The Efficiency Claim of Public-Private Partnerships: A Look into Project Operations and Maintenance Costs

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ABSTRACT

While the literature on public-private partnerships (PPPs) argues that the private sector’s life-cycle approach to design and construction results in operational cost efficiencies, empirical support is missing. This study explored this issue conducting a four-prong investigation: First, a literature review searched for evidence of such efficiencies and methodologies to evaluate them: it found no empirical evidence of superior operations and maintenance (O&M) cost-efficiency in PPPs. Second, a simple methodology is proposed to evaluate life-cycle cost-efficiency, but adequate data and assumptions about O&M costs are needed. Third, since PPP projects in the U.S. are recent and currently subject to routine O&M, indicators to compare those costs were proposed. Fourth, a case study compared the routine O&M costs of a PPP to those of a system of traditionally delivered toll roads. The results showed that the PPP was more cost-efficient in operating expenditures (OPEX) per mile (-60%) and per lane-mile (-53%). The traditional system was more cost-efficient in OPEX per vehicle miles travelled (97%), toll transactions (332%), and toll revenue (20%). However, those three indicators depend on traffic volumes, which were overwhelmingly greater on the traditional system. While the case study showed cost-efficiency differences between public and private sectors, additional research is needed to empirically test the hypothesis of the private sector’s higher efficiency. Understanding the differences in cost-efficiency between publicly and privately managed roads will help decision-makers to minimize the life-cycle cost of their investments.
1. INTRODUCTION

Demand for transportation infrastructure in the U.S. increased in the last decades and is forecast to continue growing at a time when a combination of factors undermine the financial capacity of agencies and governments to provide for those needs (1). Searching for alternatives to traditional funding mechanisms (2), and with pressure to do more with less (3), officials at various levels are increasingly considering innovative delivery options (2).

Public-private partnerships (PPPs) are gaining popularity as a method to stretch scarce funds (2, 4), and accelerate the provision of backlogged projects by leveraging the expertise and capital of the private sector (5). While various contractual arrangements can be classified as PPPs (6), one that bundles the design, build, finance, operation, and maintenance aspects is commonly referred to as DBFOM (7), and also as a concession if the users pay directly for the service (8). DBFOMs are said to offer the largest potential gains in terms of risk sharing and efficiency because the private entity is in charge of all the phases of the project (2); for this reason, they are the focus of this study.

1.1 PPPs for the Delivery of Transportation Infrastructure

Although the U.S. has been slow to embrace PPPs, the momentum is building for their increased application (9), as the number of PPPs to deliver transportation infrastructure has increased in the last decade (10). One challenge in this area is that while some agencies do not consider PPPs an option, others identify projects as PPPs prematurely with no evaluation of other procurement methods (11).

1.2 Evaluation of PPPs

One of the most recognized methodologies to evaluate PPP proposals is a Value for Money (VfM) analysis, a tool used to compare the cost of a PPP project against the hypothetical cost if it was delivered traditionally (12). Yet, VfM use is still uncommon and not standardized in the U.S. (13), which has recently lead to debates about its adequacy (14) and calls for further research on evaluation tools for PPP proposals and projects (11).

1.3 The Efficiency Claim of PPPs

PPPs are said to offer, among other benefits, increased operational efficiency (reduced costs) resulting from the private sector’s life-cycle approach to design and construction within a life-cycle asset management strategy (1, 5, 15, 16, 14, 17, 18). The rationale is that bundling construction and operation into a single contract allows the internalization of positive externalities between the construction and operational phases—thereby lowering the life-cycle maintenance cost of the facility (8), and that because the concessionaire is paid to build and maintain the facility at contractually specified service levels for long periods of time, it is in the concessionaire’s best interest to minimize operations and maintenance (O&M) costs and problems (19).
1.4 Problem Statement

Although cost is not the only factor that must be considered when exploring PPPs, it is the most often cited by advocates to support their positions both for and against (3). Yet, despite the widespread notion in the literature and among PPP stakeholders that the private sector is more efficient in managing road infrastructure, limited empirical evidence can be found on this subject, (13) so there is a need for evidence-based findings to provide clarity on what PPPs can and cannot offer (10), especially in terms of efficiency and cost savings.

