Predicting Profit Performance for Selecting Candidate International Construction Projects

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Abstract: International projects are inherently exposed to unpredictable and complicated risk scenarios. To minimize possible losses due to these risk exposures, construction firms have their own procedures or basic tools for selecting potential projects, but they are usually based on the experience and knowledge of the firm's engineers and decision makers that are often very subjective and lack scientific basis. This paper presents a quantitative profit prediction model for the early stage of an international project as a systematic risk-screening tool that involves the processes of defining, analyzing, and evaluating various profit-influencing risk variables. Various successful and unsuccessful international project cases with respect to profit levels are collected. Then, a scale-based profit prediction model to select candidate overseas projects is developed through factor analysis and a multiple regression analysis. Finally, this paper provides implications for global project management and lessons learned from case studies to improve profitability for international projects.

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Introduction

According to ENR (2005) and Global insight (2005), the present volume of the world construction market is approximately $4.1 trillion, of which the potential markets that foreign construction firms can access accounts for about $291 billion. Among this portion, the top 225 world international construction firms took $139 billion, which is only 3.4% of the total world construction market. Industry experts and other related research anticipate the rate of accessible markets to reach around 15–20% as the globalization of the construction markets expands, which will provide a tremendous opportunity to global contractors (ICAK 2004; ENR 2005).

In spite of these opportunities, a different situation threatens international construction. For instance, the long-term trend of profitability on about 3,487 projects performed by Korean global contractors in worldwide construction markets has been continuously decreasing (ICAK 2004). Here, profitability is the gain/loss divided by the total contract amount. In the 1960s, Korean contractors administered few international projects where the average profit rates were nearly 0%. Since the 1970s, the number of international projects acquired by Korean contractors has increased rapidly, with 70% of them making profits. Nevertheless, many projects in the 1980s confronted losses with the appearance of bad projects suffering losses lower than −10%. Even worse, over 50% of the projects in the 1990s and 2000s lost money or gained nearly 0%. This implies that the overall global construction market environment is deteriorating.

The profit trend that Korean contractors have experienced is similar to the top 225 global contractors. According to ENR (1994–2005), 15.1% of the "top 225 global contractors" have suffered losses in international construction projects during the last decade, while only 9.7% have suffered losses in domestic projects. Therefore, international construction projects have a higher probability of failure due to various risk variables that can reduce profitability if not managed properly.

Successful domestic projects do not secure success in international projects that are inherently exposed to unpredictable and complicated risk scenarios. For these reasons, it is very important to forecast the effects of these risks proactively from the early stage of projects and to establish risk management strategies to improve profitability. Toward that end, many authors have emphasized the importance of managing risks systematically under the floating environment of international construction markets (Bing and Tiong 1999; Hastak and Shaked 2000; Han and Diekmann 2001; Tah and Carr 2001; del Caño and de la Cruz 2002; Chan and Tse 2003). Although such research makes valuable points regarding international risk management, they do not sufficiently reveal the interaction between risk variables and project performance, particularly in view of profitability.

The main objective of this paper is to develop a profit prediction model for international construction projects by analyzing the causal relationships between risks (so called profit-influencing variables) and project profitability. As a means of capturing the associations, this study applies multiple regression analysis for causal analysis based on the 126 actual cases performed in the world construction market. Finally, this paper provides implications for global project management and lessons learned from case studies to improve profitability for international projects.

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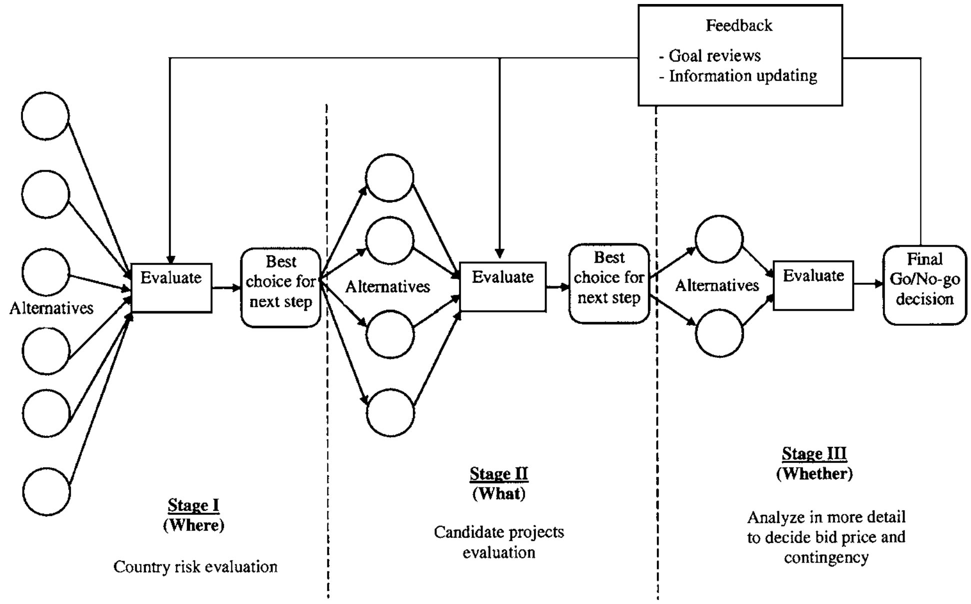

Fig. 1. Multistaged sequential decision processes

Theoretical Background

Typical Processes of Overseas Project Selection

Selecting a profitable international construction project implies sequentially evaluating candidate countries, finding potential projects, and making the bid decision for each project. Modeling representation is the step that forms the conceptual framework with which the bid decision process is organized. It is important to recognize that in many situations, one decision leads to another in a sequence (Clemen and Reily 2005). There are series and parallel systems in sequential decisions (Chun 1994). In a series system, a task is performed sequentially over time and each task must be completed before starting each successor task. On the other hand, a parallel system consists of a set of alternatives. Several different alternatives are available to perform and if one alternative fails to meet a firm's goal, it considers another.

