AN INTEGRATED REAL OPTION-RISK MANAGEMENT FRAMEWORK FOR PPP/PFI PROJECTS

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Abstract

The Public Private Partnership/Private Finance Initiative (PPP/PFI) schemes have made the private sector become a major participant involved in the development of infrastructure systems along with the government. Due to more integrated efforts among project participants and longer concession period, PPP/PFI projects are inherently more complex and risky. It is therefore very important to proactively manage the risks involved throughout the project life cycle. Conventional risk management strategies sometimes ignore managerial flexibility in the planning and execution process. This paper starts with a revised risk management framework which incorporates the real option concept. Following the presentation of the framework, a new risk classification is proposed which leads to different ways of structuring options in a project according to the stage of the project life cycle. Finally, the paper closes by discussing other issues concerning option modeling and negotiation.

Keywords: Negotiation, option modeling, Private Finance Initiative, Public Private Partnership, real option, risk management

1. Introduction

Since the 1970s, privatization has been recognized as an alternative approach to solve the difficulty of funding large scale public projects due to resource constraints. In many ways, the private sector continues to play an important role in the development of infrastructure systems. Among the various channels and modes of participation, the Public Private Partnership or the Private Finance Initiative scheme is one of the more popular procurement methods adopted. With this procurement method, the government will not provide full or direct funding for the design and construction of public works (except for indirect guarantees, support and partial funding). Instead, through the PPP/PFI scheme, government has become a partner along with the private sector.

Since PPP/PFI projects often have a longer tenure and requires more integration of services from project participants, they are perceived as more risky than those delivered using conventional delivery modes (such as Design-Bid-Build and Design-and-Build). It is thus important for all project participants to manage the risks involved in a proactive manner. In some ways, the existing risk management strategies are linked to the assumptions that underlie the traditional evaluation method using discounted cash flows (DCF). Put specifically, the appeal of alternative risk management strategies is founded on the outcome of these discounted project values, which tend to ignore managerial flexibility in the project management process [1]. Real option is regarded as a better approach to evaluate risks or uncertainties in a project and lead to a more equitable risk sharing setting [2].

2. A New Risk Management Process Integrated with Real Option

Risk exists throughout all stages of a privately financed infrastructure project. Standard risk management processes follows three typical steps: risk identification, risk measurement, and risk mitigation. Generally, risk mitigation approaches can be subdivided to include risk avoidance, risk reduction, risk shifting or transfer, and risk retention. Although these four strategies could help manage uncertainty and can effectively reduce the negative effects of uncertainty, they presume a certain degree of losses [3]. As a matter of fact, the conventional approaches limit managers' ability to recognize and exploit opportunities to increase project value. Accordingly, it is necessary to develop a risk management framework which considers the flexibility of management.

