Quality in construction management: an exploratory study

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Abstract:	

Quality in Construction Management: An Exploratory Study

1. Introduction

Jung and Wang (2006) and Lam and Thomas (2006) stated that top managers have been focusing on the need for applying quality philosophies to achieve high performance levels among various components and procedures. There has been increased interest within the construction management community in exploring possibilities for applying quality knowledge gained from manufacturing and other industrial sectors to the problems of managing the construction process (Abdel Salam and Gad, 2009). Unfortunately, contractors rarely have a realistic idea of how much profit they are losing by not attaining an acceptable level of quality. Turk (2006) stated that quality may sometimes be ignored in the construction industry in order to cut the costs and shorten the project duration. However, it is believed that the benefits of higher customer satisfaction, better quality products, and higher market share are often obtained following the adoption of quality by construction companies (Pheng and Teo, 2004). Recent events in developing countries coupled with restructuring of economics, emergence of the world trade organization and the rising price of oil are expected to yield an unprecedented growth in constructions. Consequently, a huge number of large scale projects are currently in planning and contract awarding phase (Wanberg et al., 2013). The construction industry has experienced growth during the boom that occurred in developing countries in the last decade encouraging investments in the industry and raising the importance of deploying management philosophies advancement to this industrial segment. The effects of quality on a business are numerous and have improved the productivity of design and project management and now have become vital to construction business to survive and have a competitive edge.

In response, this paper explores the factors affecting quality in construction management (housing sector) in a developing country (Jordan). Jordan is looking to develop a better management strategy for its construction projects, and this is a priority for other developing countries too (JEA, 2013). Our aim in this paper is to identify the relative importance of factors affecting quality in the Jordanian housing sector. This study addresses the following research objectives: (1) to identify the factors affecting quality in the housing sector, (2) to examine the relative importance (e.g. highest and lowest) of such factors from the view point of architects and contractors, and (3) to develop an integrated conceptual framework for quality factors.

The rest of this paper is structured as follows: quality, quality in construction, and factors affecting quality in the literature are reviewed, the research methodology is discussed, findings and discussion follows, and the final section includes conclusions and contributions.

2. Literature Review

2.1 Quality

The success of a project found in the literature depends on the project quality as a key concept (Wanberg et al., 2013, Romeo et al., 2014). Arditi and Gunaydin, (1997) define the concept of quality as meeting the legal, aesthetic and functional requirements of a project. Eng and Yousef (2003) explain quality as both a philosophy and a set of guiding principles that represents a continuously improving organization. Quality can be translated into the quality dimensions that include: levels of quality, reliability and safety, quality performance, durability, and serviceability (McGoerge and Plamer, 2000; Luu et al., 2008; Wanberg et al., 2013). Jung and Wang (2006) argue that it is the role of management to ensure the achievement of established requirements in a project as competition increases and change occurs in the business world. Understanding how closely the project conforms to its requirements, a high quality project can be described by such terms as ease in understanding drawings, level of conflict in drawings and specifications, construction economy, ease of operation and maintenance, and energy efficiency (Ardti and Gunaydin, 1997). According to Al Nofal et al., (2005) and Jraisat and Sawalha (2013), quality requires radical change to traditional management practices. Quality is one of the most complex practices for any company; it requires implementing a new way of managing business and culture which not only affects the whole organizational process and employees but also the allocation of significant resources (Santos et al., 2002; Jung, 2009).

Quality needs control which is the specific implementation of the quality assurance program. Effective control for quality reduces the possibilities of change, mistakes and omissions, which in turn result in fewer conflicts and disputes. Most of the engineers and architects were in total control during the design phase. During the construction phase, they carried out a role described as 'supervision', insuring that the owner received his money's worth in terms of quality. Recently, owners became increasingly concerned with cost and schedule, areas where design professionals were not providing good control. Engineers and architects must work together to achieve specified goals of quality and liability control, recognizing that each person and each activity affects and in turn is affected by others. As competition increases and changes occur in the business world, companies look for high levels of effectiveness across all functions and processes and choose quality management as a strategy to stay in the business.

2.2 Quality in Construction

In a construction project, quality management has been widely used by world-class companies to ensure successful projects delivery (Aichouni et al., 2014). The interactions and interrelationships between key participants (e.g. the client, the architect and the contractor) largely determine the overall performance of the construction project. Notwithstanding this mutual dependency, the performance of individual participants remains important because the overall performance is a function of the performance of each participant (Soetanto and Proverbs, 2002; Lianying and Weijie, 2013). According to Rwelamila and Wisemant (1995), Arditi and Gunaydin (1997), Turk (2006) and Saeed and Hasan, (2012), quality in the construction industry can be defined as meeting the requirements of the designer, constructor and regulatory agencies as well as the owner. Based on the three studies above, quality can be characterized based on meeting the requirements of the owner (e.g. functional adequacy, completion time, budget; and lifecycle costs), design professional (e.g. well-defined scope, qualified staff, adequate information prior to design, provisions for decisions by owner and design professional, and contracting to perform work), constructor (e.g. contract plans, specifications, timely decisions, and contracting to perform work), and regulatory agencies (e.g. public safety and health, environmental considerations, protection of public property, and laws and regulations). Moreover, one should also differentiate between product quality (the physical product itself) and the process quality (the activities that causes the product to be either acceptable or not) in a project (Culp et al., 1993). For example, "product quality" in the construction industry may refer to achieving quality in the materials, equipment and technology that go into a structure building, where "process quality" may refer to achieving quality in the way the project is managed in the three main phases of construction process which are planning and designing phase, construction phase, and operation and maintenance phase (Burati and Oswald, 1993; Arditi and Gunaydin, 1997; Lai and Cheng, 2003).