1.5 Research Goal and Objectives

The goal of this study was to try to assess the notion of whether the private sector is more cost-efficient than the public sector in the management of transportation infrastructure in the U.S. For that, four tasks were carried out. First, a literature review searched for evidence of such efficiencies and for methodologies to evaluate them. Second, from that review a simple methodology is proposed to evaluate life-cycle cost-efficiency. Third, since most PPP projects in the U.S. are recent and currently subject to routine O&M, simple indicators to compare those costs were proposed. Fourth, to illustrate their use, a case study compared the routine O&M costs of a PPP and of a system of traditionally delivered toll roads.

2. PREVIOUS STUDIES

To understand if and how the notion of higher PPP efficiency had been evaluated, the literature review focused on comparisons between PPPs and traditional procurements, performance and efficiency evaluations of PPPs, and on the O&M phase of PPPs.

2.1 Cost and Duration

Studies about PPP performance have focused on their cost and schedule. This is understandable since cost is the most cited element by both PPP supporters and critics but also because in traditional procurement, cost and time overruns are common (8). Such studies concentrate in the design and construction phases because the majority of projects have recently started operations, but also because of the difficulties in obtaining performance data about the O&M phase. Two broad types of comparisons were found in the literature: comparisons of total construction cost, and of cost and schedule growth.

2.1.1 Total Cost

Based on a review of economic theory suggesting that the ex-ante construction cost of a PPP should be higher than in traditional procurement, Blanc-Brude et al. compared the cost of constructing road projects in Europe, under DBFOMs and under traditional procurement, to examine whether and by how much construction costs differed (8). Focusing only on the construction costs, they evaluated over 200 road projects financed by the European Investment Bank between 1990 and 2005.
The results showed that on average, the PPP projects had 24 percent higher ex-ante construction costs than the projects delivered traditionally. The authors suggested the difference could be the result of higher investments in the design/construction phases that sought to reduce costs during the projects operations, and also of the risk premium charged by concessionaires for assuming the transferred risks. They acknowledged that because their analysis only focused on the construction costs, the results did not allow them to draw normative conclusions about the economic desirability of PPPs as a procurement method (5).

2.1.2 Cost and Schedule Change

To evaluate whether transportation infrastructure projects performed as promised in terms of costs, Flyvbjerg et al. (20) analyzed 258 projects in 20 countries showing with overwhelming statistical significance that the costs of transportation infrastructure projects (of all types) were highly uncertain as nine out of ten projects suffered cost escalation, with road projects experiencing average cost escalation of 20%. They concluded that the cost estimates used in public debates and decision-making for transport infrastructure development were highly, systematically, and significantly misleading.

Furthermore, they argued that such misleading of costs generated risks that were typically ignored or underplayed in decision-making. The risk of cost overruns is, along with the risk of schedule delays, one of the main risks typically transferred to the private partner in a PPP. For that reason, the review moved to explore PPPs.

2.1.3 What about PPPs?

Results from many studies (21, 19, 22, 23, 24) suggest PPPs are superior in terms of cost and schedule control than traditional procurement. However, as Hodge and Greve pointed out, statistically solid evidence to support such notion is weak and at times controversial (21).

Raisbeck et al. echoed critiques made by researchers at University College London (25) about the then-existing research on PPP performance which was suggested to be biased in favor of PPPs. Addressing most of those identified issues and under concerns of widespread optimism bias and lack of appropriate data for capital projects decision-making, they designed a rigorous methodological approach to compare time and cost of Australian PPPs and projects delivered traditionally (22).

The results showed superior cost-efficiency of PPPs with an average of 2.4% cost overruns between contractual commitment and final outcome, versus 13.8% of traditional projects. Time overruns were 2.5% for PPPs and 2.3% for traditional projects, which the authors characterized as exceptional for PPPs given they are subject to additional scrutiny, and that traditional projects were said to have a head start since their general specifications are known at the project’s announcement.
2.1.4 And in the U.S.?

European and Australian markets are so different that their findings cannot be directly transferable to North America. Therefore, Chasey et al. performed what they claimed is the first comprehensive study comparing PPPs against traditionally delivered transportation projects in North America (15). Traditional projects were defined as any procurement method other than DBFOM.

Results from a literature review of cost and schedule growth in Design-Bid-Build (DBB) and Design-Build (DB) highway projects were used as a benchmark to be compared against a group of PPP highway projects. The 12 PPP projects compared were highway and bridge projects constructed between 1990 and 2010, delivered as DBFOMs, with costs between $90M and $1.1B, located in the U.S. or Canada.

