Alternative Concession Model for Build Operate Transfer Contract Projects

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Abstract: This paper develops an alternative concession model for build operate transfer (BOT) infrastructure projects. The concession period is a measure for deciding when the project ownership will be transferred from the investor back to the government concerned; it also demarcates the benefits, authorities, and responsibilities between the government and private investors. Previous studies have developed various techniques and methods, mainly suggesting proper organization structure, contracting procedures, methods of project financing, and risk allocation strategies when BOT-contract projects are implemented. These works have provided effective methodologies for the development of BOT contracts. Nevertheless, it appears that little has been undertaken in studying the way to determine the concession period in a BOT contract. This paper critically reviews the principles of establishing the concession period in a BOT contract. Such a review leads to developing a quantitative model for determining a proper concession period that can protect the interests of both the government concerned and private investors. An example is given that indicates how the alternative model can be applied to determine the concession periods of BOT infrastructure projects.

DOI: 10.1061/(ASCE)0733-9364(2002)128:4(326)

CE Database keywords: Infrastructure; Build/operate/transfer; Contracts; Models; Project management.

Introduction

In the application of the build operate transfer (BOT) procurement system, a private investor, or a group of investors forming a consortium, which is sometimes called a project promoter, provides funds for the construction of an infrastructure and operates the built infrastructure for a given period of time on behalf of the government. This arrangement is often referred to as the franchise of the investor, by which the investor is to Build and then Operate the project within a predetermined concession period and then Transfer the project free of charge to the host government at the end of the concession period. This type of contract arrangement has been widely applied to infrastructure projects throughout the world since the middle of the 1980s. The benefit of this contractual arrangement is commonly considered to be the use of private money for developing public infrastructure facilities such as highways, railways, ports, tunnels, airports, power plants, hydraulic structures, and water conservation facilities (Shen et al. 1996).

Infrastructure projects normally require a large amount of initial investment and span a long period of construction time, and they normally have a slow payback rate, low profit ratio, and high level of risk. Thus in the application of a BOT contract the investor is given the privilege of franchise, which grants, to some extent, monopoly power during the concession period. As the BOT approach provides the mechanism for using private financing, it also allows the government to be able to build more infrastructure facilities without using additional public funds. The BOT procurement system has been developed with several similar approaches in a ‘‘family,’’ including ‘‘private finance initiative,’’ ‘‘build own operate and transfer,’’ ‘‘build own and operate’’ and ‘‘design build finance and operate’’ (Franks 1998).

Over the last 20 years, the BOT contract has proven to be an effective method in financing public infrastructure projects in both developing and developed countries. In the early 1990s, when the British government sought to privatize more public projects, the BOT approach gained popularity (Franks 1998). Most of the major public infrastructure projects in Hong Kong were built using the BOT system, which also has proven effective in attracting overseas investments in developing countries such as China. For example, Lee and Shen (1998) show the successful application for underground rail and highway works in China and suggest the future potential of adopting the system in China.

Previous research has particularly focused on the suitability of the organization structure, contracting procedures, financing method, and risk allocation strategies in a BOT contract (BECC 1995; Tiong 1995; Walker and Smith 1995; Ho 1996; Shen et al. 1996; Jun 1998). It appears that limited research has been undertaken in providing a quantitative measure for determining a concession period that can protect the interests of both the government concerned and the private investor. There are speculations that in a BOT contract the government benefits too little or the private entity benefits too much. Generally, a longer concession period is more beneficial to the private investor, but a prolonged concession period may result in loss to the government. On the other hand, if the concession period is too short, the investor will either reject the contract offer or be forced to increase the service fees in the operation of the project in order to recover the investment costs and to make a certain level of profit. Consequently, the

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Note. Discussion open until January 1, 2003. Separate discussions must be submitted for individual papers. To extend the closing date by one month, a written request must be filed with the ASCE Managing Editor. The manuscript for this paper was submitted for review and possible publication on November 14, 2000; approved on August 3, 2001. This paper is part of the ***Journal of Construction Engineering and Management***, Vol. 128, No. 4, August 1, 2002. ©ASCE, ISSN 0733-9364/2002/4-326–330/$8.00+$.50 per page.

