

IDENTIFYING BEST PRACTICES IN FINANCIAL MODELING FOR PUBLIC-PRIVATE PARTNERSHIP (P3) PROJECTS

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ABSTRACT: Public-Private Partnerships (P3) have been used by many agencies in recent decades as a method of funding, designing, constructing, and operating public infrastructure projects across the world. This method utilizes private sector funding to construct and operate public projects, including toll roads, railroads, wastewater plants, and commercial buildings. Government funding plays an important role in P3s by making projects more financially feasible and supporting better cash flow, which reduces the financial burden on private investors. In the United States, government funding source for P3s varies based on the type of project, its intended uses, and complexity. Preliminary studies have found that, in the U.S., government funding in P3 projects is supported through key sources such as Private Activity Bonds (PABs), Transportation Infrastructure Finance and Innovation Act (TIFIA) loans, and Public Sector Payments. These funding mechanisms reduce the financial burden on private sector investors and improve project feasibility. The results show that the use of public money in P3 highway projects vary from 0% to 38% of the total project costs. To understand how U.S. State Departments of Transportation (DOTs) use the Value for Money (VfM) model during the selection of P3 in their highway projects, a survey with State DOTs engineers was conducted. The survey results show that most of state DOTs used this model; however, challenges such as limited availability of reliable data, methodological inconsistencies in risk quantification, and political influences on decision-making were identified, highlighting areas for improvement in current VfM practices. The case studies' results show that the state DOTs have saved money in their highway project by using P3 compared to traditional delivery methods.

1. INTRODUCTION

Public-Private Partnership (P3s) have become a popular approach for governments to tackle infrastructure challenges and improve project delivery. Unlike traditional procurement methods, which often face delays, cost overruns, and fragmented responsibilities, P3s streamline the process by integrating all project phases under one framework. Models like Design-Build-Finance-Operate-Maintain (DBFOM) assign multiple responsibilities, such as design, construction, and maintenance, to private entities, encouraging innovation and efficiency (Yescombe & Farquharson, 2018). By transferring risks like construction delays or operational inefficiencies to the private sector, P3s incentivize better performance and cost management, making them a more effective alternative to conventional methods (Vrooman, 2012).

In the United States, transportation infrastructure, including highways, bridges, and transit systems, remains a critical domain for P3 deployments. Government support is often essential because large projects require huge upfront investments, and private investors typically look for a reasonable return in a shorter timeframe (Siemiatycki, 2013). Federal and state programs offer lower-interest loans, tax-exempt bonds, or guarantees that help reduce the financial risks for private partners, making P3 projects more attractive (Yescombe & Farquharson, 2018). For example, Transportation Infrastructure Finance and Innovation Act (TIFIA) loans and Private Activity Bonds (PABs) help lower the initial costs for private partners, encouraging

them to invest (Boardman & Vining, 2012a). Additionally, some regions create special infrastructure funds or banks to make it easier to finance these projects, allowing for more flexible arrangements (Chan et al., 2009).

Despite these potential benefits, a successful P3 relies on strong financial planning and careful risk management (Yescombe & Farquharson, 2018). Key to this evaluation is the use of decision-making tools such as the Value for Money (VfM) model. VfM analysis provides a structured way to compare the public-sector comparator (i.e., a traditional, fully government-financed approach) against various P3 scenarios, considering not only construction and operation costs but also risk transfer, ongoing maintenance obligations, and quality of service. This helps show if private partners are properly motivated to finish projects on time and within budget (Boardman & Vining, 2012b). It also helps policymakers see whether the P3 is financially sustainable, dependable for the public, and socially beneficial (Casady et al., 2020). As P3s continue to shape U.S. transportation, such evaluation methods ensure that governments and private partners fairly share both risks and rewards, ultimately benefiting communities through improved infrastructure.