A decision process for evaluating candidate overseas projects consists of these serial and parallel systems. Each multistaged series task that includes several possible alternatives is performed sequentially. Selecting a profitable international construction project consists of a dynamic decision process in multistaged sequential decision phases. It includes various decision alternatives within the series of sequential tasks. These model characteristics require a modeling tool that represents the sequential and iterative decision steps, translates the results of the best outcomes for the next step in each stage, and represents the optimal choice resulting from multistaged decision processes.

In general, there are three sequential decision stages in a strategic entry decision to find a profitable international construction project. The first stage determines favorable countries to enter. The second selects potential candidate projects in the host country in the early stage of project initiation by screening out unattractive projects. The third stage analyzes, in more detail, a specific project to determine the bid decision based on information such as reviews of contract conditions, an engineer's estimation, the firm's resources and capability, market and job conditions, and so on.

Fig. 1 shows the conceptualized sequential decision process developed for comprehensive decisions to select profitable international construction projects. Of the three sequential decision processes, this paper focuses on the candidate projects' evaluation phase, particularly in view of predicting potential profitability. This process models cause-and-effect relationships between risk variables and criteria of project outcomes for quantifying profitability levels.

Risk Variables Affecting Project Profit

The primary step in evaluating a loss in profit is to demonstrate what factors caused the loss. The search for factors on a business/project success or failure has been of great interest to both practitioners and researchers. According to Kangari and Boyer (1981), "bad profits account for over half of all business failures in the construction industry. Bad profit is the most significant in sustaining the business." Other important causes of business failure are management incompetence and lack of experience, inadequate sales, loss of market and economic decline, and difficulty collecting from customers. Loss of profit is an extremely disruptive force to construction firms.

Loss is mainly attributed to unanticipated speculative market conditions and project-related risks. A number of authors have described the risk variables specific to international construction projects, which are very sensitive to regional conditions such as currency devaluation, currency exchange restrictions, cultural differences, and unstable laws or regulations (Purtell 1982; Ashley and Bonner 1987; Arditi and Gutierrez 1991; Zhi 1995; Bing et al. 1999; Wang et al. 2000; Chan et al. 2001; Kapila and Hendrickson 2001; Chan and Tse 2003). Such research provided a basic knowledge of ascertaining risk variables involved in international construction projects. The variety of these risks make decision makers more sensitive to project conditions and forces them to require more return before making a final bid decision. Consequently, contractors are less assured about their entry or bid decisions for international projects than for doing work in domestic markets (Lynn and Reinsch 1990; Krishma et al. 1993).

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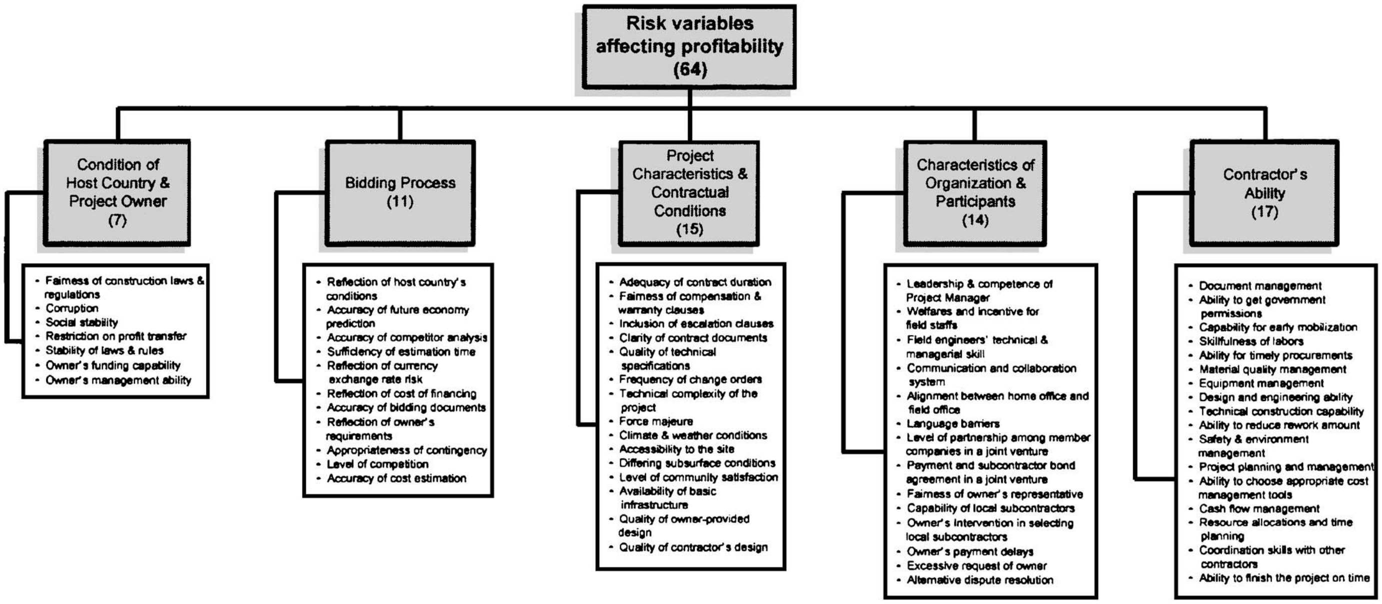

Fig. 2. Risk factors (5 classes—64 factors)

In addition, international construction projects are typically larger and more complex technologically and organizationally. Due to the distribution of projects around the world, an international contractor is more project-oriented, more mobile, and subject to more environmental influences. This risky nature of international construction makes the bid decision for potential project opportunities difficult and severely hampers a firm's success (Han et al. 2005). Perhaps this explains why construction firms should be aware of the potential causes of loss from the initial stage of bidding processes to screen the possibility of project failure.