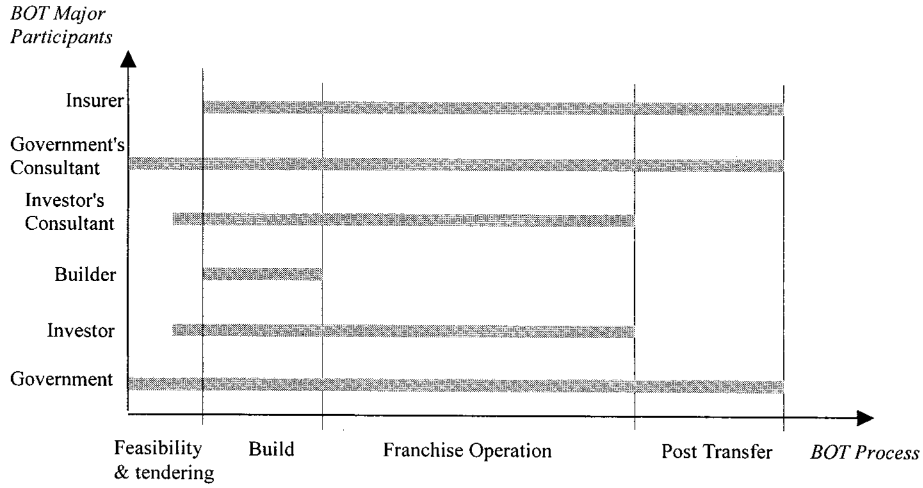

Fig. 1. Involvement of major participants in build operate transfer contract process

risk burden due to the short concession period will be shifted to the public who use the facilities.

In traditional practice, the concession period is determined by a cash flow analysis normally conducted by the investor, and the government's interests are not necessarily incorporated in the analysis. Based on the analysis, a period such as 10, 20, or 30 years or even longer will be adopted. For example, building the English-French Channel tunnel gives a 55-year concession period to the investor that involves the investment cost of $10.3 billion (U.S. dollars, Jun 1998). It is noticeable that, aside from the financial compensations to the investor, the interests of the government were not seriously considered in the analysis. In this paper, we aim to identify important variables and factors affecting the concession period and then to establish a model incorporating these variables for determining the concession period in a BOT contract.

Implementation Process of Build Operate Transfer Contract

The implementation process of a BOT contract involves many parties, including the government, investor, financing institutions, construction contractor, and operating firms. The involvement of the project participants in a typical BOT-contract process is highlighted in Fig. 1. The process of implementing a BOT-contract project can be divided into four major stages: project feasibility study and tendering, construction, operation, and posttransfer.

The concerned government and its consultants will be engaged in the project feasibility study and tendering stage. The major activities involved in this stage are to (1) initiate a project that is often an infrastructure project requiring private investment; (2) examine the project environment and conduct a feasibility study; (3) invite tenders (private investors) to bid; and (4) offer the franchise contract. The duration of this stage is affected by the availability of project information, project complexity, negotiations between tenderers and the government concerned, and the public response to the project. Investors' participation in this stage is to gain more understanding of the project in order to submit competitive tenders.

The construction stage covers a much wider range of activities such as project financing, land acquisition, design, procurement of building materials and plant, construction work, equipment installation, operation test, and training for operating staff. The timing for this stage is mainly affected by the procurement process of building materials and plant, size and complexity of the project, and construction methods selected.

The project operation stage assumes the major part of the BOT-contract time and concerns the daily operation and maintenance of the project. During the operation stage, the project investor is able to make income from providing services such as provision of bridges and highways. The investor also starts to pay capital gains taxes and repayments to financing institutions. The construction period and operation period form the concession period in a BOT contract. Upon the expiration of the concession period, the ownership of the project will be transferred to the government concerned. Transfer and posttransfer involve the inspection of the project and arrangement of transfer, operation by government, and finally dismantling of the project. The duration of the posttransfer operation period depends on the project's type and nature, its natural and economic life, maintenance and management costs, and so on.