The DBFOM projects performed better in terms of cost change (0.81%) than the DBs (4% and 1.49%), and much better than the DBBs (12.71%). From this, they concluded that the cost control of DBFOM projects may be attributable to the DB portion more than the FOM portion. In terms of schedule, the PPPs showed average schedule change of (-0.3%), compared to (-11% and 11.04%) in DBs and (4.34%) in DBBs.

The authors posed doubts about what they referred to as the conventional wisdom that the construction phase is the riskiest. In terms of schedule change, they justified the good performance of the PPPs as resulting from the concessionaire’s incentive to begin operations quickly to start recovering their investment. They also recognized that, as positive as they can be, cost and schedule control are only two aspects of a PPP and recommended research on other factors that could result in additional efficiencies, specifically on the O&M, which they related to the private sector’s incentive to produce a better quality project.

The literature review showed that, as acknowledged by Blanc-Brude et al. “the comparison of cost [and schedule] overruns in PPPs and traditional public procurement is arguably a comparison of apples and oranges” because there is less incentive to provide accurate construction budgets in traditional procurement since the public sector bears those risks (8). Also, since most projects are still in construction or in their early years of operation, most studies have focused on the design and construction phases. Yet, for a PPP to offer a greater VFM to the owner and its users, there must be other sources of value. Therefore, the review of literature explored other types of PPP evaluations.

2.2 Efficiency of PPPs

Reviewing literature about PPP efficiency did not yield nearly as many results. Two relevant studies are discussed next.

To evaluate long-term leasing of toll roads, Zhang et al. proposed a probabilistic framework focusing on the economic efficiency and in the protection of the public interest (1). In regard to economic efficiency, they used net present values (NPV) to compare two scenarios: one, the public agency leases the toll road to a private concessionaire, and two, the agency continues to operate the toll road.

In the privatization scenario the public agency receives an up-front lease payment with no revenue or risk sharing. Since the analysis was done from the point of view of the
agency, this payment was the only value evaluated as the agency would relinquish control of the facility.

In the in-house scenario, the NPV of toll revenues were calculated as:

\[
R(\varepsilon_R) = \sum_{i=1}^{n} \left[ \frac{v_i(\varepsilon_v) * t_i(\varepsilon_t)}{(1 + r_i(\varepsilon_r))^i} + \frac{o_{ri}(\varepsilon_{or})}{(1 + r_i(\varepsilon_r))^i} \right]
\]

where:

- \( R \) = present worth of total revenues in lease period,
- \( v_i \) = traffic volume in year \( i \),
- \( t_i \) = average toll for unit traffic in year \( i \),
- \( o_{ri}(\varepsilon_{or}) \) = other revenues excluding toll revenue in year \( i \),
- \( n \) = total years of lease period,
- \( r_i \) = discount rate in year \( i \), and
- \( \varepsilon_R, \varepsilon_v, \varepsilon_t, \varepsilon_{or}, \) and \( \varepsilon_r \) = uncertainties related to toll revenue, traffic volume growth, toll rate growth, other revenues, and discount rate.

And the NPV of the costs as:

\[
C(\varepsilon_C) = \sum_{i=1}^{n} \frac{o_i(\varepsilon_o) * p_i(\varepsilon_p) + o_{ci}(\varepsilon_{oc})}{(1 + r_i(\varepsilon_r))^i}
\]

where:

- \( C \) = present worth of total costs in entire lease period,
- \( o_i \) = operating costs in year \( i \),
- \( p_i \) = preservation costs in year \( i \),
- \( o_{ci} \) = other costs in year \( i \), and
- \( \varepsilon_o, \varepsilon_p, \) and \( \varepsilon_{oc} \) = uncertainties related to operating costs, preservation costs, and other costs.

Comparing the NPV’s of the two scenarios, the authors wondered about the rationale for privatization. They suggested two answers: one, that a public agency would not increase toll rates as frequent or as high, resulting in fewer revenues, and two, that the private sector tends to exhibit superior operating efficiencies, implying reduced costs. Such claimed efficiencies by the private sector are what concerns this study.

A case study of the Indiana I-90 toll road lease was done to illustrate the framework and a Monte-Carlo-simulation-based NPV analysis accounted for the input’s uncertainties. The results indicated that from a purely financial perspective, the public agency made the right decision by leasing the toll road.

