OPTION DESIGN STRATEGIES FOR INFRASTRUCTURE PROJECTS

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ABSTRACT : Since the 1980s, Build-Operate-Transfer and its variations have become a common approach to develop large-scale infrastructure projects. Despite the slight variations in contractual settings, the key issue for all parties concerned is to assess the risks and uncertainties inherent in a project. The risk factors studied and highlighted by past researchers are very diverse. This paper starts with an objective to compare the risk factors in different sectors of infrastructure, and then categorize them into two kinds: general and specific. Following this classification, risk mitigation strategies should be adopted differently at the corporate and project levels. A few short cases have also been used to illustrate the flexible measures or "options" that some project participants have designed to address risks and uncertainties at the two levels.

Key words : *General risks, Infrastructure Projects, Real Option, Risk Management, Specific Risks*

1. INTRODUCTION – INTERPRETATING RISKS IN AN ALTERNATIVE MANNER

Since the 1980s, privatization has become a common approach to develop large-scale infrastructure projects. This has come in different forms of private sector participation models such as the build-operate-transfer (BOT), build-own-operate (BOO) and build-own-operate-transfer (BOOT) type of concessions [1]. These infrastructure projects would involve the participation of many parties, a huge amount of investments and a lengthy contractual period. As a result, they are more risky than most projects that are delivered using the "conventional" mode.

Some of the parties, who are typically involved in a privately financed infrastructure project, are shown in Figure 1. Regardless of the type of contractual frameworks, the key issue for all parties concerned – government, sponsors, investors, contractors, suppliers, and users, is to assess the risks and uncertainties inherent in the project. The risk factors studied and highlighted by past researchers are very diverse, which include foreign exchange risk, revenue risk, political risk, construction risk, operating risk, market risk, financial risk, social risk, and legal risk. However, it is realized that both the extent of risks and the corresponding risk management strategies would vary according to different sectors of infrastructure, such as power, water and transportation.

Generally, all infrastructure projects can be related to either the provision of product or the provision of services. Among the common type of infrastructure projects, the former would include power plants, water and wastewater treatment plants; the latter would include toll roads and telecommunication networks. It is suggested that the distinction between the provisions of product and services helps to examine the source of risk from a different angle. It also follows that the risks associated with different infrastructural sectors can be categorized into two kinds depending on their nature – general risks that are applicable across all infrastructural sectors, and specific risks that are only relevant to one or few specific sectors. This concept is depicted in Figure 2.

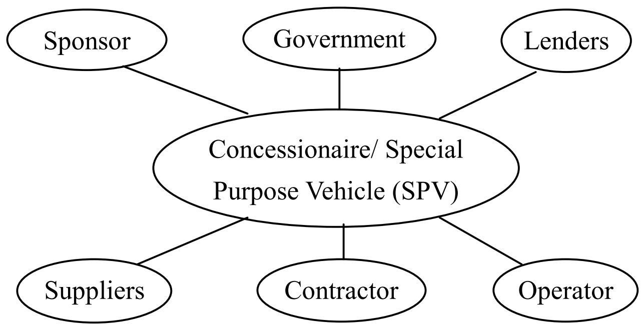

Figure 1. Typical players in a privately financed infrastructure project

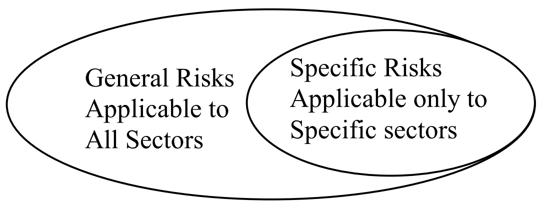

Figure 2. Risks categories

General risks are common risks which are embedded in all sectors. When an infrastructure project is undergoing development, there are always some common risks that are faced by the project sponsor, such as changes in government monetary and fiscal policies, economic uncertainty, etc. All these would be experienced regardless of the type of infrastructure developments that the sponsor is currently promoting – be it power, transportation or wastewater treatment. On the other hand, specific risks are those that are uniquely framed within one or few specific sectors. For instance, a toll road project is not directly exposed to the supply risk of fuel source, unlike the case of a power plant project. This example indicates that the differences in risks between a toll road and a power plant projects lie in the specific risks, which are mostly made up of political, construction, operating, market and revenue risks that are *unique* to the corresponding sectors. At the meantime, they are both exposed to general risks.

