Risk Management in Engineering and Construction

A Case Study in Design-Build Projects in Vietnam

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***Abstract*—The constant demand for construction in developing countries like Vietnam causes more and more challenges and difficulties to Project Management Units (PMUs) in carrying projects to completion on schedule, with quality assurance and fewer costs. In order to do this, PMUs need to have better and tighter management tools and forms. However, in order to minimize risks during project implementation, the binding terms in contracts are also becoming stricter with more and more new forms of contracts. One of them is the design-build (DB) contract form. This paper presents the critical risk factors for design-build projects in the construction industry. Good identification and management of these risk factors will help projects succeed and will increase the confidence of owners and contractors who seek to use the design-build form.**

Keywords-design-build (DB); risk management; project manager; construction management; Vietnam

I. INTRODUCTION

Vietnam's construction industry conducts projects are mainly based on the traditional design-bid-build (DBB) method [1]. In particular, a project is broken down into packages which are assigned to independent units that coordinate with the owner for implementation. Preparation of investment reports, surveys and construction designs, and bidding to select construction contractors and/or equipment suppliers is carried out. Work is assigned by the owner to individual contractors. Accordingly, the risks during the process of project implementation from the commencement to the construction, acceptance, and delivery of the work will be shared equally by the parties involved in the project [2-5]. The owner, who is responsible for the quality, progress, and the costs of the project is the focal point [6, 7]. However, the fact that individual contractors deploy at the construction site only after research of design and cost estimate increases project duration [8]. In addition, the construction units spend too much time studying designs, and work at the site requires cooperation between owners, construction units, and design consultants which may affect the overall progress of the project. The fact that independent contractors are only in charge of their tasks fails to promote their initiative, flexibility, and creativity and makes them become dependent on the consultant. Recently, many owners from different economic sectors have chosen the design-build (DB) general contractor form for their projects, which has helped domestic construction enterprises, while consultants have access to a new form of project management with high professionalism because of their ownership in all aspects of consultancy and construction services. This paper presents an overview of DB approach and also points out the critical risk factors for DB projects in the construction industry.

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II. RESEARCH BACKGROUND

Normally, the DB approach is often compared to the traditional DBB project implementation method, in which the owner hires two separate units to perform the design and construction activities [9, 10]. In other words, for DBB approach, owners employ independent contractors to carry out the design and construction of a work. In this form, design, bid, and construction activities are conducted sequentially so the design must be completed before bidding and contractor selection. After construction contractors are selected, the construction of the work begins. In DBB form, the relationship between the design contractor and the construction contractor is completely independent. However, the contractors must always exchange information and coordinate with each other during the process of project implementation through the owner, the focal point. In DB there is participation of subcontractors to assist the contractors in project implementation (Figure 1) [11]. Meanwhile, the design and construction tasks are assigned to the same contractor.

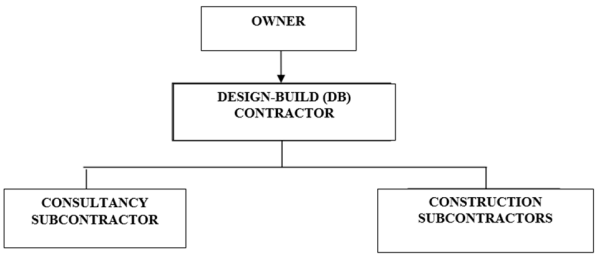

Fig. 1. DB project management model

The DB contractor may hire consultancy subcontractors and/or construction subcontractors to share part of the workload. However, the main contractor is still responsible for all design and construction activities of the DB project including the work done by subcontractors. This helps the owner to simplify management interface throughout the project

life cycle [12]. As a result, the possibility of design changes, delayed completion time, and risks caused to owners will be limited. In addition, the construction design is implemented by a single unit, therefore, the construction contractor will be aware of the designs in an earlier stage. Accordingly, the contractor can deploy the construction even if the design is not completed which makes possible to shorten the implementation time so that owner can sooner put the project into operation [13, 14]. Moreover, this limits incrimination and complaints between the design and construction contractors or between two or more subcontractors. Thanks to the continuity from design to construction, errors in the project implementation process are reduced significantly. Due to being in the same organization, the design and construction units coordinate better and make design adjustments more easily even during the construction process.

