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Critical Factors of Subcontractor Evaluation and Selection: A Case Study in Vietnam*

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Abstract

A contractor or a main contractor is a company with full capacity to construct all project's works for the owner. A subcontractor is an organization that works with the main contractor to execute and complete work packages for the project. Selecting an effective subcontractor will help the efficiency and success of any projects in the construction industry. Therefore, this study identified subcontractor evaluation factors in Vietnam by collecting questionnaire survey data from engineers and staffs in the construction industry project environment. An exploratory factor analysis (EFA) was then performed to identify the critical factors when evaluating and selecting the subcontractor in construction projects. Moreover, when considering the impact level in terms of the average value, the research results showed that the most critical concern was the subcontractor's reputation. Furthermore, the top five factors affecting the sub-contractor evaluation and selection are (i) reputation, (ii) price, (iii) construction techniques, (iv) ability to implement projects according to commitments, and (v) subcontractor competence (the team of workers, technician staff, engineers with full capacity according to regulations). These research results provide an overall perspective that will help main contractors develop suitable subcontractors' evaluation and selection factors in their projects in the construction industry.

Keywords: Construction Management, Contractor, Construction Industry, Exploratory Factor Analysis, Project Management, Subcontractor, Vietnam

JEL Classification Code: L29, L74, O18

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1. Introduction

The construction industry plays an essential role in building all countries' infrastructure, whether developed or developing (Faridi & El-Sayegh, 2006; Nguyen, 2020; Nguyen, Likhitrungsilp, & Onishi, 2018; Nguyen & Nguyen, 2020; Nguyen, Nguyen, & Do, 2020; Pham, Dao, Cho, Nguyen, & Pham-Hang, 2019; Phong et al., 2017). The changing working environment dramatically influences a construction project's features, such as the need for coordination among the parties and other risks in project management and implementation (Hinze & Tracey, 1994; Hossain, 2009; Vo, Nguyen, & Nguyen, 2020). The main contractor – the unit responsible for project management – implement their project by breaking down the project's huge workloads into smaller work packages to manage their schedule, quality, and budget to minimize their risks. A subcontractor is a construction company that contracts with the main contractor with the responsibility of implementing and completing the project's work packages, including supplying the workforce (workers), equipment, tools, designs, and other supplies (Abbasianjahromi, Rajaie, & Shakeri, 2013; Arditi & Chotibhongs, 2005). With this

form, a subcontractor shares both the benefits and risks of the construction services to the owner with the main contractor.

Subcontracting firms are increasingly specialized and outstanding in their fields and work to meet the rigorous needs of the main contractors (Arditi & Chotibhongs, 2005; Choudhry, Hinze, Arshad, & Gabriel, 2012). Subcontractors can be divided into three main groups: (i) subcontracting related to trade, material provider for the project; (ii) special services subcontracting that provide individual services such as mechanical and electrical construction, tank systems, lighting, sound, etc.; and (iii) workforce contractor, supplying skilled workers to perform parts of the construction works (Mbachu, 2008). Specialization is the construction industry trend, with subcontractors perfecting their services through different projects with similar workloads. Thus, they can perform work packages on a single project faster and at less cost than the main contractor (Arditi & Chotibhongs, 2005; Yoke-Lian, Hassim, Muniandy, & Teik-Hua, 2012). Subcontractors, thus, have an advantage in using the equipment and training more specialized workers. Therefore, the contractual relationship between the main contractor and the subcontractors has become more popular (El-Mashaleh, 2009; Hinze & Tracey, 1994; Kale & Arditi, 2001). A project's overall success was influenced by the success and effectiveness of the cooperative relationship between them. As a result, selecting the subcontractors and their selection criteria have become topics of interest to many researchers (Arditi & Chotibhongs, 2005; El-khalek, Aziz, & Morgan, 2019; Ng, Luu, & Chu, 2008; Shivam & Kashiyani, 2018; Ulubeyli, Kazaz, & Arslan, 2017).