Obviously, there are situations where general and specific risks cannot be demarcated clearly. For example, government restrictions on profits and tariff levels may follow certain sectoral or industrial policies, thereby converting an otherwise general risk into one that is more of a specific nature.

Moving along with the above categorization, general risks, to a large extent, would be subject to external uncontrollable conditions that a project is confronted with. For instance, inflation, which can be classified as a type of general risks under the category of financial risks, cannot be controlled by the project participants. On the other hand, specific risks are unique to individual projects; the exposure to some, but not all, of these risks may be limited or even "molded" by a project participant. For instance, through proper structuring of the contractual arrangement, the concessionaire in a power project may potentially solve the supply risk of fuel source (a specific risk) by entering into a long-term fixed-price supply contract.

2. RISK MANAGEMENT STRATEGIES AT DIFFERENT LEVELS

2.1 Strategy at the Firm Level

The differentiation between general and specific risks can be extended further. From a firm's viewpoint, the differentiation is related to the concept of portfolio theory in corporate finance [2] and applied to risk management when investing in a collection of infrastructure projects. At any point in time, a sponsor or an investor may have made investments in several infrastructure projects or concessions. This is a common strategy among institutional investors. In fact, large engineering and construction firms, such as Vinci from France and Hochtief from Germany, have also become strategic players in the worldwide concession market. Other than limiting their roles in the traditional areas of feasibility planning, design and construction, these firms have also taken the lead in financing the project by taking up long-term equity stakes. Again, at any point in time, the firms may be having stakes in multiple infrastructure concessions, which are undergoing different stages of project life cycles.

According to portfolio theory, diversification helps to reduce the overall variability of return, which reflects the risks of investing in a portfolio of infrastructure concessions. Moreover, even a little diversification can provide a substantial reduction in variability, although some residual risks still exist (as shown in Figure 3). In our context, general risks cannot be eliminated by diversification, since they stem from economy-wide perils that would threaten all types of infrastructure projects. In the contrary, specific risks would be reduced through diversification when a firm is invested in a larger number of projects. This stems from the fact that specific risks are peculiar to individual infrastructural sectors, thus it is unlikely that the same source of specific risk will affect two projects of different sectors at the same time. Operationally, specific risks can also be diversified by, for example, transferring profits or cash flows from well-operating projects to cover temporal shortfall in other projects. From a portfolio standpoint, the volatility of return of the overall collection of infrastructure investments is thus reduced. This helps to reduce the risk of financial distress or bankruptcy of a firm that is actively involved in infrastructure concessions.

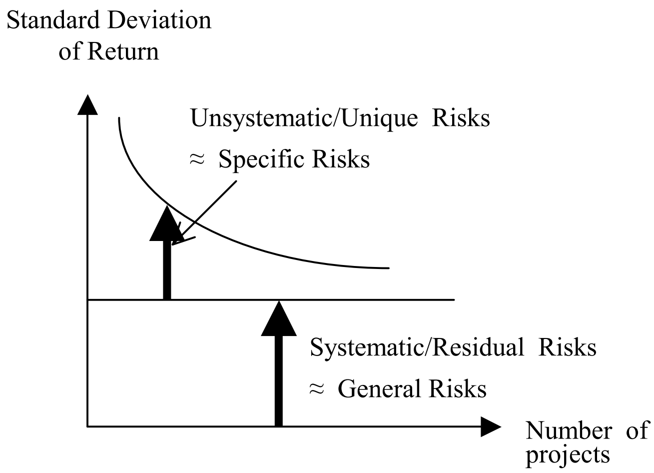

Figure 3. Risks in portfolio of infrastructure projects

2.2 Strategy at the Independent Project Level

Section 2.1 analyzes risk management from a firm's viewpoint based on the portfolio theory. Creation of a portfolio would not reduce general risks. For an independent project, all the risks are not reduced in the process of diversification. As a matter of fact, as a project participant, the sponsor holds the position of developing and shaping the project and it could take actions to mitigate some of the risks. For instance, in a power project, to protect from the shortfall in energy demand, the sponsor could find ways to sell surplus electricity to other customers, encourage consumption by lowering prices, or simply negotiating for a "take-or-pay" contract at the outset.

