

Critical Success Factors of Large Design-Build Projects in Vietnam

Chau Ngoc Dang¹, Long Le-Hoai², and Young Dai Lee³

Received July 15, 2012 / Accepted August 8, 2012

Abstract: *Design-build (D&B) has been broadly perceived as an effective project delivery method and become popular in the world. However, the implementation process of this innovative procurement method in Vietnam encounters difficulties due mainly to unfamiliarity and inexperience with the approach. Critical success factors (CSFs) which could be used to enhance the project execution are useful to practitioners in Vietnam if identified. A questionnaire survey was employed to identify CSFs of D&B projects in Vietnam. Parties' competence, especially financial capability, and contract documentation are the most important factors significantly affecting project success. It was also shown that the perspectives of two principal parties in D&B projects on the CSFs are statistically correlated. The identified CSFs were then validated with some various D&B projects. The execution results of CSFs were compared with the projects' performance measured by key performance indicators (KPIs). The most important success factors of this study were also compared with other countries'. The validation and comparison results provide project participants with some useful information to perform D&B projects better. Practitioners should well perform the identified CSFs to enhance the chance of the success of D&B projects in Vietnam. The findings of this study are useful not only to Vietnamese practitioners but also to others who are concerned about D&B method and plan to employ it in Vietnam in future.*

Keywords: *Design-build, Critical success factors, Key performance indicators*

I. INTRODUCTION

Success of construction projects in construction industry, especially large projects, is not only very important for all project participants but also for national development in industrialization and modernization age. Unfortunately for Vietnamese project participants, construction projects in Vietnam have been frequently faced with many problems, which usually make them disappointed, in recent years such as delay, cost overrun and even project failure due mainly to the increased complexity of most construction projects (Le-Hoai et al., 2008). Traditional method (design-bid-build, DBB) is the widely applied delivery method of construction projects in Vietnam.

Design-build (D&B) is a project procurement method where one entity or consortium is contractually responsible for both design and construction (Songer et al., 1997). D&B method, demonstrated to be an effective delivery method, has become popular in the world in recent years (Xia and Chan, 2010). D&B method provides project participants with many advantages such as: single-point responsibility, fast delivery/time saving, reducing change orders, potential good quality, increased productivity, reduced owner risk, decreased administrative burden, potential cost savings/enhanced financial certainty, fewer litigation claims/reduced disputes (Hale et al., 2009; Konchar and Sanvido, 1998; Satterfield, 2009). As such, many project burdens in

Vietnam would be reduced if construction projects were delivered by D&B. However, D&B has not been widely applied in Vietnam because project participants are still unfamiliar and inexperienced with this innovative procurement method.

In recent few years, Vietnam has a dynamic economy which has developed speedily. Construction industry plays a vital role in the national economy. However, the success of most construction projects is much affected by physical, political and social environment, cultural traditions, and especially human-related factors which are usually different from country to country. For this reason, practitioners in Vietnamese market would have difficulties in managing their projects if they merely applied project management strategies adapted from other countries. A study which is carried out to capture the natures and conditions of Vietnamese construction market is, therefore, useful to project participants.

This study aims to (1) identify critical success factors (CSFs) of D&B projects in Vietnam, especially large projects; (2) validate the identified CSFs with various large D&B projects; and (3) identify a general view of CSFs of developing and developed countries. This study focuses on large projects only. A large construction project is defined as a project with the total budget not less than US\$ 1 million (1 US\$ = 20,000 VNDs).

¹ University of Technology, National University of Hochiminh City, Hochiminh City, Vietnam (Email: chaungocdang@gmail.com)

² Ph.D, Lecturer, Faculty of Civil Engineering, University of Technology, National University of Hochiminh City, Hochiminh City, Vietnam (Email: lehoailong@hcmut.edu)

³ Member, Professor, Dept. of Civil and Construction Engineering, Pukyong National University, Busan 608-739, Korea (Corresponding Author, Email: ydlee@pknu.ac.kr)

II. PROJECT SUCCESS, CSFs AND KPIs

A construction project is commonly acknowledged as successful when it is completed on time, within budget, and in accordance with specifications and to stakeholders' satisfaction (Nguyen et al., 2004). Thus, project success is usually defined as meeting time, cost and quality objectives and satisfying project stakeholders (Baccarini, 1999). Project success could be refined into achieving product success, which meets quality output standards, and process success, which meets time and budget objectives (Ling, 2004). The concept of project success has remained ambiguously defined in the construction industry because determining whether a project is a success or failure is intricate (Chan, 2001; Nguyen et al., 2004). Therefore, this study focuses on identifying CSFs in order to increase the chance of project success. CSFs of construction projects are vital strategic elements to achieve positive outcomes or results from effective strategies (Sanvido et al., 1992; Nguyen et al., 2004). Project outcomes could be measured by using key performance indicators (KPIs). KPIs with the purpose to enable measurement of project and organizational performance are general indicators of performance focusing on critical aspects of outputs or outcomes (Chan, 2001).

III. LITERATURE REVIEW

A. Critical success factors of D&B projects

A review of previous studies reveals that success of D&B projects could be significantly affected by a large number of CSFs consolidated into six headings, namely project procedures, project characteristics, project work atmosphere, project environment, project strategies, and project-related participants (Lam et al., 2004). Project participants should not only clearly understand project characteristics but also well manage project procedures. Project goals could not be easily achieved without effective project strategies. It is very good for all projects if they are implemented in an advantageous environment. A pleasant and comfortable atmosphere may encourage project participants to work harder and more effectively.

Project procedures should be well performed to achieve good project performance. In D&B projects, prequalification of potential tenders is necessary to make an initial assessment of interested parties' suitability to undertake project works (Lam et al., 2004). The justice in tendering and selecting contractors should be ensured (Molenaar et al., 1999). Pretender site investigation should be comprehensive and contractors' proposals should be assessed thoroughly (Chan et al., 2001). Besides, conditions and regulations of contract documentation should be comprehensive about parties' rights and duties to provide adequate information for the responsibilities at various stages of design and construction (Nguyen et al., 2004).