Lee and Walters (1989) investigated the various tariff and nontariff barriers to international construction projects—including currency restrictions, government subsidies, and government acts and regulations—which put foreign construction firms at potential risk in doing business in international construction. Another survey performed by the International Contractors Association of Korea (2002) outlined the causes of damages/losses in international construction projects such as: (1) nonpayment by foreign governments due to a lack of funds or economic crises; (2) low profitability due to the competitive bidding process, misunderstanding of contract provisions or specification requirements, etc.; (3) miscommunication with foreign governments; (4) currency exchange rate risk exposures; (5) unfair contract clauses; (6) productivity decline due to weather, labor and material supply, etc.; (7) lack of experience and inability to perform; (8) conflicts among clients, engineers, contractors, and local subcontractors; (9) excess burden of banking and insurance cost; (10) failure to manage cash flow; and (11) damages due to inappropriate partners.

Typical causes of loss in international construction projects result from various trade barriers—related to government procurement, subsidies, license, and certification requirements—and project-specific roots such as repudiation, low bid price, and labor issues, etc. However, previous research related to the cause of success or failure factors of overseas projects has focused on the specific domains of various factors that are used to construct rudimentary or simple checklists.

Another stream of research (Baker et al. 1983; Arditi and Gutierrez 1991; Ashely et al. 1987; Chua et al. 1999; Bing and Tiong 1999; Wang et al. 2000) has provided a more analytical framework of critical success factors (CSFs) on project performance and suggested a guideline to implement CSFs in managing projects more effectively. But this research focused on domestic projects or specific configurations of risk exposures such as joint-venture risks or political risks on a build operate transfer project. In addition, it did not clearly present the causal relationships of these factors that can affect the level of profitability differently.

Based on the shortcomings of previous research, this paper identifies profit-influencing variables and their cause-and-effect structures based on case surveys from real overseas projects, which address all aspects of loss factors that can make international construction quite risky. The first step for finding possible cause of loss is to refer to previous studies related to loss of profit. The classifications used in this research are selected from various resources including the above-mentioned extensive literature and preliminary expert interviews with ten related industry practitioners.

As a result, we draw 93 risk variables associated with profitability as divided into five classes: (1) condition of host country and project owner; (2) bidding process; (3) project characteristics and contractual conditions; (4) characteristics of organization and participants; and (5) contractor's ability. Although these risk variables encompass most of the resources from the previous literature related to these issues, they have limitations for practical usage as well as duplicated meanings. Therefore, in order to ensure the applicability of risk variables, we conducted a series of focus group discussions with ten industry experts on international construction. Additionally, we examined 15 real cases of international projects that were exposed to severe losses to find any valuable sources in identifying risk variables. Through the case reviews and advice of experts to combine duplicate sources and to remove trivial variables with less impact, this paper identifies 64 profit-influencing variables on overseas construction projects, as shown in Fig. 2.

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Profit Prediction Model

Based on the responses regarding project performance and risk variables, we developed a profit prediction model which attempts to identify profit-making candidate projects in the early stage of project initiation. Various approaches exist to develop a forecasting model such as mathematical, heuristic, and statistic. The mathematical approach—including linear programming and dynamic analysis—has advantages in explaining results objectively, but the construction of a model is too difficult and as variables increase it requires considerable amounts of computer processing. The heuristic approach, such as genetic algorithms and neural networks, is capable of handling large amounts of data, but cannot guarantee the reliable results because these methods provide just heuristic optimum through trial and error. Subsequently, as a means of creating a forecasting model, this study applies multiple regression analysis to both analyze the causal relationship between the project profit level and the degree of exposure of each risk variable and to maximize its practical application.

Data Collection

We conducted structured case surveys to gather information on how project performance in view of profit was influenced by the performance level of 64 risk variables. The questionnaire consisted of two main parts: (1) the actual performance of a project in the sense of profitability; and (2) criticalities of each risk variable and the performance level of each variable in achieving the described profitability. The success level of a project (in terms of profit margin) was measured using a seven-point Likert scale ("1: not successful at all" to "7: exceptionally successful"). Similarly, the criticalities of 64 risk variables were measured by a seven-point Likert scale ("1: not critical at all" to "7: exceptionally critical"). Also, actual performance levels of each variable on the level of profit were measured by a seven-point Likert scale ("−3: very bad" to "3: very good") in order to help respondents judge easily because people are accustomed to this scale when quantitatively evaluating a phenomenon and to help understand the respondents' different opinions on the condition of profit-influencing variables. The performance level of a risk variable refers to how well contractors managed/controlled each variable. If respondents assign a negative index, it is likely that they perceive this variable, to some degree, as significant to bad profits.

Data were collected from Korean overseas construction companies based on their real performance and experience on international construction projects. As of 2005, Korean contractors completed projects abroad worth a total of $200 billion. We chose 126 sample projects randomly among 1,085 overseas projects performed by Korean global contractors during the last decade in connection with project types and regional distribution. In terms of project types, industrial plant projects account for 57%, whereas civil and building projects account for 23 and 14%, respectively. As for regional distributions, Asia is the largest portion (49%) and then sequentially followed by the Middle East (29%), and Central and South America (8%). The types of contracts were the highest in engineering-procurement-construction (EPC) projects (58%), and followed by design-bid-build (DBB), (20%) and design-build (DB), (13%). In terms of the payment condition, most projects (76%) were procured by lump-sum contracts, whereas the percent of unit-price and cost-plus contracts were only 20 and 1%, respectively. This implies that most international contracts are dominantly procured on the basis of lump-sum payment conditions.

