A Comparison of Public-Private Partnerships and Traditional Procurement Methods in North American Highway Construction

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ABSTRACT
The number of public-private partnership (P3) projects in North America increased significantly since early 1990s, as policymakers and transportation officials seek alternative methods to supplement traditional funding sources to finance and deliver projects. Scholars have compared the cost and schedule overruns of P3 projects against publicly funded projects in mature P3 markets in Europe, but similar comparisons are lacking for the North American market. This paper begins filling that gap by comparing the cost- and schedule-overrun results of 12 completed, large-scale (greater than ~US$90 million) P3 highway projects in North America with previous research studies reporting on large-scale design-bid-build or design-build highway projects. The researchers collected P3 project performance data through interviews with project executives and then utilized findings from previous studies of traditional projects for comparative benchmarking data. The research results indicate the P3 sample cost overruns averaged 0.81% and schedule overruns averaged -0.30%, compared with 1.49% cost overruns and 11.04% schedule overruns for design-build projects and 12.71% cost overruns and 4.34% schedule overruns for publicly financed large-scale design-bid-build highway projects. With a relatively small universe of completed construction phase efforts to examine, it is premature to draw explicit conclusions, yet the results reported in this study point to tighter control of highway construction costs and delivery schedules when projects are delivered via the P3 method. Findings from this study provide empirical evidence for various theoretical advantages and limitations of P3 projects, as well as serve as a reference tool to compare the appropriateness of different project delivery methods.

INTRODUCTION

The number of public-private partnership (P3) projects in North America has increased significantly since the early 1990s, as policymakers and transportation officials seek alternative methods to supplement traditional funding sources to finance and deliver projects. With the current severe fiscal constraints on government projects, the P3 delivery method is increasingly being considered by public-sector transportation agencies.

One of the major drivers of change for this slow migration toward the use of the P3 project delivery system has been primarily financial. It is the financial aspect, more specifically the initial cost of construction that manifests itself as a key differentiator between the P3 model of project delivery and design-bid-build (DBB) and design-build (DB) in terms of construction cost containment. Another significant differentiator between the project delivery methods is that the P3 construction is usually delivered in a DB mode and the roads are then maintained and operated by private entities as opposed to governmentally managed entities. The focus of this study is the effect of construction cost containment strategies. This research presents a more rigorous examination of the risks that come to bear on a construction project that ultimately manifests themselves as cost. It is important to understand how costs result because the public must buy into the financing scheme.

When the US Congress enacted the Federal-Aid Highway Act in 1956, popularly known as the National Interstate and Defense Highways Act, a majority of the highway funding was arranged through fuel taxes and, to a much lesser extent, tolls on some roads and bridges. The balance of the funding comes from a variety of sources such as general fund receipts, bond issues, designated property, and other taxes. A common misconception by the public regarding the funding of highways is likely tied to the use of the term “freeway”. The term is intended to designate controlled access and these roads are certainly not free. The notion resonates, particularly with lawmakers, as present federal law does not allow a state to change a freeway section to a tolled section for all traffic. Although 2,900 mi (4,669 km) out of the 48,876 mi (78,690 km) are tolled in some way, these were typically grandfathered into the system. Recent legislation, however, such as the Safe Accountable Flexible Efficient Transportation Equity Act, encourages states to construct new interstate highways through “innovative financing” methods including toll roads through state agencies or P3s.

Even though it has taken many years to get to this point in the US history of road building, governments still face many of the same challenges. Chief among them are the raising of funds to deliver the completed construction in the most efficient manner and then the continued operation and maintenance of those completed works. In studying the history of the transportation network, researchers found that the responsibility of who actually plans, builds, and maintains roadways has swung back and forth between the private sector and governmental agencies. The question of who is best suited to perform this work has been the subject of public discourse. In the past 60 years in the United States and Canada, the pendulum was leaning heavily toward the government side. This tendency toward heavy government activity was due in part to development of the interstate highway system. The need for extensive coordination, standardization, and a comprehensive view was paramount to the success of a nationwide system. In Europe and other parts of the world in the recent past (for this research, the past 20 years), there has been a shift to the private side in the form of P3s.

While scholars have compared cost performances between P3 and traditional public procurement infrastructure projects in more developed P3 markets such as Europe (*1*, *2*, *3*, *4*), to our knowledge similar studies do not exist for the North American market, partly due to the limited number of completed projects. A number of North American P3 transportation projects have been completed in recent years, allowing an initial observation of their performance. The effectiveness of the P3 delivery approach has been of great debate. Studies on the effectiveness of P3 projects, in terms of cost control and schedule performance, have focused on the more mature P3 markets in Europe, United Kingdom, and Australia. However, since the institutional structure of the Architectural Engineering Construction (AEC) industry in Europe is very different than that in North America, findings from the European P3 studies are not directly transferable to the North American P3 market.

