Construction project team’s competencies influencing contractor business competencies

Kittipos Kawesittisankhun, Jakrapong Pongpeng
Department of Civil Engineering, Faculty of Engineering, King Mongkut’s Institute of Technology Ladkrabang, Bangkok 10520, Thailand.
59601034@kmitl.ac.th

Abstract. Consistent arrangement of contractor business competencies and project team’s competencies helps improve project operation efficiency. Key participants in the project team are project managers, engineers, and technicians. However, a review of existing literature reveals a lack of research on the causal relationship between project teams’ competencies and business competencies. Therefore, this study attempted to identify the relationship through survey contractors’ opinions. The data were analyzed using structural equation modeling (SEM). The results suggest the regression weighs presented in parenthesis that business competencies are influenced by the competencies of a project manager (0.50) and engineer (0.49). The study also discovered the influence of competencies among project teams; that is, technician competencies influence engineer competencies (0.87), and engineer competencies influence project manager competencies (0.55). With the causal relationship between the project team’s competencies and business competencies, contractors can suitably allocate human resources for increasing their project operation efficiency.

1. Introduction

There are many challenges had been raised in the construction industry due to globalization and technology change. This causes the change in construction techniques, economy and social condition. These changes bring the construction environment to become fiercer competition. To survive, contractors need to adapt their business operation efficiency responding to this changing environment. The key participants in the adaptation process are project teams and their competencies. The project team’s key members consist of project managers, engineers, and technicians. The competencies take an important role to develop business effectiveness [1]. Additionally, [2] stated competency is not only concern about performance against an output-based measure but also posses the potential for developing the psychological understanding which is need when selecting and predicting human performance. The construction business also needs to select and predict their business performance. Business competency concerns about demonstrating the characteristic that will develop the business. Business competency can be a major determinant of contractor efficiency. In Turkey, 185 construction companies were surveyed to study business competency aiming to select and predict their business performance [3]. Construction project main works were executed through key project teams: project manager, engineer and technician. As a result, there are possible relationships among these competencies. This result is consistent with [4] (Theory of Hierarchical, Multilevel, Systems), which stated that the performance of higher level (e.g., project manager) is based on the performance of the subordinate level (e.g., engineer). Moreover, [1] mentioned the project team's competencies have impacts on business operation. Thus, this implies a possible relationship between project teams’
competencies and business competencies. Although several researchers have studied indicators of project team and contractor business competencies, the influence between competencies has not been identified. As such, the study aimed to identify such influence.

2. Literature review

2.1. Project manager competencies (PMC)
A project manager is responsible for the overall success of the project. The project tasks are distributed from project manager to different divisions which are controlled by an engineer. Then, each division distributes resources to technicians to supervise workers and their works. This character is consistent throughout most contractor organizations.

2.2. Engineer competencies (EC)
An engineer has a role in planning construction sequences, material selection and design. These activities require resources. Thus, to economically utilize project resources, an engineer needs to correspond with a project manager in order to develop an efficient way to use resources.

2.3. A subsection Technician competencies (TC)
The workforce is supervised by a technician. Construction techniques, methods and regular maintenance of tools and equipment are also within the technician roles. A technician has to work under the instruction of engineers to find an effective way to produce physical result from raw materials with acceptable production rate and standard.

2.4. Business competencies (BC)
Risk is unavoidable in the construction business because its performance depends on their project outcomes. If their projects provide uncertain performance, contractors may face many difficulties. Also, [5] mentioned that construction business competes with rivals through project efficiency. In this study, the literature regarding project team’s competencies and business competencies was used as a basis to determine latent and observed variables, which were shown in Table 1. The conceptual framework for the study was illustrated in Figure 1.

| Latent Variables | Observed variables | Knowledge Base (Theory) |
|------------------|--------------------|-------------------------|
| Project manager competencies (PMC) | knowledge management; strategic implementation; relationship management; decision making; construction management; organization management; risk management | [8, 2, 9, 10] |
| Engineer competencies (EC) | knowledge; technical skill; communication; problem solving; systematic management; resources management Learning; social; adaptability; systematic construction work; self-control | [11, 12] |
| Technician competencies (TC) | | [13, 14] |
| Business competencies (BC) | information management; strategic management; financial management; resource management; relationship management; project management; continuous development | [5, 12, 15] |
| Multi-level relationships | | [4] |
In the previous sections, the research shows the project team’s competencies were arranged in a three-level structure corresponding to project managers, engineers and technicians. A technician has specific responsibility of workforce production. Then, the technicians are responsible to an engineer. The engineer serves as a mediating role between technicians and a project manager. The engineer outcomes are one of the project manager’s performance. This implies that technician competencies have an effect on engineer competencies; then engineer competencies have and effects on project manager competencies. In addition, the contractor business depends on projects and their team. This implies that project manager and engineer competencies likely affect on business competencies.