A study by Daito and Gifford evaluated the efficiency of PPPs in a different manner. They argued that previous studies have used statistical analyses but that in the U.S. the number of completed PPPs is not large enough to allow rigorous statistical
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analysis. Further, those analyses require \textit{a priori} functional forms which make them difficult (13). Therefore, Daito and Gifford evaluated the efficiency of PPP delivery—measured as cost savings—using frontier analysis with Data Envelopment Analysis (DEA). DEA is a non-parametric approach to conduct efficiency analysis of multiple inputs and/or outputs which imposes minimum assumptions and does not require the specification of an \textit{a priori} functional form.

They used tolled and non-tolled road capacity expansion projects delivered as DB, DBF, DBM, or DBFOM contracts as Decision Making Units (DMUs), and project delivery as the production of those DMUs. They modeled the projects’ total cost at the financial close as the input, and lane-mileage, number of bridges, and number of interchanges as outputs, to evaluate 37 projects in the U.S., although they acknowledged that these projects are complex and their output should include more variables. Because unusual results were seen, they hypothesized more sophisticated variable specifications were needed to better capture project outputs.

For future research they suggested incorporating environmental and socio-economic factors due to their likelihood to affect DMU’s efficiency levels and cost structures. They also recognized the challenges to empirically evaluate whether the cost savings presumption under which PPP were originally proposed holds true in actual projects.

2.3 Performance of PPPs

The long-term nature of a PPP gives rise to project components and risks not typically found on traditional projects, some of which can change over the life of the project. Consequently, evaluating a PPP is difficult and the use of time and cost measurements does not reflect their complexity, according to Liu et al. (16). They proposed a conceptual dynamic life-cycle performance measurement framework for PPP infrastructure projects that can deal with the complexities arising from having multiple stakeholders using the \textit{performance prism} (stakeholder satisfaction, strategies, processes, capabilities, and stakeholder contribution) based on the arguments of Neely et al. (24).

Because typical evaluations of PPPs are either ex-ante or ex-post, Liu et al. suggested two additional evaluation nodes for project managers to measure project performance in each phase. This provides them real-time performance review capabilities to identify how well their resources were utilized in the previous phase, what should be done to improve, and what should be the focus in the subsequent phase.

Overall, Liu et al.’s proposed evaluation framework is said to help capture some of the dynamism of a PPP project. Yet, while the framework can help PPP project managers, its use would not be appropriate for comparing them to traditionally developed projects because the latter are, by nature, fragmented into pieces for which different parties are responsible; each with unique interests.

2.4 Operations and Maintenance in PPPs

Evaluating performance of a PPP during the O&M phase could be done by benchmarking actual performance data against: the original contract, a public sector comparator (PSC), similar facilities procured traditionally, and private competitors of the private partner
(26). Two of those methods have been documented in this study to evaluate the design and construction phases: benchmarking against conventional procurement and against the original contract. However, their use for the evaluation of the O&M phase is problematic because most PPPs in the U.S. are recent so there are not many projects that have been in operation long enough to have adequate performance data for comparison.

There is also the issue of data confidentiality and the difficulty of having a private entity share their proprietary performance data. Additionally, since the O&M phase in a PPP is usually long, it can be expected to see changes in the requirements, complicating benchmarking against the original contact (26). Perhaps for these reasons, the literature review did not find adequate empirical evaluations of the O&M phase of PPPs in the road sector.

In the UK, Private Finance Initiative (PFI) projects are the equivalent of PPPs. In 2002, Akbiyikli and Eaton (17) cited a report from the UK’s Private Finance Panel arguing that PFI is not about borrowing money from the private sector but that its premise is risk transfer to the private sector, which coupled with efficiencies in management, would outweigh the higher costs of private funding resulting in greater value to taxpayers. This is the same argument that resonates with PPP supporters in other countries.

Akbiyikli and Eaton examined the then-current O&M management practices in PFI road projects in the UK and based on two DBFOM empirical case studies, they proposed a conceptual framework for the O&M management identifying physical and functional performance as the critical O&M criteria. Secondary parameters were: innovation, effectiveness, efficiency, and certainty, all of which are to be measured in terms of time, cost, and quality (17).