2. RESEARCH OBJECTIVE

While Value for Money (VfM) assessments are widely used in P3 highway projects, their reliability depends on the accuracy of key assumptions, particularly those related to risk transfer, cost projections, and funding mechanisms. Inaccurate estimations in these areas can lead to misleading conclusions, potentially affecting the effectiveness and credibility of P3 projects. To address these challenges, this study aims to refine and enhance the practical application of VfM in U.S. transportation projects. This study investigates:

- a. Current funding strategies for P3 projects in the U.S., focusing on the use of PABs, TIFIA loans, and Public Sector Payments.
- b. Evaluate improvements to the VfM model based on feedback from State Department of Transportation (DOT) professionals.
- c. Compare the financial outcomes of P3 projects with traditional models through case studies.

3. LITERATURE REVIEW

3.1 P3 Financial Structure

P3s rely on a mix of private and public funding to finance infrastructure projects. Private companies usually provide most of the money through debt (loans or bonds) and equity (direct investments). Debt often covers more than half of the project costs and is paid back over time using project income, like tolls or user fees (Ramsey & Asmar, 2016). Equity investors, who own part of the project, take on more risk because they lose money first if the project fails, but they also aim for higher returns (Ramsey & Asmar, 2016). To manage risks, a Special Purpose Vehicle (SPV) that a separate company created especially for the project, handles financing and contracts. This keeps the public agency and private investors protected from broader financial risks (America Bureau, 2016a).

Governments play a key role by offering funding to make projects feasible. For example:

- Private Activity Bonds (PABs): These tax-exempt bonds let private companies borrow money at lower interest rates, cutting project costs. The Downtown Tunnel project used \$675 million in PABs to save on financing (America Bureau, 2016b).
- TIFIA Loans: Federal loans with low rates and flexible terms (up to 35 years) help refinance debt or cover upfront costs. They are critical for projects like toll roads (America Bureau, 2016a).
- Public Payments: Governments provide grants, milestone payments (released when construction targets are met), or regular availability payments (based on service quality). For instance, the Presidio Parkway project received payments after completing key phases (Ramsey & Asmar, 2016).

While these tools help attract private investment, they also have trade-offs. Heavy reliance on public funding, like covering 41% of costs with TIFIA loans, can strain government budgets or reduce private

partners' incentives to control costs (America Bureau, 2016a). Similarly, projects dependent on tolls, or user fees may fail if demand drops, leaving taxpayers to bear losses. P3 financing works best when private funding and public support are balanced. Government subsidies reduce risks for investors, but overuse can lead to unfair risk-sharing or hidden costs.

3.2 Value for Money

Value for Money (VfM) is a critical tool for evaluating the efficiency of P3s. Defined as the optimal balance between lifecycle costs and service quality, VfM helps governments determine whether P3s deliver better outcomes than traditional procurement (Federal Highway Administration, 2015). When the total cost of a conventional project exceeds that of a P3, the difference represents potential savings or "value" achieved through private sector involvement (Morallos & Amekudzi, 2008). Beyond financial metrics, VfM also considers qualitative factors like social equity, innovation, and environmental sustainability, ensuring projects align with broader public priorities (Burger & Hawkesworth, 2011; Helby Petersen, 2019). To conduct this analysis, agencies develop a Public Sector Comparator (PSC), a hypothetical model estimating the lifecycle costs of traditional delivery, including construction, financing, and retained risks. This baseline is then compared to a Shadow Bid, a projected P3 cost structure based on private sector proposals or pre-procurement estimates, which incorporates risk allocation and financing strategies (Federal Highway Administration, 2015).

However, VfM assessments face significant challenges. Quantifying risks, such as demand volatility or political instability, is inherently complex. While tools like Monte Carlo simulations improve accuracy, their reliability depends on data quality and assumptions, which can skew results (Yescombe & Farquharson, 2018). AI has already demonstrated its potential in construction safety by predicting hazards and mitigating risks (Ray et al., 2024), however, its role in VfM analysis remains underexplored. AI-driven scenario planning can improve risk quantification by simulating various economic, political, and operational uncertainties, enabling more data-driven decision-making. Additionally, traditional VfM frameworks often prioritize financial metrics like net present value (NPV) over social or environmental impacts. Scholars argue for integrating multi-criteria decision-making (MCDM) to address this gap, though implementation remains inconsistent (Grimsey & Lewis, 2004; Shaoul, 2005). The choice of discount rates further complicates analyses. For instance, using the Weighted Average Cost of Capital (WACC) instead of the Social Time Preference Rate (STPR) can dramatically alter outcomes, and the lack of global standards leads to cross-jurisdictional inconsistencies (Brinckerhoff, 2013; Heald, 2003). Long-term uncertainties, such as inflation or technological shifts, also undermine projections, as infrastructure projects often span decades (Federal Highway Administration, 2015).

