A QUANTITATIVE APPROACH FOR ASSESSING THE OVERSEAS BUSINESS CAPABILITIES OF CONSTRUCTION FIRMS

Hae Beom Yang[1], Woosik Jang[2], Kang-Wook Lee[3], Heedae Park[4], Seung Heon. Han[5] and Hyun-woo You[6]

[1,6] Master Student, Yonsei University, Seoul, Republic of Korea
[2] Ph.D. Student, Yonsei University, Seoul, Republic of Korea
[3] Ph.D. Candidate, Yonsei University, Seoul, Republic of Korea
[4] Ph.D., Yonsei University, Seoul, Republic of Korea
[5] Professor, Yonsei University, Seoul, Republic of Korea
Correspond to shh6018@yonsei.ac.kr

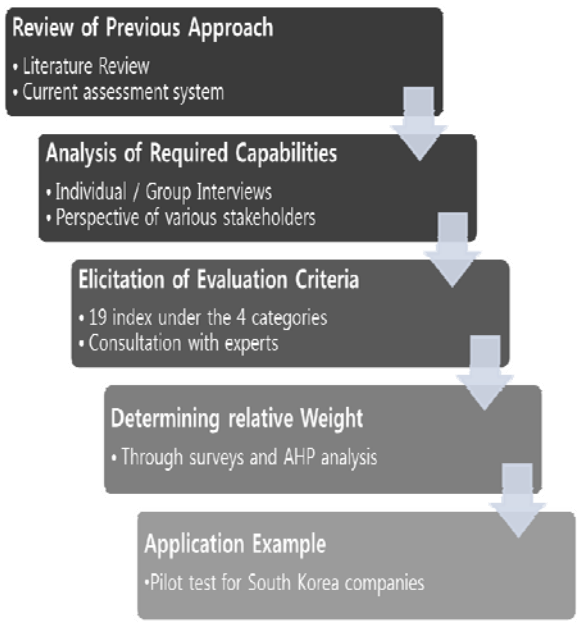
ABSTRACT: Although global construction spending has experienced slow growth due to consecutive economic crises, global contractors have consistently attempted to expand their overseas market share, leading to more intense competition among contractors in the international construction market. In this market environment, owners, clients and financial institutions require reasonable and systematic criteria to effectively assess the business capabilities of international construction firms. However, the existing evaluation methods for construction firms rarely consider overseas-focused business capabilities. To address this problem, this study proposes a quantitative approach to assessing the overseas business capabilities of international construction firms. The limitations of existing approaches are reviewed, and the capabilities required to perform overseas businesses are analyzed through expert interviews. Finally, 18 evaluation indices are suggested in four categories: technology resources, project management, experience and performance, and sustainability. The relative weight of each index is determined according to the Analytical Hierarchy Process (AHP) method, and a preliminary investigation of 11 Korean construction firms is conducted. The proposed method is expected that it will provide the rational criteria for international owners, clients, and financial institutions for decision-making and for evaluating international contractors.

Keywords: Overseas construction; Business capability; Quantitative approach; Evaluation system

1. INTRODUCTION

During last decade, the international construction market has shown a remarkable growth indebted to increasing demand for infrastructures in the Mideast and emerging market. However, due to consecutive economic crisis after 2008, i.e., Dubai moratorium, Lehman Brothers bankruptcy, and European debt crisis, the global construction spending is of tardy growth [1]. Nevertheless, global contractors continue to advance to the overseas market to secure their sources of revenue, and sustain the increased proportion of overseas revenue [1]. In this competitive overseas market, various stakeholders except contractors–owners, clients, financial and insurance institutes require reasonable and systematic criteria for evaluating contractors because the stakeholders should consider not only the feasibility and expected project performance but also the business capabilities of contractors. However, existing methods to assessing capabilities of construction firms have limitations to support such decision making. Therefore, in order to complement current practices, this study aims to identify important criteria of overseas business capabilities and propose a quantification method.

Figure 1 Research process



This study is intended to assisting the decision making of construction stakeholders except contractors. Since this study investigates the overseas project-focused capabilities, contractors those have never performed an overseas project are excluded from the research scope.

