability Management, Volume 12, No. 5, pp. 18-37, 1995.

[3] Memon N.A., "Contributions to Construction Management in Seismic Area", Ph.D. Thesis, Management Department, Technical University of Civil Engineering, Bucharest, Romania, 2007.

[4] Dahlia, A.W., Saeed, F., Shaikh, N.A., Alharazin, T., and Hassan, O.H., "Quality Management in the Design and Construction Phase: A Case from the Construction Industry of Hyderabad and Karachi", B.E. Thesis, Department of Civil Engineering, Mehran University of Engineering & Technology, Jamshoro, Pakistan, 2010.

[5] Abdul-Rahman, H., Thompson, P.A., and Whyte, I.L., "Capturing the Cost of Non-Conformance on Construction Sites: An Application of the Quality Cost Matrix", International Journal of Quality & Reliability Management, Volume 13, No. 1, 1996.

[6] Paulson, B.C., "Designing to Reduce Construction Costs", Journal of the Construction Division, Volume 102, No. 4, pp. 587-592, 1976.

[7] McGeorge, J.F., "Design Productivity: A Quality Problem", Journal of Management in Engineering, Volume 4, No. 4, pp. 350-62, 1988.

[8] Eldin, N.N., "Management of Engineering/Design Phase", Journal of Construction Engineering and Management, Volume 117, No. 1, pp. 163-175, 1991.

[9] Vlatas, D.A., "Owner and Contractor Review to Reduce Claims", Journal of Construction Engineering and Management; Volume 112, No. 1, pp. 104-111, 1986.

[10] Andia, and Minatob, T., "Design Documents Quality in the Japanese Construction Industry: Factors Influencing and Impacts on Construction Process", International Journal of Project Management, Volume 21, pp. 537-546, 2003.

[11] Peter, E.D., Love, and Amrik, S.S., "Capturing Rework Costs in Projects", Managerial Auditing Journal, Volume 18, No. 4, 2003.

[12] Burati, J., Farrington, J., and Ledbetter, W., "Causes of Quality Deviation in Design and Construction", Journal of Construction Engineering and Management, ASCE Volume 118, No. 1, pp. 34-49, 1992.

[13] Xiao, H., and Proverbs, D., "The Performance of Contractors in Japan, the UK and the USA: An Evaluation of Construction Quality", International Journal of Quality & Reliability Management, Volume 19, No. 6, 2002.

[14] Tam, C.M., Deng, Z.M., Zeng, S.X., and Ho, C.S., "Performance Assessment Scoring System of Public Housing Construction for Quality Improvement in Hong Kong", International Journal of Quality and Reliability Management, Volume.17, No. 4/5, 2000.