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# Operations and Maintenance (O&M): A Comparative Analysis of the Cost-Efficiency of Public Private Partnerships (P3s) and Conventional Project Delivery Models

**November 29, 2023**


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**Technical Report Documentation Page**

| 1. Report No. | 2. Government Accession No. | 3. Recipient's Catalog No. |
|---|---|---|
| CIAM-COR-R59 | | |

| | |
|---|---|
| **4. Title and Subtitle**<br><br>Operations and Maintenance (O&M): A Comparative Analysis of the Cost-Efficiency of Public Private Partnerships (P3s) and Conventional Project Delivery Models | **5. Report Date**<br><br>[June 30, 2023]<br><br>**6. Performing Organization Code** |
| **7. Author(s)**<br><br>Jonathan L. Gifford (https://orcid.org/0000-0001-6216-2118), Carter B. Casady (https://orcid.org/0000-0001-9215-7168), and M. Mustafa Sever (https://orcid.org/0009-0004-3523-5704) | **8. Performing Organization Report No.** |
| **9. Performing Organization Name and Address**<br><br>Center for Transportation Public-Private Partnership Policy<br>Schar School of Policy and Government<br>George Mason University<br>3351 Fairfax Dr., MS 3B1<br>Arlington, VA 22201 | **10. Work Unit No. (TRAIS)**<br><br>**11. Contract or Grant No.**<br><br>69A3551847103 |
| **12. Sponsoring Agency Name and Address**<br><br>U.S. Department of Transportation<br>Research and Innovative Technology Administration<br>3rd Fl, East Bldg E33-461<br>1200 New Jersey Ave, SE<br>Washington, DC 20590 | **13. Type of Report and Period Covered**<br><br>Draft Final Report 1/25/2022 – 6/30/2023<br><br>**14. Sponsoring Agency Code** |

**15. Supplementary Notes**

U.S. Department of Transportation
Research and Innovative Technology Administration
3rd Fl, East Bldg E33-461
1200 New Jersey Ave, SE
Washington, DC 20590

**16. Abstract**

This research project aimed to assess the operation and maintenance (O&M) performance of privately and publicly operated highway projects while exploring the validity of the Public-Private Partnership (P3) model's purported life-cycle benefits. Following a comprehensive methodology outlined in Chapter 2, the study identified 42 projects with O&M expenditure data. These findings were then consolidated into a database, allowing for an analysis of differences and similarities in the reporting of O&M elements across the identified projects. This analysis revealed inconsistency in the reporting of O&M costs. There is a total of 77 distinct elements reported within the projects' OpEX categories, many of which are nearly identical or fall under other broader categories. While detailed financial reporting is commendable for transparency, the lack of consistency poses challenges for any research endeavor seeking to compare the O&M performance of infrastructure assets.

Furthermore, the database allowed authors to conclude that solely relying on just one indicator to confirm or refute the asserted advantages of the P3 model would be an oversimplification of a multifaceted issue, since the evaluation of project O&M performance necessitates the incorporation of multiple performance indicators to account for variances in project characteristics, contractual agreements, traffic volume, regulations, and asset age. However, the observed inconsistencies impede the comparison of the O&M performance of privately and publicly operated highway projects as a way to test the validity of the P3 model's claimed life-cycle benefits.

| 17. Key Words | 18. Distribution Statement |
|---|---|
| Public-private partnerships, operations and maintenance (O&M), project delivery | No restrictions. This document is available from the National Technical Information Service, Springfield, VA 22161 |

| 19. Security Classif. (of this report) | 20. Security Classif. (of this page) | 21. No. of Pages | 22. Price |
|---|---|---|---|
| Unclassified | Unclassified | 29 | |

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## Acknowledgements

The authors would like to thank Matt Hardy for his advice and assistance in carrying out this project. They also acknowledge the use of ChatGPT for editorial assistance. The authors assume full responsibility for the final version and any errors.

CHAPTER 1

# Introduction

## Background

Transportation infrastructure projects are often divided into multiple phases, including design, construction, operations, and maintenance. In the U.S., transportation infrastructure is traditionally delivered using the "design-bid-build" model, whereby the public sector is responsible for constructing, financing, operating, and maintaining a facility, but the design and construction are contracted out to the private sector (Mallett, 2021). Public-private partnerships (P3s) allow private-sector participation in any or all phases of a transportation project, and the different configurations of P3s are categorized by the private sector's participation in these phases. These include design-build-finance, design-build-operate-maintain, design-build-finance-operate-maintain (DBFOM), and long-term lease agreements. The last two types are usually the focus of discourse about P3s, as they include ongoing participation of a private partner or concessionaire (Mallett, 2021).

Operations and maintenance (O&M) planning is critical for the long-term financial sustainability of these projects. O&M is the longest phase of infrastructure asset management. While the design and build/construct phases only take a few years, O&M typically involves a minimum commitment of 20 years for relevant stakeholders (Kordestani Ghalehnoei et al., 2018). Additionally, O&M is considered to be the most expensive part of infrastructure planning (Pelzeter, 2007). For example, Swedish Road Administration (SRA) spent 52% of its expenditure on O&M activities in 2004 (Haraldsson, 2007).

Moreover, American surface transportation P3s regularly use availability payments or toll revenues to fund their projects. Under the availability payment method, concessionaires operate and maintain the assets according to agreed performance metrics to get their periodic payments. Meanwhile, poor O&M performance results in reduced toll revenues for the private contractors of these transportation projects. Hence, this stage of infrastructure delivery carries many risks and benefits for both public and private organizations.

The motivation for this research is driven by two major factors. The first is the importance of operating and maintaining transportation infrastructure. There is plenty of evidence that governments in the U.S. at the federal, state, and local level are not keeping up with the maintenance of their infrastructure. A recent report estimated national total deferred maintenance to be at least $1 trillion (Zhao et al., 2019) (note this includes all infrastructure and has since been impacted by the Infrastructure Investment and Jobs Act). While the authors offer solutions to capital budgeting, P3s may offer a way to address this issue. Some suggest that private operators could save 40% on operating expenses by uniting the tasks of construction, operations, and maintenance, hence reducing life-cycle costs (Wee, 2012). However, there is little empirical research supporting the aforementioned claims with US-based empirical data, which is the second important motivation behind this study. As Hodge and Greve (2017) put it, little is known about the performance of P3s "even at the most elementary levels."