Efficiency, the focus of this study, was defined as the minimization of resources required to deliver the agreed outputs at appropriate quality levels. From their analysis of the two case studies, Akbiyikli and Eaton concluded that the functional and performance requirements have to be considered at the beginning of the project, and that the management of the O&M has to focus on the delivery of the services by minimizing the O&M expenses while maximizing the quality of those services.

While their paper was strictly theoretical and the framework seemed unpractical at first, as there were no indications of how it was to be used, in a subsequent study Akbiyikli applied the framework to a PFI road project in the east coast of Scotland to examine whether the performance in the operations phase was complying with the output specifications to the satisfaction of the users (19).

Based on a survey and a semi-structured interview, Akbiyikli examined the first four years of the O&M phase of the A92 project and according to the author, the results showed that the project satisfied the strategic objectives, efficiency, service delivery outcomes, quality, and effectiveness. He concluded that the concession was performing very well and to the satisfaction of all stakeholders.

Akbiyikli’s paper illustrated a different type of evaluation as it focused on qualitatively assessing the performance of the project from the point of view of the users. While it was based on a single project which does not allow generalizations, it was said to provide a very good indication of the subject project performance (19). Although the
results were not compared against a traditionally procured project, the potential for comparisons exists as it would only require conducting similar surveys to obtain comparable data.

3. METHODOLOGY TO COMPARE THE LIFE-CYCLE EFFICIENCY OF PPPS AND TRADITIONALLY PROCURED PROJECTS

The literature review demonstrated that comparisons of the benefits and costs of PPPs vis-à-vis traditional procurement are difficult and require comprehensive evaluation frameworks. Moreover, it showed that empirically determining whether or not PPPs result in more efficient life-cycle management than traditional procurement is difficult: on an individual project, until it has completed its contract cycle, and on a programmatic way, until a sufficient number of projects are completed.

3.1 Proposed Methodology

From the evaluation methodologies reviewed, the one proposed by Zhang et al. is recommended to compare the life-cycle economic efficiency of toll roads between the public and private sectors because of the methodology’s life-cycle approach, simplicity, and capability to evaluate uncertainties of the inputs. Besides, the framework can be used in a scenario approach: a DBFOM concession vs. a publicly developed and managed project.

Zhang’s paper evaluated the leasing of a toll road against the alternative of continued in-house management by a public entity. To be able to compare a DBFOM concession, two changes would be needed. First, the PPP scenario should evaluate the toll revenues and costs over the life of the concession; thus, the NPV of this scenario would result from using the proposed equations. The second change would be in the estimation of the annual operating costs. In their study, the PPP comprised only an upfront lease payment so no estimation of costs was needed. For their public management scenario, annual operating costs were estimated by fitting a statistical function to the historic costs since the facility had been in operation by the same entity. Because a DBFOM is a greenfield project, no historic operating costs exist so that method is not appropriate.

The easiest way to estimate those costs would be to fit historic data from similar facilities in the vicinity of the project which are managed by the same entity. However, the literature on PPPs argues strongly that the private sector is more efficient than the public sector; if true, it is unlikely a private concessionaire would incur in similar costs as a public entity.

Since most PPPs in the U.S. have recently started operations, they are currently subject to routine O&M activities. To assess differences in those costs among the private and public sector in the management of toll roadways, a set of indicators are proposed and used in a case study analysis in the next section.

3.2 Factors to Consider

For a comparison to be effective and fair, the compared facilities should be either of relatively similar characteristics or efforts should be made to try to “level the field.” In
the case of large road infrastructure projects, such as toll roads, this is difficult to do because those projects are rather unique. Thus, for a detailed comprehensive cost performance comparison to be made between different roadways, it is important to consider the differences in: type of highway, project type (greenfield vs. brownfield), location, traffic volume and composition, pavement type, frontage roads, bridges, number of toll gantries/ramps, O&M decision-making approach (facility vs. network), emergency response roles, intelligent transportation systems (ITS), disaster evacuation, etc.

4. CASE STUDY COMPARISON OF ROUTINE OPERATIONS AND MAINTENANCE COSTS IN TOLL ROADS

The purpose of this case study was to assess any differences in the routine O&M costs of a group of toll roadways in the U.S. to evaluate whether the private sector is more efficient in the management of roadways, as argued in the PPP literature. One aspect common to these types of projects is the need to maintain certain information confidentiality, primarily for two reasons. First, most concessions and some publicly owned toll roads are funded by private investors, and second, public access to financial and management strategies could expose the entity to unwarranted exposure and reduced competitive advantage. Therefore, to protect the confidentiality of the data presented, this is a “blind” case study, meaning that neither the names, locations, nor the owners/managers of the facilities are disclosed.

