Decision-Support Methodology for Planning and Evaluating Public-Private Partnerships[a]

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Abstract: Governments at all levels have increasingly turned to public-private partnerships (PPP) as a source of alternative financing for needed public facilities, in turn providing private developers with new markets on government land for investment and profit. Government agencies need a structured, objective methodology to plan, evaluate, and implement successful PPP projects. A structured methodology, including quantitative simulation models for financial planning, evaluation, and cost justification, is presented and demonstrated. This decision-support system methodology will minimize the two primary decision errors in public-private partnerships—accepting unsound or inferior projects and rejecting sound or superior projects.

Introduction

The purposes of this paper are to explain (1) The need for an objective, structured methodology for considering public-private partnerships (PPP); (2) the development of automated decision-support systems for marina and golf-course PPP development projects; and (3) the use of such methodologies and automated systems to plan and evaluate alternative PPP development strategies. The writer believes that more rational and successful development of public lands will result from this approach.

Decline of Public Expenditures on Facilities

The 1980s witnessed shrinking expenditures on public facilities and services (except national defense) at all levels of government. At the state and local level, California's Proposition 13 epitomized the desire of taxpayers to reverse the growth in tax-based outlays for public facilities and services. During the 1980s, the Federal revenue sharing program was phased out; revenue sharing had been an important source of funds for many local governments for over a decade. And taxpayers were generally unwilling to vote for state or local bonds as a substitute source of funds, even for revenue-producing facilities and services. Pressures to reduce the Federal budget deficit brought reductions in appropriations for construction of new government facilities, even in the military (Crosslin et al. 1990a, 1990b). In addition, the Reagan administration fostered a policy of privatizing government facilities and services that could be provided by the private sector at the same or lower cost (Privatization, unpublished report, 1988). These reductions resulted in a decrease in governments' development of land for government purposes.

As governments land development has decreased, the opportunities for

[a]Presented at the March 5–6, 1990, ASCE Specialty Conference, "Successful Land Development: Quality and Profits," held at Orlando, FL.

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Note. Discussion open until August 1, 1991. To extend the closing date one month, a written request must be filed with the ASCE Manager of Journals. The manuscript for this paper was submitted for review and possible publication on July 2, 1990. This paper is part of the ***Journal of Urban Planning and Development***, Vol. 117, No. 1, March, 1991. ©ASCE, ISSN 0733-9488/91/0001-0015/$1.00 + $.15 per page. Paper No. 25645.

private development of government land has increased. Many citizens still desire revenue-producing government facilities or services that the majority of voting taxpayers are unwilling to subsidize or capitalize with general revenues or bonds, even though the facilities or services might be economically profitable in the long run. Golf courses and marinas are good examples. In addition, some facilities and services that are not revenue producers must continue to be provided, even in the face of the citizenry's unwillingness to provide capitalization. Prisons and administrative office buildings are examples of nonrevenue-producing facilities to which the PPP approach has been applied.

Governments Turn to PPPs

Governments at all levels have increasingly turned to PPPs as an alternative to government capitalization (Crosslin et al. 1990a). PPPs are contractual arrangements whereby private companies are involved in the financing, ownership, and, sometimes, operation of public facilities. PPPs differ from simple privatization of government services where the private company provides government services for a fee. In PPPs, there is a much larger degree of entrepreneurial risk since the private company finances and owns the facilities on a speculative basis. There is no guarantee of profit, often there is no guarantee of revenues, and usually the capital investment is relatively long term such as 30 years. From the government's viewpoint, PPPs are an alternative means of acquiring facilities without a prior requesting tax appropriations or bond revenues to finance construction. From the private sector's viewpoint, business opportunities for private companies are expanded into new markets.

PPPs Need Better Planning

On the surface, it would appear that PPPs are a "win-win" proposition; governments get the facilities they need without asking recalcitrant taxpayers for increased taxes or bond indebtedness to capitalize them, the private sector gets new markets and investment opportunities, and the entire process is market driven. However, it is not that simple. There are many ways to approach a given PPP project, and each alternative has different economic and level-of-service implications for both the government and the private-sector partner. Government agencies, in general, do not follow a structured, objective methodology to determine the feasible or best set of alternative approaches to a particular PPP project. This lack of a defensible standard method for identifying and evaluating PPP opportunities may result in:

- Government agencies, and the citizens they serve, receiving lower quality and/or higher cost facilities and services.
- Private companies involved in PPPs having their investment and profit opportunities unnecessarily restricted.
- Some potentially successful PPP projects not being undertaken because the government agency is unable to correctly identify successful project parameters.