Comparison of P3 and traditional delivery models is not a novel idea, there is a vast amount of literature that focuses on the advantages and disadvantages of the two models (Blanc-Brude et al., 2009; Chasey et al., 2012; Daito & Gifford, 2014; Verweij & Van Meerkerk, 2021). In fact, a recently published book from

Verweij, Van Meerkerk, & Casady, (2022) judged the P3 model's performance against the conventional delivery model in terms of cost, time, and service quality using data from projects outside of the United States. However, evidence on whether and how the P3 and conventional project delivery models affect the long-term O&M costs of road projects in the United States is extremely limited. This is mostly due to the infancy of the U.S. P3 market and scholars focusing on how much it costs to construct a transportation project, neglecting the lifecycle costs arising during the later stages of these projects. Many P3s are not mature enough to provide long-term evidence. Additionally, state department of transportation (DOT) data on long-term O&M costs is not always readily available.

Despite these challenges, this research question is valuable to investigate because the O&M stage occupies the longest duration of a project's life cycle while constantly requiring resources. This study's case comparison aims to enable policymakers to make better informed decisions about future infrastructure projects by showing how P3 and conventional project deliveries differ in their long-term costs in the operation and maintenance stage.

## Objectives

The objectives of this project were to:

1) Understand the existing evidence on long-term O&M periods of large transportation infrastructure projects;
2) Investigate and compare the operations and maintenance costs of selected mature projects; and
3) Find possible determinants and consequences of long-term O&M that will inform policymakers on how P3 and conventional project deliveries differ in their long-term costs during the operations phase.

## Data and Data Structures

In order to tackle these questions, the research team sought to identify data that would allow comparison of P3 project O&M with O&M from projects delivered by more traditional approaches such as design-bid-build or design-build. Unfortunately, state DOTs do not systematically report their O&M expenses by facility or project. Rather, once projects have been designed and constructed, they are typically turned over to the DOT's maintenance division, which may be divided into regional districts. Virginia DOT, for example, divides the state into ten geographic districts.

As an initial step, this research sought to compare P3s against publicly operated toll road facilities and systems. Many states have established toll road authorities to develop statewide toll road systems. Toll road authorities are far from perfect proxies for state DOTs in terms of O&M practice. Toll authorities are typically bound by bond covenants to give first priority to maintaining their assets in a state of good repair, which would suggest that they are less prone to deferred maintenance than state DOTs might be. However, toll authorities are public bodies and subject to some of the same constraints faced by state DOTs in terms of personnel and procurement. Also, many toll authorities are governed by politically appointed boards that may be reluctant to raise tolls sufficiently to fund O&M as fully as asset management best practice might suggest. From a data standpoint, one strength of using public toll authorities for comparison is that most toll authorities do make their financial statements available publicly.

In order to carry out this comparison, this study created a dataset that includes P3s and public toll authorities, including project types (Highway, Bridge and Tunnel), length in miles and lane miles, and annual operating expenses for the year 2021. Operating expenses refer to the recurring expenses required to keep the highway open and functioning on a day-to-day basis. These costs can include expenses for traffic management and control, toll operations, service and safety patrols, snow removal, road maintenance, and lighting. Preservation/Maintenance Expenses capture the costs incurred during the operation phase to make sure the assets are in good condition over time. These costs  include repairing or replacing damaged roadways, bridges, and other infrastructure, as well as regular maintenance activities, such as pothole repair and resurfacing. Meanwhile, costs incurred to support a business's operations but unrelated to the creation of a particular good or service are known as general and administrative expenses. These expenses may include rent, utilities, insurance, legal fees, salaries, and marketing fees (U.S. Securities and Exchange Commission, 2007).

The research team used the "National Inventory of Specialty Lanes and Highways: Technical Report" prepared by FHWA (2021) to identify highways and collect financial information about their O&M activities. A systematic review of financial information related to each project on this inventory was carried out using dedicated project websites, FHWA's project profile pages, and the U.S. Securities and Exchange Commission's Electronic Municipal Market Access (EMMA) database. Annual Comprehensive Financial Reports (ACFRs) for 2021 of forty-nine highway projects were collected through this methodology, however the research team decided to drop seven projects due to significant differences in project characteristics compared to the other 42 toll roads (i.e., bridges and tunnels ).

CHAPTER 2

# Methodology

### Introduction

O&M costs include a wide range of ongoing expenses needed to support essential transportation services (see Table 1). Determining which types of expenses occur during the operation and maintenance stages of transportation projects is imperative for comparing the O&M performance of P3 and more conventional delivery models.

| O&M Expenses | Category |
|---|---|
| Operating Expenses | Service and Safety Patrols Fees |
| | Toll Operations and Customer Service Fees |
| | Contracted Services |
| | Snow Removal Fees |
| | Project Management Fees |
| Preservation Expenses | Renewal and Replacement Fees |
| | Materials and Supplies |
| | Maintenance Fees |
| | Capital Improvement |
| | Construction Improvement |
| | Project Improvement |
| | Roadway Maintenance |
| General and Administrative Expenses | Salaries and Related Benefits |
| | Utility Fees |
| | Insurance Claims and Premiums |
| | Travel Fees |
| | Marketing and Communications Fees |
| | Professional Fees and Services |
| | Rentals and Leases |
| | Licensing Fees |
| | Legal Consulting Fees |

*Source:* Authors' compilation.

TABLE 1 - CATEGORIZATION OF O&M EXPENSES

The Federal Highway Administration (FHWA) does not have a specific definition for O&M costs but, based on the organization's definition of O&M, one can deduce the elements of O&M expenditure. Specifically, FHWA defines O&M activities as continuing efforts to lessen the likelihood of systemic breakdowns and to mitigate their effects when they occur (FHWA, 2023b). Based on this definition, commonly reported elements of O&M costs have been identified by analyzing the financial statements of both public and private highway operating organizations. This led to the categorization of the the following O&M components: Operating Expenses, Preservation/Maintenance Expenses, and General/Administrative Expenses. This study has chosen not to take depreciation and amortization into account when collecting O&M expense data. Depreciation and amortization are both accounting methods used to spread out the cost of a long-term asset over its useful life. Depreciation is a method of accounting that spreads out the cost of a tangible asset, such as equipment or machinery, over its useful life. The goal is to match the cost of the asset with the revenue it generates. Amortization is similar to depreciation, but it is used for intangible assets, such as patents, trademarks, and copyrights. Amortization also spreads out the cost of an asset over its useful life.