The objective of this study is to examine performance of P3 transportation projects (in terms of schedule and cost) and to compare this P3 performance against traditional projects' performance as reported in other literature. To the knowledge of the researchers, this will be the first comprehensive study on North American P3 projects comparing the P3 delivery approach against the more traditional DBB and DB.

According to M. Acar et al., "Public-Private Partnerships are an umbrella term referring to a variety of collaborative undertakings between public, private, and/or nonprofit organizations, ranging from simple coordination efforts between two organizations from different sectors to more comprehensive initiatives involving a significant number of individuals and organizations representing all three sectors" (*5*). P3 projects have been procured under several different types of contracts that combine finance, operation, and maintenance with the more traditional DB project delivery approach. Projects that do not exhibit all five characteristics (design, build, finance, operate and maintain) are not characterized as P3s (*6*). P3 contracts generally require a private agent to assume responsibilities for the performance of the asset over a long term so that the public sector can realize the efficiencies from long-term investment and asset management from the private sector (*7*). For purposes of this study, traditional public procurement means any procurement method that is not a DBFOM, which will encompass a wide range of project delivery arrangements including Design-Bid-Build (all separate actions), and Design-Build contracts.

Cost and schedule overruns during construction of highway projects is common for projects over US$100 million. This phenomenon has been observed in international projects (*3*), in the United Kingdom (*8*), in Canada (*9*) as well as the United States (*10*). Flyvbjerg (*4*) advocated applying an appropriate uplift cost to offset the optimism bias on these large scale highway projects as a solution to this cost-overrun dilemma. To better understand the root causes, researchers have undertaken studies to determine if better options are available in the form of alternative project delivery methods to contain the cost of projects (*11*, *12*). The vast majority of work in the US public sector has been delivered using a traditional DBB method. DB approaches in North America have been utilized with some success, showing better cost and schedule control (*11*). Studies of the more mature European P3 delivery approach indicate that the P3 project delivery approach holds significant promise, concluding that the average construction cost overrun on P3s was around half that observed from conventionally procured projects (*13*).

Recently studies have compared theoretical arguments with empirical evidence (*6*). According to Blanc-Brude et al., risk transfer from the public to the private sector can lead to a

more explicit recognition, quantification, and pricing of the risk that is transferred. Due to the few completed P3 projects, it has been difficult to draw conclusions about this transfer of risk to the private sector for long-term P3 projects as well as the impact on pricing. Few studies on completed P3 construction have compared estimated budget to actual completed cost (*14*). Much has been written about the formation of P3s, how they operate (*15*), and their various mechanisms and means of implementation. This study looks to previously established definitions (*16*) for terminology, organization, and the particulars of implementing a P3. This research also understands and relies on earlier observations (*4*, *6*) regarding the notion that distinct differences exist between infrastructure types. For example, mixing highways with tunnels are "noisy" in that the structures are very different technically and require different cost structures that are not comparable (*6*).

The aim of this research is to objectively compare the performance of very large P3 projects with the more traditional DBB and DB project delivery methods. This study is not an attempt to verify some means of determining the costs of any large highway project. Flyvbjerg's (*3*, *4*) attempts to do that via reference class forecasting as advocated in the COWI facilitated approach are interesting but not to the point (*17*). This study will compare the North America P3 results with other studies for DBB and DB in an attempt to assist practitioners in procuring large-scale infrastructure projects.

METHODOLOGY

In this study of comparing P3 and traditional procurement methods in North American highway construction, the following key steps were developed:

1. Literature review on previous studies of DBB and DB highway projects
2. Development of input and output metrics
3. Criteria for selection of sample projects
4. Data collection for sample projects
5. Data analysis of collected data
6. Comparison of P3 research results with previous studies of DBB and DB highway projects

1. Literature Review of Previous Studies on DBB and DB Highway Projects

Researchers used a literature review of previously reported studies to benchmark performance of cost and schedule control for traditional DBB and DB highway projects. This allowed a comparison of these more traditional project delivery approaches with P3 projects.

2. Development of Input and Output Metrics

The study determines the project performance regarding cost and schedule adherence for transportation projects. Two key metrics are used: cost change and schedule change.