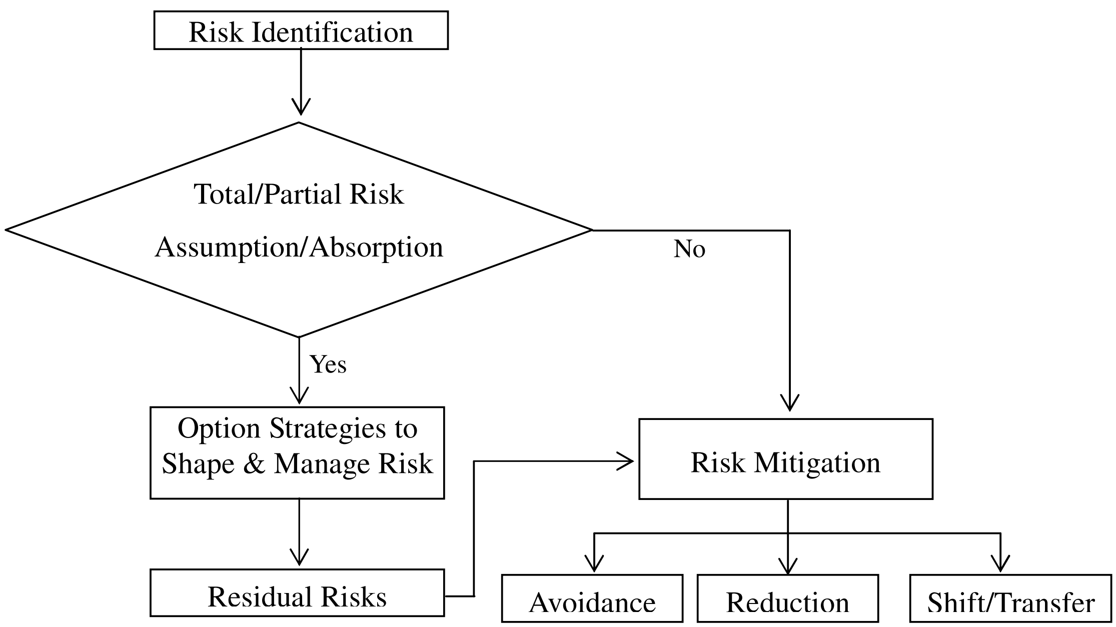

Figure 1: A New Risk Management Process in Infrastructure Projects

Figure 1 shows a new risk management process which incorporates the real option concept. The process includes risk identification and subsequent design of risk mitigation strategies. As confirmed by past literature, since real option is a better method than the NPV approach to evaluate a project and it can enhance the value of a project, the process will adopt this as an initial attempt to manage risks. In this process, parties who are willing to assume total or partial risks will adopt an 'option mindset' to shape and manage the risks [4]. For example, flexibility can be built into contracts by introducing special clauses which can be used to alter the timing and sequence of activities to achieve reduced risks [5]. Naturally, however, this option approach could only shape and mitigate certain risks – there are often other residual risks that cannot be managed well by this way. It would then be helpful to realize the complementary nature of other conventional risk mitigation strategies in view of these residual risks that cannot be handled by the real option approach. As shown in the figure, these residual risks would filter through the option strategies and will be managed by traditional risk mitigation strategies: avoidance, reduction and shifting/transfer.

3. Risk Classification in a PPP/PFI Project

In Figure 1, the logical starting point of risk management is identification of potential risks before taking measures to mitigate the effects of these risks. Risks associated with privately financed projects can be identified by forecasting risk events that might appear throughout different stages of project development or by investigating the notable sources of risks (such as market risks, currency risks etc.). This leads to different approaches of risk identification. The most common approach is the checklist approach. Li *et al.* [6] and Wang and Tiong [7] conducted insightful works on risk identification using the checklist approach. Cheah and Liu [8] have also categorized risks that exist in a typical infrastructure project into two kinds: general risks and specific risks. By consolidating the findings of past literature, Table 1 presents a checklist for some of the major risks that can be found throughout different stages of the project life cycle.

As a matter of fact, risks in a project will vary according to their nature and stages within which they are embedded. For instance, completion risk of construction will be limited to the construction stage. This timing characteristic matches with the timing nature of real option. Therefore, it is natural to classify risks according to various stages of the project life cycle.

According to the key functions of a project, its life cycle can be generally divided into three stages: initial, execution and facility-in-service. During the initial stage, the search for opportunities, feasibility studies, and planning and design of a project are conducted. The study of risks at this stage lays a solid foundation for a project. During the execution stage, key project functions would focus mainly on construction and installation of the facility. The physical construction process is often so complex that many risks and uncertainties are involved at this stage. Moreover, many activities are critical in terms of timing and sequences, and with typically large capital expenditure to be incurred at this stage, it would be wise to introduce some flexible project management measures, since some of these investments are irreversible in nature. These measures may include switching the sequence of certain construction activities, or seeking alternative sources of material supply. Finally, the stage of facility-in-service includes start-up, operation and maintenance of project facilities and also subsequent upgrading. For a PPP/PFI project, this is a key stage for the private sector to recoup their revenue and return. The nature of risks varies broadly within this stage (e.g. market risks, technology risks, currency exchange risks, inflation etc.) and the financial condition of the project is highly subjected to successful management of these risks. However, similar to the influence curve concept in project management (which purports that it would be most costly to make changes at the downstream of a project life cycle while generating the least impact to improve operating performance), it may be too late to introduce flexible measures that have not been planned for – since actions taken at this stage would be subjected to existing constraints due to pre-specified contract conditions at the earlier stage, components of the facilities that have been built and technologies that are in place. Therefore, the degree of freedom and value of such 'last-minute' options are not likely to be high.