The most common method of calculating depreciation and amortization is straight-line approach, which divides the cost of the asset by its useful life (Baker, 2014). The depreciation calculations differ between the projects; some use the straight-line approach while others employ a modified approach. Based on this variation and GASB-34 statement suggesting separate identification for operating expenses and depreciation (Governmental Accounting Standards Board, 1999), the authors decided that depreciation and amortization expenses do not fall under the scope O&M expenditures, hence should be excluded from the comparison.

## Previous Literature about O&M

The significance of effective O&M practices in transportation projects cannot be understated. Poor maintenance can lead to infrastructure deterioration, increased maintenance costs, and compromised safety, as well as increased user costs. Therefore, a proactive and well-planned approach to O&M is essential for optimizing asset performance, minimizing life-cycle costs, and maximizing the return on investment (National Academies of Sciences, Engineering, and Medicine, 2021). This literature review aims to explore key studies and research related to the O&M of transportation projects, highlighting important concepts, challenges, and best practices.

Several maintenance strategies and techniques have been studied and implemented in transportation projects. These include preventive maintenance, predictive maintenance, and reactive maintenance. Preventive maintenance focuses on planned actions to prevent failures, while predictive maintenance utilizes data and analytics to predict equipment failures and schedule maintenance activities. Reactive maintenance is performed after a failure has occurred. Optimal maintenance strategies depend on factors such as asset type, age, condition, and available resources.

Asset management plays a vital role in O&M performance. Effective asset management practices involve monitoring the condition of transportation assets, such as roads, bridges, and tunnels, to ensure early detection of defects or deterioration. Various techniques, including visual inspections, non-destructive testing, and remote sensing technologies, are employed to assess asset conditions and plan maintenance activities accordingly. Some studies suggest regression framework and subsequent determinants including traffic information (volume, estimated miles, etc.), road type (highway, national road, county road, etc.), pavement type (paved, gravel, winter operations), other road characteristics (road length, number of bridge and tunnels, road buoyance, number of roadside resting places, road length with cable, etc.), weather information (number of rainfall days and road slipperiness), and geographic regions (Haraldsson, 2007).

Another critical term in the asset management literature is levels of service (LOS). LOS are categories or criteria that describe the quality of service provided to road users, typically by specific facilities or services, and can be used to gauge service performance. Performance measures determine LOS achievement. LOS should be determined by certain service characteristics, such as quality, capacity, accessibility, mobility, dependability, comfort, and safety. Each measure can have its own set of goals. These levels of services can be thought of as a set of standards, and their achievement, like any standard, should be assessed and recorded. Because meeting a standard is sometimes referred to as performance, it is important to distinguish between an asset's condition and performance.

The performance of an asset is directly tied to its ability to offer the needed level of service; its condition is an indication of its physical condition, which may or may not affect its performance. The asset's functional performance reflects its ability to provide the appropriate level of service and can be measured using criteria such as dependability, availability, capacity, and satisfying customer wants and needs. The condition of an asset describes its physical state, which may or may not affect its performance. Asset managers should use systems to monitor asset condition and performance in order to identify underperforming assets, forecast when an asset is likely to fail to provide the needed level of service, determine the root causes of poor performance, determine what remedial action is required and when it is required (for example, preservation, rehabilitation, or replacement), and keep track of asset failures for future use in advanced asset management strategies (American Association of State Highway and Transportation Officials, 2011).

An asset can fail due to an inability to perform adequately or poor condition. Advancements in technology have significantly influenced O&M practices in transportation projects. Intelligent Transportation Systems (ITS), remote sensing technologies, data analytics, and condition monitoring systems have enhanced the efficiency and effectiveness of maintenance operations.

Additionally, the use of Building Information Modeling (BIM) and Geographic Information Systems (GIS) enables better asset management, visualization, and decision-making therefore some research suggests the adoption of BIM to the road infrastructure, not only in the design and construction phase (Chong et al., 2016), but also the O&M phases for a more integrated view such as GIS incorporation (He et al., 2022).

Another way to estimate the O&M cost for P3s includes life-cycle costing (LCC) or life-cycle cost analysis (LCCA). Life-cycle cost analysis can be a valuable tool for decision-making in O&M activities since opportunities for life-cycle cost reduction are often highest during the planning stage, when around three-quarters of the elements influencing life-cycle costs are determined (American Association of State Highway and Transportation Officials, 2011). This approach involves evaluating the total cost of ownership over the lifespan of a transportation asset, including construction, operation, maintenance, and rehabilitation. Hence, LCC is a common tool to assess the cost of various phases in a project's life-cycle (Swaffield & McDonald, 2008).

Agencies that are responsible for asset management preservation do not just anticipate asset life-cycle costs and determine the ideal time in a facility's life cycle to intervene in order to minimize costs and maximize long-term mission performance measures. Pavement and bridge management systems also include deterioration and life-cycle cost models. Employing forecasting software for measuring the long-term mission performance measures is not enough. The models must be used in the agency's routine business processes to plan future work, optimizing the scheduling of activity to best meet the agency's purpose. An agency, on the other hand, will not rely on degradation models unless they reflect the greatest possible understanding of the deterioration of the agency's own assets (American Association of State Highway and Transportation Officials, 2011).

## Case Studies

The project team carried out two case studies in order to analyze the differences between P3 and conventional delivery models in more depth. The geographic and political similarities between the candidate highway projects or systems were the main criteria for selecting subjects of the case studies. Two adjacent highway projects, Dulles Greenway and Dulles Toll Road in Virginia, have been selected for project level comparative analysis meanwhile two highway systems, the private TEXpress System and NTTA System in Texas, were found suitable for system level analysis of O&M performance.

CHAPTER 3

# Findings

## Introduction

The research team developed an O&M expenditure database for 42 American transportation projects using the methodology detailed in the previous chapter. Figure 5 has the most significant findings deduced from this database. Additionally, a detailed discussion of key findings from two case studies is also presented in this chapter.

## Case Study: Dulles Greenway and Dulles Toll Road

### Background

This case study aims to compare the O&M performance of two major toll roads in Northern Virginia, namely the Dulles Greenway (see Figure 1) and the Dulles Toll Road (see Figure 2). Insights into the effectiveness of their maintenance strategies and areas for improvement can be identified by examining their respective O&M practices and expenses.