Project characteristics are important to project success (Songer and Molenaar, 1997). In public sector D&B projects, especially large projects, well-defined project objectives and scope, thorough understanding of project

complexity and well-planned project schedule are essential to project success (Molenaar and Songer, 1998). In addition, a precise budget definition to establish a fixed cost for a project before submitting it to a D&B contractor is really good for project performance (Songer and Molenaar, 1997).

Project participants should also pay much attention to project environment. Good weather and availability of resources during project performance could enhance the chance of D&B projects to be completed by contractual completion date (Nguyen et al., 2004). In addition, favourable economic environment and government support are advantageous to project success (Lam et al., 2008).

A pleasant and encouraging working atmosphere is conducive to the success of D&B projects (Lam et al., 2004). The unity, cooperation, respect, and mutual trust among project-related parties could help all project participants have good/active attitudes to the job as well as good interaction and relationship with each other. Sharing of common project goals is likely to reduce disputes and claims (Chan et al., 2001).

An effective project management strategy is one major determinant of project success (Smith and Wilkins, 1996). Adequate systems for quality, risk, safety, and more human-related conflict management during project performance are always necessary. Communication channel and feedback systems need using properly and effectively (Lam et al., 2004). Design changes need timely and effectively monitoring and approving (Chan et al., 2001). With effective overall management actions in planning, organizing, leading, and controlling, project works could be ensured in good condition (Nguyen et al., 2004).

Project participants play an important role determining the success or failure of a project (Nguyen et al., 2004). Therefore, human-related factors should be well performed in order to achieve good project outcomes (Lam et al., 2008; Ling and Liu, 2004; Ling et al., 2000; Xia et al., 2009; Xia and Chan, 2010). Project-related participants refer to related major parties in D&B projects including owners, contractors, design consultants, project management consultants and project managers or project team

B. Key performance indicators

Project success could be measured by a range of KPIs which are objective and subjective measures (Chan, 2001). A review of relevant previous studies shows that there are four main headings including cost, time, quality, and owner that are usually used to measure project success (Ling, 2004; Ling and Liu, 2004) (see Table 1).

Cost and time are two important aspects which are usually used to measure the performance of D&B projects (Chan et al., 2001; Konchar and Sanvido, 1998; Ling and Liu, 2004; Molenaar and Songer, 1998; Rosner et al., 2009). Project costs could be managed in three areas which are unit cost, cost growth and intensity. Unit cost and cost growth are expected to be minimized whereas project intensity should be high. Relating to project time,

construction speed, delivery speed and schedule growth are three metrics which are usually paid much attention to. Project managers would like to maximize construction and delivery speeds whereas they are expected to minimize schedule growth.

TABLE I
DEFINITION OF KEY PERFORMANCE INDICATORS

Headings	Performance metrics	Definition
Cost	Unit Cost (\$/m ²) Cost Growth (%) Intensity [(\$/m ²)/month]	Final Project Cost/Gross Area /Index [(Final Project Cost – Contract Project Cost)/Contract Project Cost] × 100 Unit Cost/Total Time
Time	Construction Speed (m ² /month) Delivery Speed (m ² /month) Schedule Growth (%)	Gross Area/(As-built End Date – As-built Construction Start Date)/30 Gross Area/Total Time [(Total Time – Total As-planned Time)/Total As-planned Time] × 100
Quality	System Quality Equipment Quality	Performance of building elements, interior space and environment (1 = very unsatisfactory; 5 = very satisfactory) Performance and adequacy of mechanical and electrical equipment (1 = very unsatisfactory; 5 = very satisfactory)
Owner	Owner's Satisfaction Owner's Administrative Burden	1 = very unsatisfactory; 5 = very satisfactory 1 = very heavy burden; 5 = minimum burden

Adapted from Ling and Liu, 2004

In addition, the success of D&B projects is usually measured by important issues relating to quality and owner (Ling and Liu, 2004; Molenaar and Songer, 1998). Owner's administrative burden and owner's satisfaction are two important owner-related performance metrics. Owners always want to minimize their administrative burden when performing their projects. Owner's satisfaction is also very important to measure whether a project is successful. In order to make clients satisfied, project quality including system quality and equipment quality should be good enough to obtain their expectation.

IV. RESEARCH METHODOLOGY

This study was carried out through two phases. First, CSFs of D&B projects in Vietnam were identified based on two main parties' perspective involved in D&B projects (phase 1). The identified CSFs were then validated with various D&B projects in Vietnam (phase 2).

A. Phase 1 – Identification of Project Success Factors

At first, an in-depth literature review was done to extract a list of all potential success factors from previous related studies. A group of fourteen experts was invited to take part in refining the list. All of them are practitioners in construction industry in Vietnam and have experience with D&B projects. Ten of them have at least six years;

two have at least eleven years and two have at least twenty-five years of experience in construction. The experts were asked to review the sufficiency and appropriateness of the factors to Vietnamese condition. Some factors were found inappropriate and excluded from the list. The experts also suggested adding many factors that they experienced in D&B projects to the list. After that, a preliminary questionnaire conveying the factors in the list was developed. Another group of eight experts including five at least six years and three at least eleven years was invited to test the pilot questionnaire together with the previous group. The pilot test was completed after two rounds when achieving the experts' agreement on the structure of the questionnaire and the included factors. Forty-seven success factors were finalized and included in the final questionnaire.

To identify CSFs of D&B projects, the analysis in this study are based on the perspectives of the respondents having experience with D&B projects. Respondents were requested to rate their agreement with the success factors according to five-point Likert scale from 1 = "strongly disagree" to 5 = "strongly agree". They were also requested to add other factor(s) that they perceived as being necessary. However, the added ones were insignificant.