4.1 Compared Facilities

One toll road was developed under a DBFOM, so it was designed and built by a private concessionaire, the same that now manages it. This facility will be referred to as “the concession,” and it will illustrate the characteristics of a privately delivered and managed roadway.

To contrast the PPP model, a group of toll roads located in the vicinity of the concession was selected. These facilities were developed under traditional procurement models: either as DBB or DB contracts and they all are under the management of a State Department of Transportation (DOT). They were selected because of their proximity to the concession, they are owned by the same DOT that conceded the concession, and are collectively managed as a system. They will be referred to as “the system.”

4.2 Study Period

The study period is one year; however, the DOT records expenditures in a fiscal year basis while the concessionaire records expenditures on a calendar year basis. Consideration was given to matching their data but it was decided to maintain their original formats. Thus, the system data corresponds to fiscal year 2013, while the concession data corresponds to the 2013 calendar year.

4.3 Characteristics of the Facilities

- **Type:** All the roadways are toll highways
- **Length:**
Centerline Miles: The total centerline miles of the mainline lanes in the concession are approximately 40; in the system are approximately 73

Lane-miles: The concession has approximately 160 lane-miles and the system about 345

- **Annual Average Daily Traffic (AADT):** During calendar year 2013, the concession served approximately 5,564 vehicles per day. In fiscal year 2013, the system served approximately 130,820 vehicles each day

- **Annual Vehicle Miles Travelled (VMT):** Because no actual VMT data was available, based on the AADT and the centerline miles and assuming each vehicle traveled the entire length of the road, estimated VMT in the concession were approximately 81,157,679, and 735,970,669 in the system

- **Toll Transactions:** The number of toll transactions in the concession was about 5,153,558 and approximately 102,507,240 in the system

- **Toll Revenue:** The total amount of toll revenue collected in the concession was an estimated $18,854,588; in the system was approximately $103,984,500.

Due to the lack of readily available information about certain characteristics of the system not all of the desired indicators could be used.

### 4.4 Operations and Maintenance Costs

This section summarizes the annual operating expenses (OPEX) incurred by both the DOT and the concessionaire while operating and maintaining their respective facilities.

#### 4.4.1 Cost Differentiation

Differentiating between direct and indirect costs is important for an appropriate cost analysis. Direct costs, are those that can be identified specifically with a particular cost objective, while indirect costs, also known as overhead, are those incurred for a purpose benefiting more than one cost objective and that are not readily assignable to the cost objectives specifically benefitted (3).

#### 4.4.2 Availability of Data

Since access to detailed technical and cost information was needed about the facilities, data requests were sent to both the DOT and the concessionaire. It should be recognized that despite its private nature, the concessionaire was open and responsive to all data requests. On the other hand, and recognizing the great disposition of some of the DOT’s staff, the detailed cost information requested was not provided as the DOT’s legal department argued that, because the system is funded by private investors, there were concerns about potentially confidential information being made public. Therefore, no financial information was released other than publicly available information and no clarifications about published information were provided.

The main consequences from this non-disclosure of information were the impossibility of clearly identifying which of the system’s costs were direct or indirect and how many DOT employees supported the management of the system. For this reason, the
classification of the system’s costs presented in this study is the result of the interpretation of publicly available reports. The concessionaire did provide its own cost classification.

Lacking the DOT’s input about the nature of its costs, the more unbiased way to compare the system and the concessionaire costs was to use the same criteria to classify them all. In this case, that meant using the concessionaire’s classification as a guide. Yet, the level of detail of the system’s published information does not allow accomplishing that easily. Consequently, it was decided to create two scenarios for the system’s data trying to emulate the categorization principle used by the concessionaire, but with different levels of rigor.

**Scenario 1** Only the “Repairs and Maintenance” category was considered direct. While that might seem “extreme,” this is the only category that can be easily related to the operation and maintenance of the facility.

**Scenario 2** In addition to “Repairs and Maintenance,” “Contracted Services” was classified as direct because the system has contracted out its maintenance and toll collection operations. “Salaries” was also considered direct because the supervision of those contracts and the management of the system are performed by DOT staff.