*Source: Federal Highway Administration*

FIGURE 1 - DULLES GREENWAY MAP (FHWA, 2023A)

The Dulles Greenway, privately owned and operated by Toll Road Investors Partnership II (TRIP II), and the Dulles Toll Road, owned and operated by the Metropolitan Washington Airports Authority (MWAA), employ different approaches to O&M. TRIP II has a contract with a private maintenance firm to carry out day-to-day operations and maintenance activities on the Dulles Greenway. MWAA, on the other hand, manages the O&M activities of the Dulles Toll Road through its own internal maintenance division, which also operates and maintains Dulles International Airport and Ronald Reagan Washington National Airport.

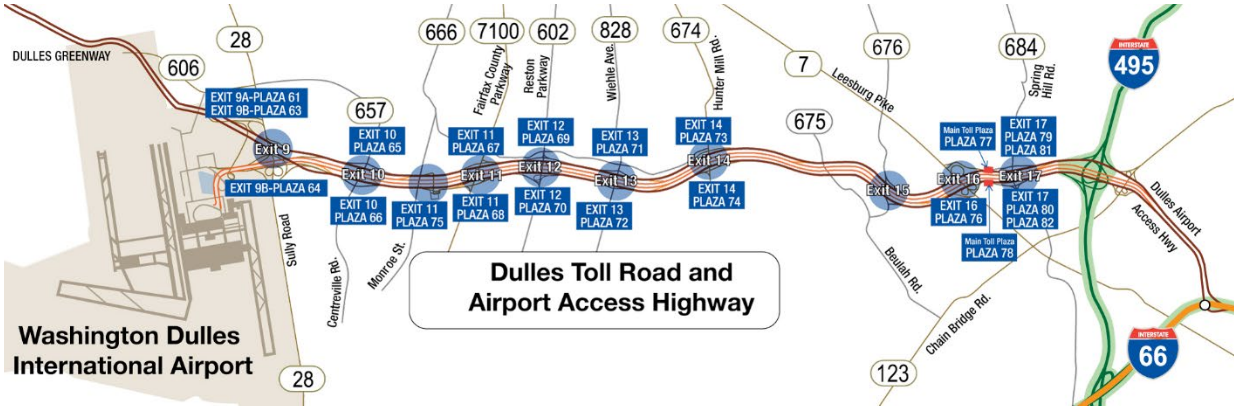



FIGURE 2 - DULLES TOLL ROAD AND AIRPORT ACCESS HIGHWAY COURSE (*DULLESTOLLROAD.COM - MAPS & INTERCHANGES*, 2023)

Both toll roads undertake various maintenance activities to ensure smooth operations and user safety. These activities include routine inspections, pavement maintenance, signage repair, landscaping, snow removal, and lighting maintenance. For instance, the Dulles Greenway has implemented regular lane striping and resurfacing programs to maintain the road's quality and the Dulles Toll Road focuses on regular pothole repairs and preventive maintenance to prolong the lifespan of the pavement.

**Comparison of O&M Expenditure**

| Project Name | State | Delivery Model | Length (Miles) | Lane Miles | OpEX |
|---|---|---|---|---|---|
| Dulles Greenway | Virginia | DBFOM - P3 | 14 | 84 | $15,182,643 |
| Dulles Toll Road | Virginia | Design-Build | 14 | 112 | $28,981,600 |

*Source:* Compilations by the authors.

TABLE 2 - OPEX PERFORMANCE OF DULLES GREENWAY & DULLES TOLL ROAD

O&M expenditure comparison of the two highway projects yields significant results. Tables 2 & 3 highlight the main differences between the two projects. The first interesting variation between the two tolled highways can be seen by analyzing their reported O&M Expenditure Elements. The private operator of the Dulles Greenway has reported the project's O&M expenses in 12 categories meanwhile Dulles Toll Road has selected a more cursory approach with only 5 categories. Unsurprisingly, "Operations and Maintenance" is the most expensive component of the O&M expenses of Dulles Greenway, and it is the "Materials, equipment, supplies, contract services, and other" for the Dulles Toll Road.

| Project Name | Reported O&M Elements |
|---|---|
| **Dulles Greenway** | |
| Operation and maintenance | $4,163,664 |
| General and administrative | $2,935,945 |
| Electronic toll/credit card processing fees | $2,026,331 |
| Real estate property taxes | $1,712,147 |
| Project improvement expense | $1,206,399 |
| Easement fees | $1,132,661 |
| State policy agreement | $714,813 |
| Insurance expense | $664,508 |
| Engineering services | $306,185 |
| Licenses and fees | $185,534 |
| Legal and consulting | $134,456 |
| **Total** | **$15,182,643** |
| **Dulles Toll Road** | |
| Materials, equipment, supplies, contract services, and other | $20,963,100 |
| Salaries and related benefits | $6,865,600 |
| Utilities | $148,900 |
| Travel | $3,600 |
| Insurance | $1,000,400 |
| **Total** | **$28,981,600** |
| *Source:* Compilations by the authors. | |