III. RISK FACTORS

Basically, risk factors can be classified into groups including risks related to politics and laws, economics and finance, design, contracts and bidding, construction, and owners and contractors [15]. Among those, common risks are divided into two groups, namely politics and laws, economics and finance. Project risks are specifically divided into four main factor groups, including design, contract and bidding, construction, and owners and contractors.

A. Group 1: Politics and Laws

Political risks affect all actions at the central, provincial, and local levels by state agencies. Political risks affect the attraction of project investment and include risks related to the advance of the project investment wihout being stopped by trade wars or protests [1, 16]. More specifically, political risks include corruption, government intervention, delays in approval, and differences in regulations due to regional differences. Bureaucracy and harassment of local authorities also cause trouble for project owners and contractors. Legal risks arise from deficiencies in the legal and institutional framework, namely incomplete legal and supervisory system, conflicts between laws, decrees, and circulars, changes in laws and decrees, risks due to tax policy changes [17, 18]. If the policies and laws of the State are altered too much from the time of project planning to the time of construction, the owners often have to change the design to fit the new policies or adjust the initially set goals.

B. Group 2: Economics and Finance

The assessment of the financial feasibility of a project is the most common method of measuring the ability to achieve the financial goals set by stakeholders [19-23]. Financial market risks and exchange rate fluctuations are unfavorable factors that have been identified in previous projects. Moreover, inflation and interest rates are quite common risk variables. Indeed, the fluctuation of inflation and interest rates affect the uncertainty in the construction industry. Unfortunately, these risk factors are related to macroeconomics and are unavoidable. Inflation can have a strong impact on the price of materials, equipment, and labor costs in a project [24]. The project must have appropriate solutions and the ability to change materials, equipment, labor costs, and machine shifts which are more relevant than the actual time of construction deployment. Unstable interest rates are undesirable for most project participants as they lead to concerns about profitability and return on equity [25]. Another possible barrier is whether private investors are able to access the projects' capital through loans from financial institutions. They will also have to pay additional interest in case they are unable to pay on time. When an economy is not stable, investment capital mobilization for projects faces many difficulties and investors may have to suspend projects because of the lack of investment capital.

C. Group 3: Design

The design risks of DB projects often stem from the roles (main or indirect) of the project participants [26]. Design experts will face design risks, of course, but those involved in the projects such as owners or contractors will also face general design risks depending on their roles and their responsibility. This is because in DB projects, design units no longer work exclusively for the owner but work in the same team with the construction units, resulting in less communication with the owner. The likely result is that there will be misunderstandings or untimely adjustments with the owner. The main design risks are changes or deficiencies in a design, inadequate designs, and difficulties in following instructions (standards). Since a project's objectives and scale are not clear, it may be necessary to adjust them during the project implementation process. This results in changes in design and the prolonging of document preparation and submission leads to project delays and excess costs. Further, construction contractors may have to change or adjust construction methods, machinery, and types of materials [17, 27]. The DB form is usually applied to projects with large scale and complex technical properties. Therefore, few companies in Vietnam can meet the project requirements, and thus, the cooperation of foreign contractors is very common. However, foreign contractors face many difficulties in organizing project implementation because they do not clearly understand climate, hydrogeology, customs, Vietnam's regulations, standards, and legal provisions because the applicable standards are outdated and inappropriate. Therefore, using foreign standards or converting from foreign standards to Vietnamese standards is often difficult and takes time, which further slows down the implementation progress.