Stages	Risks/Uncertainties
Initial	• Delay in project approval and permits • Design deficiency • Availability of Finance • Increase in financing cost • No experience of PPP/PFI projects • Public opposition to project
Execution	• Land acquisition and compensation • Geotechnical condition • Construction cost overrun • Construction time delay • Quality of construction • Variation in scope • Default by concession company, contractor, or government • Environmental damage • Restriction on import equipment/materials • Force majeure
Facility in Service	• Demand risk • Fluctuation of supply • Government restriction on profit and tariff • Operation cost overrun • Inflation • Foreign currency exchange rate • Changes in law • Payment failure by government • Termination by government • Government's adverse action or inaction • Labor risk • Technology risk • Condition of facility • Force majeure

Table 1: A Checklist of Risks in Different Stages of Project Life Cycle

Table 2 matches the profile of certain options with the nature of the three stages of the project life cycle. Obviously, Table 2 only serves as a guide for general cases. In option pricing models, there are five main parameters, among which the timing or maturity period of the option is one of the important ones. In a financial option pricing model, the maturity period is typically fixed by the standard contract. However, in a real option model, the maturity of an option sometimes falls within the control of the option owner subject to contractual constraints. For example, the project sponsor who owns an expansion option may choose to expand the scale of the project at anytime so long as such action does not violate any contract specifications. The owner will take action according to his ongoing exposure to risks that change along the way as the project proceeds through design, construction and then operation. In this case, the degree of freedom and value of the expansion option cannot be laid out clearly in Table 2.

		Stages of Project Life Cycle		
		Initial	Execution	Facility In Service
Key functions		• Search for opportunities • Feasibility studies • Planning and design	• Construction of facility • Installation of services	• Operation • Maintenance • Upgrading
Nature of each stage		• Exploratory • Shaping	• Time-critical • Expediting	• "Moment of truth" • Adapting to reality
Level of commitment / investment / sunk cost		Low – especially when planning incurs relatively lower cost compared to other stages	High – capital expenditures and construction costs are big ticket items	Varies – costs are tied to future expansion plan, switching costs, deterioration rate etc.
Degree of freedom to incorporate options / flexibility		High	Moderate	Low
Most relevant types of options	Operating	• Deferment • Abandonment	• Switching • Abandonment • Expansion / contraction	• Expansion / contraction • Switching
	Non-operating	• Learning	• Learning	• Restructuring • Learning
Value of options		Highest • Uncertainty and turbulence elevate the value of flexibility • Time-to-maturity of option is still distant	⟶	Lowest • Many uncertainties have unraveled • More constraints have taken root with facilities in place

Table 2: Matching the Profile of Options to Different Stages of Project Life Cycle

4. Structuring Options in a PPP/PFI Project

As illustrated in Table 2, the degree of freedom of structuring options would decrease with time as project stakeholders move along the decision journey – from initial searching and shaping, to constructing the facility and finally operating it. During the initial stage when many uncertainties are unresolved, options are valuable, and premature lock-in can be costly. Thus, deferment option is valuable [9]. In the presence of uncertainty, commitments ought to be low and flexible until sufficient exploration brings out a viable and optimum solution [10]. At the other end of the spectrum, the fact that the facility is in service does not necessarily preclude the existence of options. The timing of exercising expansion, contraction, switching and abandonment options may still be introduced, *albeit* subject to the constraints discussed in the previous section. Stakeholders could also undertake business and financial restructuring while incorporate additional flexibility in the future. The entire project experience also provides numerous learning options along the way in setting up future ventures. To reiterate, the underlying philosophy is not too different from the familiar concept of the life cycle cost influence curve in project management.