TABLE 3 - DULLES GREENWAY VS. DULLES TOLL ROAD DETAILED O&M EXPENDITURE

**Discussion**

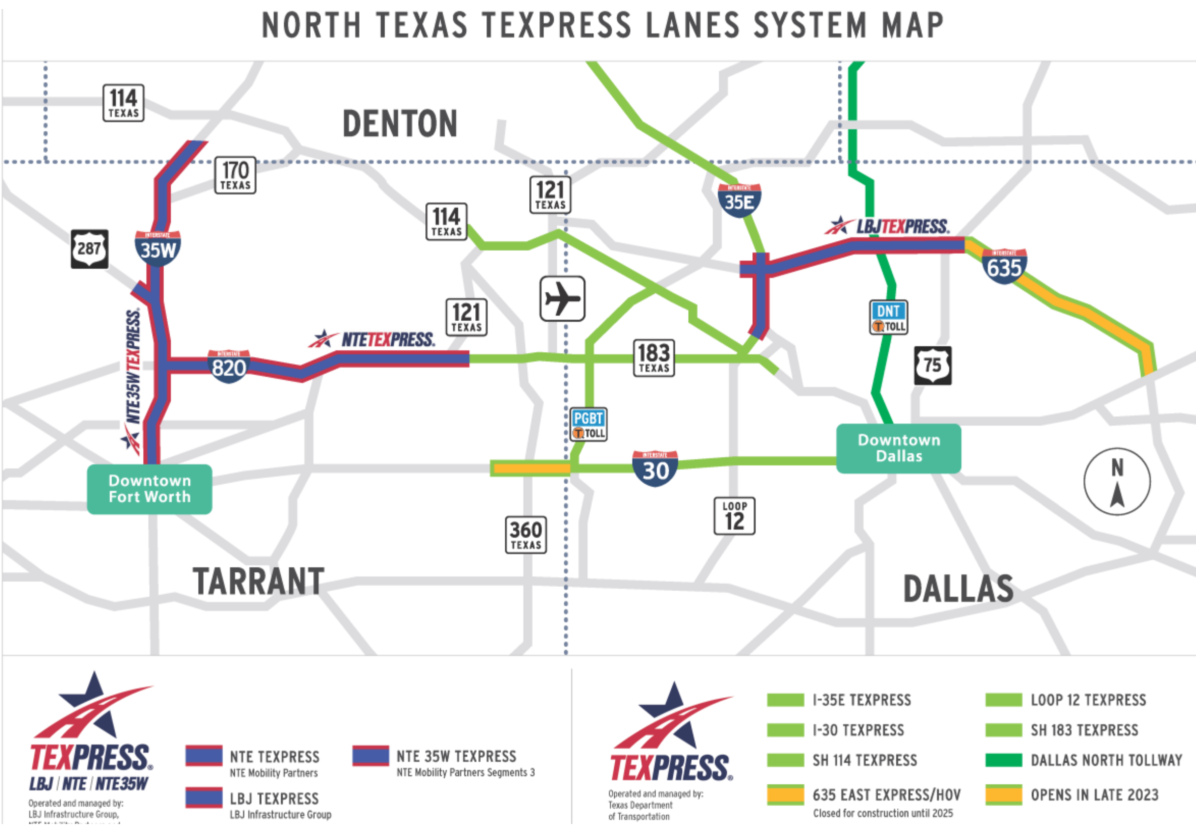
As is apparent, the Greenway reports its expenditures in much more detail than the Dulles Toll Road. Also, the Greenway includes some significant cost elements that are not present for the Dulles Toll Road, in particular easement fees, which are fees that the Greenway pays to MWAA for the use of right-of-way on the Dulles airport property. Also, the Greenway paid over two million dollars in property tax in 2021, which MWAA, as a public authority, does not pay.

As a result, any O&M comparisons metric would not be valid and would not serve as a useful basis for assessing the impact of the P3 model on O&M expenses. Moreover, it is important to note that Dulles Toll Road is a much older road than Dulles Greenway and there are other comparability issues such as project complexity and traffic levels which would need to be considered to understand how the O&M costs of the two facilities compare.

## Case Study: Dallas/Ft. Worth TEXpress and NTTA Systems

**Background**

This case study aims to compare the O&M performance of two prominent toll road systems in North Texas, the private TEXpress Lanes and North Texas Tollway System (NTTS), by examining their respective O&M practices and expenditure performance.

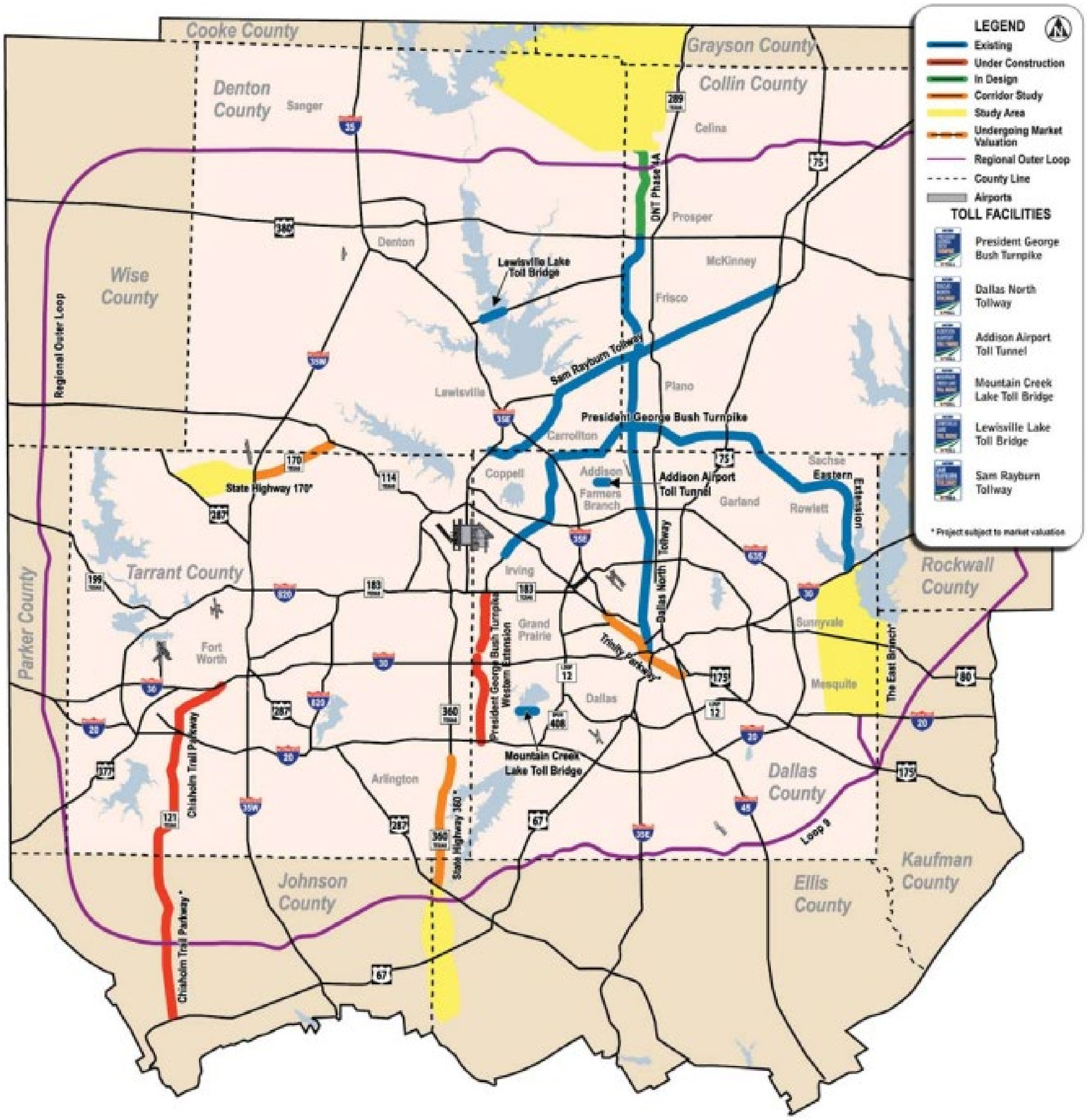



*Source: Texas Department of Transportation*

FIGURE 3 - TEXPRESS LANES SYSTEM MAP (*TEXPRESSLANES.COM*, 2023)

