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건축프로젝트에 질 관리에 있어서 디자인분야 개선요소에 관한 연구
A Study of Improvement Factors in the Design Phase of the Building Project

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<요 약>
본 연구의 목적은 건축프로젝트에 있어서 디자인분야 개선요소의 특성을 파악하는데 있다. 기존 연구에서 디자인요소 중 열여덟 개의 개선요소들이 정리되었으며 이러한 개선요소들을 중심으로 건설관계자들의 설문조사를 통하여 주요도를 결정하였다. 연구결과는 각 파트별 협조가 가장 큰 개선요소로서 나타났으며 경영개선의 리더십, 팀워크, 시공능력 순으로 나타났다. 또한 각 그룹별 공통적인 개선요소로서 설계사무소와 시공자와의 원활한 의사소통이 상위개선요소에 지적되었다. 디자인에 있어서 초기 공사와 완공 후 유지관리를 반영한 시공성에 중점을 둔 설계에 대한 관심도 크게 나타났다.

Keywords : *건축프로젝트, 디자인분야, 개선요소, 분야별협조*

1. Introduction

1.1 General

The Korean construction industry has been accelerated in the last 40 years with economic growth aspects of scale and quantity. More recently, a number of problems have arisen in the construction industry. Nowadays do not exist a period of construction market like the last high economic growth any more. The Korean construction is now a crisis to the inside and outside of the country. After 1980s, the foreign construction market has become decreasing. The one of the main reasons of the crisis is lack of construction projects, which provoked a keen competition among Korean construction companies. In Korea, the large volume of construction project, in term of numbers and size, has led giant, multi-national construction contractors to the local market and created intensive competition. They demand an origin improvement by restructuring. Recently, big

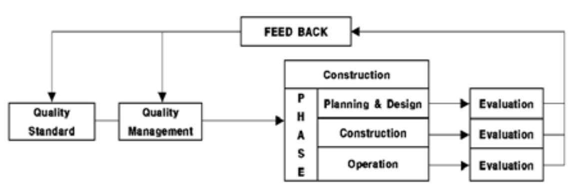

Fig. 1.1 The Quality Control Flow Chart.

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construction companies such as Dong-a was faced with bankrupt crisis.

As the construction crisis has an influence on the whole Korean economics, considerable attention has been given to improving the quality of the construction process. It is expected that process-oriented quality improvement efforts can be of benefit in all the phases of the construction activity. Here, we need to know that how engineers, designers, students and professors perceive the importance of quality control and how they are demanded that kind of changes. Fig. 1.1 shows the quality control flow chart.

1.2 Aims and Objectives

Construction becomes more and more large-scale, complexity and specialization. According to customer's needs, construction project is changing into diversification and high-degree. And also, competition ordering projects keen among the same kind of construction companies. These things are accelerating systematic changes of the Korean construction industry. More emphasis is given to process quality to increase product quality and to satisfy customer's requirement. In order to analyse the problems that are unique to the current Korean construction industry, this study investigates the perception of entry-level students, designers, and long-time practitioners with regard to process quality in building project. The factors that affect process quality in the three phases (design, construction, and maintenance and operation) of the building project's life cycle will be identified and ranked by the respondents' perceived degree of importance. The building construction process employs professionals from several disciplines, but civil engineers and architects generally dominate the process. Their attitude is vital for quality improvement. As the demand for construction management increases, their education and training needs in the basic quality concepts become more apparent. This study aims the differences in each party such as how entry level graduate students and long-time professionals perceive process quality in the building construction industry. The research takes an independent approach to the study of the building process, investigating quality issues in the design phase of a building project.

There are four big objectives of the study

1) To identify the reasons for the effectiveness of the attributes of quality management
2) To recommend generic guidelines for achieving improved quality management in the building project.
3) To identify the factors that affect process quality in design phase of a building project
4) To rank factors by degree of importance .