Face-to-face delivery and e-mailing were the two methods to distribute the questionnaires. However, the direct (face-to-face) delivery was preferred to motivate respondents to participate. With face-to-face delivery method, respondents were first identified that they had been participating in D&B projects before the questionnaires were delivered to them. Similarly, when using e-mailing method to collect data, respondents were first contacted by phoning them or sending emails to invite them to participate. The ones agreeing to participate would answer based on the online questionnaire. Although respondents were identified to be involved in D&B projects before being received the questionnaires, in order to ensure the accuracy of returned data they were still asked whether they had participated in any D&B project yet. The responses with the answer "no" were excluded from analysed data.

There are two main parties involved in D&B projects including the contractor, who performs the project, and the client, who supervises the contractor's project performance. In this study, the owner and the project management consultant are considered as the client.

After about two months, with a reminding after one month from the first contact, a total of 133 valid returned responses accounted for a response rate of about 22% were used for analysis. SPSS statistical software was employed to process the data. Respondents' ratings were regarded as invalid if two answers were selected or no answer was indicated. Invalid answers were treated as missing cases and excluded pairwise in analysis. The reliability test yielded a Cronbach's alpha coefficient of internal consistency value of 0.923, which is considered to be reliable (> 0.80).

Out of 133 valid returned questionnaires, seventy (52.6%) were from clients and sixty-three (47.4%) were

from contractors. Regarding respondents' position, 12.8% were senior managers, 27.1% were functional/project managers, 58.6% were line managers, engineers and project team members, and 1.5% were others. About 46.6% of the respondents have experience less than 5 years, 33.8% respondents have 6-10 years of experience, 18.1% respondents have 11-20 years of experience, and 1.5% respondents have more than 20 years of experience. Regarding the origin of respondent organization, 115 responses (86.5%) were from Vietnamese companies and 18 responses (13.5%) were from foreign ones. The project types included: building and industrial construction projects (79.7%); road and bridge projects (18.0%); and others (2.3%). This implies that the study is scoped in building, industrial, and road and bridge construction projects. In terms of project size, 55.6% of the respondents were involved in D&B projects with total budgets less than US\$10 million and the remainder (44.4%) were involved in D&B projects whose total budgets are more than US\$10 million.

In order to assess the importance of success factors to project success according to the two principal parties including client and contractor, mean score method was first used to analyse the data. The rating of respondents on the five-point scale was used to compute mean score for each item. The ranking of items in each group was based on their computed scores. After that, Spearman rank correlation coefficient and T-test were used. The Spearman's coefficient of rank correlation (rs) was used to demonstrate whether there was a correlation between the ranking orders of the two groups. T-test was used to examine whether there existed a difference between the two groups about mean values. Before applying T-test, Levene's test of equal variance was carried out as a precondition of T-test.

B. Phase 2 – Validation

With the purpose to validate the identified CSFs, this study employed another questionnaire which was designed based on thirty-three CSFs, identified in phase 1, and ten selected KPIs, identified from the literature review. The thirty-three CSFs are the factors having the overall mean values more than 4 (see Table 3). The ten selected KPIs are the most popular performance metrics used in previous studies on D&B method (see Table 1).

Respondents were requested to rate the performance of the related qualitative issues in D&B project(s) they have

been directly involved in according to five-point Likert scale. On the other hand, the quantitative information was collected through a direct contact to project documents. With the CSFs, respondents were requested to rate on a scale from 1 = "very not good" to 5 = "very good". Regarding project quality and owner's satisfaction, respondents were requested to rate their assessment on a scale from 1 = "very unsatisfactory" to 5 = "very satisfactory". Relating to owner's administrative burden in the project, the scale is from 1 = "very heavy burden" to 5 = "minimum burden". Regarding cost and time, the specific information about actual project performance was collected to compute cost and time performance metrics (see Table 1). Project performance is considered good when the computed values (see Table 5) are better than the comparative ones (see Table 6). In this study, the values of 5% and 10% are selected to be the limitation of cost growth and schedule growth respectively (Fox, 2006; cited in Rosner et al., 2009). On the other hand, the comparative values of unit cost, intensity, construction speed, and delivery speed are based on the collected contractual or as-planned information.

Surveyed D&B projects were first identified from various contactable companies of either clients or contractors. Then, project team leaders or project managers who were directly involved in these projects were invited to participate. Many of them are not only the key managers of these projects but also the senior managers of the companies. It is very difficult to collect the information about D&B projects with a high level of adequacy and accuracy in Vietnam. Thus, after data verification, only six projects could be used in this study. The profile of six collected projects is presented in table 2. Because inertia forces against scientific research are still strong in Vietnamese culture (Le-Hoai et al., 2010), it is very difficult to contact both client and contractor to collect the information for each project. Therefore, in this study, the assessment of owner's satisfaction with the project is not performed thoroughly. The assessment is based on the invited respondents' perspective.

V. IDENTIFICATION OF PROJECT SUCCESS FACTORS

All forty-seven success factors were computed for their mean scores and ranked based on these scores. The factor having the highest mean score has rank 1 and so on. Table 3 presents the first thirty-three success factors having the overall mean values more than 4.