The privately developed and operated TEXpress Lanes System consists of three managed lanes projects in the Dallas/Ft. Worth, Texas, metropolitan area: LBJ TEXpress, NTE TEXpress and NTE 35W TEXpress. LBJ TEXpress is a $2.7 billion P3 transportation project on I-635 and I-35E. The project's length is 13.3 miles and it opened in September 2015. NTE TEXpress and NTE 35W TEXpress are two other P3 projects developed with TxDOT in the Dallas/Fort Worth area. NTE (North Tarrant Express) is a $2.1 billion, 13.3-mile transportation project on Northeast Loop 820 and Airport Freeway in Northeast Tarrant County, which opened in October 2014. A 10.1-mile segment of the NTE 35W TEXpress Lanes along I-35W from downtown Fort Worth to north of US 287 is called NTE 35W TEXpress and opened in 2018.

NTTS is a regional network of tolled highways serving the Dallas/Fort Worth metropolitan area. The system is comprised of these key routes: 360 Tollway, Addison Airport Toll Tunnel, Dallas North Tollway, Lewisville Lake Toll Bridge, Mountain Creek Lake Bridge, President George Bush Turnpike, Sam Rayburn Tollway, and the Chisholm Trail Parkway, which are connecting major suburbs and cities. The North Texas Tollway Authority (NTTA) oversees the operation, maintenance, and expansion of the system.




*Source: North Texas Tollway Authority*

**FIGURE 4 - MAP OF THE NTTA SYSTEM (*NTTA.ORG*, 2023)**

Both toll road systems undertake various maintenance activities to ensure smooth operations and user safety, including routine inspections, pavement maintenance, signage repair, landscaping, snow removal, and lighting maintenance. Furthermore, operators of these two toll road systems focus on timely incident response, continuous monitoring of congestion levels and carry out proactive maintenance practices, such as pavement rehabilitation, bridge maintenance, and regular toll plaza maintenance, to ensure the longevity and functionality of their toll road system. However, all of these activities combined with general administrative activities consume resources and the next section will carry out a comparative analysis to identify each system's efficiency.

Delivery models are not the only important difference between these two highway systems. A lane-mile comparison showcases the substantial difference in sizes of the two systems. Specifically, the private TEXpress system is only one-fifth the size of NTTA's system in lane-miles. Another feature that differentiates the two systems is the number of tunnels and bridges in them. For instance, NTTS has Addison Airport Toll Tunnel, Lewisville Lake Toll Bridge and Mountain Creek Lake Bridge routes, obviously increases the ratio of bridges and tunnels in the system. Authors believe it is important to keep these dissimilarities before making OpEX performance comparisons between the two systems.

**<u>Comparison of O&M Expenditure</u>**

| System Name | State | Delivery Model | Centerline Miles | Lane Miles | OpEX |
|---|---|---|---|---|---|
| Private TEXpress | Texas | DBFOM - P3 | 36.7 | 173.4 | $69,948,000 |
| NTTS | Texas | Design-Build | 151 | 1145 | $277,565,495 |

*Source:* authors' compilations.

TABLE 4 - OPEX PERFORMANCE OF PRIVATE TEXPRESS SYSTEM & NTTA SYSTEM

Table 4 provides information about the combined O&M expenditure of LBJ TEXpress, NTE TEXpress and NTE 35W TEXpress versus the NTTS. Unfortunately, without conducting a thorough analysis of the contract requirements pertaining to the O&M activities for these projects, it remains impossible to precisely ascertain the impact of the delivery model on the performance differential. For instance, previous research has revealed that the O&M standards were explicitly detailed in the contract documents for the private TEXpress projects, while the maintenance contract executed by the Texas Department of Transportation mandated only routine maintenance, with significantly fewer O&M requisites for the I-30 project, which was delivered using the DBB model (Gifford et al., 2023). It is conceivable that the private partners involved in the TEXpress system may be contractually obligated or incentivized to maintain their assets in superior condition compared to the NTTA, thus pursuing an optimal OpEX to revenue ratio, even if it results in a higher OpEX per Lane Mile rate. Nonetheless, this comparative analysis serves as a robust foundational framework for future assessments of the O&M performance between the two systems.

| Project Name | Reported O&M Element |
|---|---|
| **Private TEXpress** | Toll Collection Fees |
| | Operation and Maintenance Fees |
| | Administration and Overhead Fees |
| **NTTS** | Administration |
| | Operations |
| | Reserve Maintenance |

*Source:* Author compliations.
*Note:* Expenditures by O&M element were not available for 2021 for both systems at the time of report completion.

TABLE 5 – TEXPRESS AND NTTA O&M EXPENDITURE CATEGORIES

The reported O&M elements for the Private TEXpress and NTTS highway systems share similarities in terms of having administrative and operation-related expenses. Both systems allocate resources for administrative costs, reflecting the need for efficient management and oversight. Additionally, they both recognize the significance of operation-related costs, which encompass the day-to-day activities essential for maintaining the functionality of these highway systems. However, where they differ is in the specific details. Private TEXpress notably includes Toll Collection Fees, reflecting the revenue generation aspect of the project. Also, NTTA, in addition to operating its system, also is the entity responsible for collecting and distributing tolls within the Dallas/Ft. Worth region. Thus, NTTA collects all the tolls on the TEXpress system and transfers them to the TEXpress concessionaire. It is unclear whether NTTA allocates toll collection charges to its own facilities in a way that would allow strict comparability. Also, NTTA incorporates a Reserve Maintenance element, emphasizing the importance of financial planning for future maintenance needs.

**Discussion**

The operation and maintenance performance comparison of the TEXpress Lanes and the North Texas Tollway System demonstrates the complexity and difficulty of a fair comparison at a system-level due to the unique features of the roads. Although there is a significant difference in the OpEX/Lane Mile rate between the two toll road systems, this study suggests it would be premature to explain this as an advantage of the traditional delivery model over the P3 model. Similar to the prior case study, authors suggest a deeper analysis of the projects including their contractual obligations, annual traffic levels and project complexity.