D. Group 4: Contracts and Bidding

This group of issues includes the lack of transparency in bidding (breakdown of packages, projects not yet approved but with proceeded bidding), conflicting or incomplete contracts, improper contracts signing, unfair allocation of responsibilities and risks, inappropriate contract quotes related to the bidding process and project evaluation. The lack of transparency and fraud in bidding leads to the selection of incompetent and inexperienced contractors who cannot ensure the design and construction work in accordance with specified requirements, causing problems during construction. In addition, a negative situation in bidding and collusion in bidding increases total investment cost. In addition, a DB contract is a lump-sum contract [28]. Therefore the contractor is the only one responsible to the owner for the whole project. Thus, it is necessary to clearly indicate in the contract criteria such as ensuring work quality, specifying the scope of work, the

standard system applicable to the work, identify specific timelines, and penalties, control of expenses incurred during the implementation process, bind responsibility upon the parties for risks occurring to the project, etc. in the contract's terms. Accordingly, the lack of experience in contract drafting or loose terms in the contract can cause controversies during project implementation. Especially if potential risks (fluctuation, global instability, etc.) are not anticipated and are tightly bound into the contract the project's progress will be prolonged and will often excess contract estimates.

E. Group 5: Construction

Construction risks are adverse factors in the construction phase of a DB project. These include unavailable labor/ materials/ equipment or delays, owners' requirements on special or monopoly equipment, limited supply in the market, exorbitant requirements on the quality of the work, force majeure risks (abnormal events such as earthquakes, storms, floods, etc.), and accidents [29-31]. During the construction process, the contractor will face many difficulties if the project's quality is not guaranteed [32]. Therefore to minimize risks, the management and the inspection of the rationality of the design documents compared to geological documents, quality of supervision, control and assurance, and the construction method proposed by the contractor, are critical [33]. The schedule prepared by the contractor and approved by the owner is the basis for project implementation. However, during the implementation process, it may be overlapped due to weak coordination between the main contractor, subcontractors, and suppliers [34]. Some contractors must wait for other contractors in order to be able to do their duties, causing problems for the contractors themselves and delaying the overall progress of the project. The management of project progress by the owner and the contractor must ensure the overall progress of the project [35, 36]. Unforeseen force majeure risks often have a great impact on the construction project and may cause damage to the work or lead to designs arising out of the original design proposed by the contractor. This is costly and can impact an enterprise's prestige and brand. The contractor for a DB project is not only responsible for construction techniques, means, and methods, but also for the design, accuracy, and performance. The owners' responsibility is also partially reduced while they can still follow the project quickly. As a result, contractors not only are responsible for their own specialties, but they also take more responsibilities [37]. Contractors being not familiar with this situation can cause problems, including accuracy in assessing the feasibility of the project, investor's incompetent supervisors, changes in project scope, contractors chasing maximum profit and ignoring project specifications, using inferior materials or using replacement materials to get profit because of a fixed price contract, insufficient capacity and experience of the staff on the DB project, lack of reliable support from subcontractors, unsuitable allocation of resources to the project, and ineffective communication between owner and stakeholders in the project implementation process.

IV. Research Methodology

To determine risk, we need to know two dimensions, occurring probability and consequence levels. Risk is often expressed in terms of a combination of the consequences of an event and its associated likelihood of occurrence. In short, a risk factor (RF) in this study is calculated by [17, 29, 35]:

$$RF = C + L - C.L \quad (1)$$

where RF is the risk factor or level of risk, C is the consequence measure on a scale 0 to 1 = the average of consequence factors, and L is the likelihood measure, on a scale 0 to 1 = the average of likelihood factors

Mathematically, (1) derives from the probability calculation for disjunctive events:

$$\text{prob}(A \text{ or } B) = \text{prob}(A) + \text{prob}(B) - \text{prob}(A) \times \text{prob}(B) \quad (2)$$