Critics highlight biases in VfM methodologies, where assumptions about risk transfer or financial metrics may reflect political agendas rather than objective analysis. Chan et al. (2009) warn that such biases can distort results, favoring predetermined procurement methods. To enhance credibility, scholars advocate for standardized methodologies, transparency in assumptions, and balanced frameworks that weigh both quantitative and qualitative factors. For example, adopting MCDM could better capture public value, while sensitivity analyses and long-term monitoring could mitigate uncertainty. Addressing these challenges is essential to ensure VfM remains a reliable tool for delivering infrastructure that maximizes societal benefits.

3.3 Gaps in the Literature

Limited research has been conducted related to funding mechanism of P3 highway projects. (Fathi & Shrestha, 2021, 2022) have determined the correlation between the funding types and project performance of P3 highway projects. Most of the authors have conducted studies related to P3 contractual process (Fathi & Shrestha, 2023), critical success factors (Shrestha et al., 2022), and performance comparison of P3 highway projects with DB and DBB highway projects (Fathi & Shrestha, 2022; Shrestha & Shrestha, 2024). However, detailed investigation of funding mechanisms and how the VfM has been utilized by state DOTs to select the candidate highway projects for P3 has not been conducted. This study will explore these research gaps and will assist in understanding the use of VfM, types of funding used in P3 highway projects, and the performance of some P3 projects using various types of funding mechanism in US P3 highway projects.

4. METHODOLOGY

This study employed a mixed-methods approach to investigate both the financial mechanisms of P3 projects and the effectiveness of the VfM model in capturing these complexities. The methodology is divided into three parts: (1) examining government funding mechanisms, (2) comparing P3 and Design-Bid-Build (DBB) approaches through case studies, and (3) conducting a structured survey with State DOT engineers and project managers. By integrating quantitative data from public sources with qualitative feedback from practitioners, the study offers a comprehensive understanding of how P3 structures differ from traditional models in terms of funding, risk allocation, and project feasibility.

4.1 Government Funding

This study employs a quantitative approach to analyze the extent of government financial involvement in major P3 transportation projects across the United States. Data was sourced from the Federal Highway Administration's (FHWA) Center for Innovative Finance Support and other publicly available financial reports on P3 projects. The analysis focuses on three primary government-backed funding mechanisms: TIFIA loans, PABs, and direct public sector payments. These funding sources were examined across multiple projects to determine the proportion of public versus private financing and assess their implications for risk allocation, cost efficiency, and long-term financial obligations. The data were compiled into a comparative table, categorizing projects by state and funding distribution to identify trends in government contributions. Furthermore, the study evaluates how varying levels of public sector involvement impact project feasibility, cost-effectiveness, and financial risk-sharing between government entities and private investors. The findings provide insights into optimal financing strategies that balance public investment efficiency while maintaining private sector accountability.

4.2 Case Studies Comparing P3 and DBB

This study evaluates the financial performance and VfM of P3s by analyzing three U.S. highway projects, two delivered through P3 models and one through traditional procurement. The selected projects include the I-66 Corridor Improvements (Virginia) and the LBJ Express (Texas), both procured under DBFOM concession agreements, and the Central Artery/Tunnel Project ("Big Dig," Boston), which followed a traditional DBB process. The projects were chosen based on their scale (over \$500 million), recent completion within the last decade (for the P3 cases), and availability of the financial data.

