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A simulation model for optimizing the concession period of public–private partnerships schemes

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Abstract

Public–private partnerships (PPP) are becoming an increasingly popular option of project delivery. Under the concession-based PPP arrangement, the private partner is responsible for funding the scheme, while their capital investment will be recovered through the operation revenue over the concession period. Therefore, calculating an appropriate investment return over the concession period becomes a very important aspect that influences success of the PPP project, particularly so as the concessionaire may be tempted to increase their toll/tariff should the revenue fall short of their expected. However, due to the difficulties in estimating the long-term uncertainties and wider-risk profiles at the tendering stage, the government would conduct the traditional net present value and payback period analyses to determine the concession period. In this paper, a simulation model which aims to assist the public partner to determine an optimal concession period is proposed. A hypothetical example is worked through to illustrate the concept of the simulation model. The results show that the risks and uncertainties, such as a change in inflation rate, traffic flow and operation cost, could influence the decision on the concession period. With the help of the simulation model, the impact of risk can be taken into account when establishing an ideal concession period.

Keywords: Concession period; Public–private partnership; Simulation; Toll/tariff regime

1. Introduction

There is a growing trend for governments and other clients in the construction industry to place major projects into the private sector [1]. According to Miller and Evje [2], purely public and purely private delivery mechanisms are unreliable, unstable and averse to innovation. A disparity between the desperate needs for social facilities/services and the constricted public spending has given rise to an increasing use of public–private partnerships (PPP) [3]. The PPP approach has been applied to infrastructure [4–6], sports stadia [7,8], hospital [9], prison [10] and maintenance [4,11,12] projects. Many studies have claimed that significant cost saving can be achieved through such an arrangement [9,12–14].

According to Zhang and Kumaraswamy [15], the most popular PPP option is the concession-based type such as build-own-operate-transfer in which the private partner (concessionaire) undertakes to finance, design, construct, operate and maintain the facility during a concession period that is usually determined by their public counterpart at the outset. In return, the concessionaire will recover their capital investment through the operation revenue over the concession period. Establishing an appropriate concession period is important to the success of a PPP project. Being protected by an assured minimum 'revenue stream', the concessionaire is entitled to raise the toll/tariff in case their actual profit falls short of the anticipated return. Projects with a shorter concession period could hence result in a higher toll/tariff regime, and this is obviously not desirable from the users' standpoint.

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From the government's perspective, granting an excessively lengthy concession period could mean a loss in public interest especially when the facility would reach the peak of its economic life towards the end of the concession period. Therefore, it is necessary for the government to identify an optimum concession period so that it is long enough to warrant an attractive financial return for the concessionaire but yet soon enough for the facility to be handed over to the government for subsequent operation. While common financial management techniques can help project the pay back period (PBP) of the scheme, the risks associated with the prospective incomes and expenditures must be duly considered to reflect the possible changes in market condition and external environment. To shortcut the decision process, decision-makers may rely on the PBP and value-for-money tests to determine the concession period for a PPP project.

With the ability to predict the consequences under different circumstances, simulation can be conducted to unveil the effects of risks on the concession period. Based on the expected rate of return, decision-makers can establish the corresponding concession period distribution based on the simulated costs and revenues of the project. The aim of this paper is to explore the potential of applying the simulation techniques for deducing the optimal concession period which should help balance the interests of both the government and investor. The paper begins by outlining the features of the simulation model. A hypothetical example is then applied to the model to illustrate its operation and performance. The results indicate that the simulation model can result in an optimal concession period which is otherwise difficult to be approximated by merely referring to the PBP of the project.

2. Practice in determining the concession period

Like any other capital investment programs, a PPP project must be financial viable and a scheme would be considered attractive to the concessionaire only if it attains a reasonable return rate. Consequently, a number financial evaluation techniques such as the cost–benefit analysis [16], net present value (NPV), NPV-at-risk [17], public sector comparator [18,19] and so on have been initiated. Using conventional NPV methods the PBP is calculated by discounting the net cash flow of the investment, and an investment is paid back when the NPV is equal to zero. In the absence of any uncertainty in the cash flow estimation, the PBP is an ideal concession period for the scheme, as the concessionaire will gain a desirable financial return (Fig. 1). Therefore, the government would be inclined to count on the PBP to determine the concession period of PPP projects [20].

However, cash flow estimation is overshadowed by risks and uncertainties such as fluctuations in interest rate, inflation, cost and revenue. These issues could have profound effects on PBP prediction [21]. An overly optimistic estimation could mean the return rate expected by the concessionaire may never be realized during the agreed concession period. Merna and Smith [22] advocated that mutually acceptable procedures should exist, under which the conditions in the contract can be renegotiated from time to time. Allowing the concession period to be adjusted according to the changing external environment is however uncommon practice, as it would not just transfer much of the financial risk to the government but could also dissuade the concessionaire from identifying cost saving measures. Excessive renegotiation could also be costly to both sides.

Instead, there are mechanisms in the concession contract to allow the concessionaire to increase the toll/tariff (rather than extending the concession period) if they can provide evidence that their revenue falls short of the anticipated level during the operation stage [23]. Nevertheless, this is contradictory to the government's goal of keeping the toll/tariff within a level that is tolerable to the users. The pressure from the general public could result in lengthy inquiries and negotiations even when a slight increase in toll/tariff is initiated. For instance, the concessionaire of the Hong Kong Eastern Harbor Crossing entered into arbitration with the Hong Kong Government in 1995 when the public partner rejected their toll increase application and it took almost two years for the concessionaire to win the arbitration proceedings.

Many public clients are trying to develop a better toll/tariff adjustment mechanism for their PPP projects. For instance, the toll/tariff can be automatically adjusted according to some occurrences that would have been stip-

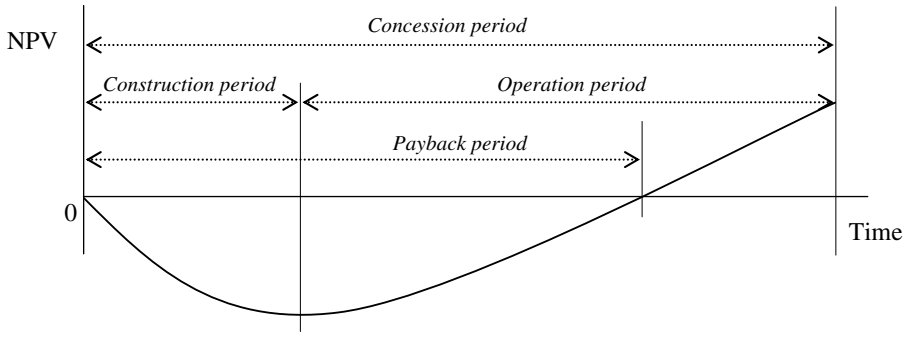

Fig. 1. Relationship between the concession period and NPV.