Table 1. Survey Results of Sample Projects Performances

Project performance	Response rate (%)	Mean	Standard deviation
Level of success (7 point Likert scale: 1–7)	97.8	4.67	1.89
Final profit margin (%)	52.2	8.24	16.33
Cost variance (%)			
Project total	94.4	102.53	12.30
Resource cost	94.4	101.35	11.73
Outsourcing cost	91.1	107.14	20.63
Management cost	91.1	109.74	43.74

As for the contract duration, the portion of projects that run two to three contractual years accounts for 51% among the sample projects. Also, these firms have experienced time extension, which indicates that 95% of projects were delayed from 1 year (61%) to beyond 2 years (7%). The total volume is valued at $26 billion, which consists of medium-sized projects ranging from $50 to $500 million (61%) and relatively small projects below $50 million (31%), followed by the megaprojects over $500 million (8%). These patterns coincide with the typical characteristics of 1,085 overseas projects performed by Korean global contractors during the last decade and reflect the recent trend of international construction markets with respect to project types, delivery patterns, and regional distributions.

More than 80% of the respondents who were taking part in those projects have at least 5 years of experience in overseas projects. Of the 126 respondents who were engaged in the sample projects, around 90% were project managers or project assistant managers in order to have the personal background and sufficient experience with the designated project. Because each participant may exhibit different types of perspectives, we asked participants to reply from their firm's view and project-specific standpoint.

Case Survey Results

We summarize results of the project performances in Table 1. First, the average success level in view of profit margin is 4.67 out of 7, which means an average level of profits achieved. The average cost variance compared to its planned cost has increased by 102.53%. Subcontracting and management costs were well beyond the average, up to the ranges of 107.14 and 109.74%, respectively. This implies that actual costs of overseas projects fluctuate greatly because of outsourcing and indirect costs rather than direct costs such as material and equipment.

In addition, we analyzed the level of success and the cost variances with respect to different project characteristics (see Fig. 3). In the case of contract types, EPC and DBB demonstrated higher levels of success (4.73 and 4.61) and slightly lower levels of cost variance (101.88, 102.44%), whereas those of DB recorded 3.83 and 107.83%, respectively. DB delivery systems involve relatively tough conditions in which to obtain profits [Fig. 3(a)]. As for the contract duration, long-term projects over 4 years showed particularly bad profitability (3.8) and a high increase of cost (113.0%), whereas short-term projects shorter than 1 year had a higher performance in profit (5.0) and a low level of cost variance under budget (95.0%). This implies that the longer the contract duration, the poorer the project profitability [Fig. 3(b)].

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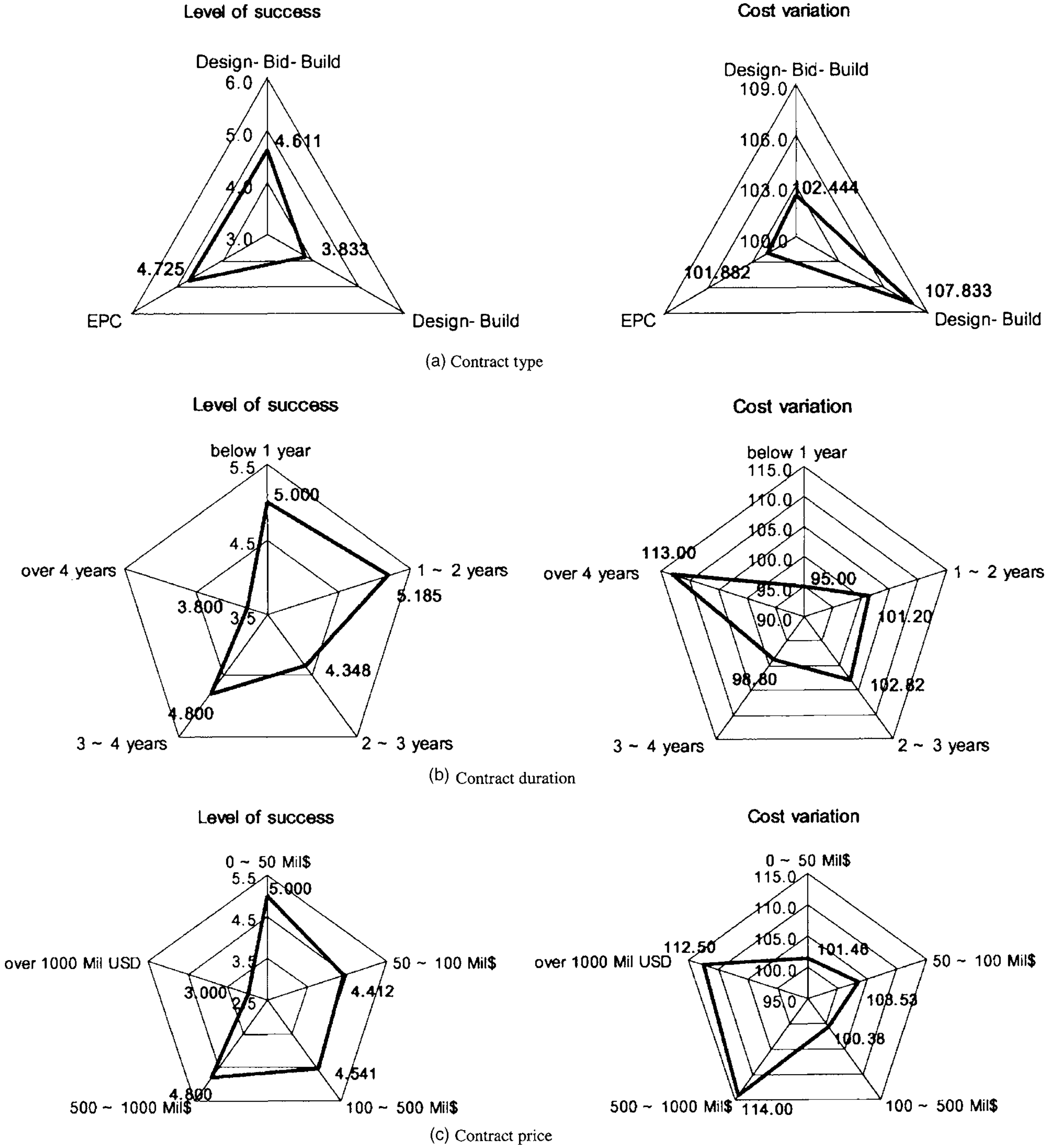

Fig. 3. The level of success and the cost variance by the project characteristics

In the case of contract volume, as shown in Fig. 3(c), mega projects over $1,000 million showed a low level of success (3.0) and a high increase in cost variance (112.50%). Apparently, based on the survey results, long-term mega projects are more likely to have bad project performances in view of both project profits and cost variances.