Variables Affecting Concession Period in Build Operate Transfer Contract

The investor's considerations in a BOT contract usually include the return on investment (ROI) and/or net present value (NPV). That is, the concession period should bring a certain level of ROI or NPV to the investor. However, the level of ROI and NPV is affected by the initial capital investment, income from operation, costs for operation, inflation, and interest rates. There is a standard procedure for calculating NPV, and the investor's NPV can be established by

$$\mathrm{NPV}^{(1)}=\sum_{t=1}^{T_c}\mathrm{NPV}_t=\sum_{t=1}^{T_c}\frac{(I_t-C_t)}{(1+r)^t} \tag{1}$$

where $\mathrm{NPV}^{(1)}$ = investor's net present value during concession period; NPV_t = net present value generated in year t; T_c

Table 1. Cash Flow Data—Dong-Fang Bridge (Millions of Dollars in Net Present Value)

Year	Income	Cost	Net value	Accumulated net value (NPV^a)	Year	Income	Cost	Net value	Accumulated net value (NPV^a)
2000	—	−14	−14	−14	2016	10	−5	5	13
2001	—	−12	−12	−26	2017	9	−5	4	17
2002	—	−10	−10	−36	2018	9	−5	4	21
2003	2	−9	−7	−43	2019	8	−5	3	24
2004	4	−8	−4	−47	2020	8	−7	1	25
2005	5	−8	−3	−50	2021	8	−7	1	26
2006	6	−7	−1	−51	2022	9	−7	2	28
2007	8	−6	2	−49	2023	9	−4	5	33
2008	9	−4	5	−44	2024	9	−4	5	38
2009	10	−3	7	−37	2025	8	−4	4	42
2010	10	−3	7	−30	2026	8	−5	3	45
2011	10	−4	6	−24	2027	6	−6	0	45
2012	11	−4	7	−17	2028	5	−8	−3	42
2013	12	−4	8	−9	2029	4	−10	−6	36
2014	13	−4	9	0	2030	3	−12	−9	27
2015	12	−4	8	8	2031	2	−15	−13	14
					2032	1	−16	−15	−1

= concession period of BOT contract; I_t = income in year t; C_t = costs in year t; and r = discounted rate taking into account the effects of both interest and inflation rates, which is calculated as $r=(1+I)/(1+I_{nf})-1$, where I_{nf} denotes the inflation rate and I the interest rate.

Obviously, higher NPV provides better potential for the investor to make good profits from the project. To formulate the decision, the investor will establish a benchmark of expectation from his or her capital investment. Usually this benchmark is given as an expected ROI from his or her capital investment (I_c). Thus the following relation can be formed:

$$NPV^{(1)} \geqslant I_c R \tag{2}$$

where $NPV^{(1)}$ = investor's NPV; I_c = investor's capital investment; and R = investor's expected return rate from capital investment.

To illustrate the quantitative discussion, a hypothetical case is designed. Assume that a private investor is tendering for a BOT toll bridge, named the Dong-Fang Bridge. It is estimated that a total investment of \$120 million is needed. The project started in 2000, and the economic life of the project will finish in 2030. The projected cash flow data are listed in Table 1. For the sake of simplicity of demonstration, all values in the table are calculated at their present values.

If the investor in the Dong-Fang Bridge is granted a concession period to end in 2020, the NPV the investor can receive is \$25 million, namely, $NPV^{(1)}_{(T_c=20)}=\$25$ million. If the investor aims for a 15% return, that is, $R=15\%$, his or her expected investment return will be $I_c R=\$120 \text{ million} \times 15\% = \$18$ million. Thus the relationship expressed in model Eq. (2) is true in the Dong-Fang project. In other words, the 20-year concession period can allow the investor to receive his or her expected return, and the investor should accept this term.

On the other hand, the government will consider what NPV can be obtained after the transfer of the project from the private investor. The NPV for the government after the concession period, which is denoted as $NPV^{(2)}$, can be established as

$$NPV^{(2)} = \sum_{t=T_c+1}^{n} NPV_t = \sum_{t=T_c+1}^{n} \frac{(I_t - C_t)}{(1+r)^t} \tag{3}$$

where n denotes the whole servicing period of the project, measured by year, and the other parameters have been defined in Eq. (1).

Referring back to the Dong-Fang Bridge, if the government is to run the project from 2021 until 2030, the total NPV that the government can receive during the postconcession period will be $NPV^{(2)}=\Sigma_{t=2021}^{2030} NPV_t=[1+2+5+5+4+3+0+(-3)+(-6)+(-9)]=\$2$ million.