The research process of this study is shown in Figure 1. First, the authors conducted extensive literature review and investigated current contractor ranking indices, assessment and evaluation methods, characteristics and limitations of existing methods. Second, to identify the required capabilities for overseas business, the authors conducted separated interviews with seven industry experts and had meetings with field staffs of five overseas construction sites. Then, the authors derived 18 evaluation indices under four categories through consultation with related 8 experts. Next, to quantify the evaluation result, relative weights for each index and category were calculated through surveys and Analytical Hierarchy Process (AHP). Lastly, based upon the evaluation index, a preliminary application was conducted with Korean construction firms to verify the proposed method.

2. BACKGROUND OF STUDY

In regard to identifying evaluation indices of construction firms, previous research mainly focused on measuring firm's performance; these studies have being performed since the mid-1990s. Most of the research derived evaluation criteria through literature reviews or expert interviews, and the importance of or correlation between indices were analyzed [2][3][4][5][6]. However, previous research was based on firms' perspectives on completing successful projects or improving internal capacity, not on evaluating construction firms under the perspective of selecting a bidder. Also, each index was based on performance at the project level, not the corporate level. In addition, they were not specialized to the capacities of overseas construction.

One of the current evaluation system specialized in the overseas business performance of construction firms is the Top International Contractors 225 announced by Engineering News Record (ENR). ENR ranks construction firms by evaluating overseas revenue and new contracts, classifying firms' revenues among nine products and seven regions [1].

ENR is widely used as a formal system; however, it has limitations as it does not reflect practical construction capability, because ENR ranks are estimated from a firm's revenue and new contract record.

The Contractors File announced by New Civil Engineer (NCE) evaluates UK construction firms by evaluating firms' revenues, new contracts, number of employees or technicians, and profits. NCE also classify revenues according to 14 product categories and 13 regions, similar to ENR [7]. NCE uses more varied assessment criteria than ENR, but it is also insufficient to reflect actual business ability and it is not specialized to overseas performance.

Korean construction firms are evaluated their construction capabilities by the Korea government using the Construction Capability Evaluation System (CCES). It ranks construction firms by deriving a total score based on four evaluation categories: performance, management, technology, and credibility [8]. Although it seems to reflect various aspects of abilities, all evaluation categories are mainly based on financial indicators, and there have been many controversies over the lack of emphasis on actual technical ability [9]. Also, it is not specialized to the overseas capability of firms.

Other countries have also used Performance Measurement Systems (PMS) to ensure the overall development of their construction industries by benchmarking performances between companies. In US, Construction Industry Institute (CII) operates PMS based on criteria such as cost, schedule, safety, change, rework, and productivity [10]. National Benchmarking System (NBS) of Chile and the SISND-NET Project of Brazil

Table 1. Comparisons of previous approaches

	ENR	NCE	CCES	CII
Assessment Criteria	□ Revenue □ New contracts	□ Revenue □ New contracts □ Number of employees or technicians □ Profit	□ Performance □ Management □ Technology □ Credibility	□ Cost □ Schedule □ Safety □ Change □ Rework □ Productivity
Specialized in overseas business	O	X	X	X
Assessment base	Corporate performance	Corporate performance	Corporate performance	Project performance
Reflection of actual capability	X	X	X	X
Announcing method	Value of each Index	Value of each index	Total Score	Value of each index
Purpose	Evaluate firms	Evaluate firms	Evaluate firms	Performance measurement

operate PMS in same manner [11].

However, performance measurement systems stated above are not relevant when selecting a contractor, because they were aimed for improving the abilities of the construction firms by themselves.

In other words, a new assessment system is needed that specializes in evaluating actual overseas business abilities, and this study proposes an assessment index as a preliminary study for developing a new assessment system.

3. RESEARCH PROCESS

3.1 Identification of influencing factors of business capabilities

In order to derive assessment indicators, first, required capabilities to perform overseas construction should be identified. To consider different viewpoint among construction participants, the capabilities considered by overseas owners, large companies (LCs) and small and medium-sized companies (SMCs) are analyzed through in-depth expert interviews. Interviews consist of 7 individual interviews and 5 group interviews, and most of the interviewees are workers from Korean large company (LC) and small and medium-sized construction companies (SMC) who have sufficient experience in overseas construction. Other interviewees are workers from the government-affiliated organization supporting overseas construction and researchers from the construction research institute in Korea. The capabilities important to overseas owners were indirectly analyzed according to the interviewees' overseas business experiences and the qualification criteria of the Prequalification document used in selecting a bidder.