Cost Change

Cost change is the difference between the actual project cost and the estimated project cost. The estimated project cost is the contract value of the capital expenditure specified in the P3 contract at financial close. The actual project cost is the cumulative value of all payments made by the sponsor(s) to the developer(s) to compensate for the construction of the project.

$$\text{percent cost change} = \frac{(\text{actual project cost} - \text{estimated project cost}) \times 100}{\text{estimated project cost}}$$

Schedule Change
The estimated construction duration is the time allotted in the contract for the construction of the project, and the final construction duration is the actual time of construction to the point of availability of use of the project.

$$\text{percent schedule change} = \frac{(\text{final construction duration} - \text{estimated construction duration}) \times 100}{\text{estimated construction duration}}$$

3. Criteria for Selection of Sample Projects

The researchers determined the criteria for selection of P3 projects by the trend of the P3 market over the past 20 years. The research study project list was obtained from "Public Works Financing, September 2010" edition. From that list, only highway transportation projects meeting the criteria below were studied.

a. Projects Constructed in North America
Studies have focused on the more mature markets of Europe, UK, and Australia, but similar studies have not been accomplished in North America.

b. Projects Constructed Between 1990 and 2010
Legislative actions have taken place over the past 20 years that have allowed alternative project delivery approaches such as P3 and DB (*20*, *21*, *22*). With these new laws, states have utilized different project approaches to seek better cost and schedule control.

c. Projects with Construction Costs Between US$90 Million and US$1,100 Million
Research by the Federal Highway Administration (FHWA) compared 11 pairs of project under US$20 million using the DB and DBB methods (*18*). The percent cost change for DBB (3.6%) was lower than that for DB (7.4%). However when Shrestha (*12*) compared four large (over US$100 million) transportation projects, the cost change was significantly higher for DBB (12.71%) compared to DB (1.49%). Cost containment for large-scale infrastructure projects is more difficult in the DBB project delivery approach. This research examines whether the P3 approach better controls cost on these large-scale projects.

d. Highway and Bridge Projects Without a Large Signature Tunnel
As noted by Blanc-Brude (*6*), "Mixing motorways and other types of roads, in some cases including significant tunnel or bridge links, are 'noisy' in that they contain observations of very different technical natures and hence different cost structures." Flyvbjerg et al. also document that the average cost overruns for these different categories of infrastructure are very different, so that risk pricing would be expected to vary in each case (*3*). To ensure comparable sample projects, researchers for this study selected transportation projects without large signature tunnels.

e. Projects Procured Under a DBFOM Procurement Model

The incentive for private industry to finance a project is to complete the work on time to begin receiving funds for the completed work. The incentive to produce a better quality project is the risk that is accepted by private industry when the operations and maintenance (O&M) portion of the contract are bundled with the DB. Although these projects have not had a chance to complete the contractual cycle, by using the DBFOM procurement model, this study will lay a foundation for future research — the construction costs have been studied and the results can then add the O&M risk and reward to the outcome.

4. Data Collection for Sample Projects

The researchers gathered data and confirmed projects to be DBFOM through a thorough literature review and a survey with personnel involved with the selected projects.

a. Literature Review

Researchers gathered data on the P3 projects through various databases available on the web and prepared an exhaustive list of all the eligible P3 projects in the United States and Canada. Maximum information was compiled from official websites of the respective projects and state departments of transportation, concentrating on the two study parameters: cost and schedule. To determine the cost change of a project, data was collected on the estimated project cost and the actual project cost of the projects under study. To determine the schedule change of the project, data was collected on the estimated construction duration and the final construction duration.

b. Survey

After collecting the data available on the projects from the web, researchers prepared a set of questions to survey public agencies involved in the selected P3 projects. Personal interviews were conducted with officials involved in the construction and procurement of the projects under consideration. The officials were project directors and/or project managers for the government agencies who had an intimate knowledge of the project. This personal survey concentrated on the size, location, type, scope, procurement, and project schedule with key emphasis on the cost and schedule performance of the projects.

5. Data Analysis

Researchers analyzed the data collected from the literature review and the surveys for percentage of cost and schedule change per the input and output metrics determined at the beginning of the research. Any changes — such as scope changes, owner's additions or deletions, unanticipated risks, force majeure as decided by the public and the private entity — were considered in the analysis to determine how the change would affect the percent of change. The average cost change and average schedule change were then calculated for all P3 projects under study, which provided the performance of the P3 procurement method for highway construction in North America.

6. Comparison of P3 with Results of Previous Studies on DBB and DB Highway Projects

Researchers used the literature review of previously reported studies to compare traditional DBB and DB project delivery approaches with P3 projects.

PREVIOUS RESEARCH ON DESIGN-BUILD AND DESIGN-BID-BUILD PROJECTS

Researchers found four previous studies comparing DBB and DB (Table 1). The most extensive study of DB highway projects was completed by Tom Warne and Associates in 2005 (*11*). However, in this study, they did not compare any completed DBB projects with the DB projects. They reviewed 21 projects across the United States ranging in size from US$83 million to US$1,300 million. The study collected data on the 21 projects and then asked the project managers to estimate how much time the project would have taken if the DBB project delivery process had been followed. The answer was a professional estimate, but no direct comparisons were made between the DB and DBB projects.