There are several option strategies that can be designed to manage the risks of a project in a proactive manner. Some options that can be structured into in an infrastructure project are given below:

4.1 Call options

Generally, large scale infrastructure projects can be split into two or more phases, whereby execution of the latter phase would be contingent on the success of the former. This strategy is helpful to solve uncertainties such as the demand risk, which is a critical factor to the success of a project. According to real option concept, it creates a call option to its owner such as the concessionaire of a project.

4.2 Put options

During the execution and facility-in-service stages, the project sponsor will make timely decisions based on the actual condition and latest information available. Given an adverse scenario, the sponsor might choose to reduce the capacity of a project, temporarily shutdown the plant when marginal operating cost exceeds marginal revenue or even sell the assets to avoid greater losses. These actions provide a put option to the sponsor. In addition, in some cases, the government grants certain forms of guarantee against risks and such guarantees can be valued as a form of put option written by the government [11].

4.3 Switching options

During the development of a project, the variation of certain exogenous factors might affect the benefits of the project. For example, the cost of raw materials or fuel sources of a plant would fluctuate. The strategy for this kind of risks is to design a facility that can be operated by using alternative kinds of input resources or switching between alternative operating modes if the technology allows so.

4.4 Timing option

Projects are generally assumed to be built once the decision is made. However, when the project is exposed to too much uncertainties that are difficult to predict, it might be better for the investor to wait for some of these uncertainties to unravel and develop the project later. This strategy will increase the probability of success and represents a form of deferment option such as to develop a piece of vacant land or to commence construction when the economic outlook of the project is brighter.

4.5 Compound option

In some projects, two or more options can exist concurrently and mutually influence the chances of being exercised. Compound option refers to a combination of two or more type of options. For example, a project split into multiple phases would imply a "sequential call option". The interactions among various types of options impose greater complexity in evaluation as the total value is usually not a simple sum of the parts [12].

4.6 Learning option

Some projects are pilot projects that are developed without much precedence or enough experience in terms of policy and technology. Under this scenario, the pilot projects are adopted simply as a learning ground or part of a larger strategic plan to pursue future goals. For example, a pilot project in a politically unstable or less developed country might be viewed as a learning option for the corporation to explore future business opportunities in the country.

5. Modeling Options

Figure 1 has shown the inclusion of option strategies in the revised risk management process and Table 2 has presented the various options that can be designed and incorporated into different stages of the project life cycle. During the course of designing option and risk management strategies, the project sponsor would also need to gauge the value of the options in order to prioritize his/her decisions. Due to the complexity of an infrastructure project, options can be evaluated in different ways. This section will discuss the modeling issues of real options in the context of infrastructure projects.

There are many ways to model and evaluate real options. By broadly categorizing models into continuous-time and discrete-time, Garvin and Cheah [9] commented on the merits and challenges of applying them to the context of infrastructure projects. Borison [13] also categorized different real option approaches based on the assumptions made and the evaluation mechanics involved.

Generally, a project is analyzed using spreadsheets constructed for cash flow models. Most information of a project cannot be conveniently represented by straightforward formulae in continuous-models, which are typically partial differential equations (PDEs). Furthermore, analytical or closed-form solutions may not exist for these PDEs and numerical techniques, such as finite difference methods, need to be adopted to generate an approximate value for the options anyway. Consequently, the authors would prefer the use of discrete-time models. By using a discrete-time model which is the binomial tree method, options such as expansion, abandonment, contract extension and switching are evaluated in the Dabhol Power Plant project [2]. The results demonstrate that discrete-time models are sufficient to provide meaningful conclusions on value implication for managerial flexibility embedded in the project.