4.3 Questionnaire Survey

A short electronic survey was developed to gather insights on current practices in VfM analysis for P3 projects. The questionnaire covered methods used by practitioners (such as financial modeling tools and scenario analyses), challenges faced (including data gaps and biased assumptions), and suggested improvements to VfM models, such as better risk allocation techniques and standardized guidelines. It also explored the selection of financial metrics, validation of revenue forecasts, and integration of both quantitative and qualitative factors. The survey specifically targeted state DOT engineers with direct involvement in planning, financing, and delivering P3 projects, particularly those engaged in VfM analysis, to ensure focused and relevant feedback. The questionnaire was designed based on an extensive literature review and internal team consultations. To maximize accessibility and maintain respondent anonymity, the survey was distributed through an online platform. Questions included both multiple-choice and open-ended formats, enabling the collection of structured data and more nuanced insights into gaps in current VfM practices. Collected data were analyzed using descriptive statistics for quantitative items to identify patterns and common practices, while open-ended responses were thematically coded to highlight recurring concerns and practitioner recommendations. This combined approach allowed the study to capture specific methods currently employed in VfM analyses, understand the major challenges practitioners face, and identify the most suggested improvements.

5. RESULTS

The initial results of survey conducted related to use of VfM by state DOTs, % of various types of funding used in P3 highway projects, and case studies' findings are described below. These findings will determine how the highway projects are evaluated to be a candidate for a P3 project, how the existing P3 projects are funded, and how the P3 highway projects are performed based on the types of funding.

5.1 Survey Results

This survey was distributed among professionals working in State DOT to assess current practices and challenges in VfM analysis. As of now, we have received only four responses, and the findings presented in this study are based on these initial responses. While the sample size is small, the insights provide a preliminary understanding of VfM assessment methods, challenges, and areas for improvement. The patterns observed in these responses are consistent with findings reported in existing literature, which supports the relevance of these preliminary observations despite the small sample. The survey remains open, and future phases are expected to engage a broader range of participants, including additional state DOT engineers, private sector practitioners, and financial analysts, to strengthen the depth and generalizability of the findings for a more comprehensive understanding of VfM applications in P3 project evaluations. The current responses represent a range of experience levels and geographic locations: three respondents reported 2–5 years of experience, while one had over 10 years. Geographically, responses were received from professionals based in Puerto Rico, Michigan, Washington D.C., and Virginia.

5.1.1 Adoption and Implementation of VfM Guidelines

Formal VfM guidelines play a critical role in ensuring consistency and reliability in assessments. The responses regarding the presence of formal VfM guidelines were mixed. One respondent confirmed the state legislation-based guidelines provide a structured framework for conducting VfM assessments in P3s. Other two stated that no formal guidelines are in place, suggesting that VfM assessments may be conducted using informal evaluation frameworks. Additionally, one response indicated that their guidelines are currently under development, which points to ongoing efforts to institutionalize VfM practices but also highlights a gap in existing regulations.

5.1.2 Methodologies in VfM Analysis

The responses provided detailed insights into VfM analysis methods, including financial metrics selection, risk quantification, discount rate determination, and toll revenue forecasting. All respondents reported using Excel-based financial models as their primary tool. Key financial metrics cited were Net Present Value (NPV), Risk-Adjusted Discount Rates, Internal Rate of Return (IRR), Lifecycle Cost Analysis (LCA), Debt Service Coverage Ratio (DSCR), and, in one case, budget impact. Discount rate determination varied: two respondents-based rates on project-specific negotiations, while another used a combination of historical data, federal guidelines, and state-specific rates. Risk quantification approaches also differed. Two respondents used only Excel-based models, one combined Excel models with expert judgment, and another employed Excel models alongside Monte Carlo simulations, probabilistic models, and expert judgment. Toll revenue forecasting methods showed similar variation. Two respondents used historical data analysis, scenario modeling, and third-party studies, while another did not use formal forecasting methods. Qualitative assessments in VfM analysis ranged from using a Multi-Criteria Decision Analysis (MCDA) framework to relying on technical approaches and expert judgment informed by past project experience. These variations highlight the absence of standardized practices across agencies and suggest that VfM applications are often tailored to individual project needs. This flexibility reflects the evolving nature of VfM analysis in the highway sector.