The characteristics of specific construction projects create difficulties for the main contractors, especially financial or cost risk (Le-Hoi, Dai Lee, & Lee, 2008; Luong, Tran, & Nguyen, 2018; Nguyen, Le-Hoi, Tran, Dang, & Nguyen, 2019; Nguyen & Nguyen, 2020; Owolabi et al., 2020; Sy, Likhitrungsilp, Onishi, & Nguyen, 2017; Thong et al., 2020). Using subcontractors is a means of minimizing risks and, thus, sharing benefits. The main contractor goes through a contractor selection process that includes evaluating the criteria for subcontractors selection (Turskis, 2008). Further, the tendering price of the subcontractors, as well as other measures need to be considered in the selection process for the main contractor. Because the tendering price is not an evaluation of all the subcontractors' characteristics and capabilities, the construction process can be affected. Delays, cost overruns, and low quality are high risk for the main contractor if their subcontractor does not comply with the contractual requirements (Nguyen, Likhitrungsilp, & Onishi, 2020; Pham et al., 2020).

The selection of subcontractors is still not given due attention to the construction industry in developing countries, which account for many SMEs (Abbasianjahromi et al., 2013;

Ulubeyli, Manisali, & Kazaz, 2010). The selection of subcontractors for specialized work in the construction process minimizes the risks for main contractors. On the other hand, if the subcontractor selection process does not match the construction industry at a project site (project size, market characteristics, and owner expectations), negative consequences are inevitable. This study was done by adopting contractor selection criteria from previous studies and practices in a specific project environment's conditions. The study also provides a method for selecting subcontractors that is appropriate, saving costs and time.

2. Literature Review

In recent literature, subcontractor selection factors have varied widely in the research. However, the most essential and characteristic factors include cost (price), quality, safety, and schedule (Bailey, 2016; Nguyen, 2020). The subcontractor selection criteria also are the expected bid, reputation (past performance), accreditation from government agencies (quality), staff qualifications (technical capacity), financial status (number of public work in the past five years), timing (estimated project duration), construction health and safety records, management (including information provided and how subcontractors respond to documents necessary), production and capacity (technology level: equipment), location, shares for subcontractors (Koçak, Kazaz, & Ulubeyli, 2018).

Experience and product quality are essential factors for ranking sub-contractors (Hartmann, Ling, & Tan, 2009). Ulubeyli et al. (2017) offered a list of critical factors affecting subcontractor selection, including experience, past performance, formal relationships, financial strength, and workload. Further, project knowledge, reliability, altruism, problem-solving ability, enthusiasm for the project, price, quality of the technical staff, labor, the payment plan, and the number of subcontracting units needed are also included. The subcontractor's work quality was indicated to be important in Shivam and Kashiyani (2018) study. The list of their factors included the quality of work, timely work completion, craft standards, the lowest bid, and flexibility and cooperation when dealing with delays. Further, the completed project's scope, financial stability, material resources equipment, health and safety records, and reputation were all issues.

A schedule was an indispensable factor when assessing the performance of a subcontractor. In Jordan, a group of factors was used for assessment: project duration, reputation (past performance based on the number of successful projects done), expected price, employee qualifications, technology level (physical equipment), equity for subcontractors, subcontractor rating, health and safety profiles, general impressions, and subcontractors' response rates, workload (financial) over the past five years, all certified by government agencies (Abunada & Mohammed, 2018).

Table 1: Subcontractor Evaluation and Selection Factors

Group name	Subcontractor selection factors
Price	Estimated price
	Bid price
	The clarity in the estimated cost of each item (Item bid price)
	Flexible payment terms
Financial capacity	Amount of cash
	Credit ratings
	Annual revenue and profit
	Total assets, liabilities, short term liabilities, short term assets, etc.
	Contract value in progress
Technical capacity	Construction machinery and equipment
	The team of workers, technical staff, fully qualified engineers
	Proposed schedule
	The project implementation schedule is faster than other contractors
	Ability to perform projects as committed
	Ability to repair on-site and have the facility to maintain machinery
	QA/QC regulation
	Construction waste management regulations
	Construction techniques
	Ability to mobilize manpower, construction machinery, and equipment
	Management ability
	Quality assurance measures
	Measures to protect the environment, occupational health and safety (HSE)
	Reputation
Competence of experience	Construction operation time
	Number of winning projects
	Number of projects completed
	Bidding package with the largest winning value
	Establishing bidding packages to be performed (scope, technical properties, geographic conditions, etc.)
Quality	The contractor's equipment and machinery have full quality inspection stamps
	The contractor ensures that the work is performed according to the quality plan
	Certified contractor assures technical quality processes
	The content of the contractor's report complies with the current construction standards
	Willing to bid
	Legal awareness and compliance
Relationship	Relationship with the owner
	Relationship with the general contractor
	Relationship with local authorities