Figure 2. Capabilities required of overseas business

Table 2. Assessment indices and its descriptions

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Category	Index	Description
Technology Resources	Level of Technology	the number of patents, new designs, new technologies
	Quality of workforce	the number of engineers, doctors, masters, bachelors/all workers
	Overseas experienced workforce	overseas experienced workers/total workers
	Labor capacity for overseas	the number of available overseas workers
Project Management	Duration reduction	reduced period/contracted period (3 years)
	Accident-free	duration of accident-free work (3 years)
	Number of completed projects	the number of overseas construction projects completed (3 years)
	Cost reduction	reduced cost/contracted cost (3 years)
	Dispute occurrence	the number of disputes overseas (3 years)
Experience & Performance	Overseas revenue	overseas revenue (3 years)
	Success rate of overseas bids	the number of contracts/number of bids (3 years)
	Overseas financing	record of amount of overseas financing (3 years)
	Product diversification	Diversification Index (Berry 1971) (3 years)
	Regional diversification	Diversification Index (Berry 1971) (3 years)
Sustainability	R&D costs	R&D costs/selling and administrative expenses
	Education & training costs	training expenses/number of workers (3 years)
	Local subsidiaries & branches	the number of overseas subsidiaries and branches
	Welfare levels	employee welfare costs/number of workers (3 years)

Required capabilities derived in common from the interviews and analyzing Prequalification documents are as follows.

First, overseas owners considered financial soundness evaluated by financial indicators and project management skills, which represent the ability of a company to finish a project without any problems through quality control or managing health, safety, and environment (HSE), as important factors.

LCs placed emphasis on overseas financing ability and size of company. Large companies advance to larger-scale projects relatively more often than other small firms, so large-scale financing is inevitable. In addition, to compete with other global companies in the international market, firms should expand their size through M&A or vertical integration to advance to more business products or regions.

SMCs considered level of technology and skilled workforce more important factors than size. In particular, they emphasized the possession of key technologies to distinguish them from other SMCs for securing their competitiveness. Because they cannot afford to advance to various fields compared to LCs. Moreover, since most technological advancements stem from a skilled workforce, the level of skilled workforce was recommended as a major factor.

Lastly, all three agents considered overseas experience and the level of relevant performance e.g. revenue to be the most important factors.

3.2 Selecting of Evaluation Criteria

Based on the overseas construction capability requirements, the assessment criteria are derived as follows.

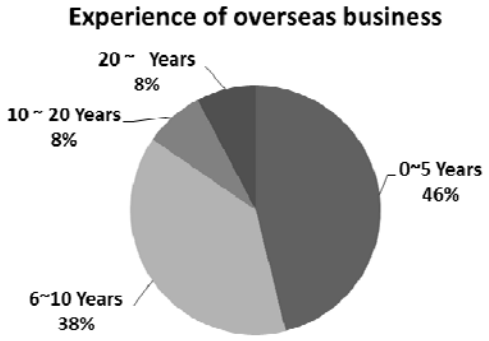

Figure 3. Information of respondents - Experience

First, the criteria used in previous studies or evaluation systems are reviewed, and several criteria corresponding to the required capability are selected. Next, final evaluation indices are derived by consultation with ten experts. The experts were consisted of as follows: three experts from the International Construction Association of Korea (ICAK); two experts from accounting firm who have firm evaluation experiences; three experts from Korean construction firms specializing in overseas projects; and two experts from research institute.

The main criteria for selecting evaluation indices are reflection of required ability, possibility of quantification, and possibility of data gathering. The reflection of required ability refers to how well the index represents a firm's ability to perform overseas construction; possibility of quantification means whether or not one could measure each index quantitatively; and possibility of data gathering is the possibility of collecting data from construction firms.

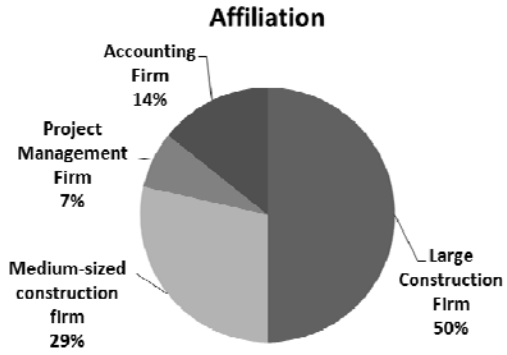

Figure 4. Information of respondents - Affiliation

Finally, a total of 18 indices are derived under four categories: technology resources, project management, experience and performance, and sustainability. The three categories technology resources, project management, and experience and performance reflect the required capabilities previously analyzed, while sustainability tells us whether a firm's capabilities could sustained in the future. Financial soundness is not considered because this study aims to evaluate what previous systems did not, and many financial evaluation systems exist already. The measurement formulations of diversification indices use methods of previous research.

