Investigating the Structural Hierarchy of Quality Capabilities in Construction Organizations

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Abstract

The purpose of this study is to investigate the relations among those factors affecting quality performance in construction organizations. On the basis of the existing literature and some new argumentations, derived from in-depth interviews with quality experts, measurement and structural models were empirically analyzed. Through an online survey for qualified quality experts, 917 valid questionnaires were collected. Measurements for validity and reliability were performed. Multivariate statistical methods (EFA, CFA, and SEM) were utilized and the hypotheses, tested. The results indicate that quality performance could be directly affected only by primary quality management activities, such as quality control and quality assurance. The capabilities of human resources could indirectly affect the performance of quality through a sequence of hierarchy: from the effects on those of a set of supportive quality management activities that affect those of primary quality management activities.

Keywords: quality performance; human resource; structural equation modeling; confirmatory factor analysis; construction industry

1. Introduction

1.1 Background and Goals of the Research

Construction organizations are notoriously difficult to manage due to the nature of the construction industry. Factors such as a fluctuating workload, prototype projects, a mobile and largely subcontract workforce, regulatory bodies, and government policy changes pose certain problems for the managers of building firms trying to apply sound management principles (Newcombe, etc., 1993). The realization that quality is an effective strategic weapon in a competitive marketplace has forced firms to make an effort to attain acceptable levels of quality in the construction industry. However, substantial amounts of time, money, and resources—both human and material—are wasted because of inefficient or nonexistent quality management procedures (Arditi & Gunaydin, 1999). The Business Roundtable study of cost effectiveness in the construction industry concluded that one of the primary causes for the decline in construction productivity directly or indirectly involved poor management practices (Business Roundtable "More," 1983). From this background, a series of researches have been conducted on the significant effects of economic and technological backgrounds in determining ways of improving construction quality (Abdel-razek, 1998). Tan and Lu (1995) proposed a quality system based completely on quality management concepts. The eight major criteria of quality developed cover the quality of input and output processes. The relative importance of each criterion was evaluated using the analytic hierarchy process (AHP) methodology (Tan & Lu, 1995). Through a series of researches, Arditi and Gunaydin (1996, 1997, 1998) identified factors that affect process quality in the lifecycle of building projects. A Delphi process was implemented and a questionnaire survey conducted in order to investigate the factors that affect the process quality of a building project's lifecycle (design, construction, and operation). Tang et al. (2003) identified a comprehensive list of factors (and their indicators) for measuring client satisfaction in the context of engineering consulting services. Using multiple linear regression, a priority list that identifies the most and least satisfactory services that clients receive from engineering consulting firms was established. Ling (2005) identified variables that significantly affect the quality scores of DBB and DB projects and constructed models to predict these quality scores. Most of the results appeared to indicate that human factors in quality management,
including effective leadership and development and management of human resources, are very important for achieving high quality in the construction process (Arditi & Gunaydin 1997, 1998, 1999). Based on these backgrounds, this study starts by presenting the research question - how can the capabilities of human resources and management activities affect quality performance in a construction organization? The objective of this study is to analyze the direct and indirect relationships among the quality capabilities in construction organizations.

1.1 Scope and Contents of the Study

To achieve the research objective, the following steps were performed. First, on the basis of the existing literature, the quality capabilities affecting quality performance were derived. Second, new argumentations on the measurement and structural models were empirically analyzed through in-depth interviews with quality experts. Third, in order to collect data, an online survey was conducted for quality experts. Finally, their purification and measurement for validity and reliability were performed. Structural equation modeling (SEM) was selected as the analytical tool to measure the effect of an organization’s quality capabilities on quality performance. Analytical procedures were conducted using statistics packages SPSS and AMOS. In this study, the definition of construction organizations that is adopted is that of the construction contractor, mainly concerned with the production rather than the design of buildings and related structures.

2. Structural Equation Modeling (SEM)

Structural equation modeling (SEM) has been a popular data analysis method in social science research areas such as sociology, psychology, and education. Although the precise origin of SEM is obscure, it is probably derived from path analysis introduced by Wright (1934). SEM is a powerful technique for the analysis of causal relationships between endogenous variables, and between endogenous and exogenous variables. Hence, in this study, a structural equation modeling method can be employed to estimate the causal relationships among quality capabilities on quality performance.