Shrestha (*12*) compared the performance of four DB and four DBB highway projects. The DB projects were selected from across the United States, while the DBB projects were selected from Texas. The design and construction cost of DB projects ranged from US$165 million to US$1,150 million, and the design and construction cost of DBB projects ranged from US$146 million to US$301 million. The cost and schedule growth of projects in this study are comparable with the criteria for the P3 study, allowing a comparison of DBB, DB, and P3 project delivery.

The FHWA completed a study on the effectiveness of the Special Experimental Projects No. 14 program, which enabled state transportation agencies to test and evaluate a variety of alternative contracting methods (DB being a core element of SEP-14), and obtained data on 11 pairs of DB and DBB projects regarding cost and schedule growth (*18*). All costs for all projects were less the US$20 million — much smaller than this study's target projects.
Gransberg et al. compared 21 DBB and 11 DB projects completed by the Florida Department of Transportation (*19*). Although all the projects were under US$10 million, much smaller than this study's target projects, DB still show improvement of both cost and schedule growth over DBB. Of all the studies reviewed, only the Shrestha study provided a direct comparison of DBB and DB of the size of projects included in this research.

P3 PROJECT DATA RESULTS

The United States and Canada have been using various forms of P3 models for project delivery of highway construction for several years. This study analyzed 12 projects from North America, specifically California, Texas, Virginia, and Canada, which met the selection criteria and had been completed through the construction phase. Figures 1 and 2 provide the percent cost change and the percent schedule change. (Figures 1 and 2)

Ten of the twelve projects did not have any cost increase associated with the project. Of the two projects that experienced cost increases, the cost increases were associated with technical changes, such as geotechnical issues.

Of the 12 projects studied, 11 had no increase or were completed before the contractual completion date. For the project that had a schedule increase, the delay was due to technical changes in the project. (Table 2)

ANALYSIS

Using the parameters of cost and schedule performance, the researchers studied the P3 projects under consideration. These P3 projects form an exhaustive list (*23*) of large-scale (between US$90 million to US$1,100 million) highway construction projects in North America that were contracted under a DBFOM project delivery model. This study provides insight into the

advantages and limitations of the P3 procurement method in North America at the present time (projects completed between the 1990 and 2010).

The results obtained from this research study are compared to previous research that has analyzed the performance of DBB projects and DB projects on the same parameters of cost and schedule growth. Of the comparison studies of DB and DBB delivery methods in Table 1, the study done by Tom Warne and Associates (*11*) and Shrestha (*12*) provide the best comparisons to this research. This research and the ones by Warne and Shrestha have analyzed projects accomplished in North American within the same time period and within a comparable cost range. (Figure 3)

Cost Control

In this research of twelve (12) P3 projects, two exhibited an increase in the construction cost from the contract amount. The remaining ten projects were completed within the contract. The average cost increase for the P3 projects was 0.81%, while the average cost increase for four DBB projects was 12.71% and for four DB projects was 1.49% (*12*). The research by Tom Warne and Associates shows an average cost increase of 4% for the 21 DB projects reviewed (*11*). Large-scale DB projects have much better cost containment performance than large-scale DBB projects, and they are comparable to P3 projects (*11*, *12*). The cost control performance of DBFOM projects may be attributable to the DB nature of the project, and not so much to the FOM portion. Future studies would be in order to further explain this attribute.

Schedule Control

The control of the construction schedule is the second study parameter of interest in this study. Of the P3 projects, only one project had an increase in schedule, four were completed per the contract schedule, while seven were completed before the contract schedule date. The average schedule change for the P3 projects is -0.30% which is less when compared to the average schedule change of 4.34% for four DBB projects and 11.04% for four DB projects (*12*), but not as effective as the 21 DB projects in the Tom Warne and Associates study, which showed a −11% schedule change (*11*).

In this initial analysis of a sample size of 12 large highway projects, the P3 delivery method shows a success ratio of over 80%; that is, 10 out of the 12 projects had no cost or schedule increase from the contract requirements. The conventional wisdom that the construction phase of the highway project is the area where the most risk is evident may not be correct (*13*). In these studies, the project cost is controlled to within 1.5% to 4% of the contract amount, which would indicate that cost growth is controlled when compared to over 12% for the large transportation DBB projects. For the P3 projects, this means that cost growth is contained within the project amount and not passed on to the tax base, as in the case of DBB or potentially DB. The P3 delivery method also indicates a control of the schedule that helps facilitate finishing projects on time. From this research, the P3 projects finished on time, which is expected. The incentive of investment return does not begin until the project is available for public use and the operational portion of the contract begins. This would seem to coincide with the Tom Warne and Associates study, which showed a −11% schedule change, since the contractors could see additional profit by finishing early but would not be impacted by the operational period.