From the analysis of the literature review, the proposed conceptual framework for the study is illustrated in Figure. 1, and stated as follows:

- H1: Technician competencies have a positive and direct influence on business competencies.
- H2: Technician competencies have a positive and direct influence on engineer competencies.
- H3: Engineer competencies have a positive and direct influence on project manager competencies.
- H4: Engineer competencies have a positive and direct influence on business competencies.
- H5: Project manager competencies have a positive and direct influence on business competencies.

3. Research method

The questionnaire was used as a research instrument and divided into two parts. Part 1 consisted of general information. Part 2 contained items related to the competencies of the project team, which are important to competitive competencies. Each item is assessed using a 5-level, Likert type agreement scale showed in Table 2.

Thai contractors’ opinions were gathered through personally meet and interview of contractor representatives who participated in well-known infrastructure construction projects. From 300 copies of questionnaires, 216 were obtained (a return rate of 72%). [6] considered this response rate to be excellent, which is sufficient for SEM analysis.

| Table 2. Likert type agreement scale. |
|--------------------------------------|
| **Level of important** | **Measurement scale** |
| Less important | 1 |
| Little important | 2 |
| Medium Important | 3 |
| Important | 4 |
| Very important | 5 |

Before distributing the questionnaire, the questionnaire results were primarily analyzed to test content validity to ensure validation of the meaning and scope of each competency. Then, questionnaire content was also checked by an in-depth interview with six experts. Four individuals were senior construction managers, and two were vice presidents. All six individuals had more than 20 years of experience in construction projects. Then, the interview results were compared with the literature on competencies to adjust for fit within the construction industry definition. As a result, content validity was confirmed.
Scale reliability also was tested by the use of Cronbach’s alpha (α). The test for the questionnaire’s reliability returned results with an average value of 0.924 for each project team’s competencies and competitive competencies. Cronbach’s alpha value of 0.7 is considered acceptable [7]. Moreover, confirmatory factor analysis (CFA) was used to test the construct validity, which determined by over fit index of each measurement model of PMC, EC, TC and BC as shown in Table 3. In the table, the values of overall goodness-of-fit indices satisfy all recommended criteria values [16]; therefore, the construct validity exists.

| Criteria Index                               | Recommended criteria values | GoF values of measurement models |
|----------------------------------------------|-----------------------------|----------------------------------|
| Chi-square (X²)                              |                            | PMC: 0.531 EC: 0.552 TC: 0.725 BC: 0.457 |
| Relative X² χ²/df                            |                            | PMC: 0.374 EC: 0.354 TC: 0.759 BC: 0.935 |
| Goodness of Fit Index (GFI)                  |                            | PMC: 0.994 EC: 0.999 TC: 0.988 |
| Root Mean Square Error of Approximation (RMSEA) |                            |                                  |
| Comparative Fit Index (CFI)                  |                            | PMC: 1.000 EC: 1.000 TC: 1.000 BC: 1.000 |
| Incremental Fit Index (IFI)                  |                            | PMC: 1.000 EC: 1.000 TC: 1.000 BC: 1.000 |
| Tucker-Lewis Index (TLI)                     |                            | PMC: 1.000 EC: 1.000 TC: 1.000 BC: 1.000 |
| Results                                      |                            |                                  |

4. Result
To develop the structural equation modeling (SEM) for testing the relationships of the latent and observed variables of the respective hypotheses, IBM SPSS AMOS (version 20) software was used. Criteria index and the recommend index values [16] were shown in Table 4. All indices showed...
satisfaction value which means the model fit the data well. The SEM result was shown in Figure 2. Additionally, the hypothesis test results were shown in Table 5.