Contract guarantees were the main contractor's interests being included in the contract (Marzouk, El Kherbawy, & Khalifa, 2013). Besides, other factors such as flexibility and cooperation when dealing with delays; compliance with specifications and quality; a supplier's ability to deliver raw materials on time; ability to complete the contract; a subcontractor's physical resources; bidding price; difficulty in repayment, and flexibility in critical operations. Other matters affecting the performance of the subcontractor were identified by El-khalek et al. (2019). For example, guaranteeing on-time delivery of materials, failure to complete a contract due to financial problems, reimbursement issues were identified as critical factors. Furthermore, issues such as prestige, bidding, and handling essential activities in the construction and progress stage that exceeded the performance contract mattered. If the labor capacity was insufficient, the work's proportion completed behind schedule, and the project's technical difficulties needed to be incorporated into the evaluation. Other factors that establish a contractor's strength in participating in a competency competition with other contractors include construction engineering, time control, operating method, material waste, service after work completion, cooperation with other subcontractors, safety and protection practices, usage habits tools (tools borrowed from contractors), work ground clearance, manageability, the personality of subcontractors, economic conditions (Ko, Cheng, & Wu, 2007). The study was done to synthesize factors from previous research in Table 1 (Abbasianjahromi, Sepehri, & Abbasi, 2018; Basu, Nanyam, & Sawhney, 2017; Keshavarz-Ghorabae, Amiri, Zavadskas, Turskis, & Antucheviciene, 2018).

3. Research Methodology

The questionnaire was designed using a five-point scale, conducting a pilot study, which was adjusted to have an official questionnaire in this study. Data was collected through surveys with project engineers and staff in Ho Chi Minh City, Vietnam, and the surrounding area. Then, the data was filtered and encoded, analyzed, and synthesized through the use of statistical software. From the survey, the results were analyzed and presented. The total value of data included in the analysis was 96 questionnaires. Statistical analysis and Exploratory Factor Analysis were performed to find the main factors in the selection of subcontractors.

4. Results and Discussion

The largest proportion was composed of engineers and staff working for the contractor (42.6%) about the job position. In the next group were people of the owner's (26.6%). The smallest two groups were composed of staff in the design and the supervision unit, 11.7% and 16%. Next, the

data gathered included many respondents with less than five years to over 15 years of experience. The largest proportion belonged to the group with 5–10 years of experience (41%). The groups with 10–15 years of experience and with less than five years were represented equally, at 27% and 23%, respectively. The lowest rate was a group of engineers with over 15 years (9%) of experience. In general, the data is a good representation of the subcontractor selection criteria since the data was primarily comprised of engineers working for the main contractor and were experienced in working directly with subcontractors.

The reliability scale of the study was verified through Cronbach's Alpha value (> 0.926). The scale is suitable and a good measure for the subcontractor evaluation criteria. Tests were performed for five groups of factors (Eco; Abi, Exp, Qua, and Rel). Cronbach's Alpha values of these groups of variables measuring the subcontractor selection criteria showed in the table below. All values (> 0.7) indicated that the scale was suitable (see Table 3).

Table 2: Data Characteristics

Description	Frequency	Percent (%)
Position		
Owner	25	26.6
Contractor	40	42.6
Designer	11	11.7
Supervisor	15	16.0
Others	3	3.2
Experience		
< 5 years	22	23.4
5–10 years	39	41.5
10–15 years	25	26.6
> 15 years	8	8.5
Total	94	100

Table 3: Reliability Statistics

Group's Name	Cronbach's Alpha	Number of Items
Eco	0.809	2
Abi	0.887	9
Exp	0.759	2
Qua	0.756	2
Rel	0.842	4