5.1.3 Current VfM Practices

When asked about how well the current VfM models account for financial and risk-related factors, responses varied. Three respondents rated their VfM model as working very well and another as moderately

well. One of the key factors evaluated in VfM analysis is risk allocation transparency. All three respondents rated their risk allocation process as highly transparent. Respondents were asked about the importance of federal funding compliance (e.g., TIFIA, federal grants). The responses indicate that federal funding requirements play a significant role in shaping VfM practices. All four respondents rated federal funding compliance as extremely important. Infrastructure projects often face fluctuations in financial and economic conditions, such as inflation, interest rate changes, and shifting economic policies. Respondents were asked to evaluate how well their current VfM models capture variations in financial and economic conditions. The responses varied, with two respondents rating their model's effectiveness as very good, while others rated it as extremely good and good. Since infrastructure projects are often subject to financial and operational uncertainties, respondents were asked about the methods they use to address uncertainties in their quantitative assessments. One respondent reported using sensitivity analysis. Another respondent mentioned using combination of all available risk handling methods including sensitivity analysis, scenario planning and Monte Carlo simulations. Other two respondents indicated that their approach to handling uncertainty is primarily through transferring the risk to the developer. Respondents were also asked about the frequency of VfM analysis updates, and their answers revealed varying practices. Two respondents reported that VfM analysis is updated only during procurement. Another respondent indicated that updates occur rarely or never. A third respondent stated that VfM assessments are updated at every key project milestone.

5.1.4 Challenges in Conducting VfM Analysis

The four respondents identified different challenges in conducting VfM analysis. Data availability and quality was cited as a significant challenge by one respondent. Another respondent mentioned political interference as a major challenge. The third respondent listed changing market conditions as a challenge, while the fourth respondent identified the lack of standardized methodologies as a significant challenge.

5.1.5 Potential Improvements in VfM Analysis

The survey respondents offered several suggestions to enhance VfM analysis, focusing on advanced tools and technologies, discount rate standardization, federal agency involvement, and post-project evaluations. Among technological improvements, the most frequently mentioned was the use of integrated lifecycle cost databases, followed by advanced risk modeling, real-time traffic data integration, and standardized VfM templates to improve analysis quality. Another respondent suggested AI-driven scenario planning to make VfM models more adaptable to economic changes and project conditions. Opinions on discount rate standardization were mixed: two respondents supported standardized rates for specific project types, while another opposed standardization. Regarding the role of federal agencies, suggestions included providing funding for better financial tools, validating post-project VfM outcomes, offering training programs to improve analyst capabilities, and mandating minimum VfM standards. Views on post-project evaluations also varied: two respondents supported making them mandatory, one preferred them only in specific cases, and one respondent remained uncertain. In addition to these structured responses, participants shared qualitative insights. One highlighted the importance of initial VfM assessments by government agencies to ensure transparent and well-informed project evaluations. Another noted that VfM analysis does not always adequately consider political influences, which can affect decisions in large-scale, government-mandated projects. The need to balance competing interests in such projects was emphasized, along with the importance of developing accurate public sector cost assumptions to enable fair comparisons between P3 and public delivery models, avoiding biases in decision-making.

5.2 Government Funding in U.S. P3 Transportation Projects

The analysis of funding sources across major P3 transportation projects in the U.S. reveals significant variation in the extent of government financial support. Some projects rely heavily on public funding through mechanisms like TIFIA loans, PABs, and direct public sector contributions, while others incorporate a more balanced mix of public and private financing. The extent of government involvement directly influences project risk allocation, cost efficiency, and long-term financial obligations. Table 1 showcases the

distribution of government-backed funding through TIFIA loans, PABs, and Public Sector Payments, reflecting diverse financing strategies across states and project types.

Table 1: Government Contributions to P3 Transportation Projects: TIFIA, PAB, and Public Payments