TABLE II
CHARACTERISTICS OF D&B PROJECT VALIDATION CASES

Project ref.	Project type	Gross area (m ²)	Total project cost (US\$)	Total time (months)	
				As-planned	As-built
Project 1	Office building (private sector)	3,200	1.291 million	24	30
Project 2	Industrial building (private sector)	7,450	1.840 million	12	12
Project 3	Residential building (private sector)	5,600	2.637 million	13	✓
Project 4	Residential building (private sector)	38,000	250.000 million	65	67
Project 5	Residential building (public sector)	21,000	48.750 million	18	18
Project 6	Residential infrastructure (private sector)	420,000	29.864 million	26	26

Note: 1 US\$ = 20,000 VNDs (2010); ✓: NA

TABLE III
CRITICAL SUCCESS FACTORS AND THE RESULTS OF T-TEST

Critical Success Factors	Client		Contractor		T-value	sig.
	Mean	Rank	Mean	Rank		
Project procedures						
Market exploration research/Market survey before investing or participating in the project	4.397	10	4.161	18	1.444	0.151
Comprehensive pretender site investigation	4.371	12	4.191	15	1.317	0.190
Reasonable tendering system	4.371	12	4.175	16	1.456	0.148
Comprehensive contract documentation	4.377	11	4.355	5	0.165	0.869
Project characteristics						
Thorough understanding of project complexity	4.229	21	3.889	35	2.278	0.024*
Well-planned project schedule	4.200	22	3.952	31	1.711	0.089
Clear project objectives and scope	4.071	31	4.048	26	0.156	0.876
Appeal of the project to end-users	4.074	30	3.919	34	1.007	0.316
Project environment						
Advantages of policy management of local government	4.100	29	4.016	27	0.574	0.567
Availability of resources during project performance	4.043	34	4.079	24	-0.246	0.806
Project work atmosphere						
Project team members' good/active attitudes to the job	4.129	28	4.127	22	0.013	0.990
Resolving structure failures in construction process quickly	4.279	19	4.129	21	0.996	0.321
Resolving conflicts quickly	4.188	26	4.079	24	0.834	0.406
Project strategies						
Adequate systems for quality, risk, safety, and more human-related conflict management	4.200	22	4.095	23	0.971	0.334
Appropriate organizational structures and cultures, roles and levels of authority	4.157	27	3.952	31	1.547	0.124
Effective monitoring and approval mechanisms for design changes	4.271	20	4.016	27	1.787	0.076
Effective control mechanisms of subcontractors' works	4.300	18	4.274	9	0.195	0.846
Effective overall managerial actions in planning, organizing, leading, and controlling	4.314	16	4.159	19	1.230	0.221
Project-related participants						
Owner's emphasis on time, cost and quality of the project	4.357	14	4.143	20	1.601	0.112
Owner's overall contribution to the project	4.200	22	4.238	11	-0.322	0.748
Owner's/His representatives' decision-making power	4.414	8	4.175	16	2.005	0.047*
Contractor's good combination of design expertise and building techniques	4.486	2	4.318	7	1.418	0.159
Contractor's experience with similar D&B projects and good reputation in the construction market	4.457	5	4.365	4	0.725	0.470
Contractor's strong design and construction management capability	4.414	8	4.381	3	0.279	0.780
Contractor's project team leader's competence, experience and delegated authority	4.457	5	4.492	2	-0.343	0.732
Contractor's project team leader's commitment to time, cost and quality	4.200	22	4.206	14	-0.044	0.965
Adequate funding throughout the project	4.500	1	4.508	1	-0.075	0.941
Competent and experienced project management consultants	4.485	3	4.226	13	2.126	0.035*
Design consultants' thorough understanding of the construction process to develop a cost-effective design on time	4.471	4	4.238	11	1.853	0.066
Consultants'/Owner's quick response to contractor's requests and instructions	4.329	15	4.333	6	-0.047	0.963
Multidisciplinary/Competent project team	4.443	7	4.302	8	1.177	0.241
Client's competent and experienced project team leader	4.314	16	4.270	10	0.346	0.730
Project participants' satisfaction with the financial return from the project	4.071	31	4.000	29	0.533	0.595

Note: *: Significant at the level of 5%

“Adequate funding throughout the project” is considered as the most important factor to project success by both groups. In Vietnam, large and important projects, especially public sector projects, are preferred to apply D&B method. These projects are usually very complex and require a high level of technology. The larger and more complex the projects are, the larger the capital scale is required accordingly. Therefore, D&B projects need regularly supplying enough fund in order to deliver them as scheduled and/or employ a fast-track basis. Vietnamese construction projects have frequently met delays and cost overruns due mainly to inadequate funding until project completion (Le-Hoai et al., 2008).

Contractor considers “contractor's project team leader's competence, experience and delegated authority” as the second factor significantly affecting project success while client ranks “contractor's good combination of design expertise and building techniques” in the second position. “Contractor's project team leader's competence,

experience and delegated authority” is also ranked fifth by client. When becoming a single-point entity contractually responsible for both design and construction in D&B projects, the contractor will engage a project team leader to manage the whole project (Ling, 2004). Because contractors must face with most of the risks and responsibilities transferred from owners (Xia and Chan, 2010), project team leaders have to face with tremendous pressure from owners about traditional goals of a construction project in terms of time, cost and quality in D&B projects. Thus, project team leaders need to be competent and experienced to manage D&B projects well. As possessing good knowledge and skills, project team leaders could cope with stresses, establish good relationships among project participants, and induce a harmonious working atmosphere during project performance (Smith and Wilkins, 1996). Project works would be also resolved better if project team leaders were delegated enough authority to make important decisions

timely (Lam et al., 2004). Apart from competent project team leaders' participation, the chance of project success could be also increased when contractors have good combination of design expertise and building techniques. Because of encouraging the overlapping of design and construction process, which could reduce project delivery schedule (Konchar and Sanvido, 1998), D&B method requires integration of design and construction works, which is quite different from the traditional method. Good integration of design and construction works requires contractors to possess sophisticated skills of both design and construction. With full combination of design and construction functions, contractors could improve the buildability of design works, provide better performance of D&B projects, speed up the project process successfully, and thereby add more values to owners (Xia et al., 2009).