Table 4. Criteria and theory of the values of goodness-of-fit(Gof) appraisal for SEM model.

| Criteria Index                  | Criteria Values | Results |
|--------------------------------|-----------------|---------|
| Chi-square (X²)                | 0.05 < p ≤ 1.00 | 0.080   | passed |
| Relative X²χ²/df               | 0 ≤ χ²= df ≤ 2  | 1.122   | passed |
| Goodness of Fit Index (GFI)    | 0.09 ≤ GFI ≤ 1.00 | 0.910   | passed |
| Root Mean Square Error of      | 0 ≤ RMSEA ≤ 0.08 | 0.024   | passed |
| Approximation (RMSEA)          |                 |         |        |
| Comparative Fit Index (CFI)    | 0.09 ≤ CFI ≤ 1.00 | 0.981   | passed |
| Incremental Fit Index (IFI)    | 0.9 ≤ IFI ≤ 1.00 | 0.982   | passed |
| Tucker-Lewis Index (TLI)       | 0.9 ≤ TLI ≤ 1.00 | 0.976   | passed |
| Cronbach’s alpha              | > 0.70          | 0.924   | passed |

Table 5. Results of hypotheses testing.

| Hypotheses                                                                 | Coef. | p-value | Results   |
|---------------------------------------------------------------------------|-------|---------|-----------|
| H1: Technician competencies (TC) have a positive and direct influence on business competencies (BC) | -     | > 0.01  | Not accepted |
| H2: Technician competencies (TC) have a positive and direct influence on engineer competencies (EC). | 0.87  | < 0.01  | Accepted  |
| H3: Engineer competencies (EC) have a positive and direct influence on project manager competencies (PMC). | 0.55  | < 0.01  | Accepted  |
| H4: Engineer competencies (EC) have a positive and direct influence on business competencies (BC). | 0.49  | < 0.01  | Accepted  |
| H5: Project manager competencies (PMC) have a positive and direct influence on business competencies (BC). | 0.50  | < 0.01  | Accepted  |

Table 6. Standard coefficients of influence equation model of latent variables.

| Latent variables | Influence | TC | EC | PMC | BC |
|------------------|-----------|----|----|-----|----|
| Technician       | DI        | -  | 0.87* | -   | -  |
| competencies (TC)| II        | -  | -  | 0.55 | 0.43|
|                  | TI        | -  | 0.87 | 0.55 | 0.43|
| Engineer         | DI        | -  | -  | 0.55*| 0.49*|
| competencies (EC)| II        | -  | -  | -   | -  |
|                  | TI        | -  | 0.55 | -   | 0.76|
| Project manager  | DI        | -  | -  | -   | 0.50*|
| competencies (PMC)| II       | -  | -  | -   | -  |
|                  | TI        | -  | -  | -   | 0.50|
| Business         | DI        | -  | -  | -   | -  |
| competencies (BC)| II        | -  | -  | -   | -  |
|                  | TI        | -  | -  | -   | -  |

Table 6 shows the relationships among the latent variables and their direct influence (DI), indirect influence (II), and total influence (TI) of each construct, with the sum of DI and II referred to as TI. This also shows that engineer competencies (EC) had the highest total influence on business competencies (BC) (TI = 0.76). These influences consist of direct influence (DI = 0.49) and indirect influences (II = 0.27). Project manager competencies (PMC) were also shown to have a direct
influence on business competencies (DI = 0.50). Technician competencies shown to have a direct influence on engineer competencies (BC) (DI = 0.87) and indirect influence on project manager competencies (PMC) (II = 0.55) and business competencies (BC) (II = 0.43). These results reflect that project manager skills (MS) had an indirect influence on foreman skills (FS) (II = 0.546).

5. Discussion and conclusion.
This study fills a gap in knowledge by exploring the relationships between the construction project team’s competencies and contractor business competencies. These relationships imply the characteristics of hierarchical arrangement which was suggested by [4]. This is likely because the need for competency improvement in the lower level staffs can motivate higher level staffs to upgrade their competencies. Moreover, the results indicated that the project manager and engineer competencies have significant influences on business competencies with 0.50 and 0.49 of regression weighs, respectively. This may be because both have a large contribution to the project resources usage, which directly affects the profit of contractor business. This study also finds that technician competencies have no significant influence on business competencies. The possible reason is that a technician has a major role in the supervision of workers to execute works to follow engineer instructions. Thus, most of the technician actions are based on direction from the engineer. However, the model indicates the relationship among their competencies that technician competencies have an influence on engineer competencies (0.87), and engineer competencies have an influence on project manager competencies (0.55), which shows that technician competencies also have an indirect influence on business competencies. These findings comply with [1] who found that the project team's competencies had impacts on business operation.

The model of project team’s competencies influencing business competencies can be used by the contractor to develop proper competencies for individual project team leading to the improvement of business competencies.
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