Developers and other private companies should be as concerned as public officials over this situation, since the PPP projects that are attempted may have requests for proposals (RFPs) that contain poorly conceived parameters that hamper a good business opportunity. The subsequent contract negotiation process may be ineffective since the government agency does not have an adequate frame of reference—the government may not conduct comparative pro forma financial, or other economic, analyses of private investment alternatives. In addition, some potentially profitable investment opportunities will never make it to the RFP stage for the wrong reasons.

For many PPPs, an important part of the process is a comparison of the private developer's proposal with in-house financing and operation. Theoretically, the full cost of the PPP to the government should be less than the full cost of in-house financing and operation in order to justify entering into a PPP contract. To be valid, the comparison should include all applicable costs for both the government and private alternatives, and should cover the entire life cycle of the project (contract term). Unfortunately, there is no standard life-cycle cost methodology specifically for PPPs. Further, prospective private developers frequently do not understand the comparison process and do not structure their proposals to reflect their best strategy within that comparison framework.

In this paper we explain an objective, structured methodology for government agencies to use in identifying the successful parameters for a PPP, for use in negotiating a successful contract for both sides, and for use in justifying the PPP project and its terms to the appropriate governmental decision making or oversight body. The paper also describes automated computer models for marina and golf-course development projects using this methodology. The computer models represent decision support systems (DSS) that can be used to plan and implement successful PPPs in these industries.

Examples of Public-Private Partnerships

PPPs are occurring at all levels of government, in all areas of the country. The U.S. Army Corps of Engineers has used concession arrangements to develop boating marinas in all regions of the country for years. The U.S. Department of the Interior's National Park Service has used similar arrangements to develop lodging facilities and restaurants on park lands. Recently, all three branches of the military services began pilot testing PPPs for facilities in a broad range of areas, including family housing, hotels, troop dormitories, restaurants, child care, bowling centers, golf courses, marinas, and administrative office buildings (Crosslin et al. 1990a).

Although a few state and local governments have had a small number of PPPs for some years, these government agencies have only recently begun to vigorously pursue this approach. The types of development projects initiated by state and local governments are quite varied, including prisons, administrative office buildings, university research/business parks, hotel and convention centers, toll highways and light rail systems, water and sewer systems, and marinas and golf courses (*Public Works* 1989).

Importance of a Structured Decision-Support Methodology

Avoid Decision Errors

The primary importance of using a structured methodology to evaluate PPPs is to avoid acceptance/rejection errors, of which there are two possible, in the decision process. We denote these as type I and type II errors (type I and type II errors, as defined and used in this context, are analogous in definition and use to type I and type II errors in statistical inference). A type I error is the acceptance of an unsound or inferior PPP project; a type II error is the rejection of a sound or superior PPP project. Type I errors result in the wrong PPP project while type II errors result in no PPP project at all. Since PPP projects can involve many millions of dollars of taxpayer or fee-user costs, often for 30–40 years, not to mention the lost profit opportunities of private developers, it is important to understand both type I and type II errors and how to avoid them.

The first type of error to be avoided is acceptance of a PPP project proposal that is economically unsound or inferior from the government's point of view. In other words, the government agency should not accept a PPP proposal from a private developer that will have a greater total life-cycle cost to the government than the alterenative cost of government financing and construction. Although this would not necessarily be undesirable from the private developer's perspective, it would be detrimental to taxpayers and/or fee users of the facilities. Likewise, the government should accept the "best" proposal from all proposals submitted by private developers. Although the term *best* may include qualitative criteria, it is usually heavily influenced by quantitative (e.g., economic) criteria. A structured methodology helps to evaluate alternative proposals on objective criteria, and also helps to avoid legal actions brought by losing developers. Therefore, a structured methodology helps to properly justify the ultimate decision to the public and to other private developers.

The second type of error to be avoided is the rejection of a PPP project that is unknowingly superior. This type of error occurs when the government agency incorrectly judges the PPP project to be too costly relative to the alternative of government-financed development or to the expected budget appropriation. For example, failure to include some "hidden" government costs in the government alternative, or failure to appropriately use life-cycle cost analysis, can lead to type II errors. We have seen situations where the government agency neglected to count such items as personnel health and retirement, utilities, and minor repairs and maintenance because they were paid out of a fund that was separate from the accounting system of the government facility in question. In other instances, agencies might not recognize the fact that a private developer's project often comes on-line one or two years prior to the government alternative. Another common mistake by government agencies is to ignore the need for a reserve for continuing capital improvements and major repairs to a facility over its life; these costs are typically omitted from the government project alternative.