The construction industry and its quality presently are facing urgency of shaping a sustainable construction process (Zhai et al., 2014).The role of quality in construction has been emphasized by the use of various aspects of quality tools and techniques (e.g. Metri, 2005). Many organizations are frustrated in their effort to improve quality because these companies have exclusively focused on financial measures instead of quality measures (Torbica and Stroh, 1999; Sharmma and Gudanne, 2002). Construction firms, therefore, need to understand the quality factors for their success in order to establish quality factors for construction firms (Saeed and Hasan, 2012). Although quality has been widely implemented in the Japanese construction industry since the 1980s and in the American construction field since the 1990s, it has not yet been implemented successfully in developing countries (Abdel-Razek, 1998; Hiyassat, 2000; Kazaz et al., 2004; Abdel Salam and Gad, 2009). Many studies have demonstrated that project

management action is a key element in achieving quality in construction. The success of quality management depends heavily on management practices. These practices include: motivation by the contractor's senior management, commitment of top managers to site management (Abdel-Razek, 1998; Kaye and Anderson, 1999), and integration of continuous improvement activities into the strategic goals across the whole organization, across boundaries and at all levels (Kaye and Anderson, 1999). Contractors, for example, need to define their objectives by creating a harmony through mutual co-ordination among all parties (Asim et al., 2013).

According to Kazaz and Birgonul (2005), Turk (2006) and Haseeb et al., (2011), construction firms have some deficiencies in getting stability in a quality concept when their business structures use temporary labors and change their location constantly and consequently. Furthermore, construction projects are widely seen as unpredictable in terms of delivery time, budget, profitability and the standards of quality expected (Love et al., 2000). Some differences must be considered when applying a quality program to construction projects (Arditi and Gunaydin, 1997; Pheng and Teo, 2004; Romeo et al., 2014). These differences illustrate that almost all construction projects are single order-production products, each construction production site always displays different conditions; the life-cycle of a construction project is much longer than the life-cycle of most manufactured products, and there is no uniform standard in evaluating overall construction quality. Thus, construction projects usually are evaluated subjectively, and the participants in the construction project (e.g. owner, designer, general contractor, subcontractor, material supplier, etc.) differ for each project.

2.3 Factors Affecting Quality in Construction Management

In construction projects, there is a need for a framework for evaluating quality to assist construction clients in selecting quality-oriented organizations that will provide higher quality products and processes within budget and on schedule (Idrus and Sodangi, 2010, Dina et al., 2010). Porter and Parker (1993) stated that in managing quality, some organizations focus on specific areas such as training, leadership, and benchmarking while others take a holistic approach for quality factors. Haupt and Whiteman (2004) have conducted a study in the U.S.A through a literature review and a survey of contractors to identify factors (e.g. management commitment and involvement, customer satisfaction, planning, participative management style, continuous improvement measurement, rewards for quality contribution, and training of workers) affecting the operations of a construction jobsite. Pheng and Hong (2005) have done a study in Singapore which involved the participation of project managers in the construction industry. A survey was used and the respondents generated eight factors and the relative importance of each factor was determined. For example, the first factor in order of priority was total commitment .Second, was strategic quality management, and followed by customer-driven

service, eliminating rework, teamwork, and training, empowering and respecting people. Furthermore, Lam et al. (2008) have explored the extent of quality in Hong Kong large-sized public building contractors. They concluded that the contractors should pay more attention first to the factors of strategic planning, human resources management, and leadership in order to attain the goal of continuous improvement then to the factors of process management, customer and market focus, measurement, and analysis and knowledge management.

Previous studies highlighted the factors affecting the quality of construction. Each study has contributed to identifying some factors affecting quality. However, there are few published works that comprehensively address the factors specifically affecting the quality of construction in different parts of the world. Researchers still differ in their perceptions as to what should be emphasized most among the different factors affecting quality. Moreover, few studies have been conducted in the Middle East regions that are addressing quality factors in construction. Fourteen quality frameworks for construction industry have been promoted by different authors, for the purpose of establishing construction quality factors in this study. A detailed analysis of the frameworks is carried out and presented in Table 1.

Table 1. Analysis of Quality Frameworks

A careful balance between the owners requirements of the project costs and schedules, desired operating characteristics, materials of construction, etc. and the adequate time and budget to meet those requirements during the design process is essential. Owners balance their requirements against economic considerations and, in some cases, against chance of failure. The constructor is responsible for the means, methods, techniques, sequences, and procedures of construction, as well as safety precautions and programs during the construction process. Project requirements are the key factors that define quality in the process of construction. After a review of the literature on quality factors in construction, it appears that not all the factors have the same frequency and importance but they complement one another. Accordingly, relying on the previous research findings about factors affecting quality in construction, this study uses 13 quality factors as the most relevant. Table 2 lists the most important factors and literature support, where definitions of the factors are provided.

Table 2. A List of Quality Factors and Literature Support

3. Research Methodology

Due to the dearth of real data relating to quality in the Jordanian housing projects, the researchers use an exploratory method to identify the most related quality factors. The present aim of this study was identified: factors affecting quality in the Jordanian housing sector and their relative importance**.** This exploratory research includes two phases of extensive review of the literature and a survey questionnaire by personal interviews in the housing sector in Jordan. The research design started with identifying a research problem, and then it provided a review of the available literature in order to understand previous research in quality and relevant fields. This has led to a determination of the key aim and objectives, and then providing the initial conceptual framework for quality factors.