"Competent and experienced project management consultants" and "contractor's strong design and construction management capability" are ranked in the third position by client and contractor respectively. Vietnamese owners who are regularly incompetent and inexperienced with construction projects usually employ project management consultants to support them in most projects. The more competent and experienced project management consultants are, the faster and more effectively project works are resolved during project performance. Therefore, in order to manage D&B projects successfully, owners should employ "competent and experienced project management consultants" to manage the projects. Besides, contractor's management capability is really important to project success. Because D&B projects require a high level of managerial expertise from D&B contractors for both design and construction process, contractors need to have good managerial capability to well manage the whole project. Moreover, although there are no specific qualifications or licensing regulations legislated for D&B business, most owners still require D&B contractors to possess the highest grade of classifications as required in general contracting (Xia et al., 2009).

Client considers "design consultants' thorough understanding of the construction process to develop a cost-effective design on time" as the fourth important factor. If design consultants take a long time to obtain approvals, the contract period continues to run while construction work cannot proceed (Ling et al., 2000). "Design consultants' thorough understanding of the construction process" is important because the failure of designers in working within budget and on schedule may cause poor performance for D&B projects (Chan et al., 2001). Rework, delay, cost overrun and even project failure may be met. Therefore, a cost-effective design on time, which is developed by competent and experienced design consultants, is not only good for D&B project performance but could also help to increase the chance of D&B projects to be completed by contractual completion date.

"Contractor's experience with similar D&B projects and good reputation in the construction market" is ranked

in the fourth and fifth positions by contractor and client respectively. In order to well combine the design and construction process together, contractors should have experience with D&B projects to well implement them (Songer and Molenaar, 1997; Molenaar and Songer, 1998). Good reputation could not only impede rivalry but also result in price premiums for projects and create additional leverage in negotiations with suppliers and creditors. In addition, good reputation of D&B contractors could also reflect their competences directly in construction field (Xia et al., 2009).

"Comprehensive contract documentation" is considered as the fifth important factor by contractor. Because contractors are exposed to huge risks and responsibilities transferred from owners in D&B projects, interest conflicts between contractors and owners could be easily increased (Xia and Chan, 2010). Thus, comprehensive contract documentation, which could allocate risks and rewards in correct proportions, is really necessary to ensure the existence of general agreements and collective genius of professionals in concerned organizations as well as proper project control (Nguyen et al., 2004). In addition, project performance could be also better when various specialists are encouraged to behave as a team without conflicts of interest and differing goals (Sanvido et al., 1992).

The success factors in top five are very important to the success of D&B projects. All practitioners when participating in D&B projects should focus on these factors to enhance the chance of project success. Other factors out of top five are also important to the success D&B projects in Vietnamese construction industry, project participants concerned about D&B method should pay attention to these factors to manage D&B projects better. The chance of project success could be, therefore, increased.

The computed Spearman's rank correlation coefficient (rs) between client and contractor is 0.885 and significant at the level of 1% (two-tailed). It implies that there is a strong agreement between the two groups on ranking the success factors. Because the Spearman's rank correlation test does not suggest whether there is a difference in assessing an individual factor, T-test is performed to test the differences of mean values of success factors between two groups. The results of T-test show that there are few differences in the assessment of two groups in some factors at the significance level of 5%. However, these differences are insignificant at the level of 1%. In general, the differences of opinion about mean rating between the two groups could be, therefore, ignored at the strict chosen level of 1%. Table 3 also presents the results of T-test of the most critical factors.

VI. VALIDATION

This phase aims to validate the CSFs which were identified in previous phase of this study. To achieve this aim, six selected D&B projects collected in Vietnam are used for validation. The performance of these six projects is presented in table 4, 5 and 6. Table 4 presents the performance of CSFs with the mean values briefly shown

in six main topics including project procedures, project characteristics, project work atmosphere, project environment, project strategies, and project-related participants. The mean values are the average scores of the issues in each topic of CSFs (see Table 3). Table 5 and 6 present the results of project performance and the comparison values respectively.

The results in table 4 show that the first three projects (project 1, 2 and 3) have poor performance of many CSFs whereas the others (project 4, 5 and 6) have good performance of most CSFs. As a result, the first three projects have problems in performance process such as: delay and cost overrun (project 1), delay and even stop of executing (project 3). In addition, system quality and owner's satisfaction in project 1 are just average. Although project 2 is completed within budget and on time, this project is not still achieved good quality and owner's satisfaction. By contrast, the remaining projects

(project 4, 5 and 6) have good project performance (see Table 5 and 6) due to good performance of most CSFs. Although there still exist little delay and cost overrun in project 4 and 5 respectively, these values are insignificant when compared with 5% and 10% (see Table 5 and 6). Owners also cost much for administrative burden of project 4 and 6 due to heavy managerial systems which were employed during their performance process. This might be because in Vietnam project participants who are managers are still unfamiliar and inexperienced with D&B projects. However, these projects are still considered successful because of meeting cost, time and quality objectives and achieving owner's satisfaction. Therefore, in general, the first three projects (project 1, 2 and 3) could be considered as unsuccessful cases whereas the others (project 4, 5 and 6) could be considered as successful ones.

TABLE IV
PERFORMANCE OF SUCCESS FACTORS

Topics of CSFs	Performance of CSFs					
	Project 1	Project 2	Project 3	Project 4	Project 5	Project 6
Project procedures	3.333	3.500	3.500	4.000	4.500	4.500
Project characteristics	3.250	2.500	3.000	4.750	4.750	4.500
Project environment	4.000	3.500	4.000	4.500	4.000	4.500
Project work atmosphere	4.000	3.000	5.000	4.000	5.000	4.500
Project strategies	3.400	2.750	4.200	4.200	4.600	4.600
Project-related participants	3.533	2.615	3.500	4.800	4.467	4.533