SUMMARY

Research has studied cost and schedule overruns of P3 projects against publicly funded projects in mature P3 markets in Europe, but similar comparisons have been lacking for the North American market. This research has begun filling that gap by comparing the cost- and schedule-overrun results of 12 completed, large-scale (greater than US$ 90 million) P3 highway projects in North America with previous research studies reporting on large-scale DBB or DB highway projects. In this initial analysis of first generation large-scale highway projects, the P3 delivery method shows a success ratio of over 80% for both cost and schedule containment. The cost control performance of DBFOM projects may be attributable to the DB nature of the project, and not so much to the FOM portion, while schedule control may be incentivized by the return on the investment which would not start until the project is successfully delivered.

RECOMMENDATIONS

P3s are not a one-size-fits-all solution. Moreover, there are many more features of a project's development that feed into its success than just the perspective of cost and schedule containment. Because every P3 studied included the feature of a DB construction contract within it, it is apparent from this study that the use of DB as a means to contract for the construction of large projects contains costs better than a DBB delivery. Further, when considering the time to complete a project, this study holds strong evidence that a P3 will get the roadway into use quicker, both clearly very positive attributes.

This study compares one aspect of the large road construction project. It is clear that the combination of faster project delivery with very tight control of construction costs provides a benefit to the public. This study examines just one of the aspects of the P3 method of project delivery. Outside the scope of this study, a number of other aspects warrant examination that may reveal additional savings, efficiencies, and benefits to the public. Due to the limited field of projects that fit the criteria for this study and, more specifically, the fact that they are early in their P3 project lifecycle, further study of these other aspects must be conducted to determine the full spectrum of benefits afforded by the method. These additional aspects are as follows:

- What are the results of a comparison of life-cycle asset management costs from a P3 compared to government costs?
- Are there differences between availability of travel lanes between a project delivered as a P3 and a government-operated road built using traditional methods?
- What are the net effects on carbon footprints of a roadway built and operated as a P3 compared to a government-operated road built using traditional methods?
- If this study's results are recognized as valid and the initial benefits can be duplicated, how best to create a P3 guidance document that is widely available and that can be continually updated with best practices?
- What are the economic benefits of wider use of the P3 model on large projects, and where are the lines of demarcation that separate the sensible decision point to engage a P3, DB, or DBB method of delivery?
- What do P3s have to offer the public in terms of where and when to build roads considering traffic and revenue considerations in the toll road schemes?

This study points out that significant research is yet to be done in comparing these three methods of project delivery: design build, design-bid-build, and P3.

DEFINITION OF KEY TERMS

Actual project costs: the cumulative value of all payments (each indexed to the year of financial close) made by the sponsor(s) to the developer(s) to compensate for the construction of the project

Contract: the legal agreement between the sponsor(s) and the developer(s) related to the procurement and delivery of the project

Contract value: the monetary amount the sponsor(s) is contracted to pay the developer(s) to compensate for the capital expenditure upon the completion of the construction project, in local currency (either US dollar or Canadian dollar) indexed to the present value of the year in which financial close takes place

Cost overrun: actual project costs minus estimated project costs

Cost overrun percentage: cost overrun expressed as a percentage of estimated project costs

Estimated project costs: contract value of the capital expenditure specified in the contract at financial close

Financial close: the point at which all contracts are signed by all parties involved in a project, including lenders, equity holders, sponsor(s), developer(s); the moment when the developer(s) has/have successfully raised the financing needed to build the project

Substantial completion: the occurrence of all events and satisfaction of all conditions set forth in the substantial completion clause of the contract, as and when confirmed by the sponsor's issuance of a notice