### Database Findings

The research team carried out an analysis of O&M Elements stated in the annual financial reports of the 42 identified projects to deduce the most frequently reported categories. Predictably, Maintenance and General Administrative are the most commonly reported O&M elements. These are followed by salaries, utilities, and toll collection fees with a 31% frequency rate, which is interesting considering that all of the projects in the database are tolled roads. Contract and professional services in a transportation project refer to formal agreements and specialized expertise utilized for the planning, construction, operation or, as in this case, the maintenance of toll roads. Contract service fees usually cover toll collection, technology, consulting, and security services, while professional services encompass engineering, financial, legal, traffic, environmental, public relations, and safety expertise.

The breadth of these two O&M categories undoubtedly increased their recurrence in the analyzed reports. Other widely reported O&M categories include materials/supplies, insurance, rentals/leases, service/safety patrols, advertising, marketing, travel, police agreements, and preservation. Less frequent elements are either contract and professional services that are not outsourced or fees unique to the specific project, such as “Parking (Non-Airport)” identified in Atlantic City Expressway financial report.

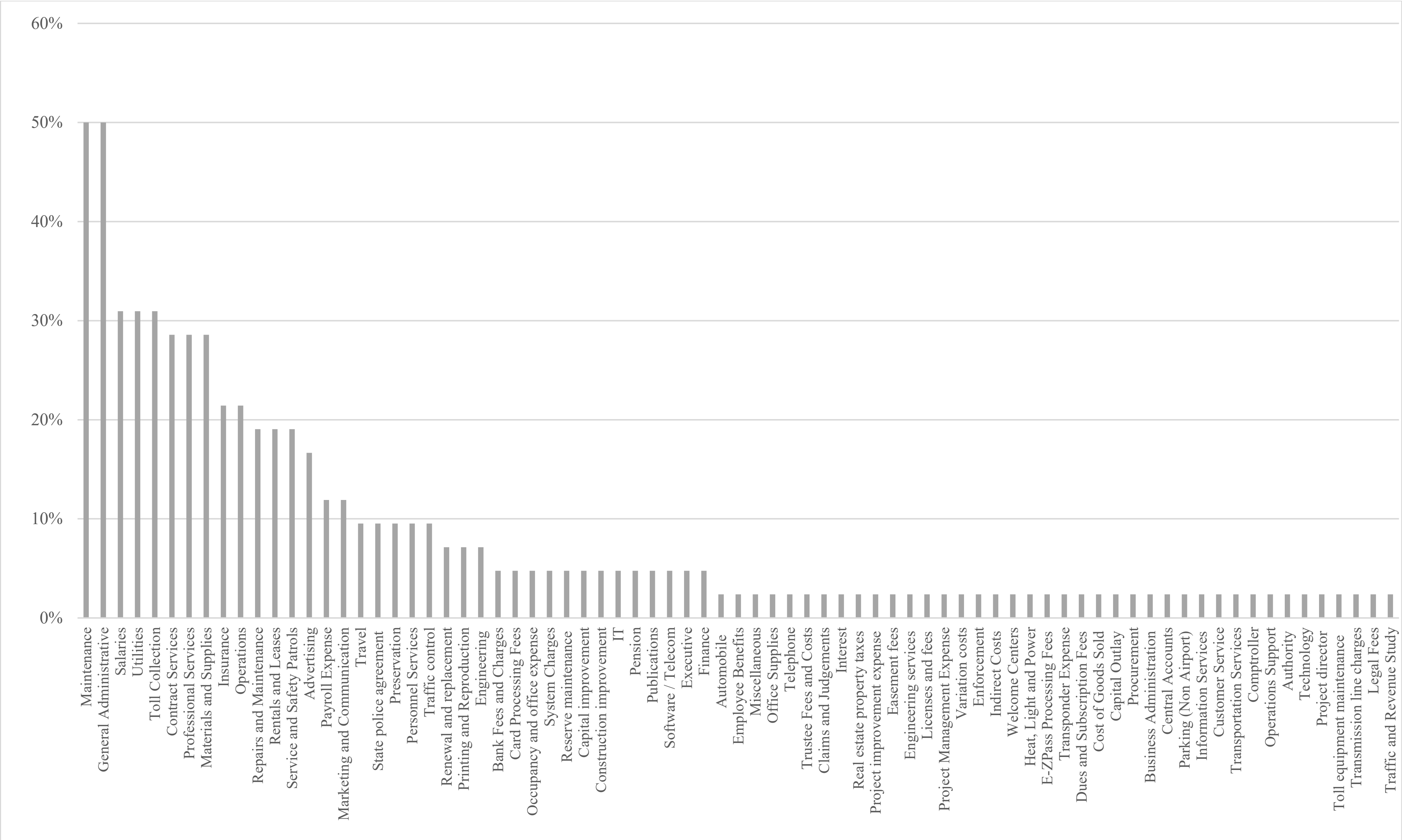



**FIGURE 5 - FREQUENCY OF REPORTED O&M EXPENSE CATEGORIES**

CHAPTER 4

# Conclusions

This project set out to analyze operation and maintenance performance of the privately and publicly operated highway projects and carry out comparisons to test the P3 model's supposed life-cycle benefits. After following the methodology detailed in Chapter 2, the research team identified 42 projects with O&M expenditure. O&M performance of projects must be evaluated using multiple performance indicators rather than one to count for the effects of variance in project characteristics, contractual agreements, level of traffic, regulations and age of assets.

This study made a significant contribution to the otherwise scant literature surrounding the cost-efficiency of Operation and Maintenance of P3 and traditionally delivered projects in the United States by analyzing the reported O&M expense categories of the 42 projects. The research team believes this initial step makes the complexity of the subject more apparent and paves the way for a more comprehensive analysis. As shown in Figure 5 the problem of inconsistency in reporting of O&M costs, which was raised back in 2011 by Adams, still exists. There are 77 different elements reported under the projects' OpEX. most of these elements are almost identical or fall under the other more generalized categories. More detailed financial reports are a positive for the research as they mean more transparency. However, lack of consistency is problematic for any studies with an objective of comparing the O&M performance of the infrastructure assets. Recommendations to tackle this problem are explained in the next section.

# Recommendations

The conclusion of this study stimulates two key recommendations to address the challenges of carrying out a comparative cost-efficiency analysis for transportation projects. Firstly, as a future research, authors suggest a multi-dimensional approach with identification and observation of multiple key operation and maintenance performance indicators to carry out a fair comparison of the Operation and Maintenance expenditure performance for the P3 and traditional delivery models.