To analyze data, the SEM approach uses a series of statistical methodologies. This series includes path analysis, confirmatory factor analysis (CFA), structural regression models, and late change models. The SEM also comprises two components—a measurement model and a structural model. The measurement model assesses latent (unobserved) variables, such as linear functions of indicators (observed variables).

The structural model reveals the direction and strengths of the relationships of latent variables. A typical structural equations model is defined as follows.

\[ \eta = \mathbf{B}\eta + \Gamma \xi + \zeta \]

where \( \eta \) represents the endogenous constructs in a model. The \( \eta \) appears on both sides of the equation, because endogenous constructs can be dependent on one another (i.e., one endogenous construct can be a predictor of another). The \( \mathbf{B} \) represents the parameter coefficients that link some endogenous constructs with others. The \( \Gamma \) is a matrix consisting of as many rows and columns as there are endogenous constructs. The \( \mathbf{B} \) is the corresponding matrix of parameter coefficients linking the exogenous constructs (\( \xi \)) with the endogenous constructs (\( \eta \)). Finally, \( \zeta \) represents the error in the prediction of \( \eta \).

As shown in Fig. 1., path analysis can also be conducted with variables: A and B affect C, C also affects D; A affects D only indirectly; B affects D directly, and also affects C indirectly through C; A and B are correlated.

Once all the correlations are defined in terms of paths, the values of the observed correlations can be substituted and the equations solved for each separate path. The paths then represent either the causal relationships between constructs (similar to a regression coefficient) or correlational estimates. The standardized coefficients in an SEM can possess more reliable estimates of how an exogenous variable affects an endogenous one than what is produced with multiple regression analysis.

Table 1. shows standardized coefficients for the direct, indirect, and total effects (combined effects) of variables on each other. As shown in Table 1., the effect of A on C (0.3) is larger than that of B on C (0.2). However, the total effect of A on D (0.12) is smaller than that of B on D (0.18).

| Path | Indirect effect (a) | Direct effect (b) | Total effect (c) = (a) + (b) |
|------|---------------------|-------------------|-----------------------------|
| A→D  | 0                   | 0.12              | 0.12                        |
| B→D  | 0.08                | 0.01              | 0.09                        |

3. Research Model

3.1 Model and Hypotheses

On the basis of the existing literature and some new argumentations derived from in-depth interviews...
with quality experts, the measurement and structural models were empirically analyzed. The schematic model of this study is shown in Fig.2. The structural hierarchy of quality capabilities was classified using aspects of human resources and quality processes. There are many kinds of human resources depending on their level and work areas within an organization. In construction organizations, the typical human resources are classified by top managers, project managers, and engineers. With regard to the aspects of quality processes, the quality management processes are classified into a sequence of primary activities directly managing quality, such as quality control and assurance. These activities are supported by a sequence of management activities, such as human resource management, head-office support on the site, the quality management information system (QMIS), and site administration.

Based on these hierarchical relations, hypotheses were presented as follows: The capabilities of human resources could directly affect quality performance. They also share indirect relations with quality performance that affects quality management activities. The capabilities of quality management activities that support primary quality management could also directly as well as indirectly affect quality performance. The primary quality management activities could directly as well as indirectly affect quality performance through causal relations affected by the capabilities of human resources and those of supportive quality management activities.

![Fig.2. Schematic Model](Image)

### 3.2 The Operational Definition and Measurement

#### (1) Capabilities of Human Resources

**Top managers (Top)**

Top managers create an organization's goals, overall strategy, and operating policy. Organizational commitment is achieved as a result of top management commitment. Leiter and Maslach (2002) considered commitment of senior executives as a (more) important factor of TQM, while their doubts are the greatest enemy. Commitment of top management is also highlighted as a critical factor in several empirical studies. In this study, based on Arditi and Gunaydin (1999) and Tang et al. (2003), five variables were identified for measuring a top manager's competence as follows: (1) customer focus, (2) business process improvement, (3) management commitment for product quality, (4) respect for people, and (5) strategic integration.

