Comparison of Public Private Partnership with Traditional Delivery Methods in Highway Construction Industry

by

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ABSTRACT

Public-Private Partnerships (P3) in North America have become a trend in the past two decades and are gaining attention in the transportation industry with some large scale projects being delivered by this approach. This is due to the need for alternative funding sources for public projects and for improved efficiency of these projects in order to save time and money. Several research studies have been done, including mature markets in Europe and Australia, on the cost and schedule performance of transportation projects but no similar study has been conducted in North America. This study focuses on cost and schedule performance of twelve P3 transportation projects during their construction phase, costing over $100 million each, consisting of roads and bridges only with no signature tunnels. The P3 approach applied in this study is the Design-Build-Finance-Operate-Maintain (DBFOM) model and the results obtained are compared with similar research studies on North American Design-Build (DB) and Design-Bid-Build (DBB) projects. The schedule performance for P3 projects in this study was found to be -0.23 percent versus estimated as compared to the 4.34 percent for the DBB projects and 11.04 percent for the DB projects in the Shrestha study, indicating P3 projects are completed in less time than other methods. The cost performance in this study was 0.81 percent for the P3 projects while in the Shrestha study the average cost increase for the four DB projects was found to be 1.49 percent while for the DBB projects it was 12.71 percent, again indicating P3 projects reduce cost compared to other delivery approaches. The limited number of projects available for this study does not allow us to draw an explicit conclusion on the

performance of P3s in North America but paves the way for future studies to explore more data as it becomes available. However, the results in this study show that P3 projects have good cost and schedule adherence to the contract requirements. This study gives us an initial comparison of P3 performance with the more traditional approach and shows us the empirical benefits and limitations of the P3 approach in the highway construction industry.

To Ma, Pa, Bhai and friends.

ACKNOWLEDGMENTS

I would like to show my gratitude to Dr. Allan Chasey, whose immense support and guidance from the start through the end helped me to develop an understanding of the topic and write this thesis. I would also like to thank Dr. Gibson and Dr. Pendyala for accepting to be on my committee, encouraging me to go ahead with this research and giving their valuable time. This thesis would not have been possible without the constant support and industrial views on this topic provided by Mr. Bill Maddex, Dr. Henry C. Chan and Mr. Richard Kerrigan of ARUP.

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CHAPTER 1: INTRODUCTION

1.1 OVERVIEW

Highway construction in North America has mainly been developed by the traditional delivery methods such as Design-Bid-Build (DBB) and Design-Build (DB). These approaches have been successful to an extent but they are not meeting the current rapidly growing requirements with the required efficiency. The transportation industry is facing an infrastructure funding gap of $138 billion for 2008-2035 (National Surface Transportation Infrastructure Financing Commission, 2009). The motor-fuel and road taxes are not able to support the present demand for transportation infrastructure and hence transportation officials are looking for delivery methods that best utilize the existing funds and become a source of funds as well.

The taxes in the US compared to the taxes in other countries could give us a picture of the current reduction in available funds through gasoline taxes in US. Figure 1 shows the vehicle fuel retail prices indicating the wholesale and distribution price and the taxes added to the gasoline price in the US and various countries. It shows that the taxes on gasoline in the US account for a very small percentage of the total retail price per liter of fuel compared to other countries. The European countries lead the way with taxes being more than the wholesale and distribution cost by about 200 percent for most of them. The graph in Figure 1 is based on 2006 US dollars.