2. Background

2.1 Definition of Quality in Construction

Quality can be defined in several ways. This term used and defined as "a measure of fitness for purpose, in the sense of meeting the needs of a customer, at a price commensurate with the extent of those needs."(Arditi 1999) ISO defines quality as the totality of characteristics of an entity that bear on its ability to satisfy stated or implied needs. (ISO 2000). It has an abstract concept. According to Juran (1988), quality can be defined in terms of

(1) Conformance to the agreed requirements of the customer

(2) A product or service free deficiencies

The American Society for Quality (www. asq.org) and Crosby (1992) support this definition. In the building construction industry, quality can be defined as meeting the requirements of the designer, constructor, and the owner (Arditi and Gunaydin 1997). In terms of function, a high quality-building project can be described by such terms as ease in understanding drawings, level of agreement in drawings and specification, economics of construction, ease of operation, ease of maintenance, and energy efficiency. The generally accepted factors that affect quality are well defined and thoroughly described in the literature. A case study conducted by Chrest (1993) shows that quality improvement team, education, continuous improvement; communications, company performance feedback from clients and employees, and statistical process control are very important factors that affect quality. Construction Industry Institute (CII) created a quality management task force to conduct research in the construction industry to identify attribute of quality management organization and techniques that have been considered to be effective in the construction industry. In the construction industry, quality can be defined as meeting the requirements of the designer, constructor and regulatory agencies as well as the owner. According to an ASCE study, quality can be characterized as follows.

1) Meeting the requirements of the owner as to functional adequacy; completion on time and within budget; life-cycle cost; and operation and maintenance.

2) Meeting the requirements of the design professional as to provision of well-defined scope of work; budget to assemble and use a qualified, trained and experienced staff; budget to obtain adequate field information prior to design; provisions for timely decisions by owner and design professional; and contract to perform necessary work at affair fee with adequate time allowance.

3) Meeting the requirements of the constructor as to provision of contract plans, specifications, and other documents prepare priced proposal or competitive bid; timely decisions by the owner and design professional on authorization and processing of change orders; fair and timely interpretation of contract requirements from field design and inspection staff; and contract for performance of work on a reasonable schedule which permits a reasonable profit.

4) Meeting the requirements of regulatory agencies(the public) as to public safety and health; environmental considerations; protection of public property including utilities; and conformance with applicable laws, regulations, codes and policies.

In this study, the author deals with 'process quality'not 'product quality', for example, 'product quality' in the construction industry may refer to achieving quality in the materials, equipment and technology, whereas 'process quality' may refer to achieving quality in the way the project is organized and managed in the three phases of planning and design, construction, and operation and maintenance.

2.2 Quality assurance/control

2.2.1 Quality assurance(QA)

According to the *Manual of Professional Practice for Quality in the Constructed Project* (Ferguson and Clayton 1988), "Quality Assurance (QA) is a program covering activities necessary to provide quality in the work to meet the project requirements. QA involves establishing project related policies, procedures, standards, training, guidelines, and system necessary to produce quality. The design professional and constructor are responsible for developing an appropriate program for each project. QA provides protection against quality problems through early warnings of trouble ahead. Such early warnings play an important role in the prevention of both internal and external problems".

2.2.2 Quality Control(QC)

Quality Control (QC) is the specific implementation of the QA program and related activities. Effective QC reduces the possibility of changes, mistakes and omissions. This results in fewer conflicts and disputes. According to O'Brien(1989), one way in which more attention will be given to quality control is development of a project quality control plan. The Japan Industrial Standards Z8101-1981 define quality control as a system for the economical production of goods and services that meet the demands of the consumers (Iami 1986). The standard for all actions and activities in quality control is that they must contribute to the satisfaction of the customer. According the Crosby (1967), quality control concepts, techniques, and practices were developed around assumptions of the inevitability of error and made no room for a defect-free situation.

2.2.3 The Difference between Quality assurance and Quality Control

The terms quality assurance (QA) and quality control (QC) are frequently used interchangeably. Because quality control is a part of quality assurance (Ferguson and Clayton 1988), maintaining a clear distinction between them is difficult but important. Quality assurance is all planned and systematic actions necessary to provide adequate confidence that a structure, system or component will perform satisfactorily and conform to project requirements. On the other hand, quality control is a set of specific procedures involved in the quality-assurance process. These procedures include planning, coordinating, developing, checking, reviewing, and scheduling the work. Most design-related quality assurance and quality control activities are covered by a design organisation's standard office procedures. Developing and monitoring the activities within the quality assurance program in the construction phase are the responsibility of either the designer or the construction management firm depending on the project delivery system in use.

3. Methodology

3.1 Factors that affect Quality in the Design Process

The quality control in design means the well-balanced design standard that combines the quality demand of the client and the construction ability of the contactor. Generally, designers pay regard to the intention of design based on drawings, specification and contract documents. Especially, the construction budget for the competitive bidding and negotiation is determined by drawing. Drawing represents not only the quality and the shape of work performed by the contractor.