Factor Analysis

We first calculated Cronbach's alpha based on the scoring scales ranging from "0" to "1." Nunnally (1978) suggested that the acceptable limits of Cronbach's alpha should be 0.7 or better based on various experimentations and experiences. The calculated alpha values ranged from 0.75 to 0.88—sufficiently above the acceptable limits. Further, we do exploratory factor analysis of empirical data to discover and detect characteristic features and interesting relationships without any definite constructs on the data (Lee 2003). This procedure is often used to reduce the number of variables in a data set. Through the principle component analysis, the variables which had eigenvalue of above "1" were sorted out to compress 64 risk variables into relevant groups.

As shown in Table 2, we drew 14 group factors as a valid subdimensional representation of the initial sources of 64 profit-

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Table 2. Result of Factor Analysis—14 Factor Groups

Factor 1 Contractors' ability and experience	[Q56] Technical construction capability
	[Q55] Design and engineering ability
	[Q58] Safety and environment management
	[Q57] Ability to reduce rework amount
	[Q59] Project planning and management
	[Q38] Communication and collaboration system
	[Q25] Technical complexity of the project
	[Q48] Document management
	[Q39] Language barriers
	[Q24] Frequency of change orders
Factor 2 Project condition (resource delivery, labor skill, etc.)	[Q63] Coordination skills with other contractors
	[Q64] Ability to finish the project on time
	[Q53] Material quality management
	[Q52] Ability for timely procurements
	[Q51] Skillfulness of labors
	[Q44] Owner's intervention in selecting local subcontractors
	[Q54] Equipment management
	[Q49] Ability to get government permissions
	[Q62] Resource allocations and time planning
	[Q43] Capability of local subcontractors
Factor 3 Project environments (site condition, climate, etc.)	[Q29] Differing subsurface conditions
	[Q28] Accessibility to the site
	[Q31] Availability of basic infrastructure
	[Q30] Level of community satisfaction
	[Q27] Climate and weather condition
	[Q26] Force majeure
Factor 4 Attitude and ability of owner and A/E	[Q46] Excessive request of owner
	[Q14] Accuracy of bidding documents
	[Q23] Quality of technical specifications
	[Q7] Owner's management ability
	[Q42] Fairness of owner's representative
	[Q45] Owner's payment delays
	[Q15] Reflection of owner's requirements
	[Q6] Owner's funding capability
Factor 5 Commitment of organization (PM competency, etc.)	[Q34] Leadership and competence of project manager
	[Q35] Welfares and incentives for field staffs
	[Q37] Alignment between home office and field office
	[Q36] Field engineers' technical and managerial skill
	[Q50] Capability of early mobilization
Factor 6 Condition of host country	[Q4] Social stability
	[Q3] Stability of laws and rules
	[Q2] Extent of corruption
	[Q1] Fairness of construction laws and regulations
	[Q5] Restriction on profit transfer
Factor 7 Project information in early stage of a project	[Q8] Reflection of host country's conditions
	[Q13] Reflection of cost of financing
	[Q10] Accuracy of competitor analysis
	[Q9] Accuracy of future economy prediction
Factor 8 Quality of design	[Q33] Quality of contractor's design
	[Q32] Quality of owner-provided design
Factor 9 Appropriateness of cost management	[Q12] Reflection of currency exchange rate risk
	[Q60] Cost management tool
	[Q61] Ability for cash flow management
	[Q16]Appropriateness of contingency
Factor 10 Quality of estimation	[Q11] Sufficiency of estimation time
	[Q18] Accuracy of cost estimation
Factor 11 Relationship in a joint venture	[Q40] Level of partnership among member in a joint venture

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Table 2. (*Continued.*)

	[Q41] Payment and subcontractor bond in a joint venture
Factor 12 Contract condition	[Q21] Inclusion of escalation clauses
	[Q20] Fairness of compensation and warranty clauses
	[Q22] Clarity of contract documents
	[Q19] Adequacy of contract duration
Factor 13 Bidding competition	[Q17] Level of competition
Factor 14 Capability of claim and dispute resolution	[Q64] Alternative dispute resolution

influencing variables. Each group factor consists of a series of similar and sensible risk variables of which the loading factors are above 0.3 at the minimum—which means those variables are loaded strongly on each of the designated group factors. In addition, we organized them by similar characteristics and higher correlations. As a result, total variance in project profitability explained by these group factors is estimated up to 70.37%. Accordingly, it would be conservative to say we elicited the group factors appropriately. The grouping result of factor analysis is listed in Table 2.

Additionally, through statistical analyses, we carefully examined the ranking of the group factors based on the mean values of criticality, which influence profitability more than the rest. The relative degree of criticality of these group factors on the project's profitability was measured using a "1"–"7" scale. As a result, "F10: quality of estimation (5.174)," "F5: commitment of organization such as project manager's competency (5.123)," "F4: attitude and ability of owner and A/E (5.032)," "F13: bidding competition (4.988)," "F12: contract condition (4.942)," and "F14: capability of claim and dispute resolution (4.840)" were the major group factors that affected the degree of overall profitability.

In addition, survey results concerning how well contractors managed/controlled each factor showed different outcomes. The average score of the group factors were recorded using a "−3" to "3" scale. The factors managed improperly that affected bad profit were mainly attributed to those related to the early stage of a project such as "F13: bidding competition (−0.459)," "F8: quality of design (−0.369)," "F12: contract condition (−0.325)," and "F11: relationship in a joint venture (−0.055)."