Overall, the system had operating expenditures of $47.3 million, of which 34.29% were assumed to be direct costs and 65.71% indirect costs under scenario 1 while in scenario 2, 64.19% were assumed to be direct costs and 35.81% indirect. The concession spent $10.3 million in total OPEX with 56.81% being direct and 43.19% being indirect, as identified by the concessionaire. See Figure 1.

**4.5 Results**

The comparison was done in two ways: for the total OPEX, and for the direct and indirect OPEX under the two scenarios. The system was used as the baseline against which the concession’s costs were compared; therefore, the values shown in the fields “difference” indicate the percent difference that the concessionaire spent compared to what the DOT spent. See Table 1.

Because cost is related to quality, differences in the level of service to which the system and the concession were operated and maintained should have been part of the comparison. The lack of appropriate data led to the assumption that the system and the concession were subject to the same level of service during the study period.

As Table 1 and Figure 2 indicate, the comparison showed that the concessionaire was more cost-efficient in terms of total OPEX and of assumed direct and indirect OPEX per mile and per lane-mile. The DOT was more cost-efficient for all types of OPEX (total and assumed direct and indirect) in relation to the number of VMT and the number of toll transactions. However, those two metrics depend on the amount of traffic volume on the facilities which, during the study period was overwhelmingly larger on the system, helping it to spread its costs among a much larger base.
Special attention should be given to the operating expense ratio (OPEX per toll revenue) because of its distinct behavior in this study. This ratio indicated that the system was more efficient in terms of total OPEX, and though this indicator also depends on traffic volume, which favors the system, when direct costs were analyzed under the conservative scenario 2, the concessionaire spent only about 6% more than the DOT.

This is important because direct costs are those directly related to the actual O&M work and the system has contracted out its maintenance to a private contractor, while the concessionaire uses its own employees. Therefore, this could indicate that the concessionaire is more efficient in the performance of the O&M activities than the DOT maintenance contractor.

While there is no data to support them, one hypothesis could be that as suggested by the literature, the concessionaire made decisions during the design/construction phases to minimize operation costs. Another reason could be that, since the DOT contractor was not involved in the design/construction of the system’s roads, its fees include a risk premium for maintaining facilities for which it cannot vouch.
TABLE 1 Comparison of Operating Expenditures (OPEX), Concession vs. System (Baseline).

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Unit</th>
<th>Concession</th>
<th>System</th>
<th>Difference (%)</th>
<th>Concession</th>
<th>System</th>
<th>Difference (%)</th>
<th>Concession</th>
<th>System</th>
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<th>System</th>
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<th>System</th>
<th>Difference (%)</th>
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</thead>
<tbody>
<tr>
<td>OPEX/Mile</td>
<td>($/Mile)</td>
<td>257,929</td>
<td>650,821</td>
<td>-60.37</td>
<td>-60.37</td>
<td>146,530</td>
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<td>-417,732</td>
<td>233,090</td>
<td>-52.21%</td>
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<tr>
<td>OPEX/Lane-Mile</td>
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<td>64,482</td>
<td>137,213</td>
<td>-53.01</td>
<td>-53.01</td>
<td>36,632</td>
<td>-69.11%</td>
<td>-88,071</td>
<td>49,143</td>
<td>-43.33%</td>
<td>-88,071</td>
<td>49,143</td>
<td>-43.33%</td>
<td>-88,071</td>
<td>49,143</td>
<td>-43.33%</td>
</tr>
<tr>
<td>OPEX/VMT</td>
<td>($/VMT)</td>
<td>12.70</td>
<td>6.44</td>
<td>97.30</td>
<td>97.30</td>
<td>7.22</td>
<td>29.68%</td>
<td>4.13</td>
<td>74.63%</td>
<td>2.31</td>
<td>4.13</td>
<td>74.63%</td>
<td>2.31</td>
<td>4.13</td>
<td>74.63%</td>
<td>2.31</td>
</tr>
<tr>
<td>OPEX/Transaction</td>
<td>($/Trans.)</td>
<td>2.00</td>
<td>0.46</td>
<td>332.75</td>
<td>332.75</td>
<td>1.14</td>
<td>137.92%</td>
<td>0.30</td>
<td>283.02%</td>
<td>0.17</td>
<td>0.30</td>
<td>283.02%</td>
<td>0.17</td>
<td>0.30</td>
<td>283.02%</td>
<td>0.17</td>
</tr>
<tr>
<td>OPEX/Toll Revenue</td>
<td>(%)</td>
<td>54.67%</td>
<td>45.56%</td>
<td>19.99</td>
<td>19.99</td>
<td>31.06%</td>
<td>23.61%</td>
<td>15.62%</td>
<td>29.94%</td>
<td>-21.13%</td>
<td>29.25%</td>
<td>6.20%</td>
<td>16.32%</td>
<td>29.25%</td>
<td>6.20%</td>
<td>16.32%</td>
</tr>
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</table>