Monte Carlo simulation is another approach that has been used to evaluate options. Again, by simply using a spreadsheet model of cash flows, factors of uncertainties which lead to the existence of options can be incorporated into the spreadsheet with their values represented as distributions rather than single value parameters. The forecast cell, which may be related to a real option value, can be flexibly linked to these uncertainty factors given the numerous built-in and customized functions endowed with spreadsheet programs nowadays (which may be further augmented with VBA programming). A distribution of the forecast cell can then be generated by simulating the risk factors. This approach was used in the analysis of the Malaysia-Singapore Second Crossing [14]. In addition, another advantage of the Monte Carlo simulation approach is that in case two or more risk factors influence the value of an option, what needs to be done is to define the correlation between these risk factors. Introducing and modeling such multiple risk factors and correlations in a continuous-time model are far more complex, and a closed-form solution is often times not available.

Finally, sensitivity analysis, though simple and common, remains an important tool in augmenting real option analysis. In the evaluation of options, the variables determined are important and critical to the resulting value of the options. For instance, the sensitivity analyses of the initial traffic volume and growth rate in the Malaysia-Singapore Second Crossing case confirm that variations of these factors have great influence on the results of options. Conducting sensitivity analysis which will help all parties involved to get a feel of the feasible range of values and thereby make a better judgment.

6. Negotiation Settings

To ensure successful development of a PPP/PFI project, government, project sponsors, developers and contractors should seek cooperation from one another at the onset. They should negotiate and finally reach a fair agreement based on the best efforts of evaluating value, risks and uncertainties that can be identified at the initial stage.

The implication of valuation on negotiation has been discussed in Cheah and Liu [14]. The authors presented a figure which summarized hypothetical positions of a service provider and a government agency that are going to enter into an off-take contract. As emphasized, a feasible negotiating range needs to be found to create a win-win situation so that both parties would enjoy positive benefits. With proper evaluation and consideration of options embedded in a project, such feasible negotiating range might be widened and the project would have avoided cancellation simply due to a negotiation breakdown. Sometimes, individual parties focus solely on risks and do not properly factor the value of support packages into consideration. Conversely, a party that is granting too many concessions should be alert to potential exploitation, since the true position of this party really reflects a lower level of return when the value of the concessions granted are taken into account.

In a negotiation setting, the design of certain key factors turns out to be extremely important since these factors directly influence the feasible bargaining range. For example, the private sector may ask the government to provide a guarantee on the level of IRR in order to secure financial benefits for a pioneer project that is deemed too risky. This occurred in the case of the Dabhol Power Plant, when the government granted a guarantee that the project would generate a return-on-equity of 16% [2]. In the case of Malaysia-Singapore Second Crossing, the government granted a guarantee on the projected revenue which subsequently led to the release of subsidy payments. Obviously, the thresholds that determine the release of payments to compensate any of these return shortfalls are important factors of consideration. These factors directly influence the value of the guarantee or support, which are a form of put option.

It is also interesting to note and conclude that with a predetermined value of IRR, the concessionaire would normally negotiate only on one variable, such as the tariff rate for a power project or the toll rates for a traffic infrastructure project. However, when the bidder needs to submit a bid with more than one technical/financial parameter (such as an initial transfer price plus a tariff rate), the value of IRR can essentially take up a wider range of value. Since, for any value of IRR, there is always an initial transfer price commensurate with a proposed tariff rate (the two parameters would be connected in the cash flow model), the government and concessionaire could each estimate the range of feasible transfer price and tariff for a series of IRR given the same set of uncertainty factors. This tender setting would further widen the ground for negotiation and there is more room for making the deal economically feasible to both parties.

7. Conclusions

Since the real option approach evaluates hidden flexibility in a project better than conventional methods (even if it cannot quantify the actual value of some risks), it is necessary to adopt this approach in the risk management of PPP/PFI projects. This paper puts forward a risk management framework that incorporates the real option concept and discusses the associated components of the framework: a new classification of risk factors, examples of options that can be identified or created in a PPP/PFI scheme, option modeling and negotiation issues. By intentionally introduce flexible management measures, certain risk factors can be shaped and mitigated while residual risks can still be managed using conventional risk management strategies such as risk avoidance, risk reduction and risk transfer. By combining the two types of risk management thinking (real option and conventional), the revised risk management framework should lead to a more proactive approach in totality.

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