Table 3. Consistency of survey results

	Category (W1)	Indicator (W2)			
		Technology resource	Project management	Experience & Performance	Sustainability
Selected No. (CI, CR ≤ 0.1)	12	11	10	10	11
Excluded No. (CI, CR > 0.1)	2	3	4	4	3

3.3 Determination of Importance Weights

To compare capabilities between companies, quantification of total or each category's score is required. Therefore, methods for determining the relative weights of each index and category should be decided. AHP, one of the multi-criteria analysis method widely used to determine the priorities of various evaluation items by quantifying the opinions of individuals or a group, is conducted to determine relative importance through survey results [12]. The survey is composed to measure the relative importance of each index or category by pairwise comparison, and a total of 14 respondents consist of various stakeholders (Figure 3&4).

Each items are debated and eliminated when the consistency index (CI) or the consistency ratio (CR) is lower than 0.1 as seen in Table 3. Also selected values are summed as geometric averages for analysis. The final result of each weight is shown in Table 4.

Among the four categories (W1), experience & performance showed the greatest importance as it was viewed as an important capacity for overseas businesses by all stakeholders and Sustainability showed the lowest importance.

The final weight of each index (W3) is calculated as the product of two weights, W1 and W2, and overseas Revenue, overseas experienced workforce, and overseas financing are derived into key indicators (KI) by the Pareto Rule, as they are positioned in the top 20%

Table 4. Weights of criteria

Category	Weight (W1)	Index	Weight (W2)	Final Weight (W3)
Technology Resource	0.2399	Level of technology	0.1905	0.0457
		Quality of workforce	0.2306	0.0553
		Overseas experienced workforce	0.4967	0.1192
		Overseas labor capacity	0.0822	0.0197
Project Management	0.2773	Duration reduction	0.2157	0.0598
		Accident-free	0.1154	0.0320
		Number of completions	0.2597	0.0720
		Cost reduction	0.1878	0.0521
		Dispute occurrence	0.2214	0.0614
Experience & Performance	0.3887	**Overseas revenue**	0.3368	0.1309
		Success rate of overseas bids	0.1435	0.056
		Overseas financing	0.3038	0.1181
		Product diversification	0.0667	0.0259
		Regional diversification	0.1492	0.0580
Sustainability	0.0941	R&D costs	0.2150	0.0202
		Education & training costs	0.2161	0.0203
		Local subsidiaries & branches	0.1851	0.0174
		Welfare levels	0.0905	0.0085

Note: the bolded cells represent Key Indicators (KI)

4. APPLICATION EXAMPLE

Based on the evaluation index and its weights, a pilot test was conducted for Korea's construction firms. Because of the difficulty in collecting available data, only 11 firms are selected from the top 30 firms according to overseas revenue for the past 3 years (2008-2010). A total of 8 indices are applied to evaluate these firms because of data availability. Quality of workforce, number of completions, overseas revenue, bid-hit ratio of overseas projects, product diversification, regional diversification, education & training costs, Welfare levels are applied to test.

Table 5. Formulation of normalization of the score

Condition	Formulation
$1.645 \leq Z \leq$ Max(Z)	60 + [95 + 5 x{(Z-1.645)/(Max(Z)-1.645)}] x 0.4
$1.282 \leq Z \leq 1.645$	60 + [90 + 5 x{(Z-1.282)/(1.645-1.282)}] x 0.4
$0.526 \leq Z \leq 1.282$	60 + [70 + 20 x{(Z-0.526)/(1.282-0.526)}] x 0.4
$-0.526 \leq Z \leq 0.526$	60 + [30 + 40 x{(Z+0.526)/(0.526+0.526)}] x 0.4
$-.282 \leq Z \leq -0.526$	60 + [105 + 205 x{(Z+1.282)/(-0.526+1.282)}] x 0.4
$-1.645 \leq Z \leq -1.282$	60 + [5 + 5 x{(Z+1.645)/(-1.282+1.645)}] x 0.4
$\text{Min}(Z) \leq Z \leq -1.645$	60 + [0 + 5 x{(Z+lMin(Z)l)/(-1.645+lMin(Z)l)}] x 0.4

For the normalization of the scores of each index, standardization of z-score method is used, which can reduce the significant impact of specific values by setting the lowest score [13].