FIGURE 1 Operating Expenditures (OPEX) Cost Differentiation for the System and the Concession.
FIGURE 2 Graphical comparison of all scenarios.
5. CONCLUSIONS

The literature on PPPs argues extensively that the private sector is more efficient than the public sector in operating road infrastructure, identifying this as a benefit of PPPs. Yet, those studies don’t provide empirical support. This study conducted a four-prong investigation: First, it searched the literature for evidence of those efficiencies and methods to evaluate them. Second, it proposed a simple way to compare life-cycle cost efficiency in toll roads. The results showed the following:

1. The literature review found no empirical evidence of superior cost-efficiency of PPP concessionaires in the O&M phase.
2. The majority of studies comparing PPPs against traditional delivery projects focused on design and construction cost and schedule overruns, some of which used not-so-rigorous evaluations.
3. The studies that assessed performance and/or efficiency during a project’s life-cycle were at times highly theoretical and not likely being employed outside of academia.
4. The NPV-based probabilistic framework proposed by Zhang et al. could be used, in a scenario analysis, to evaluate the life-cycle efficiency of DBFOM projects against traditionally developed alternatives. The framework is useful because of its simplicity, life-cycle approach, and ability to evaluate uncertainty. Yet, in Zhang’s study, a methodology to estimate the annual operating costs for both the public and private scenarios is not available for the evaluation of greenfield projects.

Third, to empirically test the assumption about the private sector’s higher efficiency, simple comparison indicators were proposed. Fourth, to illustrate the use of these indicators, a limited-scope case study was performed to compare the routine O&M expenditures of a concession against a system of publicly managed toll roads, yielding these results:

5. There were significant differences between the privately and the publicly managed facilities in terms of the cost-efficiency of routine O&M. Specifically:
   • The concession was more cost-efficient in terms of OPEX per mile and per lane-mile.
   • The system was more cost-efficient in relation to VMT, the number of toll transactions, and the toll revenue collected. Yet, those indicators depend on the traffic volume, which during the study period was overwhelmingly greater on the system, helping it to spread costs over a much larger base.

6. The difference in managing a network of facilities (as public agencies do) versus a single facility (as concessionaires do) is most evident in terms of coordination between sections within the entities. Some DOT staff lacked a basic understanding of the system’s management, financial, and performance characteristics; this was not an issue with the concessionaire’s staff.
6. LIMITATIONS

This study’s main limitation was the non-disclosure of the system’s detailed financial data. Citing confidentiality concerns, the DOT’s legal department forbade any release or clarification of financial information. This created the need to assume what costs were direct or indirect and eliminated the possibility of assessing efficiency per number of employees, among other things.

Another limitation of the case study was the inability to use more comparison indicators due to the lack of readily available information about some of the system’s physical characteristics. This further limited the comprehensiveness of the case study’s evaluation.

7. FUTURE RESEARCH

The case study showed differences in cost-efficiency of routine O&M activities in toll roads between the public and private sectors; however, more research is needed to empirically test the hypothesis of higher efficiency of the private sector through a comparison of total life-cycle costs. While it would be interesting if other methodologies are proposed, Zhang et al.’s proposed framework can be used as it is simple and easy to understand by decision-makers and stakeholders, an important consideration that is sometimes forgotten by academics. However, adequate data and assumptions about O&M costs are needed to produce adequate results. For that, more comprehensive case studies than this one should be performed, using either the proposed or similar indicators, to obtain sufficiently detailed empirical data. The factors discussed as necessary to make the comparisons adequate should be evaluated.

The results will help public sector decision-makers to decide whether to procure a project as a PPP, and aid concessionaires wanting to evaluate themselves against public agencies or when entering new markets. Ultimately, those results can help to either prove or disprove the still unsupported claims found in the literature today.
REFERENCES