In fact, after the expiration of the concession period, the management organization will be changed. In order to maintain the capability for the project to provide service, project maintenance costs will gradually increase as the project ages; thus the annual NPV can be negative. According to the projected cash flow, the Dong-Fang project will produce a negative annual NPV after 2027. The government would receive a total of −\$11 million NPV if it has to operate the project until the end of 2031. Therefore, if the $NPV^{(2)}$ is negative or significantly small, the government will have to adjust to offer a shorter concession period to the investor so that the government can obtain a certain level of return. The benchmark for the government decisionmaking is that the NPV must be positive. Thus the following relationship, represents the government's interests:

$$NPV^{(2)} \geqslant 0 \tag{4}$$

However, a proper concession period in a BOT contract should satisfy both the investor's interests defined in Eq. (2) and the government's interests defined in Eq. (4). The model for establishing the proper concession period will be discussed in the following section.

Model for Determining Concession Period (T_c)

As addressed in the previous section, the proper concession period should satisfy both the investor's and the government's interests. To satisfy the investor's expectation as defined in Eqs. (1) and (2) and to satisfy the government's expectation as defined in Eqs. (3) and (4), the concession period T_c should concurrently meet the following constraints:

$$NPV^{(1)} = \sum_{t=1}^{T_c} NPV_t = \sum_{t=1}^{T_c} \frac{(I_t - C_t)}{(1+r)^t} \geqslant I_c R \tag{5a}$$

Table 2. Typical Build Operate Transfer Projects with Different Concession Periods

BOT project	Country	Investment (U.S.)	Concession (years)
Dartford bridge	U.K.	310 million	20
Channel tunnel	U.K. & France	10.3 billion	55
Sydney harbor tunnel	Australia	550 million	30
Shajoe B power plant	China	550 million	10
East harbor tunnel	Hong Kong	565 million	30
South-North highway	Malaysia	1.8 billion	30
Bangkok highway	Thailand	880 million	30
No. 3 route	Hong Kong	940 million	30

$$\mathrm{NPV}^{(2)}=\sum_{t=T_c+1}^{n}\mathrm{NPV}_t=\sum_{t=T_c+1}^{n}\frac{(I_t-C_t)}{(1+r)^t}\geqslant 0 \qquad (5b)$$

Again using the Dong-Fang Bridge as an example, when $T_c=20$ years and $n=30$ years, the constraints expressed in model Eq. (5) will be met. It can be seen from model Eq. (5) that the cash-flow format (I_t-C_t) and the investor's expected return rate R have essential impacts on the value of T_c. Therefore, it is essential to establish a proper cash-flow profile and a proper expected return rate before the concession period is agreed upon. As different development plans will incur different cash-flow profiles from their future operations, each alternative development plan should be arranged with a specific concession period in order to satisfy both the investor's and the government's interests. In practical applications of BOT contracts, as the operation of different types of projects will bring different cash-flow formats, different concession periods are applied. Table 2 provides examples of different concession periods for several typical BOT projects (Walker and Smith 1995; Jun 1998).

To develop the model for determining the concession period, it is assumed that the projected incomes and costs of a BOT-contract project can be graphically presented using the curves illustrated in Fig. 2. Specifically, Fig. 2(a) indicates the distributions of incomes and costs of the project. Fig. 2(b) is the distribution of the NPV obtained by subtracting the cost curve from the income curve. In Fig. 2(b), parameter t_1 indicates the time when the project starts to generate profit, and Fig. 2(c) is an accumulated NPV curve.

In Fig. 2(c), the parameter NPV^a denotes the accumulated NPV, while $\mathrm{NPV}^a(t_c)$, measured in the coordinate system NPV^a-T, is the accumulated NPV that the investor will obtain if the project concession period is t_c. To satisfy the investor's interest, which is defined in Eq. (2), the following relation should be true:

$$\mathrm{NPV}^a(t_c)\geqslant I_c R \qquad (6)$$

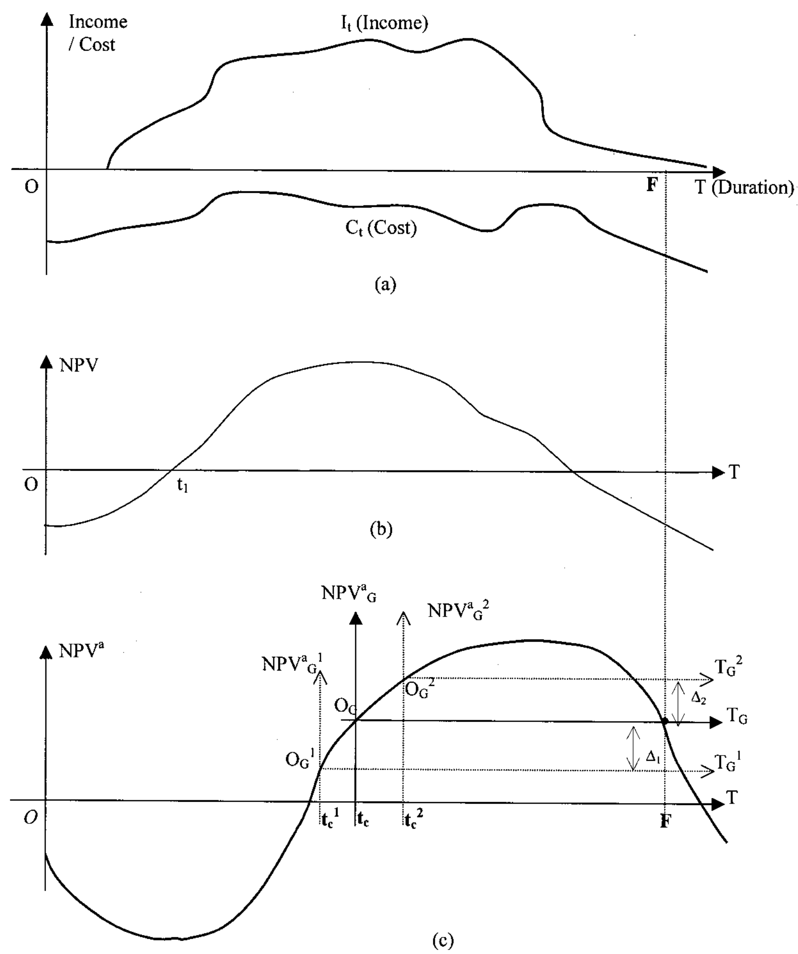

Fig. 2. Modeling BOT concession

After the transfer, the government will start to operate the project from the point of time t_c where the government has nil NPV but the investor has received $\mathrm{NPV}^a(t_c)$, marked at point O_G on the NPV^a curve. The NPV that the government can accumulate for the entire posttransfer period is measured from point O_G [Fig. 2(c)]. As O_G is the starting point for examining the government's NPV, the value of the government's NPV can be measured in the new coordinate system $\mathrm{NPV}_G^a - T_G$, taking O_G as the origin point, as shown in Fig. 2(c). Assuming that the economic life of the project will be ended at point F, we can identify the position of t_c, which allows the government's accumulated NPV at point F to be zero, measured in the new coordinate system $\mathrm{NPV}_G^a - T_G$. In other words, the position of t_c can be identified to meet $\mathrm{NPV}_G^a(F)=0$.

The point t_c in Fig. 2(c) is defined as the critical concession point and its value as the critical concession period, as any time for transferring the project before t_c will allow the government to receive positive NPV during the whole posttransfer period and vice versa. For example, if the transfer happens at t_c^1 [Fig. 2(c)], the government's accumulated NPV can be measured in the coordinate system $\mathrm{NPV}_G^{a\,1} - T_G^1$, with O_G^1 as the origin point. In this coordinate system, it can be seen that the value of $\mathrm{NPV}_G^{a\,1}$ at the time point F is positive, measured with Δ_1, namely, $\mathrm{NPV}_G^{a\,1}(F) > 0$. On the contrary, the government will make negative accumulated NPV if the transfer of the concession happens after t_c. For example, if the transfer happens at t_c^2, the government's accumulated NPV will be negative at F when the project ends, measured by Δ_2 in the coordinate system $\mathrm{NPV}_G^{a\,2} - T_G^2$, taking O_G^2 as the origin point. That is, $\mathrm{NPV}_G^{a\,2}(F) < 0$.