**Project managers (PMr)**

Project managers are responsible for the planning, execution, and closing of any project. Key project management responsibilities include creating clear and attainable project objectives, meeting project requirements, and managing the triple constraint for projects. Tang et al. (2003) focused on a project manager's leadership as a factor in communicating with, coordinating, integrating, and motivating team members. Andi and Minato (2003) indicated that project managers need to be active in solving the problems arising during a project. For successfully executing a project, they are also required to have abundant experience and technical knowledge in related fields (Tang et al., 2003; Ling, 2005). Based on previous studies, five variables were derived to measure the capabilities of project managers: (1) communication skills, (2) problem solving, (3) experience with similar projects, (4) experience with quality-related works, and (5) professional expertise.

**Engineers (Engr)**

In this study, engineers are defined as technical staff working on the site or in the head office. On the basis of existing researches (Andi and Minato, 2003; Tang et al., 2003; Ling, 2005), five variables were identified to measure the capabilities of engineers: (1) technical expertise, (2) communication skills, (3) problem-solving skills, (4) experience with similar projects, and (5) experience with quality work.

#### (2) Capabilities of Quality Management Supporting Activities

**Human resource management (HR_A)**

As the demand for construction professionals increases, their education and training needs in basic quality concepts become more apparent. With regard to human resource management, 5 variables were derived based on the research results of Abdel-razek (1998) and Arditi and Gunaydin (1999): (1) training, (2) employee opportunity and motivation, (3) performance evaluation, (4) job satisfaction and financial reward, and (5) employee loyalty.

**Head-office supporting management on the site (HO_A)**

Most construction organizations have made efforts to support the site. The variables for measuring these activities were derived with reference to Pheng and Tan (1996) and Ling (2005): (1) management staff supplement, (2) stable input of the engineer workforce, (3) just-in-time material purchase support, (4) equipment support, and (5) safety concern.

**Quality management information system (QMIS)**

To more efficiently apply the quality standard, the need for managing quality information has been emphasized (Tang et al., 2003) and QMIS has been
developed (Chin et al., 2004). The capabilities of QMIS were measured as follows: (1) system management and operation, (2) proficient information communication, (3) error minimization in work processing, (4) qualitative utilization, and (5) quantitative utilization.

**Site Administration (S_A)**

Effective site administration could contribute toward improving quality performance (Arditi and Gunaydin, 1999; Tang et al., 2003). On the basis of previous researches and expert interviews, the variables for measuring the capabilities of site administration were as follows: (1) team efforts, (2) work coordination, (3) schedule planning and progress monitoring, (4) feedback system, and (5) responsibility and authority delegation.

(3) **Capabilities of Primary Quality Management Activities**

**Quality assurance (QA)**

Quality assurance (QA) is a program covering activities necessary to bring quality to the work in order to meet project requirements. QA involves establishing project-related policies, procedures, standards, training, guidelines, and systems necessary to improve quality (Ferguson and Clayton, 1988). In this study, to measure QA, the following variables were derived through an analysis of previous researches (Arditi and Gunaydin, 1999; Ling, 2005): (1) QA objectives and standard, (2) preventative activities, (3) data collection, (4) use of the collected data, (5) measurement of quality performance, (6) plan for continuous improvement in quality performance, and (7) fulfillment of quality experts.

**Quality Control (QC)**

Quality control (QC) is a specific implementation of the QA program and related activities. Effective quality control reduces the possibility of changes, mistakes, and omissions, which in turn results in fewer conflicts and disputes (Iami, 1986). The variables of QC were also derived through an analysis of the previous researches (Arditi and Gunaydin, 1999; Ling, 2005): (1) setting control items, (2) baseline for corrective action, (3) measurement methods, (4) comparison between the actual results and quality standards, (5) correction of nonconforming processes and material, (6) device monitoring and control, and (7) detailed documentation for all work processes.

(4) **Quality Performance (QP)**

In this study, quality performance is measured using 5 variables: (1) frequency of defect occurrence, (2) size of defect, (4) failure cost, and (5) material performance maintenance.