The survey was conducted by means of structured personal interviews within two months (September and October, 2013), carried out face to face for checking the information accuracy, and developing an understanding of quality factors based on the designed questionnaire. During the interviews, interviewees were briefed on research problem, research objectives and quality factors. The interviews were conducted at the premises of the selected companies that agreed to participate. The questionnaires were answered by contractors and architects who were in charge of quality awareness to ensure that the respondent has the necessary knowledge to respond. All the companies included in the survey were located in Amman due the constraints of time and cost. Amman is considered to be the main economic hub of the country, and 77 % of the housing projects are concentrated there (JEA, 2013).Most of the survey questions were adopted from previous literature that had been used to determine the factors affecting quality in construction. The questionnaire was made of two parts: the demographic information of respondents and quality factors. The importance of factors affecting quality was measured using a perceptual measure on a five-point likert scale to ensure consistency and the ease of data computation. The perceptual measures are in the form of attitude statements with (1 = totally disagree, 2 = generally disagree, 3 = somewhat agree, 4 = generally agree, and 5 = totally agree). It was important to have a valid instrument for measurement, so the process of developing the questionnaire ended with a pre-test, which were used to modify and eliminate a number of variables. However, it was found to be valid on the basis of our study. The list of ISO 9000 certified companies (as of June, 2013) was obtained from Jordan Institution for Standards and Metrology. This list contained the name, telephone and fax number and the certification body for 283 certified firms in Jordan. Of these firms, only four of them are construction firms. Companies that were ISO 9000 certified were used in the population to capture the benefits and to ensure the maturity of the system in the firms.

An exploratory pilot study was conducted at Jordanian Engineering Association (JEA), Jordan Construction Contractors Association (JCCA), Ministry of Public Work and Housing, Ministry of Industry and Trade (MIT), to seek out detailed information regarding the potential participants constituting the housing sector in Jordan. The population of the study consists of working contractors and architects in the Jordanian housing sector obtained from the lists of JEA, JCCA and MIT. These lists were carefully verified and cross-checked to ensure complete and up-to-date information, as follows:

Contractors: contracting companies are classified by Ministry of Public Work and Housing into six classes according to their capital, and their experience in completing projects with a minimum total value. As considerably meeting in JCCA, the classes which usually take the housing projects are classes D and E as summarized in Table 3 which comprise 243 companies (JCCA, 2013).

Table 3. Classes of Contractors

Architectural firms, consulting companies and engineering offices: they represent a number of 1198 companies and offices (JEA, 2013). According to the JEA, architectural firms, consulting companies and engineering offices share similar architectural activities; thus they are classified under the same category. This point was taken into consideration when the population of the study was selected, and for the purpose of the study, the researchers chose 85 companies and offices of which their capital exceeds JOD 10000 (MIT, 2013; JEA, 2013).The sampling was confined to specific types of companies conforming to the criteria set by the researchers: contracting companies where their capital between JOD 20000 and JOD 50000 (class D and E) and architectural companies with capital in excess of JOD 10000.

The researchers followed a census sampling approach "where the sample size equals the population size" .Therefore the sample size for contractors equals 243 while the sample size for the architects is 85.The response rates were: 61.2 % and 22.6 % for architects and contractors respectively. This study implemented a number of statistical techniques and procedures to answer the questions of study. Descriptive statistics and reliability analysis were carried out to estimate the internal consistency of items, where Cronbach's coefficient, α, was selected for this test. Then, *t*-test (one-tailed) at 95 % confidence level was conducted among the means of responses from the two groups (contractors and architects) to check any significant differences among the groups' perceptions regarding the importance of various factors. All statistical procedures were estimated using Statistical Package for Social Sciences (SPSS) version 15.0 (Gerber and Finn, 2005). In order to increase the validity of the research findings, the researchers also use cause-effect diagram (Fishbone) in the analysis procedure in order to

explore the theoretical links of the factors affection quality in the Jordanian housing sector. "The Fishbone Diagram" is easy to use and is an effective cause-and-effect technique. The diagram refers to its use in identifying the causes of various quality characteristics, including problems (Ozeki and Asaka, 1990). This type of analysis will illustrate the most important quality factors and their variables in order to support the new proposed conceptual framework for this study.

4. Results and Discussion

The responses indicated that the majority of contractors who participated in the study were 100% male and 49.1% with ages ranging between 41 and 50 years old. The contractors were well experienced professionals and were able to give reliable data. The respondents over five years of experience in the construction industry were 89.9% and over 49.1% of them had over a ten years' experience. All of the respondents have graduated from high school and 72.7% of them hold bachelor degrees. Amongst the architectural companies, the large proportion is 65.4% of the respondents which were male and 34.6% were female. The statistical results show that about 55.8% were less than 40 years, 78.8% of them hold bachelor degrees, and 15.4% of the participants have completed graduated studies. About 11.5% of the respondents had less than 5 years' experience, 21.2% between 6-10 years, 55.8% between 10-15 years, and 11.5% over 15 years.

4.1 Validity and Reliability

An instrument has content validity if researchers agree that the instrument is made up of a group of items covering the issues to be measured. The researchers utilized the available literature to ensure the questionnaire validity. The pre-test consisted of a first revision of the questionnaire with five Jordanian academic people in order to ensure technical accuracy and clarity and to improve the questionnaire. The internal consistency method was used to measure construct reliability by the use of Cronbach's alpha. In the present research, the coefficient of Cronbach's alpha for all factors was 0.82. This indicates a high level of reliability which is above the recommended minimum level 0.60 for social sciences. The ranking of factors affecting quality in the Jordanian housing sector was determined by taking the respective average scores of the reported data for all respondents, as shown in Tables 4, 5 and 6 respectively.