Identification of Feasible Project Parameters

There is always more than one approach to any given PPP project; and a structured methodology that incorporates pro forma financial modeling will aid in identifying the best set of parameters for a project solicitation. In one case, an agency initially planned a PPP project with a requirement that the physical capacity of the currently government-run fee-use facility be increased by at least 50%. Using our structured methodology and model we demonstrated to the agency that the current demand would only support a one-third expansion at most, from the perspective of private developers. Further, demand had been decreasing for two years, and no expansion was war-

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ranted unless the private developer could reverse the downward trend in demand. If the agency had proceeded with its initial PPP plan, there probably would not have been any private developers willing to submit a proposal. In another recent example our methodology was used to show that a relatively riskless minimum-usage guarantee by the government agency could be exchanged for lower user fees from the private developer, due to resulting lower interest rates on facility debt instruments (Crosslin et al. 1990b). In this latter case we used a model to simulate several hundred project parameter combinations to demonstrate the sensitivity of probable PPP project success to changes in project parameters under consideration.

A Basis for Evaluating Proposals

Besides identifying the best set of parameters for a successful PPP solicitation, a structured methodology gives a basis for evaluating between alternative proposals submitted by developers. Different proposals often have different sizes and streams of capital investment, different unit or total costs (or revenues) to the government, different levels of service, and other measurable differences. A structured methodology helps in at least two ways. First, it gives measurable and objective criteria on which to base an evaluation of alternative proposals. For example, the net present value of all cost and revenue streams over the life of the PPP project may be the primary criterion for choosing between developers. Second, and often overlooked, a structured evaluation methodology that is communicated to prospective developers in the request for proposals gives developers the information they need to design their proposals to more closely fit the government's project expectations. For example, awareness of a net present value calculation automatically informs developers that earlier capital outlay schedules are preferred to (and scored higher than) delayed ones. Obviously, known objective and defensible ground rules will reduce postcontract award litigation probabilities and costs.

Another reason that a structured methodology, including quantitative models of the planned project, is important is that the models will put the government agency in a better bargaining position in the final contract negotiation stage. If the government agency is able to model and understand the likely impact of proposed contract changes on the developer's costs and profits, then the agency is in a better bargaining position.

For the aforementioned reasons, a structured decision-support methodology will give credibility to the entire PPP planning and implementation process. Most PPP projects must go through several levels of review and approval, often at multiple stages in the process, including the final contract award stage. A structured methodology, with realistic quantitative estimates of costs and benefits for all alternatives, is likely to gain faster political approvals than an unstructured process.

Components of the Methodology

In summary, the structured methodology that we recommend, and have successfully used, for PPP project planning and implementation has the following components:

- Measurable goals and objectives that are consistent with the agency's policies and in the public's interest.

- Use of appropriate life-cycle cost and revenue measures.
- Use of a quantitative decision support system model for avoiding type I and type II decision errors; specifically use the model for:
  1. Identifying, through simulation and sensitivity analysis, the best set of project parameters that will attract the best proposals in the public's interest.
  2. Evaluating alternative proposals from different developers.
  3. Justifying to the responsible government officials that the final PPP project decision is preferred to all others, including the alternative of government financing.
- A set of objective, measurable selection criteria on which to base a PPP contract award, and communication of the fundamental nature of these criteria to developers in the government's request for proposals.

Incorporate the Structured Methodology Into a Decision Support System

A major part of our structured methodology is a quantitative model. However, for maximum usefulness, the quantitative model should be part of a decision support system (DSS) that guides a manager toward the proper PPP decision. A DSS can be defined as an information system that helps managers with relatively "unstructured" decisions (Mandell 1989). Unstructured decisions are those without a necessarily unique solution. In other words, there is no precise formula that identifies the optimal decision to be made (in mathematical modeling terms, there is no analytic solution for an unstructured decision situation).

Planning and evaluating PPP projects involve unstructured decision situations for government agencies. Suppose that a municipality has about 200 acres (81 ha) of undeveloped land upon which it would like a new, 18-hole, public golf course. Further, suppose that taxpayers are unwilling to pass either a tax increase or an authorization for revenue bonds to finance the construction and operation of the course. The municipality decides to pursue a PPP project to obtain a privately financed and operated public golf course. There are many questions that must be answered before an RFP can be issued and a contract signed with a developer. What length and level of difficulty is most suitable for this course? Are restaurant and/or lounge facilities appropriate? What other facilities requirements are appropriate? Will the cost of facilities requirements be consistent with expected revenues, and over what length of contract period? Can the municipality expect to share in gross revenues or profits with the developer, and how much? Obviously, the answers to these questions and others are interdependent, and there is no analytic formula that will yield a unique, optimum decision, even if one can answer all the questions satisfactorily. What is needed is a decision-support system with quantitative models that can simulate the effects of alternative scenarios and guide the government agency to a feasible set of sound PPP alternatives that can be justified in the public interest.