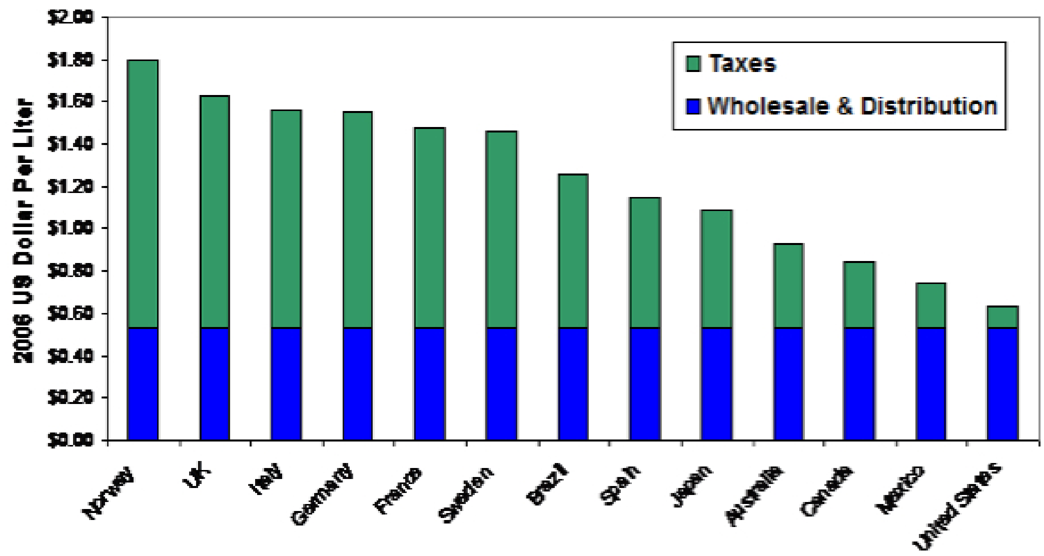

Figure 1. Vehicle Fuel Retail Prices (International Fuel Prices 2007)
Source: VTPI, Fuel Taxes: Increasing Fuel Taxes and Fees, 2011

The trend for gasoline taxes in the US has been fairly even for the past five decades (shown in Figure 2). Taxes are shown in 2004 US dollars per gallon. The total fuel costs have been rising significantly since 2003; however fuel taxes have been flat. Funds for construction of new transportation infrastructure depend highly on the taxes derived from fuel consumption in the US, and hence fuel taxes need to be in rationality with the rising need for new facilities and for operation and maintenance of existing ones. The requirement to increase fuel prices and its advantages are mentioned in the 2011 report by Victoria Transport Policy Institute (VTPI) on Fuel Taxes saying “Higher fuel prices encourage more efficient transportation and fuel conservation. For oil consuming nations, reduced fuel consumption reduces the economic costs of importing petroleum. For oil producing countries it leaves more product to export, increasing revenues and income. For all countries, reducing total vehicle mileage reduces costs such as traffic congestion, road and parking facility costs, accident and pollution costs, helps maintain a diverse transportation system (walking, cycling and public transport), and reduces sprawl."

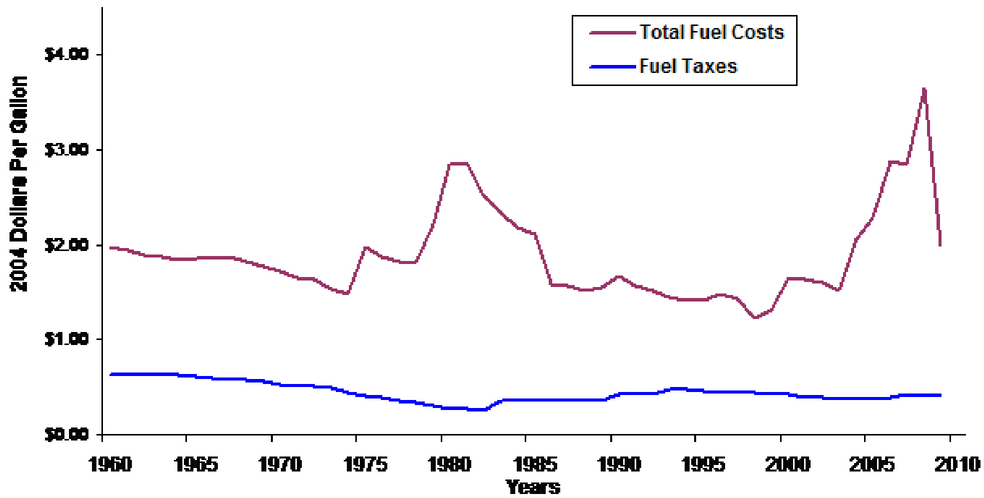

Figure 2. U.S. Fuel and Fuel Tax Cost Trends

Source: VTPI, Fuel Taxes: Increasing Fuel Taxes and Fees, 2011

Figure 3 shows the Highway Construction Price Index (HCPI) from 1956 to 2007 – illustrating the rising demand for funding of transportation infrastructure in the US. The data for the graph is published by the Bureau of Economic Analysis and shows a considerable growth in the price index from 1956 through 2007, taking the index value for 2009 to be 100. A steep increase in the HCPI is observed from 2003 to 2007, due to a rise in wages paid to the construction workers. This increase was also due to the increase in prices of materials used in highway construction. The price of petroleum rose by 21 percent, which eventually led to a rise in prices of asphalt and diesel used in construction activities. Prices of iron and steel rose 13 percent annually. Sand, gravel, cement and concrete rose by 7 percent each year, architectural and structural metal prices rose by 6 percent. The overall costs of highway and road construction increased at a pace of 10 percent annually from 2003 to 2007 compared to 2.4 percent increase in the two decades preceding 2003 (CBO, 2010).