Table 4: Ranking Factors of Selection of Subcontractors

Code	Factors of selection of subcontractors	Mean	SD	Rank
Abi9	Reputation	4.41	0.94	1
Price	The clarity in the estimated cost of each item (item bid price)	4.31	0.82	2
Abi5	Construction techniques	4.16	1.02	3
Abi3	Ability to perform projects as committed	4.04	0.90	4
Abi2	The team of workers, technician staffs, engineers with full capacity according to regulations	4.00	0.79	5
Qua2	Legal awareness and compliance	3.94	1.01	6
Abi1	Construction machinery and equipment	3.91	0.86	7
Abi7	Quality assurance measures	3.90	0.84	8
Abi4	QA/QC regulations	3.74	0.98	9
Abi8	Measures to protect the environment and occupational health and safety (HSE)	3.72	0.97	10
Abi6	Ability to mobilize manpower, construction machinery, and equipment	3.70	0.79	11
Rel4	Relationship with qualified inter-suppliers, operations training institutions, credit institutions, etc	3.70	1.11	11
Qua1	The contractor ensures that the work is performed according to the set specifications	3.69	0.9	13
Eco1	Annual revenue and profits	3.65	0.95	14
Exp1	Number of projects completed	3.54	0.83	15
Rel1	Relationship with the owner	3.51	1.03	16
Eco2	Total assets, liabilities, short term liabilities, short term assets, etc	3.50	1.02	17
Rel2	Relationship with the main contractor	3.50	0.97	17
Exp2	Similar bidding packages performed (scope, technical properties, geographic conditions, etc.)	3.38	0.94	19
Rel3	Relationship with local authorities	3.30	1.1	20

The factor rating average showed how much influence each factor has on the selection of subcontractors. Ranking factors according to their importance was based on the average of the factors in Table 4.

The results of this ranking of all the factors affecting the selection of subcontractors, which included 20 factors, reputation (4.41) was considered to have the most significant influence on subcontractor selection (rank 1). Next, the factors that had a strong impact after prestige were price (4.31); construction techniques (4.16); ability to implement projects as committed (4.04); a team of workers, technicians, engineers with full capacity according to regulations (4.00). The above five criteria focus on two groups: (i) price and (ii) technical capacity or resources. Moreover, the research results showed the degree of correlation between the contractor and supervisor in the ranking factors in selecting

subcontractors ($r = 0.786$). Besides, the contractor was the direct unit in the selection of subcontractors. They were correlated with the design unit ($r = 0.690$) and owner with $r = 0.676$ ($p < 0.01$). The results found the correlation coefficient $r = 0.405$ ($p = 0.77$) was not statistically significant. It indicated the difference in the evaluation of a subcontractor selection between the owner and the designer. Nevertheless, that did not greatly affect the results' accuracy as the subcontractors' selection was closely related to the main contractor. Therefore, the results showed that evaluating contractor selection among related units was quite similar, from the contractor's point of view. In the Exploratory Factor Analysis (EFA), twenty variables were used in the Principal Component Analysis (PCA). KMO (Kaiser-Mayer-Olkin) and Bartlett's of Sphericity tests were to check the suitability of data before performing EFA analysis, as shown in Table 5.

Table 5: The Correlations between Parties

			Owner	Contractor	Designer	Supervisor
Spearman's rho	Owner	Correlation Coefficient	1.000	0.676**	0.405	0.573**
		Sig. (2-tailed)		0.001	0.077	0.008
	Contractor	Correlation Coefficient	0.676**	1.000	0.690**	0.786**
		Sig. (2-tailed)	0.001		0.001	0.000
	Designer	Correlation Coefficient	0.405	0.690**	1.000	0.714**
		Sig. (2-tailed)	0.077	0.001		0.000
	Supervisor	Correlation Coefficient	0.573**	0.786**	0.714**	1.000
		Sig. (2-tailed)	0.008	0.000	0.000	

** . Correlation is significant at the 0.01 level (2-tailed).

The KMO value (0.861) and the sig. value of Bartlett's Test of Sphericity (0.000) indicated that the data were suitable for analysis. EFA analysis was performed with 20 observed variables and was reduced by Principal Component Analysis (PCA) with varimax rotation. In the first run of EFA, the results showed that item Abi3 had an extraction value of <0.440. It was excluded from analysis, and we conducted the second EFA analysis with items of 19. The EFA analysis process was done through seven steps and with six inappropriate items removed, including Abi3, Abi5, Rel4, Abi8, Qua1, Abi4, respectively (see Table 6).