1) Project specification Specifications are documents that provide technical information on materials, performance, and quality requirements (Ferguson and Clayton 1988). Project specifications are some kind of translated form of the requirements of the owner. Inadequate translation means loss of valuable owner information. Therefore definitions should be clear and consistent with the requirements and perceived same by all parties. In case change, the specifications should be updated thoroughly and promptly for all parties. Recent developments in information and database technologies may contribute to the solution of this problem (Brandon and Betts 1995)

2) Selection of designer Each project is unique and therefore, the selection of an appropriate design firm for a project may contribute to the quality. Designers' experience may become the most effective problem-solving tool for construct ability and prevention tool against reworks and errors.

3) Communication with owner The main purpose of communication with owner is not for the owner to only define the project requirements but also to transmit those requirements effectively to the other parties involved in the process. According to Covey (1990) win-win situations depend on well-defined requirements promoted through effective communication.

4) Construct ability Construct ability is one of the major factors that affect the quality of design. The project must be constructible by those retained to build the project. Like codes, construction techniques vary in different geographical areas. In addition, design professionals must clearly and adequately communicate the design intent to the constructor.

3.2.2 Questionnaire Survey

The survey is designed to analyze the factors that affect quality in the construction phases. A 1-5 scale of importance is used in the questionnaires. The issues investigates are listed in Table3.1, The factors are organized in three different questionnaires that are administered to the following four different parties.

Design firms, Construction companies, Property management and Professors and students will receive all three questionnaires. (Design phase, construction phase, and operation phase)

The arbitrary Korean 100 construction firms, design firms, property management firms, and professors and students were selected to be survey groups. The surveys were sent out to these 400 companies and persons with letters and e-mail. After one month, another interview by the phone and face-to-face interview was made to companies and persons that had not responded.

Table 3.1. Investigation factors

Design	Cooperation of parties, Project specifications, Teamwork in design firm, Management leadership, Selection of design firm, Management commitment, Communication with owner, Construct ability, Design budget, Feedback system, Drafting practices, Codes and standards, Designer's training, Office practices, Personalities, Designer's education, Statistical methods.

4. Findings and Analysis

4.1 The General Factors

The number of responses and corresponding rates of return for each group of respondents are presented in Table 2.

Table 2. Rank of Factors that Affect Quality in Design Phase

Rank (1)	Factors (2)	Mean (3)	Standard deviation (4)
1	Cooperation of parties	4.53	0.48
2	Management leadership	4.34	0.75
3	Teamwork in design firms	4.33	0.47
4	Construct ability	4.09	2.84
5	Design budget	4.04	0.61
6	Communication with owner	4.01	0.96
7	Designer's training	4.00	3.83
8	Selection of design firm	3.96	0.56
9	Drafting practices	3.90	0.79
10	Project specifications	3.86	0.71
11	Feedback system	3.75	0.75
12	Codes and standards	3.75	0.91
13	Office practices	3.75	0.45
14	Personalities	3.54	0.71
15	Statistical method	3.52	1.61
16	Designer's education	3.05	1.27

Scoring system scale of 1-5: 1 not important, 5 very important
(Average career: 6.72 year　　Mean: 3.94)

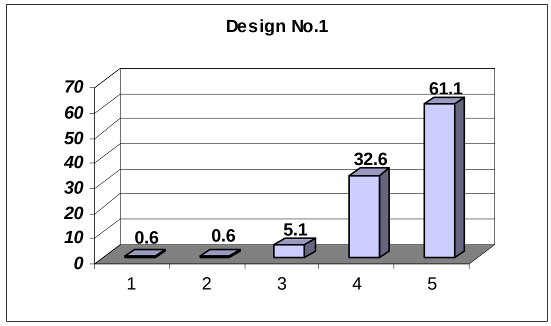

Fig.1. Cooperation of designer's professionals.

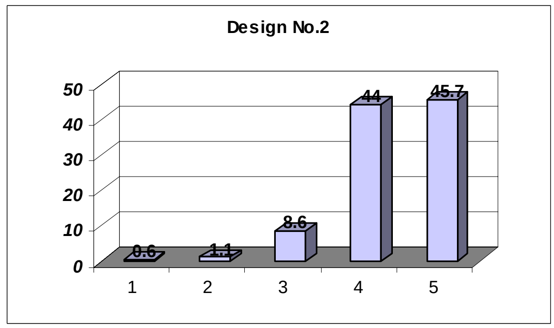

Fig.2. Team work of outside parties.