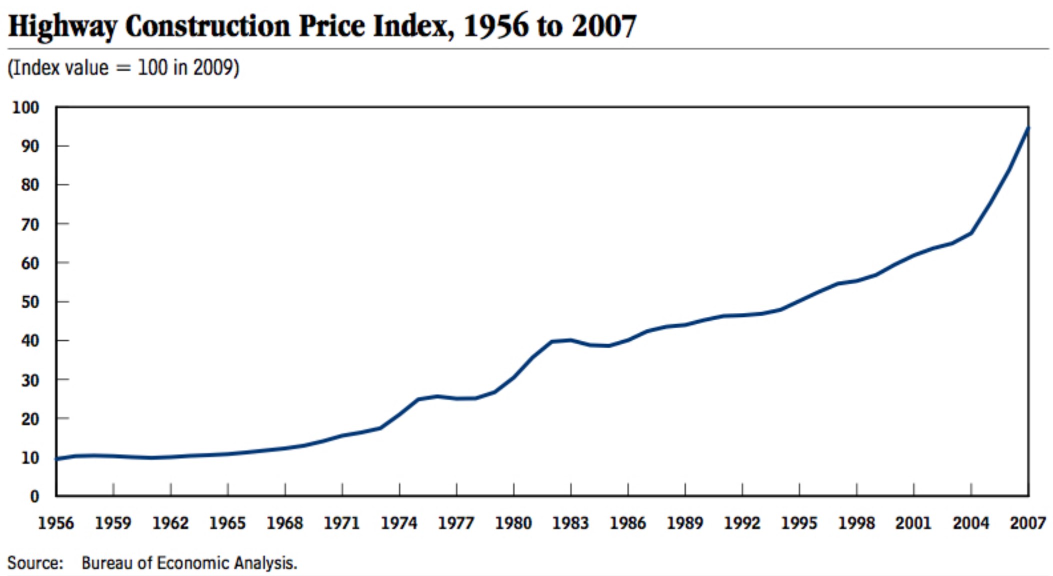

Figure 3. Highway Construction Price Index, 1956 to 2007
Source: CBO, 2010

According to the report by Robert A. Sunshine, Congressional Budget Office (CBO, October 2007), the rise in highway construction cost from 2003 to 2007 more than offsets an increase in nominal spending on these facilities with spending in constant dollar falling by an average of 1.6 percent per year. This is illustrated in Figure 4 with the trend of constant dollars and nominal dollars shown from 1956 to 2007 in billions of 2009 dollars. Figure 4 shows total public spending, comprised of expenditures by the federal, state and local governments. The total spending includes purchase, construction, rehabilitation, or improvements of physical assets and equipment. The constant dollars shown in the graph have been adjusted to reflect the effects of inflation between the year the spending occurred and the base year 2009. Spending expressed in nominal dollars is the spending without the effect of inflation.

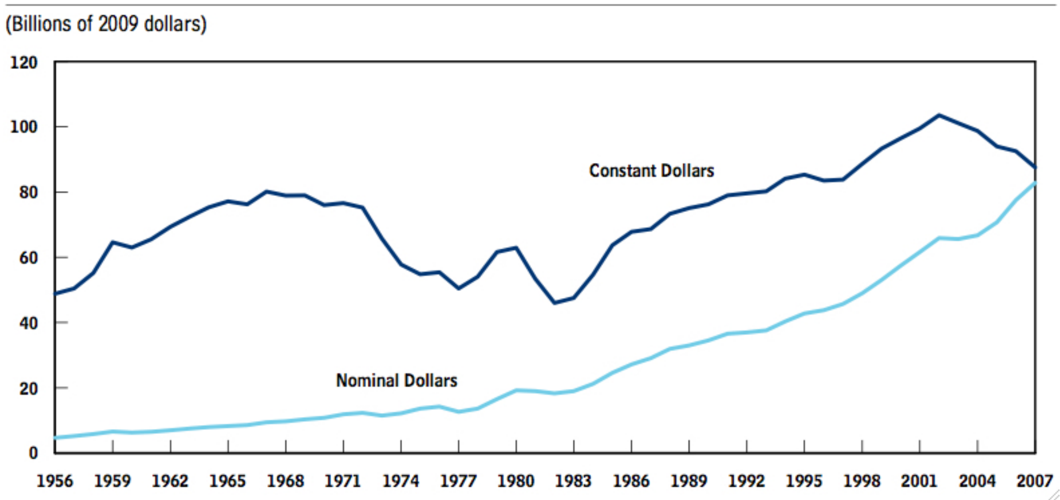

Figure 4. Total Public Spending for Highway Capital, in Constant and Nominal Dollars, 1956 to 2007
Source: Congressional Budget Office, 2010