The list of items as shown in Table 2. was developed as a questionnaire after being purified through in-depth interviews with quality experts. To measure the constructs, the five-point Likert-scale was utilized, which was anchored with responses to the statements ranging from 5 for very important, 4 for fairly important, 3 for neutral, 2 for unimportant, and 1 for very unimportant.

4. **Analysis and Research Results**

4.1 **Data collection**

The online survey was conducted from June 19–July 6, 2006. An E-mail invitation containing a link to the web survey was sent to the members of the Kiscon (Korea Construction Infonet). A total of 4500 members were invited to participate in the study. Of the 4500 invitations, 917 valid responses were received. Among the valid respondents, 64% had more than 4 years work experience (Table 3.). As shown in Table 4., the respondents' positions comprised top managers (11%), project managers (35.4%), site engineers (25.2%), and others (head office managers, etc., 28%).

| Table 3. Respondent's Working Experience |
|------------------------------------------|
| Years | Questionnaires received (number) | Questionnaires received (percent) |
|<4 | 325 | 35 |
|4–7 | 277 | 30 |
|8–11 | 188 | 21 |
|12–15 | 66 | 7 |
|15–19 | 39 | 4 |
|>20 | 22 | 2 |
|Total | 917 | 100 |

| Table 4. Respondent's Position |
|--------------------------------|
| Position | Questionnaires received (number) | Questionnaires received (percent) |
|Top manager | 101 | 11 |
|Project | 325 | 35.4 |
|Manager | 231 | 25.2 |
|Engineer | 260 | 28.4 |
|Other | 917 | 100 |

4.2 **Data analysis tools**

In this study, several steps were taken to assess the reliability and validity of the construct scales. A two-step covariance structure analysis approach described by Anderson and Gerbing (1982) was used to analyze the data. For the measurement of the constructs, empirically observable indicators were utilized that reflect the characteristics of the latent variables. They create the measurement model. On the basis of empirical data, the measurement model is then tested for validity and reliability in order to become part of the structural model. For the assessment of reliability and validity, exploratory factor analysis (EFA) and the Cronbach alpha coefficient are used in this study. After validating the measures, a test of the hypothesized causal relationships among variables is carried out through multiple regression analysis.

The results obtained are sometimes used as inputs for path analysis, an analytic method involving the decomposition of linear relationships (direct and indirect) among a set of variables. Confirmatory factor analysis (CFA) is first used to validate the factor structure that emerged in the previous
Table 2. Summary of Constructs and Measurement Variables