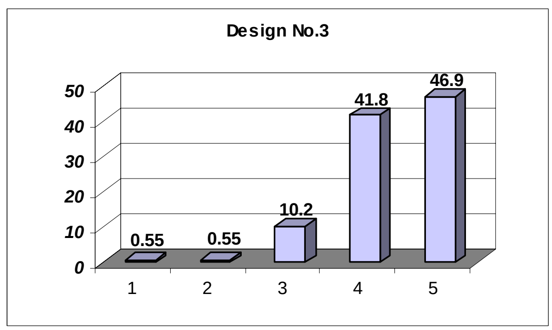

Fig.3. Management leadership in chief of design.

Scoring system scale of 1-5: 1 not important, 5 very important

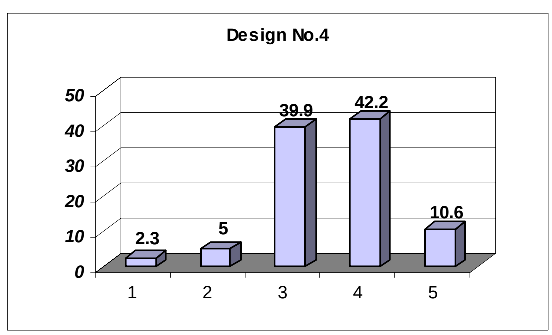

Fig.4. Use of statistical methods.

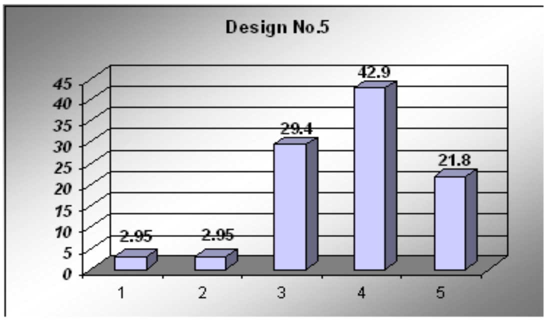

Fig.5. Feed back system.

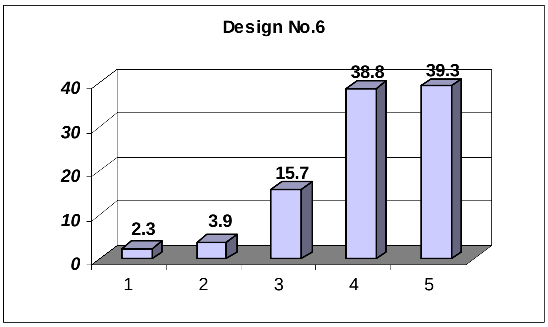

Fig.6. Constructability of the design.

Scoring system scale of 1-5: 1 not important, 5 very important

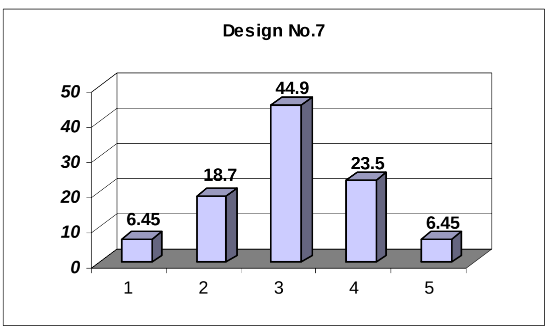

Fig.7. Educational background of designers.

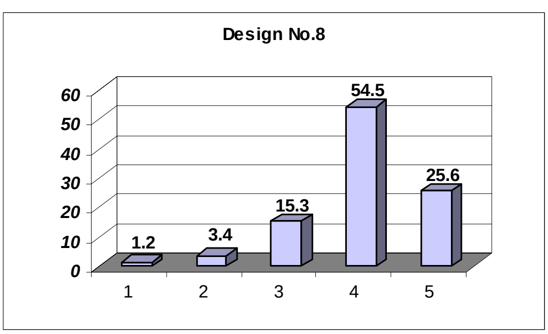

Fig.8. Continuing education of designers training.

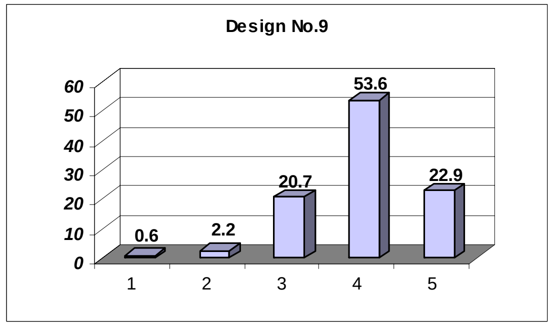

Fig. 9. Selection of appropriate design firm.