Table 4. Ranking of Factors from the View Point of Contractors
Table 5. Ranking of Factors from the View Point of Architects
Table 6. Ranking of Factors from the View Point of Contractors and Architects Combined

The homogeneity of variance must be examined to know if the variances assumed are equal or not at significance 'p' of 95% ($\alpha = 0.05$), then *t*-test is conducted. For this purpose, the researchers examine these statistical hypotheses, if significance 'p' value is less than 0.05; then reject the null hypothesis (H_0), implying that the variances are unequal.

H_0: there is no difference in variances of contractors and architects ($\sigma 1 = \sigma_2$) (equal variance)
H_1: there is difference in variances of contractors and architects ($\sigma 1 \neq \sigma_2$)

The results of homogeneity of variance for the highest and the least common factors are demonstrated in Tables 7 and 8, respectively.

Table 7. Homogeneity of Variance for the Three Highest Factors Ranked according to Contractors and Architects Combined.
Table 8. Homogeneity of Variance for the Three Lowest Factors Ranked according to Contractors and Architects combined.

4.2 T-Test

The *t*-test was carried out for the three highest factors from the view point of both contractors and architects combined: human resources management, customer satisfaction, construction specific factors, and the three lowest factors combined: strategic management, continuous improvement, and resources. Null hypothesis: $H_0: \mu_1 \leq \mu_2$; i.e. there is no significant difference in the mean of population between contractors and architects for the highest quality factors. Alternative Hypothesis: $H_1: \mu_1 > \mu_2$; i.e. there is a significant difference in the mean of population between contractors and architects for the highest quality factors. The result of the *t*-test is given for the most common highest and lowest factors in Tables 9 and 10.

Table 9. *t*-test for the Most Common Highest Factors.
Table 10. *t*-test for the Most Common Lowest Factors.

4.3 The Highest Three Factors

In this research, *human resources management* is the first highest factor from the view point of contractors and architects combined. However, there is no significant difference according to the mean of overall averages of the contractors and architects concerning this factor. Table 11 shows that this factor (education and training, involvement, and teamwork) is considered as the most important factor which affects quality in many countries.

Table 11. Supportive Studies of Human Resources Management.

Research results have revealed that education and training are the most important elements affecting quality. This result is in agreement with the conclusion drawn by Chan et al.(2006), Lam et al. (2008) and Lai and Cheng (2003) in Chinese companies where it was conducted for public housing. It is in agreement with pheng and Hong (2005) in Singaporean companies from the view point of contractors. The result also is in agreement with the study of Sharmma and Gudanne (2002) in Australlian construction companies that stated that they had an on going quality training programmes as an important quality strategy. In the U.S.A, a study by Arditi and Gunaydin (1997) emphasized that training should be targeted to every level of the company and in all stages of construction. Findings from an Egyptian survey in 1998 by Abed-Razek reflected that the most important factor was up-grading for the current training methods. The entire project team (contractor, subcontractor, supplier, designer, project manager, and customer) must be involved in the quality process (Pheng and Teo, 1996). Several authors have suggested the importance of involvement in decision making which enhances the individuals' self-esteem and improves ability to solve problems (e.g. Metri, 2005; Fotopoulos and Psomas, 2009). Each project also requires an effective teamwork on jobsite where both the construction managers and workers require a paradigm shift to team approach which will lead to a better support to all members (Hellard, 1991; Haupt and Whiteman, 2004; Pheng and Hong, 2005).

Customer Satisfaction is the second most important factor. It is not surprising that most respondents understood the importance of customer satisfaction and emphasized the satisfaction of customers in support of overall quality. Also, there is no significant difference in the mean of responses of contractors and architects regarding this factor (Table 12).

Table 12. Supportive Studies of Customer Satisfaction.

As shown in Table 12, this study is in agreement with studies of U.K, U.S.A, Singapore, Malaysia, India, Australia, and China. In construction, quality consciously focuses all parties to the common goal of systematically identifying and meeting the customers' requirements as the superordinate goal where customers' requirements are increasingly complex and expectations uncertain. However, a large proportion of migrant labor may exacerbate these difficulties, and the application of quality can become difficult (Pheng and Wei, 1996). Customer satisfaction is achieved by ensuring that drawings and specifications are communicated to the rest of the parties, should there be any changes. The parties affected by the changes can then promptly adjust their information and help to reduce the amount of time wasted.

Construction specific factors were ranked as the fifth highest factor from the perspective of contractors and the fourth highest factor of architects, and the third highest factor on average. This shows that most of the contractors and architects know the value of construction specific factors and use it to improve the level of quality. This really implies the awareness of specific factors such as the construction industry officials, associations, and governments. This is in agreement with findings of (Arditi and Gunaydin, 1997; Abdel- Razek, 1998; Lau and Tang, 2009) as shown in Table 13.

Table 13. Supportive Studies of Construction Specific Factors.

Companies that pursue construction specific factor will be able to reduce total quality cost and improve product quality in the long run (Arditi and Gunaydin, 1997; Wanberg et al., 2013). Contractors and architects should investigate the source of the specified requirements, namely, the current standards and codes of practice as well as the specifications, since these may be ambiguous in certain aspects, and so difficult to conform to. Additionally, the consensus is that, in Jordan, contact with the government is basically done to obtain certain permits. This is usually done at both the early and the late stages of the project which indicates awareness of the importance of construction specific factors. In the case of this survey, it can be clearly shown that there is a significant difference between architects and contractors, where architects give higher concern regarding this factor.

Therefore, contractors should pay more attention to construction specific factors in order to enhance quality practices, as stated in the study conducted in Singapore (Pheng and Wei, 1996). The contractors, nevertheless, pay more attention to completing the works on schedule and controlling the costs within budget than to achieving quality in construction. One reason for this might be that the contractors cannot plan and control the works; they lack the skills to interpret the design and cannot provide the end products on site in accordance with the design and specifications. Another reason is that the designers do not consider the "build ability" problems in design. Designers are sometimes unaware of the difficulties contractors experience on site. Consequently, contractors do not realize that it is not the quality that costs but rather the non-conformance to quality that is expensive.