P3 Project	State	TIFIA	PAB	Public Sector Payment
Presidio Parkway	CA	41%		
South Bay Expressway	CA	21%		
Central 70	CO	36%	9%	
Eagle Project	CO	14%	19%	
US 36 Express Lanes (Phase 2)	CO	29%	10%	36%
I-595 Corridor Roadway Improvements	FL	33%		13%
I-4 Ultimate	FL	33%		
Port of Miami Tunnel	FL	31%		19%
I-69 Section 5	IN		52%	20%
Ohio River Bridges - East End Crossing	IN & KY	12%	39%	26%
I-75 Modernization Project Segment 3	MI		44%	3%
I-77 Express Lanes	NC	30%	16%	15%
Goethals Bridge Replacements	NY & NJ	31%	30%	20%
Southern Ohio Veterans Memorial Highway	OH	32%	35%	14%
Pennsylvania Rapid Bridge Replacement Project	PA		71%	
Pennsylvania Major Bridge Program	PA		78%	
SH 130 (Segments 5-6)	TX	32%		1%
North Tarrant Express (I-820 and SH 121/183)	TX	31%	19%	28%
LBJ Express	TX	32%	23%	18%
North Tarrant Express 35W Project	TX	32%	17%	21%
SH 288 Toll Lanes	TX	34%	28%	2%
Elizabeth River Tunnels	VA	20%	32%	20%
I-495 Capital Beltway HOT Lanes	VA	28%	29%	24%
I-95 HOV/HOT Lanes	VA	33%	27%	9%
I-95 Express Lanes Fredericksburg Extension	VA		33%	
Transform 66 - Outside the Beltway	VA	33%	20%	

Source: (FHWA - Center for Innovative Finance Support)

Projects with high public sector involvement, such as Pennsylvania’s Rapid Bridge Replacement Project and Major Bridge Program, demonstrate a heavy reliance on government-backed funding, with public payments and PABs accounting for a substantial portion of their financing. This level of public investment places significant long-term financial obligations on the government, shifting much of the risk away from private partners. As a result, private sector incentives to optimize costs and innovation may be weakened, as their financial exposure is limited. Conversely, some projects follow a more balanced funding model, distributing financial responsibilities between public and private entities. The Elizabeth River Tunnels and I-495 Capital Beltway HOT Lanes projects in Virginia illustrate this approach by combining TIFIA loans, PABs, and public contributions. Such models encourage private sector participation while ensuring that

public financing is leveraged effectively to maximize efficiency and minimize risk. TIFIA loans play a critical role in supporting large-scale P3 infrastructure projects. North Tarrant Express and SH 288 Toll Lanes in Texas relied on TIFIA loans for over 30% of their funding. These loans offer low-interest financing, reducing borrowing costs for private developers and improving project feasibility. However, while TIFIA loans enhance financial viability, their widespread use underscores the importance of ensuring that private entities still bear a fair share of the risks and responsibilities. In some cases, P3 projects adopt availability payment models, particularly in Florida and Indiana, where significant upfront public funding is provided to reduce long-term private sector revenue risks. While this approach minimizes financial uncertainty for private investors, it increases government oversight responsibilities and requires rigorous contract management to ensure that projects remain cost-efficient and deliver expected value. This also highlights the risks associated with excessive government funding. Projects with high public contributions, such as the I-69 Section 5 and the Ohio River Bridges - East End Crossing, shift financial burdens to the government while reducing private sector exposure. This can lead to inefficiencies, as private partners have less incentive to control costs and manage risks effectively. Additionally, long-term public sector liabilities can create fiscal strain, particularly if economic conditions change or policy priorities shift. To optimize P3 project financing, government funding strategies should carefully balance risk transfer and private sector incentives. Public financing tools like TIFIA loans and PABs should be strategically deployed to reduce borrowing costs while ensuring that private entities remain accountable. Encouraging competition and maintaining an optimal mix of private equity, public contributions, and debt financing can further enhance project efficiency and taxpayer value.

5.3 Case Studies

Case Study 1: I-66 Corridor Improvements/Transform 66-Outside the Beltway (Virginia): The Transform 66 “Outside the Beltway” project covers about 22.5 miles from US 29 in Gainesville to I-495. It involves new express lanes, interchange upgrades, and multimodal enhancements. Procured under a DBFOM model, the private partner, known as I-66 Express Mobility Partners, includes Cintra, Meridiam, John Laing, and APG. The total cost is around \$3.7 billion, funded by a \$1.229 billion TIFIA loan, \$737 million in PABs, and more than \$1.5 billion in private equity. VDOT oversees the project and provides right-of-way support. Express lanes opened in late 2022, with finishing touches continuing into 2023. From the state’s perspective, there have been no direct cost overruns, since the private team shoulders most construction risks. Early estimates suggest a 10–15% cost advantage over a traditional public-sector approach, mainly due to risk transfer and innovation by the private sector.