There has been a decent amount of research conducted on risk management of infrastructure projects. However, many of these covered the idea of risk management following the conventional process of identification, measurement, control and mitigation. It also follows that four general methods of risk mitigation are commonly adopted: avoidance, reduction, shifting or transfer, and assumption [3]. Although these four methods are applicable to avoiding potential losses due to risks, it is easy to overlook the fact that certain risks can be managed or restructured by "shaping" the plan of execution of the project. This ultimately enhances the value of a project. Among others, Lessard and Miller [4] recommended, with general descriptions, for developing a real option framework to manage risks in large engineering projects. Throughout the life cycle of a project, risks are expected to result in either gains or losses. Real option thinking argues that managers can take advantage of the upside scenarios (gains) and avoid the downside scenarios (losses) by incorporating flexibility in risk management of a project [5].

Through the descriptions of a few short case studies, the following section illustrates how flexibility or options may be built into a project so as to address some of the general and specific risks.

3. SHORT CASE STUDIES ON FLEXIBILITY AND OPTIONS

3.1 Texas High-Speed Rail Corporation

3.1.1 Background

The Texas cities of Dallas, Fort Worth, Houston, Austin, and San Antonio, through an unusual combination of geography and demographics, represent a promising market in the United States for an inter-city high-speed passenger rail network. They are situated on a rough triangle with 250-mile-long legs (Figure 4). Residents and visitors traveled frequently between these cities. In one study, the volume was projected to reach about 20 million person-trips per year by 2000, of which 12 million would be by air. Most of the air travel within the state was to and from Dallas-Fort Worth, a major air traffic hub, and most of it consisted of business trips. The Texas High-Speed Rail Corporation (THSRC) was formed by the Texas TGV ("Train à Grande Vitesse") Consortium, a group of private investors, to construct and operate a rail network. In 1991, the Consortium was awarded an exclusive franchise for such a system by the State of Texas. Although the project was eventually cancelled in August 1994, the original execution plan is worth studying here.

The THSRC project was planned to pass through five phases, each characterized by a different set of activities, uncertainties, and funding needs. A preliminary phase of relatively low expenditure lasted until sometime in 1993. A two-year development phase would then mark the beginning of large expenditures and involved some irreversible investment. The construction phase would last for five years and involve heavy expenditure in many locations. A startup phase was then planned to begin in 1998 and would last for two years as the systems swung into full operation, so that THSRC could make adjustments to operating policies and systems. Finally, in time to come, the high-speed rail system was expected to arrive at a steady state characterized by stable operations and a new equilibrium in the Texas inter-city transportation market.

THSRC planned to operate trains along the eastern leg of the triangle beginning in 1998, and offer door-to-door travel times comparable to existing air service at prices comparative with airfare. Following this, by the end of 1999, services would commence along the western corridor from San Antonio to Austin and Dallas-Fort Worth. A southern corridor, connecting Houston and San Antonio, would be added later if sufficient demand materialized.

One problem predicted was that the high-speed line between Dallas-Fort Worth and Houston was unsubsidized and it was difficult to project whether it could match competing airfares and realize high enough load factors to produce an adequate return on investment.

Based on the construction of the facility, THRSC could provide several other potential services such as parking, package delivery, and advertising. In addition, some of THSRC's right-of-way and station sites would create opportunities for real estate development, though none of THSRC's current projections included costs or revenues from such projects. THSRC also planned to lay fiber-optic cables along its right-of-way.

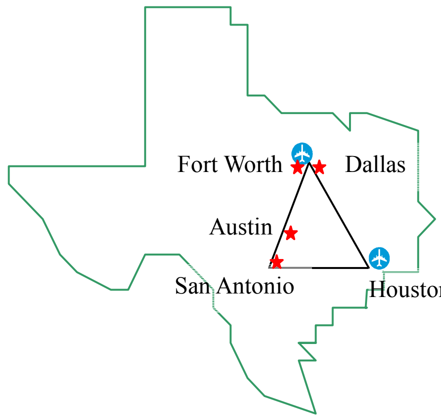

Figure 4. Route alignment of the "Texas Triangle"

3.1.2 Options identified from the case

(1) Abandonment option along five phases

As mentioned, THSRC would implement the project on a phased schedule. Based on the phased schedule, THSRC could make a projection of the facility's prospect according to information collected in each stage. If the prospect turned out to be favorable, the project would be continued; otherwise, it would be abandoned to avoid larger losses, just as what indeed actually happened. This strategy gave THSRC a series of abandonment options during each of the five phases.