The graph in Figure 5 shows the federal spending on highway projects from 1985 to 2000 as compared to the spending by the state and local governments. The federal spending has been fairly constant over the given period; meaning the state and local governments have been left to take the burden of required investment in the highway construction industry. The spending includes the construction of new facilities and also the operation and maintenance of the existing ones. Both categories need more financial support from the federal government. With this much unavailable, yet necessary federal funding, policymakers have reached a point where they are in search of innovative project delivery methods which are efficient in both cost and time.

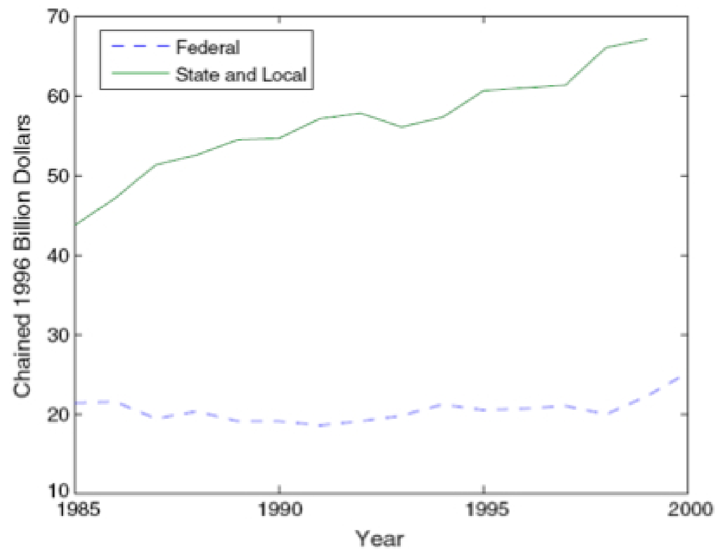

Figure 5. Spending on Highways by Federal and State & Local governments in Billions of 1996 Dollars
Source: Government Transportation Financial Statistics 2001. BTS, US DOT

A project delivery method is a process of designing and constructing a facility. "The project delivery method is the process by which a construction project is comprehensively designed and constructed for an owner—including project scope definition; organization of designers, constructors, and various consultants; sequencing of design and construction operations; execution of design and construction; and closeout and start-up. In some cases, the project delivery method may encompass operation and maintenance." (TRCP Report 131). Another definition that describes project delivery method is given by Texas Department of Transportation (DOT) "A project delivery method equates to a procurement approach and defines the relationships, roles and responsibilities of project team members and sequences of activities required to complete a project. A contracting approach is a specific procedure used under the large umbrella of a procurement method to provide techniques for bidding, managing and specifying a project" (Walewski, Gibson, and Jasper 2001).

The project delivery approach most talked about by practitioners in North America at present is the Public-Private Partnership (P3/PPP). Since 1990, several government projects have been accepted to be delivered through the P3 approach by the transportation officials because of the severe economic constraints. The key element that differentiates this delivery approach from the more traditional methods like Design-Build (DB) and Design-Bid-Build (DBB) is the Finance element. In P3s the private entity not only designs and builds the government project but also finances it. The other important difference is that the DB and the DBB projects have been operated and maintained by government-managed entities but in the P3 method, the private entity would assume the responsibility of the operation and maintenance of the project for a certain contractual period. These projects are either tolled (toll - the fees collected from the user of the road by the public or the private entity that constructed the facility), or progressive payments (progressive payments – periodic payments made to the contractor by the owner of the facility) are made to the private entity by the government.

In the last few decades, the Public-Private Partnership approach has been accepted around the globe including mature markets like Europe and Australia. In these markets, many research studies have been accomplished reporting the efficiency of P3s in the construction world as compared to the traditional delivery methods. While in North America, comparisons have been made between the Design-Bid-Build, Design-Build and other traditional delivery methods, to date no comparisons have been made on the performance of Public-Private Partnership delivery method concentrated on the transportation sector with the non-traditional delivery methods. This could be because of the limited number of completed transportation P3 projects available for study. In the past two decades, a number of transportation P3 projects have been completed through the construction phase that allowed an initial investigation on the construction performance (concentrated on Cost and Schedule) of the P3 projects. Hence this appears to be the first comprehensive study that compares the cost and schedule performance of North American highway P3 projects to the more traditional DB and DBB projects.