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REFERENCES

1. Blanc-Brude, F., H. Goldsmith, and T. Välilä. *Ex Ante Construction Costs in the European Road Sector: A Comparison of Public-Private Partnerships and Traditional Public Procurement.* Economic and Financial Report of the European Investment Bank, 2006.
2. Ahadzi, M., and G. Bowles. Public-Private Partnerships and Contract Negotiations: An Empirical Study. *Construction Management and Economics*, Vol. 22, No. 9, 2004, pp. 967–978.
3. Flyvbjerg, B., M. K. Skamris Holm, and S. L. Buhl. How Common and How Large Are Cost Overruns in Transport Infrastructure Projects? *Transport Reviews*, Vol. 23, No. 1, 2003, pp. 71–88.
4. Flyvbjerg, B. *Procedures for Dealing with Optimism Bias in Transport Planning.* The British Department for Transport, 2004.
5. Acar, M., C. Guo, and K. Yang. Accountability When Hierarchical Authority Is Absent: Views from Public-Private Partnership Practitioners. *American Review of Public Administration*, Vol. 38, No. 1, 2008, pp. 3–23.
6. Blanc-Brude, F., H. Goldsmith, and T. Välilä. A Comparison of Construction Contract Prices for Traditionally Procured Roads and Public-Private Partnerships. *Rev Ind Organ*, Vol. 35, 2009, pp. 19–40.
7. Nisar, T. Risk Management in Public-Private Partnership Contracts. *Public Organization Review*, Vol. 7, No. 1, 2007, pp. 1–19.
8. Mott MacDonald. *Review of Large Public Procurement in the UK.* Prepared for HM Treasury, 2002.
9. Iacobacci, M. *Dispelling the Myths: A Pan-Canadian Assessment of Public-Private Partnerships for Infrastructure Investments*. The Conference Board of Canada, 2010.
10. United States General Accounting Office. *Transportation Infrastructure: Managing the Costs of Large-Dollar Highway Projects*. Publication GAO/RCED-97-47, 1997.
11. Tom Warne and Associates, LLC. *Design-Build Contracting for Highway Projects: A Performance Assessment.* California Design Build Coalition, 2005.
12. Shrestha, P. P. Performance Benchmarking of Large Highway Projects. PhD thesis, University of Texas at Austin, Austin, Texas, 2007.
13. Bain, R. Construction Risk — What risk? *Project Finance International*, Issue 426, February 10, 2010, pp. 46–50.
14. Hodge, G. A., and C. Greve. PPPs: The Passage of Time Permits a Sober Reflection. *Economic Affairs*, Vol. 29, No. 1, 2009, pp. 33–39.
15. Yescombe, E. R. *Public-Private Partnerships: Principles of Policy and Finance*. Butterworth-Heinemann, Burlington, MA, 2007.
16. Ontario. Making Projects Happen: Value for Money Assessment, A Guide to Infrastructure Ontario's Methodology. Ontario: Queen's Printer for Ontario. 2007
17. Blitstein, R. Derailing the Boondoggle. *Miller-McCune*, August 18, 2008.
18. Science Applications International Corporation, AECOM Consult, and University of Colorado Boulder. *Design-Build Effectiveness Study.* Prepared for USDOT – Federal Highway Administration, 2006.
19. Gransberg, D. D., D. F. Runde, and J. Stergios. The Effect of Innovative Highway Construction Contract Methods. *AACE International Transactions*, 2000.

20. Gehrig, D. *Alternate Project Delivery Methods for Public Works in California*. HansonBridgett LLP, San Francisco, California, March 2009.
21. Commonwealth of Virginia. *Public-Private Transportation Act of 1995 (as Amended), Implementation Guidelines*. Richmond, Virginia, October 2005.
22. Matheny, T. *Alternate Project Delivery Methods for Texas Public Projects for Cities, Counties, and River Authorities*. Texas City Attorney's Association, Texas Municipal League Convention, October 2005.
23. Public Works Financing, September 2010, Volume 252.

TABLE 1 Research Summary of Design-Build Versus Design-Bid-Build

Research Study	Research Abstract	Delivery Method	Percent Cost Change	Percent Schedule Change
Warne (*11*)	21 DB projects across the United States with the individual project costs greater than US$83 million	DB	4	−11
Shrestha (*12*)	4 pairs of similar DBB and DB projects with the individual projects costs greater than US$100 million	DB	1.49	11.04
		DBB	12.71	4.34
FHWA (*18*)	11 pairs of DBB and DB projects Cost of individual projects under US$20 million	DB	7.4	−4.2
		DBB	3.6	4.8
Gransberg (*19*)	21 DBB projects and 11 DB projects Cost of individual projects under US$10 million	DB	−1.99	−35.7
		DBB	10.64	33.5

TABLE 2 Research Summary of P3 Projects

Research Study Projects	Delivery Method	Percent Cost Change	Percent Schedule Change
Twelve projects between US$90 and $1100million	DBFOM	0.81	-0.3