Case Study 2: LBJ Express (Dallas, Texas): The LBJ Express project reconstructed and expanded about 17 miles of the LBJ Freeway (I-635) and parts of I-35E, adding managed toll lanes, general-purpose lanes, and frontage roads. It was delivered as a 52-year DBFOM concession by the LBJ Infrastructure Group (led by Cintra and Meridiam). The total cost of \$2.615 billion includes an \$850 million TIFIA loan, \$615 million in PABs, \$446 million in private equity, and \$495 million from the Texas DOT and local sources. Construction began in 2011 and finished in late 2015, mostly on schedule. There was an 8–10% increase above initial private estimates, largely due to rising material costs. Even so, project sponsors claim about 10% savings compared to a traditional public-sector model, because of risk transfer and the use of performance-based contracting.

Case Study 3: Central Artery/Tunnel Project (“Big Dig,” Boston): The “Big Dig” rerouted Interstate 93 through downtown Boston via an underground tunnel, built the Leonard P. Zakim Bunker Hill Memorial Bridge, and redesigned multiple interchanges. Managed under a traditional DBB process, its initial cost estimate in the late 1980s was \$2.56 billion. By 1992, this estimate increased to \$7.74 billion, then to \$10.4 billion in 1994, and ultimately reached \$14.8 billion upon project completion in 2007, more than 5.7 times the original estimate. Sections of the tunnels opened between 2003 and 2005, and the final closeout ended in 2007. Funding came mainly from federal highway grants and state bonds, with little private financing. The massive cost overrun, more than 400% above early estimates, stemmed from factors like difficult tunneling conditions, design changes, and fragmented responsibilities across many contracts.

6. LIMITATIONS

There are limited highway projects that have used the VfM model, so the sample size cannot be increased. Due to the small sample size, it is recommended that the conclusions drawn from this study be used with caution. The main goal of the survey was to gather the opinions of state DOT personnel regarding the use of the VfM model in selecting the PPP delivery method to fund, design, and construct highway projects. These responses do not determine the efficacy of the VfM model but shed light on how this tool has been used by industry personnel.

7. CONCLUSIONS

This study examined best practices in financial modeling for P3 projects, with a focus on Value for Money (VfM) analysis and government funding mechanisms in U.S. transportation infrastructure. Analysis of financial structures, case studies, and survey responses from State DOT professionals provided critical insights into P3 financial planning. P3s offer notable advantages in risk transfer, cost efficiency, and innovation, but their success depends on well-structured government support. Our evaluation of funding tools, TIFIA loans, PABs, and Public Sector Payments, revealed that balanced public-private financing improves risk-sharing, accountability, and overall project viability, while over-reliance on public funds can create inefficiencies and fiscal strain. Survey findings, though based on a limited sample, highlight key challenges in current VfM practices, including inconsistent methodologies, data limitations, and political influences. Respondents emphasized the need for standardized discount rates, advanced risk assessment models, and better integration of qualitative factors. Differences in financial modeling approaches, risk quantification, and revenue forecasting further underscore the need for uniform evaluation frameworks. Case studies of major U.S. projects, Transform 66 (Virginia), LBJ Express (Texas), and the Big Dig (Boston), illustrate these dynamics. P3 models achieved cost advantages by leveraging private sector efficiency and risk transfer, while traditional models, such as the Big Dig, faced significant cost overruns due to fragmented responsibilities and inadequate risk allocation. Overall, the study underscores the importance of refining P3 financial modeling. A balanced mix of public and private funding enhances accountability and efficiency. Advanced tools like AI-driven scenario planning and integrated lifecycle cost databases can strengthen risk quantification in VfM analysis. Political influences remain a significant challenge; future VfM frameworks should incorporate third-party validation and transparent assumption disclosures to minimize bias. Finally, standardized post-project evaluations are essential to ensure P3 projects meet financial goals and to continuously improve future financial modeling practices.

ACKNOWLEDGMENTS

The authors would like to thank all the state DOTs personnel, private consulting personnel, and P3 experts in providing survey feedback for this study. We would also like to thank all the participants who provided comments during phone conversations regarding funding process of P3 highway projects.

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