The Federal Highway Administration (FHWA) in the US has taken steps towards trying innovative approaches to project development and delivery as a way to expedite the delivery of much needed transportation projects. For this, FHWA developed a Special Experimental Project (SEP) programs in which the federal as well as the state transportation agencies test and then evaluate new methods of delivering the projects. The SEP-14 was established by the FHWA in 1990 with the objective of reducing life-cycle costs of projects while maintaining product quality and contractor profitability. The projects under this program included roads, highways, bridges, tunnels, Intelligent Transportation Systems, etc. that ranged from micro projects (less than $2 million) to mega projects (greater than $100 million). Under SEP-14, 282 Design-Build projects were proposed to be constructed in different states which included 19 mega projects. These 19 mega projects representing only 7 percent of the total number of projects accounted for 73 percent of the total investment in the transportation infrastructure projects which was greater than $10 billion (Design-Build Effectiveness Study, 2006 by FHWA).

To further increase private participation in public projects, FHWA initiated the SEP-15 program in which the goal was to increase project delivery flexibility, encourage innovation, attract private investment in transportation improvements, improve schedule containment of projects, and promote public-private partnerships. The key motive of the P3 delivery approach is to increase the life-cycle cost efficiency (Nossaman LLP website, 2012). Design-Build-Finance-Operate-Maintain (DBFOM) is the approach that undertakes the oversight of the project over a longer period, and shares and possibly transfers much of the risks from the Public side to the Private side. Texas, Virginia, Florida and Colorado have procured new transportation infrastructure projects that involve private investment as outlined in the SEP-15 program. Eight P3 projects worth $13 billion are under construction in the above mentioned states (ARTBA, May 2011) as shown in Figure 6. These projects include the toll roads as well as projects on availability payments from the public entity.

U.S. Transportation Concessions, 1993-2010

Notice to Proceed	Project Name	Public Sponsor	Risk	Project cost (nominal $ mill.)	Developer ($ capital/design-builder)
TF 12/07	I-495 HOT Lanes, VA	Virginia DOT	DBFOM (toll)	1,998	Transurban/Fluor ($1.4bn /Fluor–Lane)
TF 3/08	SH 130 segments 5-6, TX	Texas DOT	DBFOM (toll)	1,358	Cintra/Zachry ($968m /Ferrovial–Zachry)
TF 2/09	I-595 Managed Lanes, FL	Florida DOT	DBFOM (ap)	1,814	ACS Infrast. ($1.2bn /Dragados–EarthTech)
TF 10/09	Port of Miami Tunnel, FL	Florida DOT	DBFOM (ap)	914	Meridiam ($607m /Bouygues–Jacobs)
TF 12/09	North Tarrant Express, TX	Texas DOT	DBFOM (toll)	2,047	Cintra/Meridiam ($1.46bn /Ferrovial)
TF 6/10	I-635 LBJ Managed Lanes, TX	Texas DOT	DBFOM (toll)	2,800	Cintra/Meridiam ($2.1bn /Ferrovial Agroman)
8/10	Denver Eagle PPP Rail, CO	Denver RTD	DBFOM (ap)	2,100	Fluor/Laing/Uberior ($1.27bn /Fluor–BB)
1/11	Jordan Bridge, VA	Chesapeake, VA	BOO (toll)	100	Figg/Amer. Infra. MLP/ Lane ($100m/Lane)

Figure 6. P3 projects under construction in the US
Source: ARTBA, May 2011

In a recent article, published in the China Daily, March 2012; Zhang Yuwei reports that China, after evaluating the crumbling infrastructure of the US is considering investing into infrastructure projects in the US. This article states that about one third of the roads in the US are in poor or mediocre condition, and one fourth of the bridges are said to be either structurally deficient or functionally obsolete. Also, it states that in the annual infrastructure report of American Society of Civil Engineers (ASCE), the US transit system is rated as "D" which is a major concern for the US. The overall US infrastructure rating has fallen from 8^{th} to 16^{th} position in 2011-12 rankings in the past three years according to the World Economic Forum's economic competitiveness ranking (Figure 7). The Yuwei report also states that China's Ministry of Railways intends to spend about $300 billion on building transport systems through 2020; conversely the US Federal Railroad Administration commits $8 billion in similar projects in 2012. Experts say that US government lacks in funding and hence, Yuan Ning, president of China Construction America suggests collaborating through public-private partnership. The San Francisco-Oakland Bay Bridge is one of the examples of P3 between a Chinese private entity and the US government. The cost of the project was about $7.2 billion - having the Chinese contractor build it saved about $400 million, according to the California Department of Transportation.