(2) Expansion option

THSRC initially planned to operate the eastern and western legs of the triangle. From the viewpoint of THSRC, the construction of the southern corridor is an expansion option based on the execution plan. The decision to construct the southern corridor is subject to its value and cost. According to real option theory, the uncertainty of traffic volume is a key factor, which would lead to an uncertain asset value but a positive option value. If the present value of asset is greater than the present value of cost, it would be valuable to construct the southern corridor; otherwise, the decision can be postponed.

(3) Growth option from air traffic handling

There were two approaches to tackle the previously mentioned problem of the high-speed line between Dallas-Fort Worth and Houston. One was to compete head-on against the airline; the other was to cooperate with it. As the high-speed line was unsubsidized, it is difficult to realize a good return of investment with a substitute transportation means. The idea of increasing rail traffic by cooperating with airlines to deliver air passengers from outlying parts of Texas to the DFW hub seems to be more feasible. The feasibility of the high-speed line would then be subjected to the income negotiated for delivering air passengers and the cost of cooperating with the airline. In this strategic arrangement, cooperating with the airline would represent a form of growth option to THSRC.

(4) Call options from other revenue sources

The potential services from parking, package delivery, advertisement, real estate development and so on could form ancillary sources of revenue and it could generate stable, if modest, cash flows. Laying fiber-optic cables along its right-of-way would involve low incremental costs during the system's construction phase, and create some immediate cash flow when the resulting telecommunications capacity was sold or leased. All these potential opportunities provided some call options to capture additional revenue to THSRC.

3.2 Rocksavage Power Plant

3.2.1 Background

In the U.K., the first wave of private power was politically motivated, the driving force being a desire for low cost, non-polluting electricity production. New technology constantly plays an important part in achieving this goal. The plant being built at Rocksavage is a good example of this.

The Rocksavage independent power project involved a 770 MW combined cycle power plant built for the chemical company ICI (Imperial Chemical Industries). The developer was InterGen, a U.S. power plant developer jointly set up by Bechtel and Pacific Gas & Electric in 1995. The Rocksavage plant was designed to provide 300 MW to ICI's adjacent Runcorn chloro-alkali facility, 400 MW to Scottish Hydro Electric, with the remainder transmitted to the national grid.

In the Rocksavage IPP project, fuel was supplied to the plant on a "tolling" basis. Gas was procured and provided to the plant by the users – ICI and Scottish Hydro, and processed through the power plant which then provided them with electricity. Whether the plant operates or not would depend on whether the two main customers need the electricity and if it is to be their cheapest option.

Rocksavage was InterGen's first exclusively developed and owned international project. The entry into commercial operation of Rocksavage was a milestone for InterGen. The first kWh generated by Rocksavage was also the first product generated by a wholly InterGen-owned plant, which marked the company's transition from a developer to an operator of power plants.

3.2.2 Options identified from the case

(1) Switching option of altering operation (shutdown and restart)

Gas-fired plants built in the early 1990s were sometimes criticized because they operate predominantly in a baseload mode. They gave no thought to flexibility, load following, frequency response, security and the greater good of the whole electricity system. The Rocksavage IPP plant was not a baseload plant that runs regardless of pool price. It was the first U.K. IPP-developed and was not designed to just be switched on and run continuously. This flexibility was built in from the outset. In fact, the design basis of the plant assumed around 200 stop/start sequences per year. InterGen could provide power according to the actual energy demand. This option helps to avoid losses that would have resulted from a baseload model.

(2) Growth option

As Rocksavage is InterGen's first exclusively developed and owned international project, it could be seen as a flagship plant launching what it hoped would become "a national energy company in the U.K." The setting up of what it called national energy companies, which handled all aspects of electricity production, from power project financing to electricity marketing, was a key element of the InterGen strategy. So the development of Rocksavage gave InterGen a growth option from the level of company strategy. Indeed, InterGen continued to look for opportunities in the U.K. and had further constructed two combined cycle gas-fired plants at Coryton and Spalding.