Therefore, from Fig. 2(c), in order to satisfy Eq. (4), which protects the government from absorbing any loss, the position of t_c in the coordinate system $\mathrm{NPV}_G^a - T_G$ must satisfy the relation $\mathrm{NPV}_G^a(F) \geqslant 0$. This relation can be rewritten within the coordinate system $\mathrm{NPV}^a - T$ as follows:

$$\mathrm{NPV}^a(F) \geqslant \mathrm{NPV}^a(t_c) \tag{7}$$

Eqs. (6) and (7) work collectively as an alternative model for formulating a concession period that protects both the investor's and the government's interests. It shows that the position of F (the period of a project's service life) directly affects the arrangement of the concession period. The longer project servicing life can allow for a longer concession. For example, the study by Hudson et al. (1997) shows that the service life for highway works is normally within 35–45 years, and 20–40 years is regarded as a normal service life for power plants. Previous records show that highway BOT projects are usually given a 25–30 year concession, and 10–20 years are allotted for power plant projects (Jun 1998).

By applying the concession model formed in the sets in Eqs. (6) and (7), a range of alternatives of concession period t_c can be obtained from the relationship defined in the following model:

$$I_c R \leqslant \mathrm{NPV}^a(t_c) \leqslant \mathrm{NPV}^a(F) \tag{8}$$

As all alternatives satisfying the model Eq. (8) will be able to protect both the investor's and the government's basic expectation of interests, the application of the model provides more flexibility for negotiation between the private investor and the government concerned, thus improving the effectiveness of the contracting arrangement. To illustrate the application of this model, the Dong-Fang Bridge project is used again. Based on the information given in Table 1, we can obtain the following values: $I_c R = \$120\ \text{million} \times 15\% = \$18\ \text{million}$ and NPV^a ($F=$year 2030) $=\$27$ million.

By applying these two values to model Eq. (8), the value of the concession period t_c can be defined as it has to satisfy the criterion $\$18\ \text{million} \leqslant \mathrm{NPV}^a(t_c) \leqslant \$27\ \text{million}$. From Table 1, it can be seen that this criterion can be met as long as the transfer of the project happens between 2018 and 2022. This provides a range of feasible alternatives that can protect the basic interests of both the private investor and the government concerned. The negotiation between the two sides should not go outside of the range of feasible alternatives. Although the final agreed concession period may be more favorable to either the investor or the government, it will certainly protect the basic interests of both sides.

Conclusions

The concession period is one of the most important decisions to be made when the build operate transfer (BOT) contract is applied to infrastructure projects. This is the measure for deciding the timing of ownership and for delineating benefits, authorities, and responsibilities between the government and private investor. The duration of the concession period directly affects both the investor's level of return on the investment and the government's interests. Traditional methods of determining the concession period rely on the investor's analysis of the project cashflow profile, without considering the interests of the government. This study suggests that a proper concession model needs to incorporate both the investor's and the government's interests. The model developed in this study provides an alternative approach for determining the concession period.

The significant potential impact of applying the new model is improving the efficiency of the contract arrangement as the model provides a simple tool to determine a proper concession period that balances the interests of the government and all the private parties involved. Accordingly, the effectiveness of contracting management in a BOT contract can be improved.

References

Beijing Engineering Consultant Corporation (BECC). (1995). *Guideline on the application of BOT projects*, Earthquake Publications, Beijing, 15–64, 82–95.

Franks, J. (1998). *Building procurement systems*, Chartered Institute of Building, U.K., 29–31.

Ho, H. K. (1996). ''Project finance for BOT infrastructure projects in developing countries.'' *Proc., CIB (International Council for Building) Beijing Int. Conf.—Construction Modernization and Education*, Ministry of Construction, Beijing, 180–189.

Hudson, W. R., Haas, R., and Uddin, W. (1997). *Infrastructure management: Integrating design, construction, maintenance, rehabilitation, and renovation*, McGraw-Hill, New York, 41–63, 171–173.

Jun, S. (1998). ''The theory, method and practice of running BOT projects,'' MSc thesis, University Press, Southeast Univ., Nanjing, China, 3–6, 11–16, 30–51.

Lee, R., and Shen, L. Y. (1998). ''Overview of Chinese government policies to attract BOT investment.'' *J. Hong Kong Surveyor,* 9(1), 48–52.

Shen, L., Lee, K. H., and Zhang, Z. (1996). ''Application of BOT system for infrastructure projects in China.'' *J. Constr. Eng. Manage.,* 122(4), 319–324.

Tiong, R. L. K. (1995). ''Risks and guarantees in BOT tender.'' *J. Constr. Eng. Manage.,* 121(2), 183–188.

Walker, C., and Smith, A. (1995). *Privatized infrastructure: The build operate transfer approach*, Thomas Telford, London, 25–49, 143–171, 240–251.