TABLE V
RESULTS OF PERFORMANCE OF D&B PROJECTS

Performance metrics	As-built performance of six D&B projects					
	Project 1	Project 2	Project 3	Project 4	Project 5	Project 6
Unit Cost (\$/m ²)	403.319	246.956	✓	6,578.947	2,321.429	71.104
Cost Growth (%)	36.628	0.000	✓	0.000	1.881	0.000
Intensity [(\$/m ²)/month]	13.444	20.580	✓	98.193	128.968	2.735
Construction Speed (m ² /month)	177.778	784.211	✓	622.951	1,500.000	17,500.000
Delivery Speed (m ² /month)	106.667	620.833	✓	567.164	1,166.667	16,153.846
Schedule Growth (%)	20.000	0.000	Stopped	3.077	0.000	0.000
System Quality	3.000	3.000	4.000	5.000	5.000	4.000
Equipment Quality	4.000	3.000	✓	5.000	4.000	✓
Owner's Satisfaction	3.000	3.000	4.000	5.000	5.000	5.000
Owner's Administrative Burden	3.000	3.000	3.000	2.000	4.000	2.000

Note: ✓: NA

TABLE VI
VALUES USED TO COMPARE WITH AS-BUILT COST AND TIME PERFORMANCE OF D&B PROJECTS

Project cost and time	Values used to compare with as-built project cost and time					
	Project 1	Project 2	Project 3	Project 4	Project 5	Project 6
Unit Cost (\$/m ²)	295.195	246.956	470.821	6,578.947	2,278.571	71.104
Cost Growth (%)	5	5	5	5	5	5
Intensity [(\$/m ²)/month]	9.840	20.580	✓	101.215	126.587	2.735
Construction Speed (m ² /month)	266.667	784.211	✓	644.068	1,500.000	17,500.000
Delivery Speed (m ² /month)	133.333	620.833	✓	584.615	1,166.667	16,153.846
Schedule Growth (%)	10	10	10	10	10	10

Note: ✓: NA

In three unsuccessful cases, some CSFs including project procedures (contract documentation), project characteristics (project schedule; project objectives and scope) and project-related participants (financial factor; parties' competence and experience) all have poor performance in all three projects while project strategies (monitoring and approval mechanisms for design changes; overall managerial actions in planning, organizing, leading, and controlling) has poor performance in two of them (project 1 and 2). Especially, inadequate funding is the most severe cause of delay (project 1 and 3) and cost overrun (project 1) due mainly to owners' financial difficulties. On the other hand, all CSFs were well performed in three successful cases, especially contract documentation, project schedule, project objectives and scope, financial factor, and parties' competence. This could imply that project procedures, project characteristics, project-related participants and also project strategies have more effects on project outcomes than project environment and project work atmosphere. Poor performance of CSFs may cause some unexpected results, which could be found in the first three cases, whereas good performance of CSFs could enhance the chance of project success, which could be achieved in the remaining cases. In general, success of D&B projects is simultaneously affected by a large number of CSFs. If a D&B project with clear objectives and scope is implemented by competent and experienced parties with well-planned schedule, comprehensive contract documentation, good funding, and effective management actions, the D&B project could have a better chance of success and vice versa. However, there still exists a highly subjective point of view in conclusions or inferences in this section due to the limitation of the number of surveyed projects and respondents' subjectivity. Further research on investigating the causes of CSFs on performance of D&B projects should be also conducted through qualitative case studies with a larger sample size and sufficient participation of main parties including contractor, owner and/or project management consultant.

In conclusion, the better CSFs are performed in performance process of D&B projects, the better results of project performance, which could be measured by KPIs, will be. Project participants should pay more attention to performance of CSFs identified in this study to better manage D&B projects in Vietnam in order to enhance the chance of project success.

VII. PROJECT SUCCESS IN DEVELOPING AND DEVELOPED COUNTRIES

This section aims to discover a general view on CSFs of D&B projects among some developing and developed countries. To achieve this aim, eight important success factors of this study are selected to compare with other selected countries' including two developing countries (Ghana and China) and two developed countries (Singapore and the United States). The studies, selected for comparison in this study, are up-to-date or have been done in recent years and after 2000. Some of them do not

definitely have the same purpose and methods of survey. However, the comparison is useful for more understanding the success of D&B projects in Vietnam and some other similar developing countries.

In general, financial capability for the project is very important in developing countries. In developed countries project scope and owners' experience with D&B projects are more important than in developing countries. Contractor always plays an important role in D&B project success in both developing and developed countries.

Adequate funding for the project, which relates both owners and contractors, is very important in Vietnam (rank 1). Owners' ability to fund the project is also very important in Ghana. In addition, financial capability for D&B projects is one of important competences of contractors (rank 4) and of owners (rank 2) in China. In Singapore, financial management ability is paid more attention to. This could imply that the success of D&B projects in developing countries mostly depends on funding for them because capability of capital supply is an important factor for competition in construction market and project success (Le-Hoai et al., 2010; Nguyen et al., 2004).

Although contractor's role is always important to D&B project success not only in Vietnam, Ghana and China but also in Singapore, there still exist a few differences. In Vietnam, the success of D&B projects mostly depends on contractor's capabilities and experience (rank 3, 4 and 5). Award of bids to the right bidder is also important in Ghana. These competences of contractors are also found very important in Chinese construction industry (rank 1, 3 and 6). In addition, competent and experienced project team leaders' participation is necessary in D&B projects in Vietnam (rank 2) and in Ghana. However, apart from these capabilities, contractor's track record for completing projects on budget, on schedule and to acceptable quality and contractor's magnitude of claims and disputes in past projects are found important in D&B projects in Singapore. Contractor's current backlog and a mutual understanding of the scope of work between contractor and owner are important to the success of D&B contracting in the United States. This could imply that in developing countries the size and reputation of contractors' organization are important while in developed countries the evidences of contractors' project execution are more important.

Owners' and consultants' competence and experience are important in D&B projects in Vietnam (rank 6 and 8). Owner's adequate staff or consulting team is also important in China (rank 4). Owner's experience with D&B projects is important to project success in Singapore, in the United States, and also in China. However, this is not important in Vietnam and in Ghana. Although China is also considered as a developing country, China's construction industry development is much more than Vietnam's and Ghana's. This could imply that in developed countries owner's experience with D&B projects is more important than in developing countries.