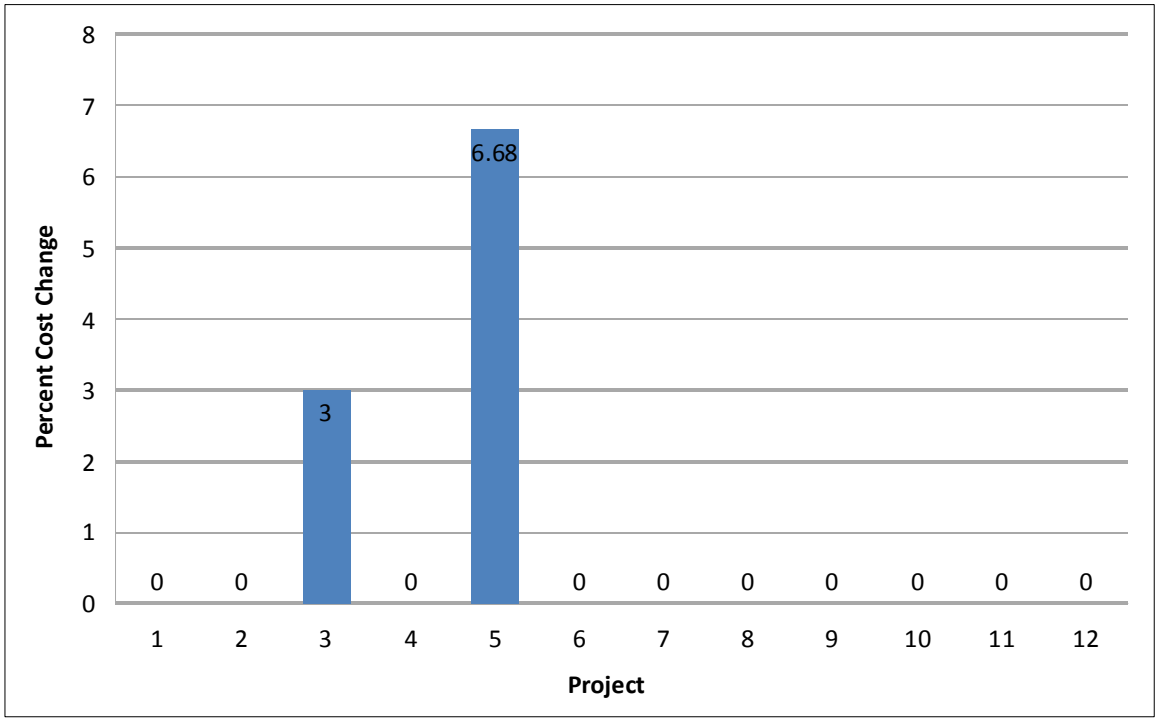

FIGURE 1 Percent cost change of P3 projects.