Development of Decision-Support Systems for Public-Private Partnerships for Marinas and Golf Courses

The core of a DSS is a quantitative model, or set of models, that captures the important relationships in the financing, construction, operation, and maintenance of PPP facilities and services over the life of the project. Key variables and operational constraints must be identified and built into the models. For example, the pattern of growth in golf rounds played is a key variable that is in turn dependent on other key variables such as population growth, regional golf participation rates, existing excess capacity at other regional courses, relative greens fees, etc. Examples of operational constraints on a golf course would be the maximum number of annual rounds that can be played on the course (which is dependent on region of the country), rainfall and soil conditions, allowance of alcoholic-beverage consumption, etc. These relationships and key variables should be identified and placed in a quantitative model. The advent of inexpensive, powerful personal computers, and off-the-shelf analysis software such as LOTUS 1-2-3, make the development of a customized decision-support system for PPP projects relatively easy and inexpensive.

Pro-Forma Financial Model

The central DSS model for a PPP project is an expanded pro forma financial model. A typical pro forma financial model contains projected annual income statements for the first few years of a project's life. A PPP project will have a finite contract period, and the pro forma financial model should contain projected income statements for each year of the contract. For expansion/renovation and operation of an existing golf course or marina, the term would be from five to 15 years. For new construction and operation, the term would likely be from 20 to 30 years, due to the higher capital costs to be amortized. In either case, the model should be able to simulate the effect of changes in contract term on key indicators of project feasibility.

By definition, pro forma income statements are projections of what might happen, not what has happened. Certain assumptions, therefore, are necessary and should be based as much as possible on concrete historical evidence, and possibly on market research done specifically for the PPP project. A PPP golf course, for example, requires assumptions in at least the following areas:

- Rounds played first year, by weekday and weekend play.
- Increase in rounds played, by year.
- Capacity of course in annual rounds.
- Initial weekday greens fees.
- Initial weekend greens fees.
- Increase in greens fees, by year.
- Golf cart fees and take-up rates.
- Costs of construction.
- Interest rate on indebtedness.
- Contract term.
- Expected return on investment.
- Operating expense ratios.

We suggest that the government agency undertake a market-research study, either in-house or through a contract, to determine initial rounds played and expected rates of increase; the same recommendation holds for determining expected project demand for any other fee-user (i.e., revenue generating) PPP project. These are key assumptions and depend on demand and supply

TABLE 1. Baseline Assumptions for PPP Golf Course Pro Formas

Parameter (1)	Assumption (2)
Rounds played first year	50,000
Rate of increase in annual play	5.0%
Capacity of course in annual rounds	72,000
Weekday 18-hole greens fee	$8.65
Weekend 18-hole greens fee	$10.25
Golf-cart fees	$15.00
Land rent	$0
Cost of construction	$4,500,000
Financing rate on debt	11.5%
Contract term	30 years
Return on investment, before taxes	17.0%
Banquet and catering services	Authorized

conditions, population growth, and population participation rates. Standard methodologies exist for undertaking such market-research studies, and they can be accomplished relatively quickly. The other assumptions can usually be derived from published industry sources or personal contact with local companies in the industry.

If government financing, construction, and operation are serious options, then the model should include a set of pro forma income statements for the government alternative for composition and justification purposes.

Another expansion to the typical pro forma financial statement is a capital outlays module. For a marina, for example, the costs of dredging, pilings, piers, breakwaters, utilities, dry storage, parking, and upland facilities should be in this module. Based on the facilities that the government agency may consider as minimum required capital improvements, the capital outlays module will feed the pro forma income statement with either a debt or equity, or both, to be paid back at interest over the life of the project. The model should be able to simulate the effect of changing minimum capital improvements on the overall economic feasibility and cost to the government of the PPP project.

The expanded pro forma financial model is essentially a detailed business plan for the PPP project and, if applicable, the government-financed alternative. When combined with the other models discussed below, it is used to simulate numerous alternative scenarios to help the government agency identify the feasible set of parameters for a successful PPP project.

Using the DSS we have developed for PPP golf courses, Table 1 shows the baseline assumptions for financing, construction and operation of a new golf course on government land. The resulting pro forma income statements for years one, 10, 20, and 30 of the project, along with the cumulative pro forma results, are shown in Table 2. The information in Tables 1 and 2 is discussed in a later section of the paper.

Life-Cycle Cost Analysis

The second most important part of a DSS for a PPP project is a life-cycle cost-analysis model. PPP projects, especially if they involve new construction, require long-term contracts; 30–40 years is not uncommon. We believe

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TABLE 2. Pro Forma Income Statement for PPP Golf Course: Selected Years