TABLE VII
COMPARISON AMONG COUNTRIES

Developing countries				
Rank	Vietnam (This study, 2011) (1)	*Ghana (Ameyaw, 2009) (1)	China (Xia et al., 2009) (2)	China (Xia and Chan, 2010) (3)
1	Adequate funding throughout the project	Award of bids to the right bidder	Experience with similar D&B projects	Ability to clearly define project scope and requirements
2	Contractor's competent, experienced project team leader	Availability of resources	The capability of corporate management	Financial capability for the projects
3	Contractor's experience with similar D&B projects and good reputation	Clients' ability to adequately fund the project	Combination of building techniques and design expertise	Capability in contract management
4	Contractor's good combination of design expertise and building techniques	Overall managerial actions in planning, organizing, leading, and controlling	Financial capability for D&B projects	Adequate staff or consulting team
5	Contractor's strong design and construction management capability	Contract documentation	Enterprise qualification and scale	Effective coordination with contractor
6	Multidisciplinary/Competent project team	Project team leaders' knowledge and skills	Credit records and good reputation in the industry	Experience with similar D&B projects
7	Comprehensive contract documentation	✓	✓	✓
8	Competent and experienced project management consultants	✓	✓	✓
Developed countries				
	*Singapore (Ling and Liu, 2004) (1)	*Singapore (Ling, 2004) (1)	*USA (Schaufelberger, 2004) (4)	
	Contractors' adequate staffing level	Contractor's high staffing level	Well-defined project scope	
	Contractors' good track record for completion on budget	Contractor's adequate plant and equipment	A mutual understanding of the scope of work between owner and contractor	
	Contractors' ability in financial management and quality control	Contractor's track record for completing projects on budget, on schedule and to acceptable quality	Design completion less than 35% to provide contractors with maximum chance for design innovation	
	Consultants have a high level of construction sophistication and have handled many D&B projects in the past	Magnitude of claims and disputes in contractor's past projects	Owner's reputation regarding treatment of contractors	
	Owner's experience with similar projects and with many D&B projects	Contractor's high technical expertise	Owner's sufficient experience with D&B method	
	Tender evaluation and selection project criteria	Contractor's good design capability	Size, scope, and location of the project	
	Contract form and contract period	✓	Contractor's current backlog	
	Project scope definition when tenders are invited	✓	✓	
	Importance of project to be completed within budget	✓	✓	
	Optimal level of design completion when budget is fixed and tenders are invited	✓	✓	
	Flexibility of scope of works when contractor is hired	✓	✓	

Note: (1): CSFs of D&B projects; (2): Key competences of D&B Contractors; (3): Key competences of D&B Clients; (4): CSFs of D&B contracting; *: The most important success factors; ✓: NA

Project scope, level of design completion and scope of works are important in Singapore and in the United States. An ability to clearly define project scope and requirements is also an important competence of owners in China (rank 1). However, these are not found important in Vietnam and Ghana where comprehensive contract documentation is considered important to project success. In addition, a capability in contract management which is an important competence of owners in China is not also found important in Vietnam and Ghana. This could imply that project scope, level of design completion and scope of works are more important in developed countries while comprehensive contract documentation is more important in developing countries.

In conclusion, success factors of D&B projects could be the same in the countries having the same natures and conditions of the construction market and vice versa. However, the comments or conclusions in this section still exist a highly subjective point of view due to the limitation of the number of collected studies. When participating in D&B projects, project participants should pay more attention to the natures and conditions of the

construction industry in each country to manage D&B projects better by using proper project management strategies effectively. The chance of project success could be, therefore, increased.

VIII. CONCLUSIONS

Project success is not only important for all project participants but also for national development. However, success of construction projects, especially the projects delivered by an innovative procurement method as D&B, could not be easily achieved without good performance of CSFs. Therefore, identifying CSFs of project execution could increase the chance of project success. In this study, forty-seven success factors which could affect the success of D&B projects in Vietnam are identified. Some factors are found very important in D&B projects by client and contractor including: adequate funding throughout the project; contractor's good combination of design expertise and building techniques; contractor's project team leader's competence, experience and delegated authority; competent and experienced project

management consultants; contractor's strong design and construction management capability; design consultants' thorough understanding of the construction process; contractor's experience with similar D&B projects and good reputation in the construction market; and comprehensive contract documentation. This implies that parties' competence, especially financial capability, and contract documentation are the most important factors significantly affecting the success of D&B projects. Therefore, project participants are advised to more focus on these factors to manage D&B projects better and enhance the chance of project success.

The findings of this study also provide some practical implications useful not only to Vietnamese practitioners but also to others who are concerned about D&B method and plan to employ it in Vietnam. The validation results confirm that some factors which could much affect project outcomes should be well performed in D&B projects including: contract documentation, project schedule, project objectives and scope, financial factor, and parties' competence and experience. Poor performance of these factors may cause some unexpected results which could make owners unsatisfied. Results of comparison of CSFs among countries also provide a useful piece of information for project participants is that CSFs of D&B projects in the countries which have the same natures and conditions of the construction market could be the same. In fact, CSFs of D&B projects, identified in this study, are important for practitioners in Vietnam and other similar developing countries. Project team leaders or project managers could not only more understand how to achieve the success of D&B projects but also have a chance to review their companies' capability of employing D&B. Then, they could establish a conceptual framework of CSFs for D&B projects and make improvements on their management approaches successfully. D&B projects could be, therefore, managed better. Further research should be carried out on case studies to explore the effect of success factors between before and after adopting the result of this study. More success sample projects should be also reviewed and analyzed. Moreover, models of project success for D&B projects should be established to identify the causal relationships between CSFs and KPIs or project success criteria from qualitative analysis. While construction projects are more and more complex, the causal relationships, once identified, could provide practitioners with some useful information to implement them successfully.