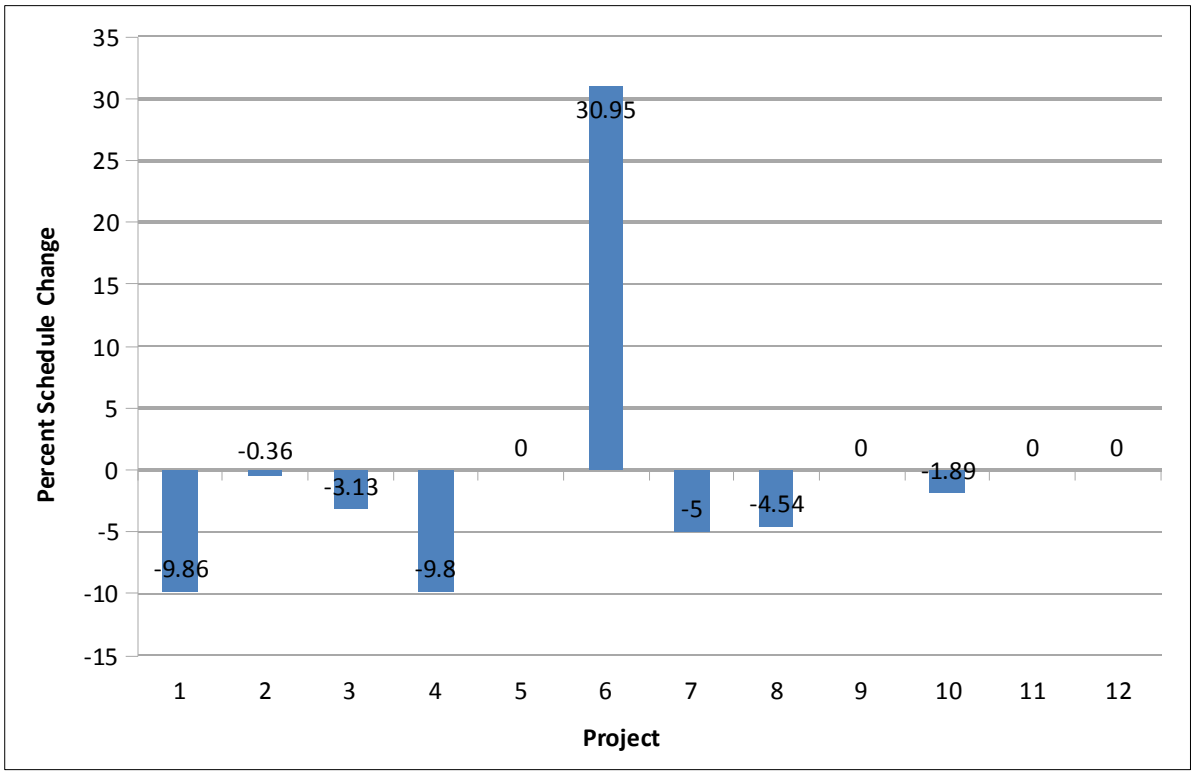

FIGURE 2 Percent schedule change of P3 projects.

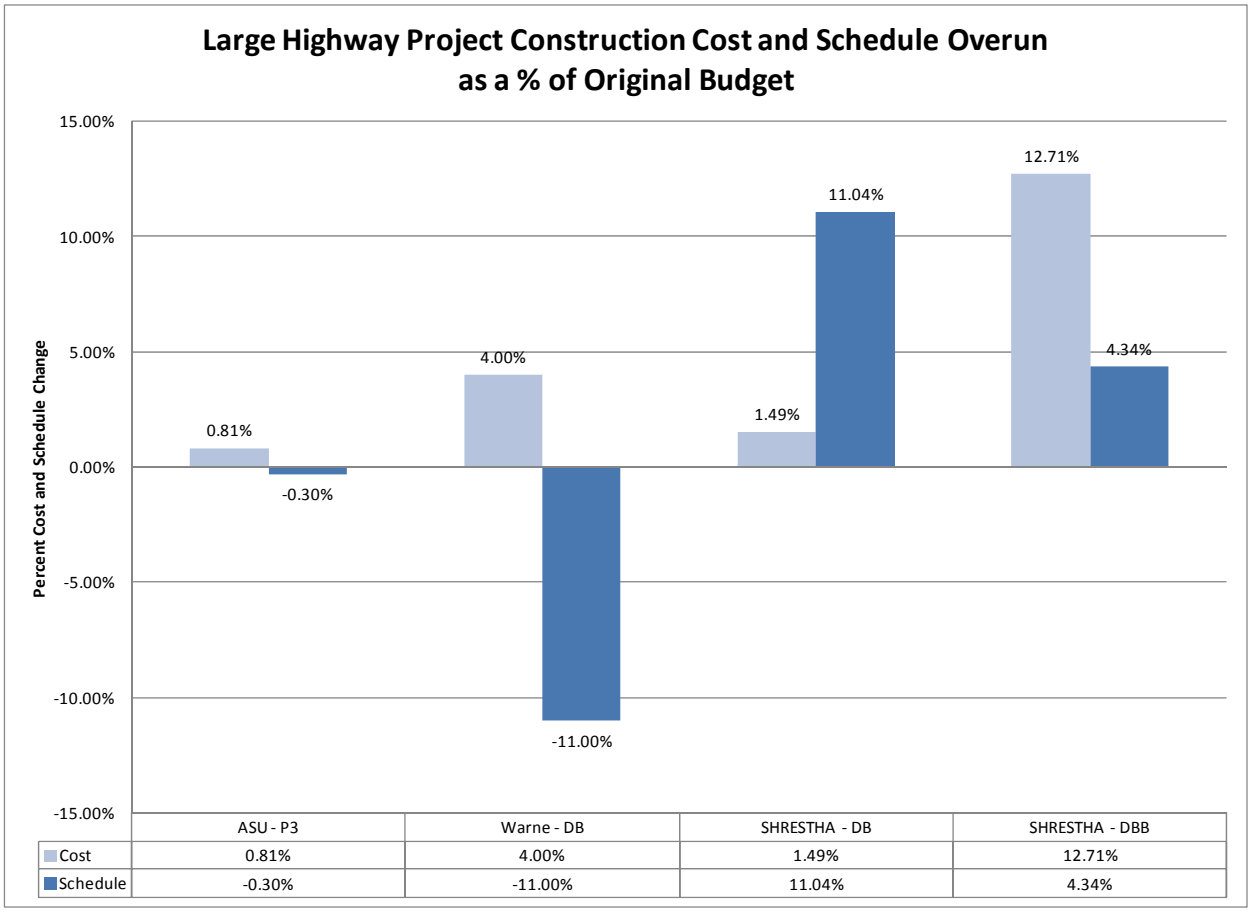

FIGURE 3 Large Highway Project Construction Cost and Schedule Overrun as a % of Original Budget for Projects over $90 million.