4.4 The Lowest Three Factors

The lowest three factors in ascending order are resources, continuous improvement, and strategic management. *Resources* are the least important factor affecting quality in the Jordanian housing sector. It is viewed as the least important from the perspective of contractors. This factor also ranked as ninth of those important factors from the view point of architects. Moreover, there is no significant difference according to the mean of the overall average of the respondents. The supported studies are summarized in Table 14.

Table 14. Supportive Studies of Resources**.**

There is disagreement in our research with the study of Hellard (1991), where he stated that managers must organize their resources of men, materials, machines, methods, and money within the framework of the law on one hand, and within the established customs and practices on the other – to achieve a balance and harmony through which the stated objective of the client's building can be economically achieved. We agree with Both Metri (2005) and Abed-Razek (1998), they showed little relative importance of the resources factor to improve construction quality and concluded that it is a well-known fact that resources are mainly a part of top management commitment and partially of other factors.

The contractors and architects appeared to agree statistically on the relative importance and ranking of the *continuous improvement*. These results are in agreement with the outcomes of the research conducted in India by Metri (2005) which revealed that a continuous improvement (benchmarking and statistical process control) are presented in very few frameworks in literature review, and they are the techniques used normally for process improvement. In the real sense, they are not considered as important factors; they are part of the routine process management. Hellard (1991) argued that use of statistical methods has relatively very little effect on the quality of construction projects and that individual construction projects are unique and can eliminate the potential for any kind of statistical process control. However, there is a clear disagreement with studies summarized in Table 15.

Table 15. Supportive Studies of Continuous Improvement

As shown in Table 15, statistical techniques and benchmarking are the least applied tools in some countries, but widely used in specific countries where quality was previously developed and considered as one of the most important factors, such as U.S.A (e.g. Arditi and Gunaydin, 1997; Haupt and Whiteman, 2004) , Hong Kong (e.g. Lai and Cheng, 2003; Lam et al., 2008) ,U.K (e.g. Oakland and Aldrdgie, 1995), Malaysia (e.g. Abdul - Alazi , 2002), and Singapore (e.g. Pheng and Wei, 1996; Pheng and Teo, 2004).

The previous work emphasized that continuous improvement will yield excellence in design and create teamwork. This quality factor is still not applied in Jordan in an integrated way and a little awareness regarding this new approach. The previous studies stressed the importance of quality improvement and measurement of product improvement. For example, statistical methods (e.g. histograms, cause and effect diagrams, check sheets, Pareto diagrams, graphs, control charts, and scatter diagrams) provide problem-solving tools to the quality process (Arditi and Gunaydin, 1997). Benchmarking is also researching and observing best competitive practices of direct competitors and the high performing companies for improvement.

Strategic Management was ranked as the tenth important factor according to contractors and eleventh lowest according to architects and twelfths lowest on averages. This result is in disagreement with findings summarized in Table 16**.** Moreover, there is significant difference between the contractors and architects.

Table 16. Supportive Studies of Strategic Management

Table 16 illustrates that construction companies in Singapore and Hong Kong regarding public housing were in fact leading other countries in the area of strategic planning; perhaps other countries can use the public sector as a benchmark. Strategic planning is essential for integrating quality requirements and target improvements in the whole process and to examine how the company develops and deploy strategic objectives and action plans, including short and long term planning and analyzing collected data. Some immediate measures should be taken to increase awareness regarding new management approaches for better quality strategies and policies.

4.5 Fishbone Diagram

The findings related to the quality factors are generated from the literature review and the questionnaire analysis. The factors are analyzed from the view point of the contractors and architects combined to gain a full-understanding of quality factors' importance in the Jordanian housing sector. The Fishbone diagram illustrates the importance of these factors to the quality concept as seen in Figure 1.