| Construct                        | Measurement Variable                                           | Descriptions                                                                 | References                      |
|----------------------------------|----------------------------------------------------------------|-------------------------------------------------------------------------------|---------------------------------|
| Human Resources (HR)             | Top customer focus                                             | X1 Top managers need to take an active interest in clients’ requirements and  | Arditi & Gunaydin (1999);       |
|                                  | business process improvement                                   | conditions.                                                                   | Tang et al. (2003)              |
|                                  | management commitment                                          | X3 Top managers need to take an interest in product quality and make constant |                                               |
|                                  | respect for people                                             | efforts to improve quality.                                                   |                                 |
| PMr                              | strategic integration                                          | X5 Top managers need to reflect on and integrate the various elements that    | Tan and Lu (1995);              |
|                                  | communication skills                                           | can aid in improving the quality in corporate strategies.                    | Tang et al. (2003);             |
|                                  | problem solving                                               | X7 Project managers need to be active in solving problems that may arise      | Andh Minato (2003);             |
|                                  | experience with projects                                       | during a project.                                                             | Ling (2005)                     |
|                                  | quality-related works                                          | X8 Project managers need to have experience with projects of similar size and  |                                 |
|                                  | professional expertise                                         | and kind.                                                                     |                                 |
| Engr                             | technical expertise                                           | X9 Project managers need to acquire abundant experience with quality works.  |                                 |
|                                  | commutation skills                                             | X10 Project managers need to have professional expertise in engineering.     |                                 |
|                                  | problem-solving skills                                         | X11 Engineers need to have abundant technical expertise and use it well.     |                                 |
|                                  | experience with similar projects                               | X12 Engineers need to communicate with team members.                          |                                 |
|                                  | quality-related works                                          | X13 Project managers need to be active in solving the problems that may arise |                                 |
|                                  |                                                                   | during a project.                                                             |                                 |
|                                  |                                                                   | X14 Engineers need to have experience with projects of similar size and kind. |                                 |
|                                  |                                                                   | X15 Engineers need to acquire abundant experience with quality works.        |                                 |
| Supportive Quality Management Activities (S_QM) | training opportunity and motivation performance evaluation | X16 It is important to prepare the educating and training program.            | Abdelrazek (1998);              |
|                                  | job satisfaction and financial reward                          | X17 It is important to provide opportunity and motivation.                    | Arditi and Gunaydin (1999)      |
| HO_S                             | management staff supplement                                    | X18 It is important to properly evaluate business performance.                |                                 |
|                                  | stable input of the engineer workforce                        | X19 It is important to ensure employees’ job satisfaction and provide financial |                                 |
|                                  | just-in-time material purchase support                         | rewards.                                                                     |                                 |
|                                  | equipment support                                              | X20 It is important to ensure employees’ loyalty.                             |                                 |
|                                  | safety concern                                                 | X21 It is important to allocate the right management staff in the appropriate |                                 |
| QMIS                             | system management and operation                                | spot and quickly fill a vacancy.                                             |                                 |
|                                  | proficient information communication                            | X22 It is important to employ a stable engineer workforce.                   | Pheng and Tan (1996);          |
|                                  | error minimization                                             | X23 It is important to have the support of the head office with regard to      | Ling (2005)                     |
|                                  | qualitative utilization                                       | material.                                                                    |                                 |
|                                  | quantitative utilization                                       | X24 It is important to have the support of the head office as regards necessary|                                 |
| S_A                              | efforts to establish teamwork                                   | equipment.                                                                   |                                 |
|                                  | work coordination                                              | X25 It is important to provide safety education and a manual for the same.    |                                 |
|                                  | schedule planning and progress monitoring                      | X26 It is important to properly develop and operate QMIS.                    | Tang et al. (2003);             |
|                                  | feedback system                                                | X27 It is important to proficiently communicate with project team members     | Chin et al. (2004)              |
|                                  | responsibility and authority delegation                        | with appropriate information.                                                |                                 |
| Primary Quality Management Activities (P_QM) | QA objectives and standard preventative activities | X36 It is important to clearly establish the QA objectives and standard.       | Arditi and Gunaydin (1999);     |
|                                  | data collection                                                | X37 It is important to carry out prevention activities rather than post       | Ling (2005)                     |
|                                  | use of the data measurement of quality performance plan for    | treatment on defects.                                                        |                                 |
|                                  | continuous improvement                                        | X38 It is important to collect data for continuous improvement.               |                                 |
|                                  | fulfillment of quality experts                                 | X39 It is important to plan the use of the collected data.                   |                                 |
|                                  | setting control items                                          | X40 It is important to properly measure quality performance.                 |                                 |
|                                  | baseline for corrective action measurement methods             | X41 It is important to establish a plan for continuous improvement in quality |                                 |
|                                  | comparison of the actual results correction of nonconforming   | performance.                                                                 |                                 |
|                                  | processes and material                                         | X42 It is important to fulfill the expectations set by quality experts        |                                 |
| QC                               | device monitoring and control                                 | X43 It is important to set control items.                                     | Arditi and Gunaydin, 1999;      |
|                                  | detailed documentation                                         | X44 It is important to establish the baseline for corrective action.          | Ling, 2005                      |
|                                  |                                                                   | X45 It is important to clearly establish measurement methods.                 |                                 |
|                                  |                                                                   | X46 It is important to compare the actual results based on the quality        |                                 |
|                                  |                                                                   | standards.                                                                   |                                 |
|                                  |                                                                   | X47 It is important to correct the nonconforming processes and materials.    |                                 |
|                                  |                                                                   | X48 It is important to constantly monitor and control the measurement device. |                                 |
|                                  |                                                                   | X49 It is important to document work processes in detail.                    |                                 |
exploratory stage, or that was simply hypothesized to the conceptual level. In this way, the adequacy of the measurement model is examined, after which the reliability and convergent validity of the measurement is determined. After this, the structural model is estimated in order to test the causal relationships among theoretical constructs.