	BASIC REQUIREMENTS		1. Institutions		2. Infrastructure		3. Macroeconomic environment		4. Health and primary education	
Country/Economy	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score
Turkey	64	4.61	80	3.69	51	4.39	69	4.76	75	5.62
Uganda	127	3.55	98	3.50	128	2.49	127	3.87	122	4.33
Ukraine	98	4.18	131	2.98	71	3.87	112	4.21	74	5.64
United Arab Emirates	10	5.84	22	5.21	8	5.97	11	6.14	41	6.06
United Kingdom	21	5.60	15	5.34	6	6.09	85	4.54	14	6.42
United States	36	5.21	39	4.64	16	5.68	90	4.49	42	6.05
Uruguay	43	5.04	35	4.80	49	4.46	59	4.90	47	5.98
Venezuela	125	3.62	142	2.42	117	2.72	128	3.85	84	5.48
Vietnam	76	4.41	87	3.63	90	3.59	65	4.78	73	5.66

Figure 7. Infrastructure Ranking of US in the World

Source: The Global Competitive Report 2011-12, World Economic Forum

The growing implementation of P3 approach in the highway construction industry makes it necessary to compare the cost and schedule control performance of this method to the more traditional DB and DBB method. The study objective is to bridge the gap of missing studies in North American highway construction industry on P3s and serve as a basis to future studies that could further develop the methodology for P3 cost and schedule performance.

1.2 DEFINITION OF P3, DBB & DB

Public-Private Partnership (P3) can be a term which has no specific definition attached to it. Many definitions are available by practitioners and policymakers to express the Public-Private Partnership delivery approach. Acar M. et al. define P3 as, ".. 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" (Acar M. et. al., 2008). According to E.S. Savas, "The term public-private partnership is particularly malleable as a form of privatization. It is defined broadly as an arrangement in which a government and a private entity, for-profit or nonprofit, jointly perform or undertake a traditionally public activity. It is defined as a complex relationship - often involving at least one government unit and a consortium of private firms" (Savas, 2010). These are some of the definitions that do not talk about the finance, operations or maintenance aspect of the delivery approach but only about the involvement of the private entity in the public sector projects. Indeed, as per Zarco-Jasso, there are eight different ways in which there could be a relation between the public and the private entity. The key elements associated with a project, which are control, funding and ownership could be handled by either the Private or the Public partner in the Public Private Partnership giving eight types of P3 (Zacro-Jasso, 2005). Hence, the above mentioned definitions do not lead us to a precise explanation of the P3 delivery approach.

In 1992, the Private Financing Initiative (PFI) program was introduced in the United Kingdom with the vision of encouraging public-private partnership in the UK. PFI was designed to increase private sector involvement in the provision of public services. The report by Grahame Allen, The Private Finance Initiative, describes the most common form of PFI in which the private sector designs, builds, finances and operates (DBFO) facilities based on output specifications decided by the public sector (Allen, 2001).

The US DOT report on P3s defines them as “a public-private partnership is a contractual agreement formed between public and private sector partners, which allows more private sector participation than is traditional. The agreements usually involve a government agency contracting with a private company to renovate, construct, operate, maintain, and/or manage a facility or system. While the public sector usually retains ownership in the facility or system, the private party will be given additional decision rights in determining how the project or task will be completed” (USDOT, 2007). A report from the General Accounting Office states that “P3 is a contractual arrangement between public and private-sector entities, typically involving a government agency contracting with a business or non-profit entity in order to renovate, construct, operate, maintain, and/or manage a facility or system, in whole or in part, that provides a public service” (GAO, 1999). The two definitions above also mention that these agreements allow the private entity to invest a substantial amount in the project, helping the public entity to gain a different source of revenue and labor without making a substantial capital investment. This arrangement impacts positively the project delivery schedules, especially with the use of improved technological and managerial resources.