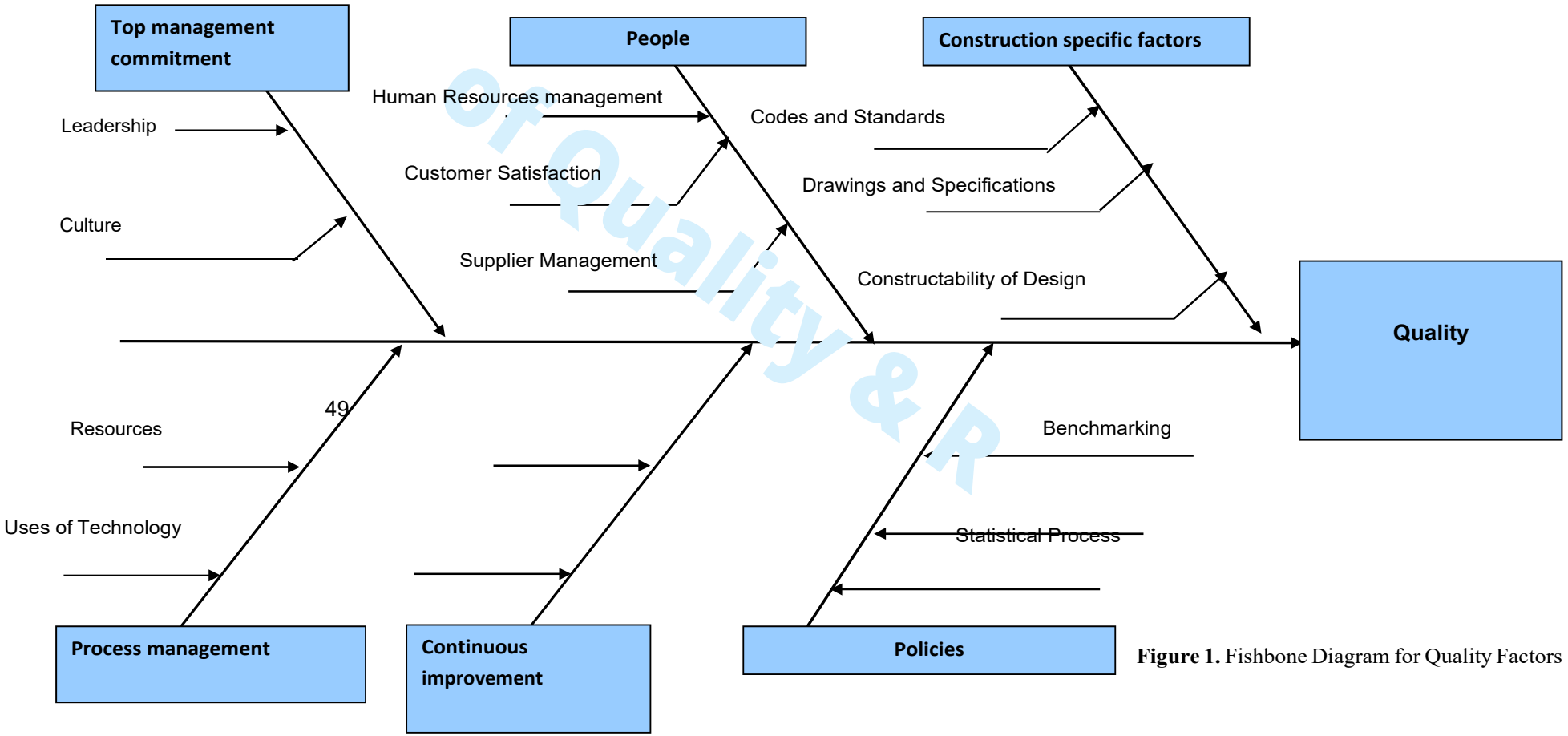

Figure 1. Fishbone Diagram for Quality Factors

Strategy

Planning

Quality

Management

System

eliability

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Mana

5. Conclusion and Contributions

In this research, the concept of quality can be defined from the viewpoints of contractors and architects combined as: *how closely the project conforms to its requirements and meeting the requirements of the designer, constructor, and regulatory agencies as well as the owner*. This research contributes theoretically in providing a conceptual framework for quality factors in the quality field. Figure 2 illustrates the 13 factors showing the highest and lowest quality factors with business involving housing sector.

Figure 2. The Proposed Framework for Quality Factors in the Housing Sector

Architects and contractors combined ranked the highest and lowest significant factors affecting quality with no significant difference. The research findings identify implications for managers in construction industry (e.g. contractors, architects, and owners) and policy makers (e.g. Jordanian government). Future strategies and potential developments should be based on the present findings for developing quality in the Jordanian housing sector. For example, team-working with the client as part of the team in a genuine partnership is required to achieve project objectives. A use of non-hierarchical organizational structure is to support quality improvement and facilitate information flows for better project environment. There is a need to evaluate customer satisfaction with performance objectives. Construction specific factors of standards, drawing, and specifications must be established before detailing in the form of contract and before performing the tasks. Construction projects should prepare quality plans for all levels of work and

schedule especially during the pre-construction phase. Managers should learn from the experience of the top performers in the service and public utilities sectors. They need benchmarking of direct competitors and upgrade the original quality standards adopted at the beginning by using statistical analysis. Contractors should organize their resources of men, materials, machines, methods, and money in any construction project. The construction businesses also do have to catch up with their own weak factors in order to maintain a balanced and integrated quality approach. Construction organizations should realize that results cannot be gained overnight and that an organization needs time to adapt, change, and learn.

The present research has some limitations. The survey findings are only based on the viewpoints of contractors and architects. The study findings would be improved if the research used more respondent types such as owners of construction projects and policy makers. Future research should expand the research to other types of projects such as public projects. Carrying out a study depending on a larger number of companies and focusing on all companies sizes (small, medium, and large) would provide better results. The key findings might differ if a future empirical study considered small companies and multi-level of respondents. Moreover, this study used a single-well informed respondent from each sampled company, as the success of quality management implementation demands an organization wide focus. It is important in future research to use other methodologies such as case studies (single or multi-case types). In the meantime, although the data collection is very costly and requires personal meetings and having the right space and time, a future longitudinal study to examine the relative importance of quality factors would end with more integrated results. In order to generalize the proposed framework to the construction industry in Jordan and other industries and countries, further empirical research will need to involve data collection from diverse industries and countries. Nonetheless, Jordan's experiences in quality in housing sector will be applicable to other Middle East countries, where comparison studies could provide support for the conceptual framework of quality factors. A study for quality factors in different cultures and social contexts will not only help to generalize the findings but also contribute to determining how differences in cultural and social context influence quality.