Interestingly, this paper compared the deviation (D) between the management level and the criticality of each group factor by converting Likert scores to 100 points (see Fig. 4). As a result, it highlights that factors related to "F13: bidding competition ($D=24.11$)," "F12: contract condition including host country's environment and adequacy of contractual duration ($D=21.13$)," "F8: quality of design ($D=17.99$)," and "F4: owner and A/E's ability and attitude such as owner's funding capability and excessive request ($D=17.64$)," were rated as having higher importance. However, the performance rating (level of management) of these factors were below the overall average. In a real business environment, control over every factor is impossible, so in project performance management it is better to focus on the critical factors identified in the preceding analyses. These factors are the highest priority for managing profit-influencing factors according to our interpretation of survey responses.

Multiple Regression Analysis

The 14 group factors can be useful in developing a profitability prediction model. We correlated the results of factor analysis with project performance to evaluate the relationships between the success level of a profit and the 14 underlying dimensions of the group factors. We performed stepwise regression analysis to test the hypothesis in these relationships. Subsequently, we drew the following regression model through the eight steps of variable selection processes. Table 3 shows the result of the regression analysis and Eq. (1) represents the final regression model:

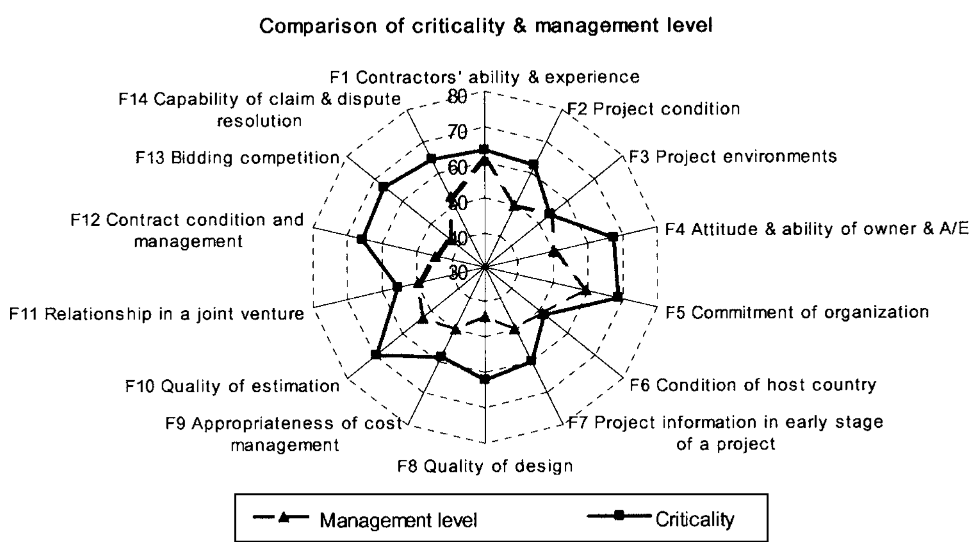

Fig. 4. Factor analysis results—the criticality and the management level

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Table 3. Result of Multiple Regression Analysis

(a) Model summary

Number of factors	R	R square	Adjusted R square	Standard deviation of presumption	Durbin–Watson
8	0.843	0.652	0.608	1.308	1.805

(b) Coefficients of multiple regression analysis

	Unstandardized coefficient		Standardized coefficient		
Composition (group factors)	B	Standard error	β	t	Significance
Constant	4.670	0.138		33.873	0.000
F10 Quality of estimation	0.619	0.139	0.332	4.467	0.000
F7 Project information in early stage of a project	0.527	0.139	0.283	3.800	0.000
F4 Owner and A/E's ability and attitude	0.506	0.139	0.271	3.647	0.000
F12 Contract condition and management	0.499	0.139	0.267	3.596	0.001
F2 Project condition—Resource delivery, labor skill, etc.	0.477	0.139	0.256	3.440	0.001
F5 Commitment of organization—PM competency, etc.	0.470	0.139	0.252	3.393	0.001
F1 Contractor's ability and experience	0.402	0.139	0.216	2.899	0.005
F8 Quality of design	0.379	0.139	0.203	2.734	0.008

Note: Dependent variable—the level of success (in terms of profit margin).

$$\begin{aligned}\text{Performance of profit} \\ &= 4.670 + 0.619 \times \text{F10} + 0.527 \times \text{F7} + 0.506 \times \text{F4} \\ &\quad + 0.499 \times \text{F12} + 0.477 \times \text{F2} + 0.470 \times \text{F5} \\ &\quad + 0.402 \times \text{F1} + 0.379 \times \text{F8} \qquad (1)\end{aligned}$$

Also, 8 of 14 group factors have a significant linear relationship with the success level of project profit. Among these factors, "F10: quality of estimation," "F7: project information in the early stage of a project," and "F4: owner and A/E's ability and attitude" have higher impacts on project profit than those from other factors, where their coefficient values are 0.619, 0.527, and 0.506, respectively. All of the coefficient values are significant in the 95% confidence level. According to Choi (2000), the regression model is considered reliable in general terms when the value of R square is above the 0.4–0.5. The generated model accounts for 65.2% of the variance (R square), which indicates a good association between the independent variables and the dependent variable. In addition, it requires a test for autocorrelation in the residuals of regression to confirm the appropriateness of the regression model. The Durbin–Watson statistic measures the degree of autocorrelation in the residuals of regression. A value below 2.0 for the Durbin–Watson statistic indicates that there is no serial correlation along the factors in the model. The proposed model is measured as 1.805, which denotes a lower possibility of self-autocorrelation of residuals.

The prediction model uses 126 projects to apply quick forecasting at the early stage of candidate projects. However, it cannot yet reflect project characteristics such as types of project, region, and contract types that critically affect the conditions of international projects. To compensate for this limitation, we derived significant influencing aspects in evaluating candidate projects with consideration of the project characteristics using multiple regression analyses.