4.3 Checking the reliability and validity

In order to ensure the appropriateness of the groupings of the variables with the respective constructs, as shown in the conceptual model (Fig.1.), the convergent validity and unidimensionality of each construct were verified using EFA. As shown in Table 5., using a maximum likelihood method and direct oblique rotation procedure (factor loadings for each construct are above 0.5), communication skills (X6), setting of control items (X23), loyalty (X34), and safety concern (X39) were eliminated.

The internal consistency of the constructs also has to be checked using Cronbach’s alpha reliability testing. Table 5. details the results obtained from the testing. All the groupings have Cronbach alpha values above 0.7, which suggests that the variables indicate good internal consistency reliability.

Table 5. Measuring Results of EFA and Cronbach’s α

| Capabilities |Constructs | Items | Cronbach’s α |
|--------------|-----------|-------|--------------|
| HR           | Top       | 4     | 0.956        |
| P Mr         | 5         | 0.949 |
| S_QM         | HR M      | 4     | 0.965        |
|              | Engr      | 4     | 0.964        |
|              | QM S      | 4     | 0.969        |
|              | QM S      | 4     | 0.964        |
|              | A S       | 4     | 0.980        |
|              | QA        | 4     | 0.980        |

4.4 Confirmatory Factor Analysis (CFA) Model Fit Indices and measure validation procedure

To achieve goodness-of-fit for the empirical data, both the measurement and structural models should meet the requirements of the selected indices. Following the suggestion of McIntosh (2007), the first overall test of model fit selected was the chi-square test. According to Hair et al. (2006), researchers should report at least one incremental index and one absolute index in addition to the chi-square value; at least one of the indices should be a badness-of-fit index. Following this guideline, this study involves the use of the "chi-square value" along with the corresponding "p-value." Model fit has also been assessed with other fit measures, such as RMR (Root mean squared residual), GFI (Goodness-of-fit), NFI (Normed Fit Index), CFI (Comparative-fit-index), and TLI (Tucker and Lewis index). Table 6. presents a summary of the recommended benchmark for model fit indices adopted in this study.

In addition to the basis of goodness of fit, the adequacy of measurement of constructs has been assessed by some additional indicators that provide more direct information about the convergent validity of the constructs developed. The convergent validity of the CFA results should be supported by item-level reliability, composite-level reliability (i.e., for the set of items used jointly to measure a construct), and average variance extracted (AVE). The value of the reliability indices used have generally been high, achieving or exceeding the recommended level of 0.7. The AVE value should be superior to 50% (Hair et al., 1998).

Convergent validity of Constructs

The goodness-of-fit indices of all latent constructs are listed in Table 7. In this study, the goodness-of-fit results for each of the constructs are judged as "fitness.”

Table 7. Goodness-of-fit Results for each Construct

| Constructs | χ² | Absolute Fit Measures | Incremental Fit Measure |
|-----------|----|-----------------------|-------------------------|
| HR        | 686.68 | 0.000 | 0.024 | 0.898 | 0.96 | 0.956 | 0.964 |
| S_QM      | 755.62 | 0.000 | 0.161 | 0.911 | 0.968 | 0.969 | 0.974 |
| P_QM      | 391.50 | 0.000 | 0.069 | 0.94 | 0.982 | 0.984 | 0.981 |
| QA        | 13.83 | 0.001 | 0.004 | 0.992 | 0.997 | 0.998 | 0.993 |

The values of the convergent validity of the constructs are listed in Table 8. In this study, the composite reliability and AVE for all latent variables are greater than the prerequisites (Table 6.). These results indicate that the measurement items have high reliability and validity.

4.5 SEM Analysis and Hypotheses Testing

In this study, SEM was estimated on the basis of the hypotheses that quality performance shares a relationship with the capabilities of not only primary quality management activities but also human resources, including supportive quality management activities.