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Table 1. Analysis of Quality Frameworks

Author	Country	Quality Factors
Hellard (1991)	U. K	Team Building ; Planning and Documentation ; Leadership; Customer Involvement; Education; Culture (Attitude Change); Resources
Oakland and Aldrdgie (1995)	U.K	Process; Customer-Supplier Quality Chains; Quality Systems; Tools And Techniques; Teamwork; Culture; Commitment To Quality at all Levels; Communication
Pheng and Wei (1996)	Singapore	Customer Satisfaction; Construction Specific Factors; ISO 9000; Subcontractors Involvement; Continuous Improvement
Arditi and Gunaydin (1997)	Hong Kong	Team work; statistical methods; customer service; supplier involvement; cost of quality; training; management commitment leadership; statistical methods; construction specific factors
Abdel Razek (1998)	Egypt	Design and Planning During the Pre Construction Phase; Quality Control and Assurance System; Improving the Financial Level and Standards of Living Of Employees; Accuracy of Estimating and Tendering; Proper Classification of Contractors, Consultants and Construction Projects; Raining for Contractors, Owners and Consultants; Encouraging the Accreditation ISO 9000; Maintenance Systems During and after Construction; Utilization of Resources; More Specialization in Construction Work; Innovation for Simpler and more Accurate Construction Methods.
Abdul Alazi (2002)	Malaysia	Market in Concept :Client Satisfactio; Turn PDCA Cycle (Control Cycle); Thinking based on Data and Facts; Participation by all Members
Lai and Cheng (2003)	Hong Kong	People and Customer Management; Supplier Partnerships; Communication of Improvement; Customer Satisfaction; External Interface Management; Strategic Quality Management; Teamwork Structures for Improvement; Operational Quality Planning; Quality Improvement Measurement Systems; Corporate Quality Culture
Pheng and Teo (2004)	Singapore	Top Management Commitment; Customer Involvement Satisfaction; Employee Involvement and Empowerment; Customer–Supplier Relationships; Process Improvement
Metri (2005)	India	Top Management Commitment; Quality Culture; Strategic Quality Management; Design Quality Management; Process Management; Supplier Quality Management; Education and Training; Empowerment and Involvement; Information and Analysis; Customer Satisfaction; Resources
Lau and Tang (2009)	Hong Kong	Responding and Resolving Clients Complaints; Continual Review of Construction Safety; Work Environment; Construction Quality; Culture; Commitment of Every One

Table 2. A List of Quality Factors and Literature Support

Factor	Definition
Quality	Meeting the requirements of the designer, constructor and regulatory agencies as well as the owner (McGoerge and Plamer, 2000; Luu et al., 2008).
Customer Satisfaction	Determine customer requirements and success in meeting them towards loyalty, and also to respond quickly with new ideas and technology that satisfied or exceed customer satisfaction (Metri, 2005; Arditi and Gunaydin, 1997).
Human Resources Management	The success of efforts to develop and realize the full potential of the workforce for quality (Metri, 2005).
Process Management	The effectiveness of processes for assuring the quality of all operations, adding value ,raising productivity and integrates production and delivery requirements and manages the performance as expected, without breakdowns and shortage (Pheng and Teo, 2004; Lam et al., 2008).
Leadership	The executives success in creating and sustaining a quality culture and managing people (Hellard, 1991; Metri, 2005; Lam et al., 2008).
Top Management Commitment	Long term visibility and support by top managers to the quality and continuous improvement through actual action (Pheng and Teo, 2004; Lam et al., 2008)
Uses of Technology	The adoption of new technology such as computer-aided drafting and design, robotics, and automation (Arditi and Gunaydin, 1997).
Supplier Management	The cooperation with suppliers, providing inputs that conform to customers end-use requirements. It includes fewer dependable subcontractors, reliance on suppliers process control, purchasing policy, emphasizing quality rather than price (Pheng and Teo, 2004; Lam et al., 2008).
Strategic Management	The effectiveness of integrating quality requirements into business plans, put into practice by the inclusion of quality objectives in the strategic planning process and through strategic planning frameworks (Metri, 2005; Arditi and Gunaydin, 1997).
Continuous Improvement	The effectiveness of information collection and analysis for quality improvement and planning consist of evaluation for various policies and strategies, quality audit, analysis of quality costs, and performance evaluation (Arditi and Gunaydin ,1997).
Construction Specific Factors	Characteristics that distinguish construction such as standards, specifications, and constructability of design (Arditi and Gunaydin, 1997).
Culture	Use of information for improvement, authority equal to responsibility, job security, climate of fairness, teamwork, collaboration, learning and involvement, ownership, and development form an organizational culture (Metri,2005).
Quality Management Systems	Systems of support and mechanism for the effective conduct of quality related activities (Metri,2005 ;Arditi and Gunaydin ,1997).
Resources	Men, materials, machines, methods and money - monitoring them within the framework of the law on the one hand, and within the established customs and practices on the other (Hellard, 1991).

Table 3. Classes of Contractors

Class	Capital (JOD)	Equipment price (JOD)	Maximum Total Value of project (JOD)	Technical Person	Number of Companies
A	500000	250000	---	Engineer	76
B	300000	150000	5 Million	Engineer	66
C	150000	50000	2 Million	Engineer	155
D	50000	30000	750000	Civil Engineer	115
E	20000	10000	250000	Civil or Architect Engineer	128
F	10000	5000	100000	Observer	424

Table 4. Ranking of Factors from the View Point of Contractors

Factors	Contractors		
	Mean	S.D	Rank
Human Resource Management	4.44	0.573	1
Customer Satisfaction	4.31	0.605	2
Top Management Commitment	4.26	0.700	3
Supplier Management	4.16	0.788	4
Construction Specific Factors	4.10	0.429	5
Leadership	4.07	0.634	6
Quality Management Systems	3.96	0.860	7
Uses of Technology	3.91	0.908	8
Process Management	3.89	0.497	9
Strategic Management	3.85	0.488	10
Culture	3.80	0.621	11
Continuous Improvement	3.62	0.638	12
Resources	3.58	0.875	13

Table 5. Ranking of Factors from the View Point of Architects

Factors	Architects		
	Mean	S.D	Rank
Human Resource Management	4.42	0.583	1
Customer Satisfaction	4.33	0.513	2
Uses of Technology	3.88	0.784	3
Construction Specific Factors	3.88	0.722	4
Culture	3.73	0.866	5
Supplier Management	3.73	0.910	5
Quality Management Systems	3.71	1.016	6
Top Management Commitment	3.69	0.781	7
Leadership	3.54	0.851	8
Process Management	3.54	1.093	8
Resources	3.50	0.828	9
Continuous Improvement	3.30	0.788	10
Strategic Management	3.25	1.235	11