REFERENCES

- [1] C. Ameyaw, "Comparative performance evaluation of the traditional design-bid-build (DBB) and design-build (DB) procurement methods in Ghana", Master Thesis, University of Science and Technology, Kwame Nkrumah, available at: <http://dspace.knust.edu.gh/dspace/handle/123456789/1173>, 2009. (accessed March 2011).
- [2] D. Baccarini, "The logical framework method for defining project success", *Project Management Journal*, vol. 30, no. 4, pp. 25-32, 1999.
- [3] A.P.C. Chan, "Framework for measuring success of construction projects", Report 2001-003-C-01, available at: <http://eprints.qut.edu.au/26531/>, 2001. (accessed March 2011).
- [4] A.P.C. Chan, D.K.C. Ho, C.M. Tam, "Design and build project success factors: Multivariate analysis", *Journal of Construction Engineering and Management*, vol. 127, no. 2, pp. 93-100, 2001.
- [5] D.L. Fox, "FY06 MILCON dirtkicker award criteria", *MAJCOM/A7/A7C*, HQ USAF/ILE, Wash, 2006.
- [6] D.R. Hale, P.P. Shrestha, G.E. Gibson, G.C. Migliaccio, "Empirical comparison of design/build and design/bid/build project delivery methods", *Journal of Construction Engineering and Management*, vol. 135, no. 7, pp. 579-587, 2009.
- [7] M. Konchar, V. Sanvido, "Comparison of U.S. project delivery systems", *Journal of Construction Engineering and Management*, vol. 124, no. 6, pp. 435-444, 1998.
- [8] E.W.M. Lam, A.P.C. Chan, D.W.M. Chan, "Benchmarking design-build procurement systems in construction", *Benchmarking: An International Journal*, vol. 11, no. 3, pp. 287-302, 2004.
- [9] E.W.M. Lam, A.P.C. Chan, D.W.M. Chan, "Determinants of successful design-build projects", *Journal of Construction Engineering and Management*, vol. 134, no. 5, pp. 333-341, 2008.
- [10] L. Le-Hoai, Y.D. Lee, J.Y. Lee, "Delay and cost overruns in Vietnam large construction projects: A comparison with other selected countries", *KSCE Journal of Civil Engineering*, vol. 12, no. 6, pp. 367-377, 2008.
- [11] L. Le-Hoai, Y.D. Lee, J.J. Son, "Partnering in construction: Investigation of problematic issues for implementation in Vietnam", *KSCE Journal of Civil Engineering*, vol. 14, no. 5, pp. 731-741, 2010.
- [12] F.Y.Y. Ling, G. Ofori, S.P. Low, "Importance of design consultants' soft skills in design-build projects", *Construction and Architectural Management*, vol. 7, no. 4, pp. 389-398, 2000.
- [13] F.Y.Y. Ling, "How project managers can better control the performance of design-build projects", *International Journal of Project Management*, vol. 22, no. 6, pp. 477-488, 2004.
- [14] F.Y.Y. Ling, M. Liu, "Using neural network to predict performance of design-build projects in Singapore", *Building and Environment*, vol. 39, no. 10, pp. 1263-1274, 2004.
- [15] K.R. Molenaar, A.D. Songer, "Model for public sector design-build project selection", *Journal of Construction Engineering and Management*, vol. 124, no. 6, pp. 467-479, 1998.
- [16] K.R. Molenaar, A.D. Songer, M. Barash, "Public-sector design/build evolution and performance", *Journal of Management in Engineering*, vol. 15, no. 2, pp. 54-62, 1999.
- [17] N.D. Nguyen, S.O. Ogunlana, Đ.T.X. Lan, "A study on project success factors in large construction projects in Vietnam", *Engineering, Construction and Architectural Management*, vol. 11, no. 6, pp. 404-413, 2004.
- [18] J.W. Rosner, A.E.J. Thal, C.J. West, "Analysis of the design-build delivery method in Air Force construction projects", *Journal of Construction Engineering and Management*, vol. 135, no. 8, pp. 710-717, 2009.
- [19] V. Sanvido, F. Grobler, K. Pariff, M. Guvents, M. Coyle, "Critical success factors for construction projects", *Journal of Construction Engineering and Management*, vol. 118, no. 1, pp. 94-111, 1992.
- [20] Z.P.E. Satterfield, "Design-build." *The National Environmental Services Center*, vol. 9, no. 2, pp. 1-4, 2009.
- [21] J.E. Schaufelberger, "Success factors for design-build contracting", *Journal of Construction Engineering and Management*, Record, ASCE Conference Procurement, 2004.
- [22] A. Smith, B. Wilkins, "Team relationship and related critical factors in the successful procurement of health care facilities", *Journal of Construction Procurement*, vol. 2, no. 1, pp. 30-40, 1996.
- [23] A.D. Songer, K.R. Molenaar, "Project characteristics for successful public-sector design-build", *Journal of Construction Engineering and Management*, vol. 123, no. 1, pp. 34-40, 1997.
- [24] A.D. Songer, K.R. Molenaar, G.D. Robinson, "Selection factors and success criteria for design-build in the U.S. and U.K.", available at: <http://www.colorado.edu/engineering/civil/db/papers/usuk/>, 1997. (accessed May 5 2010).
- [25] B. Xia, A.P.C. Chan, J.F.Y. Yeung, "Identification of key competences of design-builders in the construction market of the People's Republic of China (PRC)", *Construction Management and Economics*, vol. 27, no. 11, pp. 1141-1152, 2009.
- [26] B. Xia, A.P.C. Chan, "Key competences of design-build clients in China", *Journal of Facilities Management*, vol. 8, no. 2, pp. 114-129, 2010.