3.3. Indiantown Cogeneration Project

3.3.1. Background

This project involved the construction and operation of a coal-fired cogeneration facility in Southwestern Martin County, Florida, U.S.A. The cogeneration facility, with an electric generating capacity of 330 MW and a steam export capability of 175,000 pounds per hour, was certified as a "qualifying cogeneration facility" under the Public Utilities Regulatory Policy Act of 1978 (PURPA). The partnership, which was formed by Toyan Enterprises, Palm Power Corporation, and TIFD III-Y Inc., sold electric power to the Florida Power & Light Company (FPL) under a 30-year Power Purchase Agreement and sold steam to the Caulkins Indiantown Citrus Company under a 15-year energy services agreement. Bechtel Power Corporation was responsible for constructing the cogeneration facility pursuant to a fixed-price turnkey contract. Bechtel Power's responsibilities included design, engineering, procurement, construction services, plant start-up, training of personnel, and performance testing.

Construction began in October 1992. The guaranteed date for substantial completion of the cogeneration facility under the construction contract was January 21, 1996. If the facility failed to achieve substantial completion by the guaranteed completion date, Bechtel Power would have to pay substantial liquidated damages. However, Bechtel Power's total liability for delay and performance liquidated damages was subject to a cap of US$100 million (in addition to any delayed completion insurance payments).

The Power Purchase Agreement gave FPL broad control over power dispatch levels. FPL might suspend its receipt of energy for specific reasons, including safety reasons or system emergencies.

The Steam Purchase Agreement had a term of 15 years following the commercial operation date. Either party can renew the agreement for five additional years. The agreement can be extended for two additional terms of five years each, if Caulkins and the partnership both agree.

The partnership and a company known as U.S. Operating entered into an Operating Agreement. Under this agreement, U.S. Operating was responsible for operating and maintaining the cogeneration facility. The term of the Operating Agreement is 30 years with automatic renewal for successive 5-year periods, unless terminated by either party.

3.3.2. Options identified from the case

(1) Cap/written call option

Although Bechtel would pay liquidated damages in case of delay, the contract had set a cap to the total liability. From the partnership's standpoint, the payoff foregone due to this cap represents a "written call" (i.e. a call option granted to Bechtel).

(2) Switching option of altering procurement sources

This contract feature of the PPA gave FPL the flexibility to adjust its energy purchases from the cogeneration facility based on FPL's relative costs of power from its alternative sources, such as other merchant plants. This arrangement helped FDL to control the uncertainty caused by the cost of power in the form of a switching option.

(3) Extension /call option

The Steam Purchase Agreement offered an extension option to either party. At the end of term, both parties could renew it and extend for a new term if it turns out to be worthy; otherwise, the term could be ended. This clause offered each party the right to benefit from a new term under an optimistic scenario, which presented a call option.

(4) Abandonment option

Although the Operating Agreement offered an opportunity to extend the term as the Steam Purchase Agreement, it was expressed differently from an option standpoint. By default, the term would be automatically extended for five years if either party was satisfied with it. However, either party would have the right to terminate the contract before the end of the successive terms, which represents a form of abandonment option.

4. OPTION DESIGN STRATEGIES AND THEIR RELEVANCE TO RISKS

Infrastructure projects tend to have lengthy construction periods and are generally long-lived, with the entire project life-cycle often spanning several decades. It is tough to predict the actual consequence of each risk in a project in such a long time. However, according to the case analyses, innovative strategies can be designed in all stages of an infrastructure project regardless of the delivery scheme of the project. These strategies create flexibility for the management of a project to reduce risks. Sometimes, such flexibility would even represent a form of value enhancement [6].

First, the splitting of a project into two or more phases was verified as an effective strategy given the right circumstances (e.g. the Texas High-Speed Rail Corporation case). Generally, a project can be phased into different forms depending on the type of sectors. For a product-providing project, it can be phased into several independent units of a smaller scale, which would collectively generate and furnish the same product to clients in the required quantity or volume. For example, a huge power plant or a wastewater treatment plant may be decomposed into smaller units that would be constructed over several phases in order to address demand uncertainty and even technological risks. Whether the subsequent units are built would be determined by the operation of the forgoing phases and the realized demand. A service-providing project, similarly, may be broken into phases, albeit in a slightly different manner. A toll road facility can be divided into sections or lanes. Again, the construction of the following sections or lanes is subjected to the realized traffic demand since the opening of the toll road.

The division of a project into phases will create valuable flexibility. Whether it is a product- or service-providing project, the operation of the forgoing units/sections/lanes would provide information for the execution of the later stage. This strategy of phasing offered the manager a right to enter into the subsequent phase or give it up, essentially creating a form of expansion option, abandonment option or learning option. In the THSRC project, this strategy led to an expansion option and an abandonment option for the developer.