Item (1)	Year 1 ($) (2)	Year 10 ($) (3)	Year 20 ($) (4)	Year 30 ($) (5)
(*a*) Income				
Greens fees	431,641	782,369	1,267,732	1,876,553
Driving range (net)	22,818	30,320	33,189	33,189
Golf cart rental	178,872	239,126	263,212	263,212
Lessons	3,406	6,821	10,096	14,944
Pro shop	30,650	40,729	44,582	44,582
Snack bar	129,839	245,579	397,931	589,035
Banquets	160,992	379,611	561,916	831,774
Total income	73,960	1,724,554	2,578,658	3,653,289
(*b*) Expenses				
General and administration	25,747	105,268	155,823	230,655
Salaries and benefits	51,600	318,252	471,092	697,330
Course maintenance	37,324	155,454	230,110	340,619
Pro shop	25,747	34,212	37,450	37,450
Utilities and water	51,600	73,443	108,713	160,922
Repairs and maintenance	37,324	53,124	78,636	116,400
Snack bar	97,379	138,600	205,162	303,691
Banquets	119,134	445,050	445,050	445,050
Debt service	445,050	280,912	415,819	615,512
Miscellaneous	6,020	8,568	12,683	47,616
Total expenses	1,189,033	1,612,884	2,160,537	2,995,246
Net profit before taxes	(242,796)	120,238	209,061	705,658
Net profit after taxes	(242,796)	55,835	186,206	329,021
Additional profit	0	27,917	93,103	164,511

that the appropriate methodology for determining total net costs or benefits to the government is life-cycle cost analysis. Life-cycle cost analysis considers all costs and revenues of a project for each year of the contract (i.e., project life), and discounts the resulting dollar streams to a single amount in today's dollars [i.e., net present value (NPV)] for the project. The NPV represents the economic worth of the PPP project to the government and taxpayers.

The starting point for the life-cycle cost model is the pro forma income statement model. The net of income and expenses for each year are taken as inputs to the life-cycle cost model where each year's net income is discounted to a present value. If the PPP project is a nonrevenue producing facility (e.g., an administrative office building) then there are no revenues, only expenses. The discounted net incomes are then summed to yield the net present value of the income/expense stream for the PPP project.

Facilities have worth, even at the end of a PPP contract term. Even though a marina, golf course, or other PPP facility has been fully amortized and all loans paid by the end of the contract, it may still have some remaining useful life, especially if continuing capital improvements and major repairs have consistently been made to maintain the facility's usability. There are several methods for determining a facility's value in life-cycle cost analysis. Probably the most common method is to count each capital expenditure in the year it occurs, and annually depreciate this capital investment as part of the facility or equipment according to generally accepted accounting principles. A minimum salvage value (i.e., minimum use value) must be estimated to serve as a cumulative depreciation floor. This undepreciated, or end-of-contract facility use, value represents the value of the service the government could expect from the facility beyond the end of the PPP contract term.

The dollar value of the facility at the end of the contract term, discounted to a present value, must be added to the net present value of the income/expense stream, resulting in the total (i.e., cumulative) net present value of the PPP project to the government. Obviously, larger capital investments result in larger total net present values of the PPP project to the government.

There are actually two life-cycle cost models for a PPP decision-support system. The first model is used in the PPP planning and evaluation stages to make projections and identify the feasible set of project parameters. The second model is used in the evaluation stage to evaluate alternative proposals from different developers, and in the justification stage to compare the selected (i.e., winning) developer's proposal with the government-financed alternative as a justification to award a contract.

In the first model, the government agency is projecting capital outlays, operating expenses, and revenues (if any) over the life of the contract for both the government and PPP alternatives. This model is used to simulate various PPP parameters that the government agency might require and/or be willing to accept from private developers. The results of using this model will indicate to the agency the range of project parameters that are likely to be economically feasible from the private sector's perspective, and the range of project parameters that will likely result in the least cost, or greatest revenue in some cases, to the government. These results will help the agency to structure the RFP to elicit proposals that are not only a good business deal for developers, but that are also a good business deal for the government, taxpayers and, fee-users of PPP facilities.

Once a developers' proposals have been submitted, a second model should be used to evaluate alternative proposals and to justify the winning proposal to appropriate officials for the purpose of awarding a contract. Developers submitting PPP proposals probably will not have been required to submit full pro forma income statements for the life of the contract. Rather, they will have submitted information on the amount and timing of capital outlays, size, and expected usage of the facilities, lease payments from the government (if any), revenue or profit-sharing arrangements with the government (if any), and other important project information on which they might be evaluated. The second model does not use the PPP projections from the pro forma income statement model. Instead, it uses the information submitted by developers in their proposals to generate net present value of life-cycle income and expenditures. For example, the amount and timing of capital outlays for each proposer can be discounted and depreciated to arrive at the present value of the facilities. In addition, the amount and timing of lease payments, and the amount and timing of revenue or profit-sharing payments for each proposer can also be discounted to arrive at their net present values. Care must be taken at this stage in the assumptions applied to proposers future revenue estimates about projected user demand for all proposers, and apply proposers' differing revenue or profit-sharing percentages against the common demand projections; this provides a more objective net present value