However, as shown in Table 9., there is no direct relation between the capabilities of human resource and quality performance. Supportive management activities also have no direct relationship with quality performance. Thus, a revised model was suggested in which quality performance could be directly affected only by primary quality management activities. Fig.3. presents the direct and indirect effects of independent variables on the effectiveness of quality capabilities. The effects of human resources capabilities on quality performance can be calculated by multiplying the effects of human resources
capabilities on quality management capabilities, supportive quality management capabilities on primary quality management capabilities, and primary quality management capabilities on quality performance.

The total effects of human resources, supportive management activities, and primary management activities on the effectiveness of quality performance were estimated to be 0.90(0.95*0.97*0.96), 0.94(0.95*0.97), and 0.96, respectively.

5. Conclusion
Nowadays, most construction organizations have made an effort to attain acceptable levels of quality in order to gain a competitive advantage in today's competitive marketplace. Substantial research has revealed various solutions to achieve high quality in
the construction industry. Most of the results have tried to analyze not only the key factors but also the causal relations connected with increasing the quality performance from various aspects, such as human factors and quality process management. This study suggested the structural hierarchy of the direct and indirect relationships among quality capabilities in construction organizations. The hypotheses were tested using SEM. The results showed that quality performance could be directly affected only by primary quality management activities, such as quality control and quality assurance. There was no direct relationship with the capabilities of human resources. The capabilities of human resources could only indirectly affect the quality performance through a sequence of structure hierarchy. These findings contribute to a better understanding of the nature of the quality capabilities of construction organizations.

References
1) Abdel-Razek, R.H., Factors affecting construction quality in Egypt, Engr., const. & arch. Mgmt., 5(3), 1998.
2) Abdel-Razek, R.H., Quality Improvement in Egypt, J. of conc. & mgmt., 124(5) 1998.
3) Andi, A. and Minato. T., Design documents quality in the Japanese construction industry, Int'l j. of p/j mgmt., 2003.
4) Arditi, D. and Gunaydin H., Total quality management in the construction process, Int'l j. of p/j mgmt. 15(4), 1997.
5) Arditi, D. and Gunaydin H., Factors that affect process quality in the life cycle of building projects, J.of const.eng.&mgmt.124(3), 1998.
6) Arditi, D. and Gunaydin H., Perception of process quality in building process, J. of mgmt. in eng., 15(2), 1999.
7) Asparouhov, T. & Muthén, B. (2009). Exploratory structural equation modeling. Structural Equation Modeling, 16, pp.397-438.
8) Chin, S.Y ., Kim, K.R, and KIM, Y .S., Process-based quality management information system, A. in Conc., 13(2), 2004.
9) Dainty A., Cheng, M., Moore, D., Competency-based model for predicting construction project managers' performance, J. of mgmt. in eng., 12(1), 2005.
10) Hair, J. F., Anderson, R ., Tatham, R. L. and Black, W. C. 1998, Multivariate data analysis 5th Ed., Prentice-Hall, N.J., pp.88-92.
11) Leiter, M. and Maslach, C. Beating burn-out, Human Resource Mgt. I. Digest, 2002, 10(1).
12) Ling, F.Y.Y ., Models for predicting quality of building projects, Eng. Conc. & Arch. Mgt., 12(1), 2005.
13) McIntosh, C. N., Rethinking Fit Assessment in Structural Equation Modeling, Personality and Individual Differences, 2007.
14) Newcombe. R, Langford D., Fellows. R, Construction Management, B.T. Batsford Ltd, 1993.
15) Pheng,Total quality facilities management, Facilities, 14(5/6),1996.
16) Rwelamila, P.D., Quality management in the SADC construction industries, Int'l j. quality & reliability mgt., 12 (8), 1995.
17) Tan, R.R and Lu Y.G., On the quality of construction engineering design projects,Int'l j. quality & reliability mgt. 12(5),1996.
18) Rwelamila, P.D., Quality management in the SADC construction industries, Int'l j. quality & reliability mgt., 12 (8), 1995.
19) Wright, S., The method of path coefficients., A.of Math.Stat.,5, 1934.
20) XIE K., XIAO J., ZHANG D., and WAN X., Human Resource Management Quality, Maturity and Consistency, MASS(EMS/ISM) Conference, 2009.