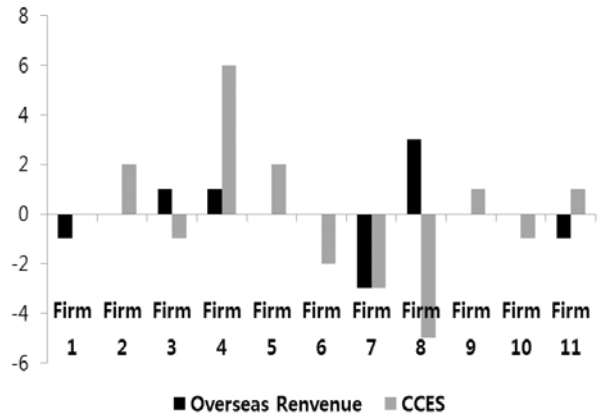

Figure 5. Comparison between RBR and CCES

The results are compared with the Construction Capability Evaluation System (CCES) Rank of Korea and overseas revenue-based rank to analyze its differences from the proposed method. As shown in Figure 5, rankings of the firms show somewhat differences by considering additional influencing factors of business capabilities.

Particularly, the assessment results of three firms (4, 7, and 8) present remarkable gaps in the reflection of their characteristics. First, due to the lack of overall business capabilities, with the exception of welfare levels and regional diversification, the capability of firm 4 was assessed as much lower than the corresponding CCES rank. In the case of firm 7, the overseas business capability was underestimated by both the revenue-based rank and the CCES rank. The proposed method evaluated firm 7 in a much better position in terms of the quality of the workforce, regional diversification, and bid-hit ratio. Finally, based on the superior level of overseas revenue and the bid-hit ratio, firm 8 was evaluated as having a lowest rank than the corresponding CCES rank. The proposed method ranked firm 8 in a lower position than the revenue-based rank due to the firm's weaknesses in education and training costs, the level of diversification, and the number of completed projects.

5. DISCUSSION

Comparison between RBR and CCES (figure 5) is insufficient to decide the better method. It just said that RBR and CCES represent the different results at the international construction firms.

To verify the CCES, we performed trend analysis between actual revenues from 2010 to 2012 and results of figure 5. But only 4 of firms (out of 11 firms) can collect the actual revenue data from ENR 2010-2012. Fundamentally, past data helps prediction of future phenomena. So past RBR and CCES from 2008 to 2010 can predict the variation of actual revenues from 2010 to 2012. Table 6 shows results of comparison.

Table 6. Variation comparison (+ is above 0 of Z score)

Firm	Actual Revenue Variation	RBR	CCES
1	8.22	-	+
2	19.49	+	+
3	-3.14	+	-
4	23.73	+	+
7	129.94	-	-
Concordance rate		40%	80%

According to table 6, CCES calculation is more precise than RBR. Similarly, both RBR and CCES calculate the two of negative firms. But CCES results represent the correct predictions except firm 7. Firm 1, 2 and 4 gain a positive variation from 8.22% to 23.73%. And firm 3 record the negative variation. Especially, Z score of firm 1, 2 and 4 shows close relations to actual revenue variation (high CCES related to high positive variation). Nevertheless, both methods show notable discrepancy from negative to 129.94% in firm 7. But, both method calculate the same Z score (figure 5) and over the doubled growth among 3years represented that variation of firm 7 is unpredictable.

So we can conclude that CCES is effective method to calculate the overseas business capabilities for international construction firms.

6. CONCLUSIONS

In the wake of the globalized project delivery environment, competition among contractors is becoming increasingly intense. For owners and clients, evaluating and selecting superior contractors based on a reasonable assessment system is a difficult but important task. This study proposed a quantitative approach for assessing the overseas-focused business capabilities of international construction firms. 18 indices were identified in 4 categories (technology resources, project management, experience and performance, and sustainability), and a relevant quantification method was presented. The applicability of the proposed method was verified with an illustrative example of Korean contractors, and the results showed a significant difference in contractors' ranks compared with existing methods.

Because this study is a preliminary step toward developing a new evaluation system for assessing overseas business capability, future studies are required to address the following limitations. First, the means of determining the relative weight of each criterion should be further examined and other stakeholders' opinions should be collected because this study collected opinions from only 14 respondents from international contractors, accounting firms and project management firms in Korea. Second, an in-depth study is needed to improve the quantification method. Finally, to apply the proposed system to the construction industry, related policies must be established to collect large amounts of data from numerous construction firms.

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