“Public–Private Partnerships allow private companies to build, own and operate public projects such as schools and hospitals on behalf of the public sector. P3 contracts commonly require the private agent to take responsibilities for the performance of the asset over a long term, at least for a significant part of its useful life, so that efficiencies arising from long- term investment and asset management can be realized" (Nisar, 2007). Also, according to Frédéric Blanc-Brude et al., public–private partnerships are defined as "infrastructure projects procured under DBFO/M-type contracts that bundle Design, Build, Finance and Operation/Maintenance" (Blanc-Brude et. al., 2009). The National PPP forum in Australia defines P3 as "a contracting arrangement in which a private party, normally a consortium structured around a Special Purpose Vehicle (SPV), takes responsibility for financing and long term maintenance or operation of a facility to provide long term service outcomes. This may involve the private entity taking responsibility for the design and construction of a component of new infrastructure; and/or taking over a long-term lease or concession over existing assets; and/or the development of a new long- term contract to operate and manage the infrastructure. Typical forms of procurement include: Design, Build, Finance and Operate/Maintain (DBFO/M), Build-Own-Operate and Transfer (BOOT) or Build-Own-Operate (BOO)" (National PPP Forum, 2008). These definitions of P3 take into account all five aspects of the delivery of a project - Design, Build, Finance, Operation and/or Maintenance - which is the P3 model that is considered in this study.

In the Design-Bid-Build method the owner procures the design and the construction of the project through different entities. The construction phase of the project is not initiated until the design is completely ready. A descriptive definition is given in the TRCP Report 131 characterizing DBB as a method in which "an owner retains a designer to furnish complete design services and then advertises and awards a separate construction contract that is based on the designer's completed construction documents. The owner is responsible for the details of design and warrants the quality of the construction design documents to the construction contractor" (TCRP 131, 2009). In theory, DBB method has various advantages compared to other delivery methods (Kay, 2009 & Beard et. al., 2001):

- It encourages competition amongst bidders and after the design is complete for the contractors to bid.
- The design firm is obligated to protect the long-term interests of the client.
- Being an age old delivery method, most of the public entities have established their rules and guidelines for permits and use and hence DBB does not have to deal with many legal or political issues.
- The contractors could come up with good cost estimates as they have access to the complete design of the project.

On the other hand, disadvantages associated to DBB delivery method are (Kay, 2009 & Beard et. al., 2001):

- The public sector retains all the risks of design defects and design changes and not the contractor.
- The restriction of activities to be performed sequentially increases the project duration considerably.
- Since the owner is carrying the major risk in the project, he has to identify the inadequacies in the work performed by the contractors as well as the subcontractors.

The contractual flowchart for DBB project is as shown in Figure 8.

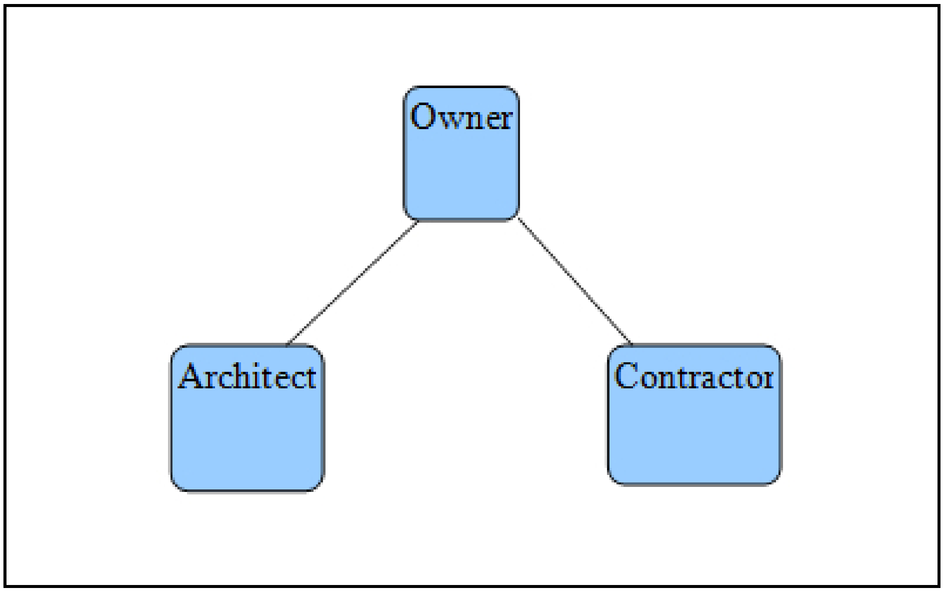

Figure 8. Contractual Flowchart for DBB projects

In the Design-Build method, the owner gives the responsibility of the design and construction to a single entity in which the project enters the construction phase after a certain percentage completion of the project. TRCP Report 131 defines DB method in three major steps: “First, the owner develops an RFQ/RFP that describes essential project requirements in performance terms. Second, proposals are evaluated. Finally, with evaluation complete, the owner must engage in some process that leads to contract award for both design and construction services” (TCRP 131, 2009). The key advantages associated with DB delivery approach are (Kay, 2009 & Beard et. al., 2001):