Scoring system scale of 1-5: 1 not important, 5 very important

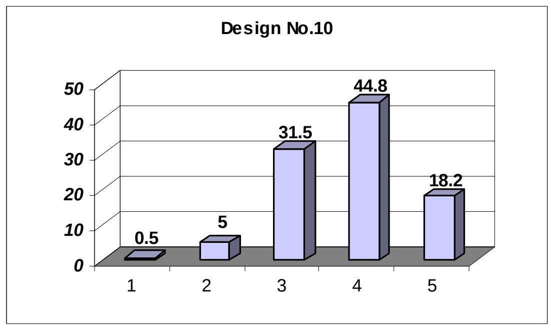

Fig.10. Characteristics of office practices.

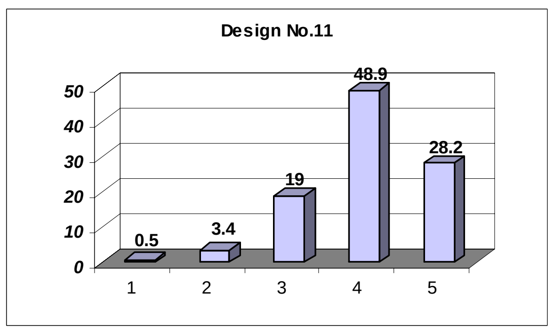

Fig. 11. Briefing of owner.

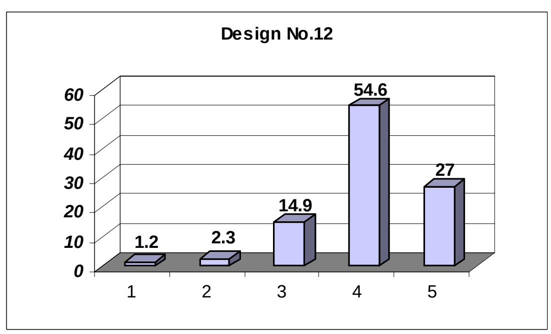

Fig. 12. Budge tallocated for design.

Scoring system scale of 1-5: 1 not important, 5 very important

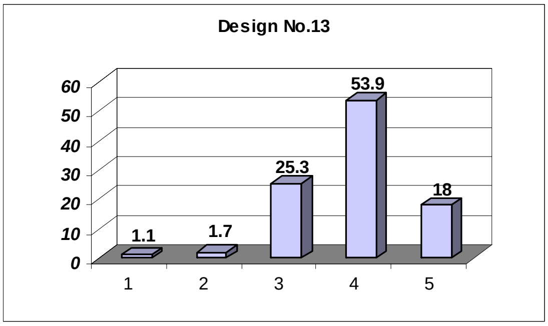

Fig. 13. Appropriateness of project specifications.

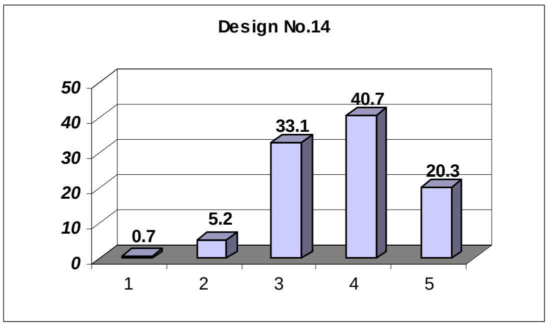

Fig. 14. Quality of codes and standards.

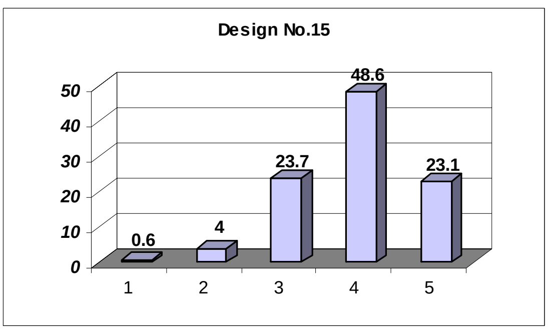

Fig. 15. Characteristics of drafting practices.