As the first step, we classified 126 projects in accordance with the aforementioned characteristics. Next, we generated specific regression models based on the grouped sample projects. Then, we compared coefficient values of each model along with the project characteristics. As for the project types, as shown in Table 4, civil projects showed higher importance on the factors such as "F1: contractor's ability and experience," "F8: quality of design," and "F10: quality of estimation." On the other hand, "F5: commitment of organization," F2: "project condition," and "F13: bidding competition" affected profit performance more significantly in building projects. In the case of industrial plant projects, "F12: contract condition," "F5: commitment of organization," and "F7: project information in early stage" factors are more sensitive. These results imply that civil projects are affected more easily by a contractor's own ability such as design, estimation, and construction capabilities. Building projects involve the important factors associated with participants' relationships because there are assorted parties and complex relationships generally involved in building works. Further, the significant factors for industrial plant projects are affected more by the factors related to early stage information, organizational relationships, and contractual environments because they are typically delivered in the EPC form and subsequently necessitate many contractual relationships due to the inherent complex characteristics and the importance of the design and procurement process.

We also compared related factors associated with the country regions where the projects were located. Due to insufficient sample data in deriving the specific models according to the various regional features, we were only able to compare the differences between Southeast Asia and the Middle East. As shown in Table 4, "F4: attitude and ability of owner and A/E" and "F7: project information in early stage" recorded higher values in the Middle East, whereas "F7: project information in early stage," "F10: quality of estimation," and "F1: contractor's ability and experience" had more effect in Southeast Asia.

Finally, through the comparison of contract types (see Table 4), "F8: quality of design," "F10: quality of estimation," and "F1: contractor's ability and experience" are major considerations in traditional design-bid-build projects. However, as expected, "F7: project information in early stage," "F5: commitment of organizations," and "F12: contract condition" were highly ranked in the cases of EPC and DB projects. This can be explained by the fact that the profit performance of these types can be affected more easily by the factors related to preconstruction phases or the conditions of project environments including unfair contract forms

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Table 4. Result of Multiple Regression Analysis by Project Characteristics

(a) Project type

Group factors	Regression coefficients: Civil	Building	Plant	Total
Constant	4.737	3.988	5.005	4.670
F1 Contractors' ability and experience	1.102		0.487	0.402
F2 Project condition		1.672	0.416	0.477
F3 Project environments				
F4 Attitude and ability of owner and A/E				0.506
F5 Commitment of organization		2.299	0.623	0.470
F6 Condition of host country				
F7 Project information in early stage of a project			0.568	0.527
F8 Quality of design	0.924			0.379
F9 Appropriateness of cost management				
F10 Quality of estimation	0.729		0.591	0.619
F11 Relationship in a joint venture				
F12 Contract condition			0.780	0.499
F13 Bidding competition		0.821		
F14 Capability of claim and dispute resolution				
Sample size (*N*)	34	20	72	126
R^2	0.575	0.487	0.568	0.652

(b) Region

Group factors	Regression coefficients: Southeast Asia	Middle East	Total
Constant	4.611	4.645	4.670
F1 Contractors' ability and experience	0.501		0.402
F2 Project condition			0.477
F3 Project environments			
F4 Attitude and ability of owner and A/E		1.505	0.506
F5 Commitment of organization		0.536	0.470
F6 Condition of host country			
F7 Project information in early stage of a project	0.808	1.287	0.527
F8 Quality of design		0.546	0.379
F9 Appropriateness of cost management			
F10 Quality of estimation	0.666		0.619
F11 Relationship in a joint venture			
F12 Contract condition			0.499
F13 Bidding competition			
F14 Capability of claim and dispute resolution		0.835	
Sample size (*N*)	62	37	126
R^2	0.360	0.720	0.652

(c) Contract type

Group factors	Regression coefficients: EPC	DB	DBB	Total
Constant	4.590	3.923	4.914	4.670
F1 Contractors' ability and experience			0.791	0.402
F2 Project condition				0.477
F3 Project environments				
F4 Attitude and ability of owner and A/E				0.506
F5 Commitment of organization	0.482			0.470
F6 Condition of host country				
F7 Project information in early stage of a project	0.807			0.527
F8 Quality of design			1.180	0.379
F9 Appropriateness of cost management				
F10 Quality of estimation	0.646		0.835	0.619
F11 Relationship in a joint venture				
F12 Contract condition		1.784		0.499
F13 Bidding competition				
F14 Capability of claim and dispute resolution				
Sample size (*N*)	72	17	26	126
R^2	0.425	0.507	0.775	0.652

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Table 5. Comparisons of Actual and Predicted Performances

Project	Actual level of success	Regression model: Forecasting results	Deviation
1	7	6.71	0.29
2	5	4.18	0.82
3	5	3.28	1.72
4	5	7.00	2.00
5	7	6.15	0.85
6	7	7.00	0.00
7	1	1.00	0.00
8	5	2.96	2.04
9	5	4.83	0.17
10	6	6.28	0.28
11	4	5.98	1.98
12	6	7.00	1.00
13	1	1.00	0.00
14	1	1.37	0.37
15	2	2.83	0.83
Average			0.82
RMSE			1.109
Overall accuracy			86.3%

and specifications rather than typical construction-specific or contractor-oriented causes such as capability of contractors, experiences, and accuracy of estimation.

Validation of the Model

Although the 126 projects used to build the model have similarities to the other projects, we needed to validate the model because the collected data are particular samples of a population. Toward this end, we selected 15 additional projects to validate the model by comparing the predicted outputs from the model to the actual success level of profit. T-test was used to find differences between the 126 sample projects and the 15 additional projects in terms of project size and contractual durations. The T-test result revealed that the level of significance of a two-tailed test is 0.962, which means that there are few differences (only 3.8% of error) between the two project groups.