The results extracted four groups of factors, with a total cumulative explanation variance of 81,523%. Factor loadings for each factor were shown in Table 7. The four groups of factors have been named, as follows: (i) Experience and Relationship; (ii) Competence; (iii) Reputation; and (iv) Finance. The Experience and Relationship Group included five items with a percentage variance of 22,042%. This group represents subcontractors' values through their relationships and experiences of the number of projects they have worked on. The first significant group most greatly affected their ability to succeed in competing in the construction industry. The Competency group included four items, accounting for a variance of 18,402%. This group represented the values of the subcontractor's capacity (in terms of machinery, human resources, and safety measures, etc.) was the second group in explaining the factors that influence the selection of subcontractors in construction projects. Next, the Reputation group of three factors with the percentage of variance explained was 15.916%. This group addressed issues of clarity in their cost estimates, the credibility of the entity, and their compliance

with regulations. Finally, the last group was Finance. This group included two items, and the explanatory variance accounted for 13,531%. That group represented the financial situation of the business.

5. Conclusions

With a high growth rate, Vietnam is one of the most dynamic developing countries in the East Asia Pacific region (Nguyen & Bui, 2020a, 2020b; Nguyen & Ngo, 2020). This is because a large portion of the construction industry is industrialized. To achieve industrialization and modernization, construction companies need a process and criteria for selecting a competent subcontractor because this selection and the effectiveness of the selection process have a direct impact on the overall project outcomes. The evaluation of subcontractors in construction projects has become popular and has attracted both industry practitioners and researchers' attention. This study has been carried out to find the most critical factors in the evaluation when selecting a subcontractor from the project staff and engineers' point of views in Vietnam. The exploratory factor analysis results showed that there were four main criteria groups with 14 items to be considered, including issues related to experience and relationship, competence, reputation, and finance. These research results contribute to business practice, making the partnership between the main contractor and subcontractor more sustainable. These subcontractor evaluation factors provide a basis of reference to help the main contractor have a general perspective on the comprehensive evaluation. Also, subcontractors, too, have the basis for orienting the development of the company's capabilities.

Table 6: The Exploratory Factor Analysis Processes

No	Number of items	KMO and Bartlett's Test	Number of components	Total Variance Explained	Exclusive Item
1	20	0.861/ sig.(0.00)	4	–	Abi3
2	19	0.862/ sig.(0.00)	4	67.627	Abi5
3	18	0.853/ sig.(0.00)	4	67.793	Rel4
4	17	0.847/ sig.(0.00)	4	68.190	Abi8
5	16	0.842/ sig.(0.00)	4	68.426	Qua1
6	15	0.828/ sig.(0.00)	4	69.100	Abi4
7	14	0.811/ sig.(0.00)	4	69.891	none

Table 7: The Research Results

Code	Factors of selection of subcontractors	Factor loading	% of variance
	<i>Experience and Relationship</i>		22.042
Rel1	Relationship with the owner	0.795	
Rel2	Relationship with the main contractor	0.795	
Exp2	Similar bidding packages performed (scope, technical properties, geographic conditions, etc.)	0.707	
Rel3	Relationship with local authorities	0.682	
Exp1	Number of projects completed	0.587	
	<i>Competency</i>		18.402
Abi6	Ability to mobilize manpower, construction machinery, and equipment	0.827	
Abi1	Construction machinery and equipment	0.749	
Abi7	Quality assurance measures	0.663	
Abi2	The team of workers, technician staffs, engineers with full capacity according to regulations	0.651	
	<i>Reputation</i>		15.916
Price	The clarity in the estimated cost of each item (item bid price)	0.808	
Abi9	Reputation	0.728	
Qua2	Legal awareness and compliance	0.706	
	<i>Finance</i>		13.531
Eco2	Total assets, liabilities, short term liabilities, short term assets, etc.	0.823	
Eco1	Annual revenue and profits	0.815	
	Cumulative % of Variance		69.891

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