Table 6. Ranking of Factors from the View Point of Contractors and Architects Combined

Factors	Overall		
	Mean	S.D	Rank
Human Resource Management	4.43	0.577	1
Customer Satisfaction	4.32	0.559	2
Construction Specific Factors	3.99	0.575	3
Top Management commitment	3.97	0.740	4
Supplier Management	3.95	0.848	5
Uses of Technology	3.9	0.846	6
Quality management Systems	3.84	0.938	7
Leadership	3.81	0.742	8
Culture	3.77	0.752	9
Process Management	3.71	0.795	10
Strategic Management	3.55	0.861	11
Continuous Improvement	3.46	0.713	12
Resources	3.45	0.852	13

Table 7. Homogeneity of Variance for the Three Highest Factors Ranked according to Contractors and Architects Combined

Quality Factors	P value at α =0.05	Variance assumed	Sig (2-tailed)
Human Resources Management	0.881	Equal	0.86
Customer Satisfaction	0.206	Equal	0.870
Construction Specific Factors	0.014	Not Equal	0.06

Table 8. Homogeneity of Variance for the Three Lowest Factors Ranked according to Contractors and Architects combined

Quality Factors	P value at α =0.05	Variance assumed	Sig (2-tailed)
Strategic Management	0.0	Not Equal	0.002
Continuous Improvement	0.627	Equal	0.022
Resources	0.760	Equal	0.621

Table 9. *t*-test for the Most Common Highest Factors

Quality Factors	Sig (2-tailed)	p-value one- tail(p\2)	Statistical hypothesis conclusion
Human Resources Management	0.86	0.43	Equal in opinion, no sig.
Customer Satisfaction	0.870	0.435	Equal in opinion, no sig.
Construction Specific Factors	0.06	0.03	Differ in opinion, sig.

Table 10. *t*-test for the Most Common Lowest Factors

Quality Factors	Sig (2-tailed)	p-value one- tail(p\2)	Statistical hypothesis conclusion
Strategic Management	0.002	0.001	Differ in opinion, sig
Continuous Improvement	0.022	0.011	Differ in opinion, sig
Resources	0.621	0.3105	Equal in opinion, no sig.

Table.11. Supportive Studies of Human Resource Management

Factor	Country	Author	Respondent
Human Resource management	United States	Haupt and Whiteman (2004)	Contractors
		Arditi and Gunaydin (1997)	Construction industry
	Singapore	Pheng and Hong (2005)	Project manager in construction industry
		Pheng and Teo (2004)	Construction contractors
	Hong Kong	Lam et al. (2008)	Large-sized public building contractors
		Chan et al. (2006)	Public housing project manager
		Lai and Cheng (2003)	Quality manager in public housing
	U.K	Oakland and Aldrdgie (1995)	Construction industry (consultant)
		Hellard (1991)	Construction industry
	Egypt	Abdel- Razek (1998)	Contractor and consultant
	India	Metri (2005)	construction industry
	Australia	Sharmma and Gudanne (2002)	CEO of construction industr
	Malaysia	Abdul -Alazi (2002)	Contractor

Table 12. Supportive Studies of Customer Satisfaction

Factor	Country	Author	Respondents
Customer Satisfaction	United States	Haupt and Whiteman (2004)	Contractors
		Arditi and Gunaydin (1997)	Construction industry
	Singapore	Pheng and Hong (2005)	Project manager in construction industry
		Pheng and Teo (2004)	Construction contractors
		Pheng and Wei (1996)	Construction industry
	Hong Kong	Lam et al. (2008)	Large-sized public building contractors
		Lau and Tang (2009)	Contractors
		Lai and Cheng (2003)	Quality manager in public housing
	U.K	Hellard (1991)	Construction industry
	Malaysia	Abdul -Alazi (2002)	Contractors
	India	Metri (2005)	Literature review
	Australia	Sharma and Gudanne (2002)	CEO of construction industry

Table 13. Supportive Studies of Construction Specific Factors

Factor	Country	Author	Respondents
Construction Specific Factors	United States	Arditi and Gunaydin (1997)	Construction industry
	Hong Kong	Lau and Tang (2009)	Contractor
	Egypt	Abedl- Razek(1998)	Contractors
	Singapore	Pheng and Wei (1996)	Construction industry

Table 14. Supportive Studies of Resources

Factor	Country	Author	Respondents
Resources	Egypt	Abdel- Razek (1998)	Contractors and consultants
	India	Metri (2005)	Construction industry
	U.K	Hellard (1991)	Construction industry

Table 15. Supportive Studies of Continuous Improvement

Factor	Country	Author	Respondents
Continuous Improvement	United States	Haupt and Whiteman (2004)	Contractors
		Arditi and Gunaydin (1997)	Construction industry
		Pheng and Teo (2004)	Construction contractors
	Hong Kong	Lam et al. (2008)	Large-sized public building contractors
		Lai and Cheng (2003)	Quality manager in public housing
	U.K	Oakland and Aldrdgie (1995)	Construction industry (consultant)
	Malaysia	Abdul -Alazi (2002))	Contractor and consultant
	Singapore	Pheng and Wei (1996)	Construction projects

Table 16. Supportive Studies of Strategic Management

Factor	Country	Author	Respondents
Strategic Management	Singapore	Pheng and Hong (2005)	Project manager in construction industry
	Hong Kong	Lam et al. (2008)	Large-sized public building contractors
		Lai and Cheng (2003)	Quality manager in public housing