TABLE 3. Marina PPP Life-Cycle Cost Analysis

Year (1)	Inflation factor (2)	Contractor payment to agency ($) (3)	NPV of payment ($) (4)
1	1.000	0	0
2	1.046	0	0
3	1.092	0	0
4	1.140	0	0
5	1.190	0	0
6	1.243	0	0
7	1.297	6,006	3,617
8	1.354	22,786	12,465
9	1.414	40,483	20,317
10	1.476	65,174	30,008
11	1.541	79,022	33,380
12	1.609	93,480	36,226
13	1.680	108,573	38,602
14	1.754	124,331	40,554
15	1.831	140,782	42,129
16	1.911	157,957	43,365
17	1.995	175,888	44,301
18	2.083	98,949	22,864
19	2.175	89,680	19,012
20	2.271	98,109	19,081
21	2.371	214,544	38,281
22	2.475	223,731	36,624
23	2.584	233,322	35,041
24	2.697	243,336	33,527
25	2.816	253,789	32,080
Total		2,469,942	581,474
Total with initial capital improvement			2,681,474

analysis for the revenue side of revenue-generating PPP projects.

Once a developer has been selected, the net present value to the government of the winning developers proposal, as determined by this second life-cycle cost model, is compared to the net present value of the government-financed alternative, as determined by the first life-cycle cost model. To justify a contract award to implement a revenue-generating PPP project, the net present value of the winning developer's proposal must be greater than that of the government-financed alternative. If it is not a revenue-generating project, then the net present value of the PPP project's cost stream must be less than that of the government-financed alternative.

Table 3 illustrates a life-cycle cost-analysis summary from our DSS for a PPP marina. In this particular example there is an existing government agency owned and operated marina. The proposed PPP project is for major capital improvements and operation by a private developer for a 25 year period.

Simulation and Sensitivity Analysis

Pro forma financial projections are estimates based on historical data and

TABLE 4. Parameters for Simulation in Decision-Support System for Public-Private Partnership Golf Course or Marina

Management control (1)	Exogenous (2)
Greens fees	Rounds played
Golf cart fees	Rounds played growth
Slip rental fees	Slip occupancy rates
Dry storage fees	Boat rental rates
Construction costs	Facility capacity
Contract term	Interest rate
Discount rate	Inflation rate
Hours of operation	Length of season

expert judgement; there is no certainty that the projections will come true. Sometimes a government agency makes a set of projections for a privately developed project and the government alternative but fails to simulate and analyze a range of possible conditions. Simulation and sensitivity analysis is an important step in the planning process to minimize the chance of type I and II decision errors.

Simulation of the pro forma and life-cycle cost analysis models allows us to observe the behavior of key decision variables (e.g., net present value of total costs) over a wide range of combinations of parameters or assumptions. Some of these parameters are under management control of the government agency while others are exogenous to the process. The management-control parameters represent requirements or operational controls that the government agency or private developer can place on the project. For example, contract term can arbitrarily be set by the government agency at any number of years it chooses.

The exogenous parameters, on the other hand, are out of management's control, and their values over the life of the project are uncertain. Uncertain exogenous parameters can be represented by random variables with probability distributions for simulation purposes (Watson and Blackstone 1989). For example, the growth rate for rounds played on a golf course could be represented by a simple triangular probability distribution—pessimistic, most likely, and optimistic growth rates, three probabilities of occurrence that sum to one. Table 4 gives an example listing of management and exogenous parameters for PPP golf-course and marina development projects.

The DSS models can be used to simulate any combination of values for the management control and exogenous variables. Even though all possible combinations for either the golf-course or marina projects runs into the hundreds, computer simulation is relatively straightforward and can be accomplished in a matter of hours, even on personal computers.

Analyzing the results of many simulations shows the sensitivity of the feasibility of the PPP project to arbitrary changes in management control parameters and to random deviations in the exogenous parameters. That sensitivity analysis enables the government agency to identify the feasible set of management-control parameter values that will result in a successful PPP project and, from the feasible set, to select the set of project parameter values that best suits the objectives of the government agency while still rep-

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resenting a good business opportunity for private developers. The next section demonstrates the use of our DSS models for golf courses and marinas to identify feasible project parameters and select the best developer.

Using the Decision Support System to Plan and Evaluate PPP Projects

Structure of the DSS for Golf and Marina Projects

Tables 1 and 2 in the previous section provided baseline assumptions and pro forma income statement projections for a new PPP golf course. Tables 5 and 6 provide similar information for a PPP marina expansion (and the private developer takes over the existing marina operations and doubles capacity).