The risk factor value from 0 (low) to 1 (high), reflects the likelihood of a risk arising in the element and the severity of its consequences. The risk factor will be high if the likelihood L is high, or the consequence C is high, or both. It is important to remember that risk analysis rates consequences first, and then likelihoods, not the other way round. Events may have many kinds of outcomes that could range from quite small to quite large, so the sequence of rating likelihood before a consequence is difficult: which of the many consequences should be selected when rating a risk? In practice, people who use this approach often select the likelihood of an event occurring irrespective of the level of consequence, and then select a conservative or worst-case consequence. This generated likelihood-consequence pairs that could never arise in practice and levels of risk that are far too high. We now rate the consequence first, usually a 'most-likely' or characteristic consequence, and then the likelihood of that level of consequence is arising. This ensures that likelihood-consequence pairs are coherent, can actually occur, and describe the risk in a meaningful way [38].

V. Results and Discussion

Based on the results of the literature review and of the in-depth interviews with experts, a total of 28 risk factors were identified in DB projects in Vietnam. After using (1), we can conclude that the top three most important risk factors have been identified. These leading risks are analyzed as follows:

A. Delays in Project Approval and Licensing

In Vietnam, project approvals are often delayed and sometimes even a previous approval is canceled. The project approval process is prolonged for several reasons, including the lack of capacity and professionalism of the approval departments and complex project approval procedures. Different departments often have different laws and regulations of their own with which contractors must comply. Environmental agencies, land offices, electricity, water and irrigation authorities often cause delays in DB projects. In addition, the amendment of some applicable laws and regulations in a short time forces contractors always to face changing regulations, which also takes a lot of time at the beginning of the project. Moreover, complex legal hoops, prolonged submission procedures, and changes in the legal policies of the government also cause difficulties for owners, and contractors in the project implementation process as well as in payment and final settlement.

B. Interest Rate Fluctuation

Interest rate fluctuation can have a positive or negative effect on both owners and contractors [39, 40]. Normally, owners and contractors borrow more than 50% of the capital from banks, with the interest rate depending greatly on the policies of the State Bank. Low interest rates will attract investors and motivate them to pay more attention to the construction market. On the other hand, when interest rates are volatile, there are problems with potential profit or return on equity. Moreover, getting access to loans from financial institutions in the private sector is also difficult.

C. Design or Technical Specifications Deficiency and Change

Design or technical specification deficiency and change risks are unavoidable, particularly in large-scale DB projects, because most of the design elements are not completed during the contracting period, resulting in disputes between owners and contractors. Bigger inaccuracy creates higher risks for the contractors because they bear the cost [41-43]. In DB projects, the investors regularly bring only an original idea about the project that they wish to build, but it is the contractors that prepare the proposals including the preliminary design and the estimated costs for the project based on the owner's requirements. The bid price from the contractors is often fixed. Therefore, if the DB project contractors have incurred further costs for shortcomings in design or construction, they cannot have a claim against the owner. However, if an owner changes the requirements for the design or the project specifications, the contractors commonly do require an additional amount from the owner [44, 45]. One of the major reasons there are omissions in the design is due to unconditional surveying and measuring by the contractors [5], e.g. if the contractor conducts an improper geologic survey on the construction site it may result in inconsistency in the course of construction and augmented cost in the design. This can also cause serious problems in the quality of the structure if the problem is not detected quickly. The contractors may need a long time to carry out resurveying and design revisions. Besides, the costs for troubleshooting during construction caused by unsatisfactory geologic survey works will be very high. Thus, surveying and measuring are terribly significant for ensuring the project do not encounter difficulties.

VI. CONCLUSION

This paper investigates the risk factors affecting the implementation of DB projects in construction industry in Vietnam. The results showed that the top three critical risk factors in descending order of importance are: delays in project approval and licensing, interest rate fluctuations, and design or technical specifications deficiency and change.We expect that the research results will support researchers and project managers in the DB contract approach in project management.

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