Second, if a governmental support is negotiated for in the project, it would represent a form of option strategy [6]. Given that a privately financed infrastructure project often involves high risks, unless the financial viability of the project over its entire lifespan can be clearly demonstrated, potential sponsors will be unwilling to take part in the project. To attract private sector investors, the host government often provides support against risks such as demand, foreign exchange, default of a lower level governmental agency, etc. This support may come as a direct guarantee, capital contribution (equity/debt/subordinated debt participation), preferential tax treatment, grant or subsidy. The support would help the sponsors to mitigate loss under a pessimistic scenario, and therefore the associated payoff resembles that of a "put" option.

Third, a cap can be set on the level of profit or penalty payment. Generally, it is difficult to estimate the demand and revenue of a project. If the return derived from the project is too high, the sponsor may be perceived as exploiting the host country in structuring a one-sided deal. Politically, the host government may also be projected as having failed to protect the interest of its people. Consequently, the host government sometimes places a cap on the maximum rate of return. Objectively, the government is introducing a call option for itself in the deal – to call upon any excess return beyond a certain level. A separate scenario is a cap that is placed on liquidated damages due to construction delay, as in the case of the Indiantown Cogeneration Project. The contractor has in fact been granted a call option by having a cap on its liability.

Fourth, an innovative use of advanced technology would help to introduce switching options for the operation of a project. The new technology may allow the change of the input/output of a project during the course of operation. In the Rocksavage case, the technology that was designed based on a stop/start model instead of the baseload model changed the operation of the project and presented a switching option.

Fifth, a properly structured supply agreement could be used as an effective strategy against supply risks. If the concessionaire is concerned with the fluctuation of the cost of an input, it can negotiate for a long-term fixed-price contract with the supplier or even enter into a swap if the input is a widely traded commodity. Technically, it has been shown that a swap is equivalent to a combination of options [7]. Alternatively, if a party is concerned with a decrease in demand of its output which would warrant a downscale of its operation, this party can negotiate for a flexible term with its supplier to match the demand level, as opposed to constraining itself with a fixed off-take contract. This strategy was implemented by ICI, Scottish Hydro and FPL in those two cases. Obviously, this option will not come free, as it is expected that the supplier would command for a higher unit rate or compensation in other means.

Sixth, the option to extend a contractual term can be a valuable strategy. Generally, the concession period of a BOT project is limited to a certain number of years. A party may introduce a clause to have the right to extend for a new term (either unilaterally or bilaterally). This arrangement would offer the party an opportunity to continue with the operation of the project if this is economically beneficial given the circumstances at the end of the concession period.

Seventh, revenue derived from ancillary sources would represent a form of call option and a growth strategy. In some cases, the project could provide a byproduct or the completed establishment could serve as an infrastructure to bring in extra revenue. In the THSRC project, the potential revenue from parking, package delivery, advertisement, real estate development and telecommunication services all represent call options and a growth strategy to THSRC.

Finally, investment in a pilot project provides a valuable learning option to understand the business environment in a foreign country. Not only that this is important in terms of exploring future opportunities in the context of internationalization strategy, it is also a risk management strategy. In developing countries such as China and India, the market for large-scale infrastructure projects is great, but the risk and uncertainty are also very high. Foreign sponsors usually explore the market by moderating their investment budget in one or more pilot projects. Other than serving as a learning platform, the pilot project provides a growth opportunity in the form of a call option, as evident in the Rocksavage case from the standpoint of InterGen.

5. CONCLUSIONS

This paper introduced the notion of classifying risks in an infrastructure project into general and specific risks. At the firm level, the portfolio theory is considered as relevant to risk management; at the level of independent project, strategies are put forward in the form of real options to incorporate flexibility into the project. The short cases clearly support the claim that option strategies can be designed to enhance asset value and mitigate risks. These strategies should be designed on the basis of the risk classification adopted in this paper. Due to the commonality of general risks to all infrastructure projects, strategies designed to control this type of risks should be implemented at the corporate level. These include efforts to negotiate for guarantees from the host government or to address foreign exchange risk at the aggregate level. On the other hand, option strategies of a more specific form should be schemed out according to the risks of individual projects. These include phasing a project, applying new technology, structuring supply agreements, and seeking revenue from ancillary sources.

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