Scoring system scale of 1-5: 1 not important, 5 very important

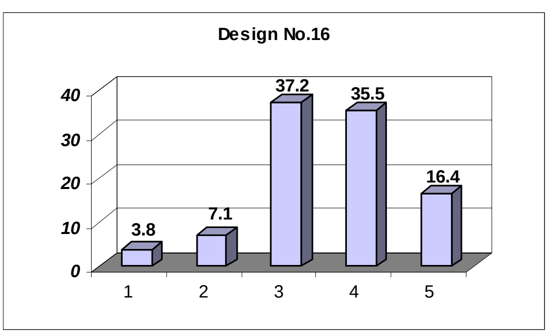

Fig. 16. Personalities of the participants.

Scoring system scale of 1-5: 1 not important, 5 very important

5. Conclusions

In the design phase, a significant positive correlation is found between designer's and construction contractor' response (Both ranked top three). The ranking of the composite indices presented in Table 4.1 does not show major differences from the rankings of group indices. Indeed, all factors that are perceived as important (mean value of 3.9) are ranked in each group. Even though the correlation is quite high, it appears that there also are some disagreements . The cooperation of parties, construct ability in design phase are the factors that are found to be more important by design and construction group than by maintenance and university group. Teamwork in design firms is found to be very important by the all group (ranked 1st). The factor that the educational background of designers is found to be relatively less important all group (ranked 16th). Designers' training, on the other hand, covers inner training courses and continuing education programs ranked 7th in design phase. The fact that only maintenance group ranked designers'training as more important (8th), compared with other group, is indicative of the higher value that operation managers attach to continuing education and training in general. In design phase, training is targeted toward developing a new quality culture and implementing the quality improvement process. However, both of these education-related factors, the educational background of designers and designers' training, are ranked quite low (16th and 7 th, respectively) in importance by all groups. The factors like cooperation of parties, management leadership, teamwork in design firms, construct ability, and design budget, the first five factors, are of greater priority in achieving high process quality than education and training. Each project is unique and, therefore, the selection of an appropriate design firm (ranked 8th) for a project may contribute to quality. Factors like the design firm's experience, capabilities, workload, expertise, and financial stability may play a significant role. Designers' experience may become the most effective problem-solving tool for construct ability and prevention tool against reworks and errors. Information technologies and database systems are being explored to increase efficiency in the design process. Communication with owner (ranked 6 th) in the design phase has to be handled carefully. It also involves the other parties briefing the owner relevant information that is necessary for high- quality design and construction. Improved and systematic communications may save money, time of all parties. It is interesting that university group namely, entry level professionals who have probably never dealt with an owner consider this factor to be of more importance (ranked 10th) than any other group. Construct ability is ranked second by construction group, fifth by maintenance group and eighth by university group. It is important that the design professional must consider the requirement of the constructor. Designs also must be reviewed for effectiveness, including both the initial construction and the post construction operations. The designer should review both the initial design construct ability and the completed operational design.

The adoption of new technology such as three-dimensional computer-aided drafting and design and automation in construction has generated increased interest in the construct ability of the project. With these new innovations, designers can be configured to enable efficient construction. According to the ASCE manual Quality in the constructed project, the project design team should include engineers with field experience. Many organizations have these engineers on staff to avoid construct ability-related problems.

References

1) Arditi, D., and Gunaydin, H.M. (1997), *Total quality management in the construction process,* Int.J.Proj.Mgmt, 15(4), 235-243
2) Arditi, D., and Gunaydin, H.M. (1999), *Perceptions of process quality in building projects*, J. Manage. Eng., 15(2), 43-53
3) Bates,G. D., ed. (1993). *An organization development process to prepare for total quality management,* J. Mgmt. Energ., ASCE, 9(4), 291-294
4) Brandon, P., and Betts, M., ed (1995), *Integrated construction information.* , Chapman & Hall, Ltd., New York, N.Y.
5) Burati, J.L., Farrington, J. J., and Ledbetter, W. B. (1992a), *Cause of quality deviations in design construction,* J. Constr. Engrg. and Mgmt, ASCE, 118(1), 34-49
6) Burati, J.L., Farrington, J. J., and Ledbetter, W. B. (1992b), *Quality management organizations and techniques.",* J. Constr. Engrg. and Mgmt, ASCE, 118(1), 112-128
7) Chase, G. W., and Federle, M. O. (1992), *Implementation of TQM in building design and construction,* J. Mgmt,Engrg., ASCE, 8(4), 329-339

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