The flow of data and information through the DSS models is depicted in Fig. 1. Baseline assumptions for the management control and exogenous parameter are input into the pro forma income statement model. The outputs of the pro forma income statement model are then input into the first life-cycle cost model to estimate net present values of the proposed PPP project and the government-financed alternative. This process is repeated (i.e., simulated) using various combinations of management control and exogenous parameter values to determine a feasible set of management control parameter values. The best set of project parameters is selected from the feasible set and used to formulate the project request for proposals. Proposals received are evaluated using the second life-cycle cost model to select the winning developer and to justify the contract award to appropriate officials.

Simulation and Sensitivity Analysis for a PPP Golf Course

The sensitivity of project feasibility to changes in the Table 1 baseline assumptions is simulated here for greens fees, initial rounds played, growth in rounds played, and cost of construction. The results of all of the simulations are summarized in Table 7. The column labeled "additional profits" is the amount of expected profit from operations that is over and above the assumed industry standard profit rate. Developers would propose in their

TABLE 5. Baseline Assumptions for PPP Marina Pro Formas

Parameter (1)	Assumption (2)
Slip rental fee (monthly)	\$4.10 per ft + \$2.00[a]
Capital improvements	\$2,100,000
Number of rental slips	250
Number of dry storage slips	0
Occupancy rate	92%
Financing rate on debt	11.0%
Term of loan	20 years
Term of contract	25 years
Land rent	\$0
Capital improvement escrow (start year four)	3% of slip rentals
Food and beverage services	Authorized

[a]Monthly utility charge.

TABLE 6. Pro Forma Income Statement for PPP Marina: Selected Years

Item (1)	Year 1 ($) (2)	Year 10 ($) (3)	Year 20 ($) (4)	Year 25 ($) (5)
(*a*) Income				
Slip rental	403,493	651,381	1,001,937	1,242,633
Boat rental	4,732	6,985	10,744	13,325
Chandlery	16,561	24,447	37,604	46,637
Lessons	9,085	13,411	20,628	25,584
Food and beverage	141,952	209,544	322,316	399,746
Dock box rentals	7,098	10,477	16,116	19,987
Miscellaneous	16,561	24,447	37,604	46,637
Total Income	599,481	940,692	1,446,947	1,794,548
(*b*) Expenses				
General salaries	106,464	157,158	241,737	299,809
Food and beverage salaries	23,431	34,587	53,201	65,982
Employee benefits	20,783	30,680	47,190	58,526
General and administration	54,415	80,326	123,554	153,236
Repairs and maintenance	35,488	52,386	80,579	99,936
Utilities	19,636	28,987	44,587	55,298
CGS chandlery	10,931	16,135	24,818	30,780
CGS food and beverage	93,688	138,299	212,728	263,833
Cost of lessons	6,814	10,059	15,471	19,187
Insurance	25,788	38,067	58,554	72,620
Miscellaneous	11,356	16,764	25,785	31,980
Capital improvement escrow	0	19,542	30,058	37,279
Debt service	185,134	185,134	185,134	0
Total Expenses	593,927	808,122	1,143,398	1,188,468
Net profit before taxes	5,554	132,570	303,549	606,080
Net profit after taxes	5,554	132,570	186,206	337,472
Contractor's desired profits	59,460	76,520	101,833	119,213
Additional profit	0	56,050	84,374	218,259

proposals how much, and in what manner, of this additional profit they would be willing to share back with the government agency (the numbers shown in Table 8, although based on actual data and simulations for PPP projects, have been systematically altered for confidentiality and proprietary reasons).

The first management-control parameter we examined was the structure of greens fees, which we varied across the range of fees for comparable golf courses in the area. Greens fees produce the most sensitivity in net present value results of any of the parameters tested for this particular PPP project. A relatively small simulated change in the fees is estimated to have a very large change on the PPP golf course's profitability and net present value.

The next parameter we examined through simulation was initial (i.e., first year) number of rounds played. A market-research study indicated that about 50,000 rounds would be the most likely estimate; we simulated more pessimistic and more optimistic levels for initial rounds played. For more pessimistic levels, the net present value results showed a high degree of sensitivity. However, the results are not very sensitive to initial rounds played

Pro Forma Income Statement Model	First Life Cycle Cost Model	Second Life Cycle Cost Model
Inputs: • Baseline assumptions • Capital outlays	Inputs: • Income and expense from Pro Forma Model • Discount rate • Facility salvage assumptions • Sensitivity assumptions	Inputs: • Developer's proposals - Capital outlays, amounts and timing - Profit sharing formulas (for revenue generators) • Government estimate of demand/usage • Discount rate • Cumulative NPV of government alternatives
Outputs: • Income and expenses by year	Outputs: • Present values by year • Cumulative NPV - PPP - Government alternative • Simulation and sensitivity analysis of project parameters	Outputs: • Cumulative NPV of each developers proposal • Comparisons to government alternative • Selection of best proposal

FIG. 1. Public-Private Partnership Decision Support System

above 50,000. The reason is that, for all but the most pessimistic assumptions about the growth rate in rounds played over time, the annual rounds-played figure soon reaches the maximum course capacity. This can also be seen by noting the relatively large sensitivity of the net present value results to changes in the growth rate of rounds played.