The second recommendation is aimed at solving the issues arising from inconsistent reporting practices of operating agencies. These issues increase the complexity of a fair comparison between delivery models which has many intricacies of its own. This study suggests a standardized operation and maintenance reporting practice which involves three categories: operating fees, preservation fees and general/administrative fees. Definition of these categories and each O&M elements that should fall under them have been outlined in the second chapter of this report. Adaption of these recommendations will enable future policy makers and academics to reach more robust and consistent conclusions regarding the O&M performance of each infrastructure delivery model.

# References


Adams, T. M. (2011). *Estimating cost per lane mile for routine highway operations and maintenance* [Technical Report]. Midwest Regional University Transportation Center. https://minds.wisconsin.edu/handle/1793/54136

American Association of State Highway and Transportation Officials. (2011). *AASHTO transportation asset management guide: A focus on implementation.* American Association of State Highway and Transportation Officials.

Baker, R. E. (2014). *Advanced financial accounting* (Tenth edition.). McGraw-Hill Irwin.

Blanc-Brude, F., Goldsmith, H., & Välilä, T. (2009). A Comparison of Construction Contract Prices for Traditionally Procured Roads and Public–Private Partnerships. *Review of Industrial Organization*, *35*(1–2), 19–40. https://doi.org/10.1007/s11151-009-9224-1

Chasey, A. D., Maddex, W. E., & Bansal, A. (2012). *A Comparison of Public-Private Partnerships and Traditional Procurement Methods in North American Highway Construction*.

Chong, H. Y., Lopez, R., Wang, J., Wang, X., & Zhao, Z. (2016). Comparative Analysis on the Adoption and Use of BIM in Road Infrastructure Projects. *Journal of Management in Engineering*, *32*(6), 5016021-. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000460

Daito, N., & Gifford, J. L. (2014). U.S. highway public private partnerships: Are they more expensive or efficient than the traditional model? *Managerial Finance*, *40*(11), 1131–1151. https://doi.org/10.1108/MF-03-2014-0072

*dullestollroad.com—Maps & Interchanges*. (2023). https://www.dullestollroad.com/maps-interchanges

FHWA. (2021, February). *National Inventory of Specialty Lanes and Highways: Technical Report—FHWA Operations*. https://ops.fhwa.dot.gov/publications/fhwahop20043/index.htm

FHWA. (2023a). *FHWA - Center for Innovative Finance Support—P3 Toolkit: Publications—Other Guides*. https://www.fhwa.dot.gov/ipd/p3/toolkit/publications/reports_discussion_papers/highway_p3s/appendices.aspx

FHWA. (2023b). *Maintenance—Federal Highway Administration*. https://www.fhwa.dot.gov/maintenance/

Gifford, J. L., Zhu, S., & Grimaldi, D. (2023). Delivery methods, risk sharing, standards and performance for construction, operations, and management: The TEXpress managed lanes system, Dallas-Ft. Worth, Texas. *Case Studies on Transport Policy*, *12*, 101016. https://doi.org/10.1016/j.cstp.2023.101016

Governmental Accounting Standards Board. (1999). *Statement No. 34 of the Governmental Accounting Standards Board*. https://gasb.org/page/PageContent?pageId=/standards-guidance/pronouncements/summary--statement-no-34.html&isStaticPage=true

Haraldsson, M. (2007). *Marginal costs for road maintenance and operation: A cost function approach*. Statens väg- och transportforskningsinstitut. https://urn.kb.se/resolve?urn=urn:nbn:se:vti:diva-679

He, Q., Ghofrani, F., Gao, T., Wang, P., He, C., Li, Y., & Ai, C. (2022). Intelligent construction for the transportation infrastructure: A review. *Intelligent Transportation Infrastructure*, *1*, liac007. https://doi.org/10.1093/iti/liac007

Hodge, G. A., & Greve, C. (2017). On Public–Private Partnership Performance: A Contemporary Review. *Public Works Management & Policy*, *22*(1), 55–78. https://doi.org/10.1177/1087724X16657830

Kordestani Ghalehnoei, N., Saghatforoush, E., Nikooravan, H., & Preece, C. (2018). Evaluating solutions to facilitate the presence of operation and maintenance contractors in the pre-occupancy phases: A case study of road infrastructure projects. *International Journal of Construction Management*, *21*, 1–13. https://doi.org/10.1080/15623599.2018.1512027

Mallett, W. J. (2021). Public-Private Partnerships (P3s) in Transportation. *Congressional Research Service*.

National Academies of Sciences, Engineering, and Medicine. (2021). *Performance Metrics for Public-Private Partnerships*. Transportation Research Board. https://doi.org/10.17226/26171

*NTTA.org*. (2023). https://www.ntta.org/

Pelzeter, A. (2007). Building optimisation with life cycle costs – the influence of calculation methods. *Journal of Facilities Management*, *5*, 115–128. https://doi.org/10.1108/14725960710751861

Swaffield, L. M., & McDonald, A. M. (2008). The contractor's use of life cycle costing on PFI projects. *Engineering, Construction, and Architectural Management*, *15*(2), 132–148. https://doi.org/10.1108/09699980810852664

*TEXPressLanes.com*. (2023). LBJ, NTE & NTE 35W TEXpress Lanes. https://www.texpresslanes.com/roadway-info/maps/

U.S. Securities and Exchange Commission. (2007, February). *SEC.gov | Beginners' Guide to Financial Statements*. https://www.sec.gov/oiea/reports-and-publications/investor-publications/beginners-guide-financial-statements

Verweij, S., Meerkerk, I. van, & Casady, C. B. (2022). The performance advantage of public-private partnerships: Does it exist or not? In *Assessing the Performance Advantage of Public-Private Partnerships* (pp. 1–26). Edward Elgar Publishing. https://www.elgaronline.com/edcollchap/book/9781800889200/book-part-9781800889200-9.xml

Verweij, S., & Van Meerkerk, I. (2021). Do public–private partnerships achieve better time and cost performance than regular contracts? *Public Money & Management*, *41*(4), 286–295. https://doi.org/10.1080/09540962.2020.1752011

Wee, J. (2012). *Public-Private Partnerships: The Project Financing of the Indiana Toll Road*. https://store.hbr.org/product/public-private-partnerships-the-project-financing-of-the-indiana-toll-road/INS190

Zhao, J. Z., Fonseca-Sarmiento, C., & Tan, J. (2019). America's Trillion-Dollar Repair Bill: *Volcker Alliance*.