Then, we compared the deviation between the output from the model and actual success levels from the respondents. The accuracy of the model was expressed by means of a percentage of accuracy (Table 5). As a validation result, the average deviance on the level of profits is estimated at 0.82 and the overall accuracy reaches 86.3% by converting the deviance into 100 point scales. In addition, the root-mean-square error (RMSE) was measured to evaluate the accuracy of the proposed model. The RMSE is widely used in evaluating the performance of the model, as expressed by Eq. (2). Generally, a smaller RMSE indicates a better performance. The RMSE of the prediction model is estimated at 1.109, which indicates a reasonable accuracy in predicting a scale-based profit for any probable overseas project

$$\mathrm{RMSE} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}[\hat{F}_i - \tilde{F}_i]^2} \tag{2}$$

where $\hat{F}_i$=estimated profitability of project; $\tilde{F}_i$=actual profitability of project; and N=sample size of test.

Validation results reveal that the model effectively predicts scale-based profitability for overseas projects in the early state of project initiation, while maintaining reasonable accuracy. Although the model was developed based on Korean overseas contractors' performance and is valid only for the Korean construction industry in a straightforward sense, the benefits of using this model as a screening and selecting tool for overseas projects are not limited to a specific country. Also, the experiences and performance of the Korean overseas contractors can provide useful information for other country's contractors and a similar model can be developed easily by reflecting specific conditions through the model development procedure suggested.

Discussions on the Key Determinants

This research provides a basis for profitability evaluation with which overseas construction participants can forecast and analyze risk more systematically, by eliciting profit-influencing factors from real overseas construction projects and identifying their causal relationships. It also reveals critical factors directly related to profitability aggravation through a quantitative analysis. Ultimately, with this causal structure as the base, this research suggests how to develop a quantitative profitability forecasting model.

As presented, critical factors concerning profitability in international construction projects mainly lie in: (1) quality of estimation such as provided estimation period and ability of quantity surveyors; (2) project information in the early stage such as adequacy of financing, prior bid information, site investigation, and country risk-rating, etc; (3) attitude and ability of owners and A/E; (4) contract condition and management ability; (5) project environment and condition such as resource delivery, procurement system, labor skill, etc.; (6) commitment of organization such as the project manager's competency and the ability of field engineers; and (7) contractor's ability and experience.

Along with the critical factors, we asked each respondent to list the three most critical criteria that affected their decisions in selecting profitable projects. The top ranked criteria are: (1) desirable contract forms and specifications; (2) credibility and stability of funds; (3) business environment of host country; (4) contractors' technical construction capability; (5) factors related to the owner such as not having an established relationship and reputation; (6) number of risks; (7) conditions of resource supplies and procurements; (8) familiarity and experience with the work; (9) project scale and contractual duration; (10) field conditions; and (11) degree of localization. Interestingly, these criteria mostly coincide with the top-ranked factors or important risks prioritized by the criticality among the 64 profit-influencing variables, which implies that the model underlines the basic characteristics of bid decisions and experts' perceptions in selecting potential overseas projects.

At this point, by the model's results and content analysis of descriptive answers, we found the differences between the loss and profit projects. First, we found the common reasons for earning profits from 30 excellent cases. These are summarized as: (1) top management support and leadership; (2) competent project manager; (3) good relationship with owners; (4) high-quality estimations by proficient persons in charge of cost estimation; (5) careful examination on contract terms and strategic negotiation for improving project conditions; (6) timely procurements and resource supply; (7) good efforts for localization; (8) systematic

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prevention of conflicts; (9) timely provision of schedule and plans for monitoring and feedback; (10) trouble-shooting to handle unexpected events; and (11) availability of skilled local subcontractors and expertise to improve engineering and construction activities.

On the other hand, most loss projects (50 cases) entail diverse problems due to the risks originated from the local countries and owner's inclination. The critical causes affecting bad profit were mainly attributed to the incapability of local subcontractors, corruption in the host country, excessive owner requests, client dissatisfaction with the delivered projects, inadequate coordination within the project organizations, lack of the technical expertise and skilled personnel in the domain of overseas projects, and lack of a monitoring mechanism to handle deviations and successive changes.

More specifically, the lack of information during the early period of a project led to a deficiency of contract management, and subsequently induced losses during the construction phase, whereas, in the case of the profit projects, the contractors endeavored to reduce or mitigate the risks that seemed to be unexpected or uncontrollable in the early step of contract negotiation. Clearly, correct information collectable in the early stage of the bidding process is worthwhile as a basis of negotiation to minimize unfair or unfavorable contract clauses. In addition, resource procurement and supply management are closely related to an economic situation, a regulation, a local custom, and the cultural background of local countries. Despite these facts, loss projects often faced problems associated with inefficient material supply by the local countries' cultural custom and regulation.

Conclusions

All overseas projects are possible candidates for losses due to the risks inherent in the process. The circumstances of a project's gains or losses are unique and subsequently attempts for formalizing a prediction model are hard to pin down. An important finding of our study, however, is that overseas projects have some fundamental similarities concerning the factors that can determine the success or failure with respect to profitability. While the causes of project gain/loss differ in various ways across the projects, our research draws essential and similar requirements for acquiring profitable projects. Particularly, this work identifies key variables and develops a prediction model that can determine the profitability of an overseas project.

In summary, this research can allow construction firms to screen out bad projects when the warning signals of failure are detected early by paying attention to critical factors. The prediction model can assign weights to every risk factor embodied as an application and so provide a prompt management guideline for construction companies just by answering 64 questions regarding the profit-influencing variables at the early stage of project initiation. By abandoning bad projects, firms can improve their financial structure at the corporate level.

Despite its advantages, however, our forecasting target is focused on the scale-based success level of projects because real earnings ratio could not be collected due to companies' privacy and confidential policy about actual profit rates. In addition, this paper develops a model for general types of overseas projects due to the limited sample data. With all the statistical analysis results so far, the importance of the group factors can be varied according to the various classification criteria such as project or contract types, countries, or even company-specific factors. Future research will focus on establishing the specialized models with respect to the different types of owners or diverse regional locations by collecting more valuable project samples. A range of data mining techniques, such as neural network, discriminant function, structural equation model, and case-based reasoning, will also be considered to improve the profit prediction accuracy.

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