The final parameter that we analyzed for this paper is cost of construction, a management-control variable. The government agency can decide whether it wants a "championship" level course, or something less. Likewise, the amount and quality of other supporting facilities can be varied for budget or level of service reasons. Not surprisingly, the net present value results are

TABLE 7. PPP Golf Course: Sensitivity of Net Present Value Results to Changes in Key Variables

Key variable (1)	Value (2)	Cumulative additional profit ($000) (3)	NVP of profit ($000) (4)
Greens fees (weekday/weekend)	$8.00/9.75	2,585	(300)
	$8.65/10.25	3,567	(24)
	$9.00/10.50	4,051	112
Initial rounds played	45,000	2,893	(448)
	50,000	3,567	(24)
	52,000	3,733	126
Growth in rounds played	2%	558	(834)
	4%	2,944	(271)
	5%	3,567	(24)
	7%	4,014	199
	10%	4,290	363
Cost of construction	$3,500,000	5,074	602
	$4,000,000	4,365	304
	$4,500,000	3,567	(24)
	$5,000,000	2,687	(378)

TABLE 8. PPP Marina: Sensitivity of Net Present Value Results to Changes in Key Variables

Key variable (1)	Value (2)	Cumulative additional profit ($000) (3)	NPV of profit ($000) (4)
Number of slips	250	2,662	667
	300	4,121	1,136
	400	7,359	2,279
	500	10,092	3,240
Contract term (yrs)	15	1,183	427
	20	2,098	607
	25	2,662	667
Construction costs	$2,100,000	2,662	667
	$2,800,000	2,637	553

very sensitive to changes in the cost of construction, since debt service on mortgage loans is one of the largest operating expense items in the pro forma income statement model.

Our simulations and sensitivity analysis reported in this paper varied only a few parameters from the baseline assumptions. In reality, one would simulate many other combinations of the management control and exogenous parameters to find the feasible set of PPP project parameters. We performed such simulations for this example, and came to the following conclusions for the best set of project parameters. First, the project is only marginally feasible at the most likely set of assumptions for the parameters. Therefore, the agency should be careful not to impose restrictions through the management-control parameters that might lessen economic feasibility from private developers' perspectives. Hence, the agency should allow for a relatively long contract term, and minimize the amount of nonessential facility requirements (e.g., extensive locker rooms, size and scope of pro shop, etc.).

Simulation and Sensitivity Analysis for a PPP Marina

The sensitivity of project feasibility to changes in the Table 5 baseline assumptions is simulated here for number of slips, slip rental fees, and contract term. The results of all of the simulations are summarized in Table 8.

The first parameter we simulated for sensitivity analysis purposes was the size of the marina (i.e., number of wet slips); unlike a golf course, the capacity of a marina development has a lot of flexibility. The number of slips is both a management-control and an exogenous parameter. It is exogenous in that the available shoreline and water access area sets a finite limit on the number of slips that can physically be built on the site. It is a management control parameter in that the local marina market, and/or environmental constraints, may limit the number of slips to less than the site's physical maximum. For this example, the number of slips varies from 200 to 500, with considerable sensitivity of the net present value results to these changes.

Slip rental fees were simulated next; they are a management control parameter but are also constrained by market forces. The range of slip rental fees is normally determined through a market-research study. For this example, we varied slip rental fees around the median for comparable marinas

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in the local area. Once again, the net present value results were very sensitive to changes in slip rental fees.

Contract term, another management control parameter, was the last one simulated. For this example, the contract term was varied from 15 to 30 years. The change in net present value results was roughly proportional to the change in the length of contract term. However, no matter what the contract term, the marginal development project appears to be highly feasible.

Simulation and analysis of many other parameter combinations could be, and have been, run for this example. However, even from these few simulation runs, we might make the following conclusions. The PPP marina development project is likely to be highly feasible, and more profitable than the government-financed and operated alternative, under any set of project parameters.

Conclusions

A structured methodology for planning, evaluating, and implementing public-private partnerships, especially if the methodology embodies decision support system models, will strengthen the likelihood of successful PPP projects. Pro forma financial statements, life-cycle cost models, and simulation and sensitivity analysis of management control and exogenous parameters can help government agencies identify the feasible set of PPP project parameters. Government agencies, and private developers alike, have an important stake in encouraging the use of these methodologies since the acceptance of unsound or inferior projects, and the rejection of sound or superior projects, may be reduced. Government and taxpayers will receive the largest amount and best quality of facilities they want, while at the same time bringing new investment and profit opportunities to willing private developers.

Appendix. References

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