- The designer and the owner are involved at a very early stage of a project with almost the same starting point which leaves little room for potential discrepancies between them.

- For many projects the construction stage starts sooner, often times after thirty percent of the design had been completed, which saves time and construction inflation costs.

- The designer and contractor working together at an early stage of the project, have opportunities for innovation and value engineering.

The disadvantages of the DB delivery method are (Kay, 2009 & Beard et. al., 2001):

- The qualification criteria to bid for a DB project do not allow many firms to participate and hence does not encourage as much competition. Also, the smaller firms can be left out of the competition as the larger design and construction firms take the lead, having resource departments that strictly deal with DB projects.

- The contract between the public and private entity has to be scrutinized in-depth to avoid issues in the future. This is an intense negotiation period which could last for several months, where potential risks are carefully studied by each entity. Hence, a lot of time is invested before the commencement of construction which is not the case in DBBs.

- The contractor in some cases could dominate the contracted design firm and influence the design according to its own convenience, while the owner would not have much of a say once the contract is signed. Hence, this potential risk should be addressed in the contract.

The contractual flowchart for DB delivery method is shown in Figure 9.

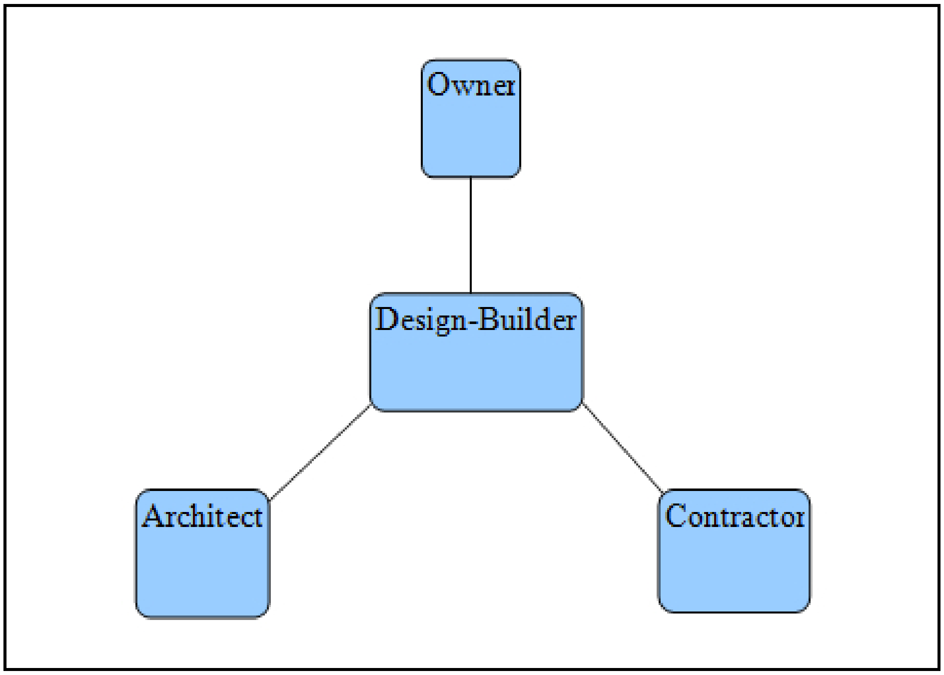

Figure 9. Contractual Flowchart for DB projects

The key benefit of DB over DBB is the integration of design and construction during the project development lifecycle. In the case of DBB projects, they are separated. The DB approach allows parallel processing of activities, while DBB keeps the process sequential. As given in the Design-Build Effectiveness Study of FHWA in 2007, the difference in the sequencing of activities involved in the two delivery methods are shown with a simple figure (Figure 10). The overlap of the *Final Design and Project Clearances* phase with the *Construction* phase saves a significant amount of time in the DB process, while considerable time is lost in the selection of a Design firm and later again during the selection of the contractor to construct the facility.

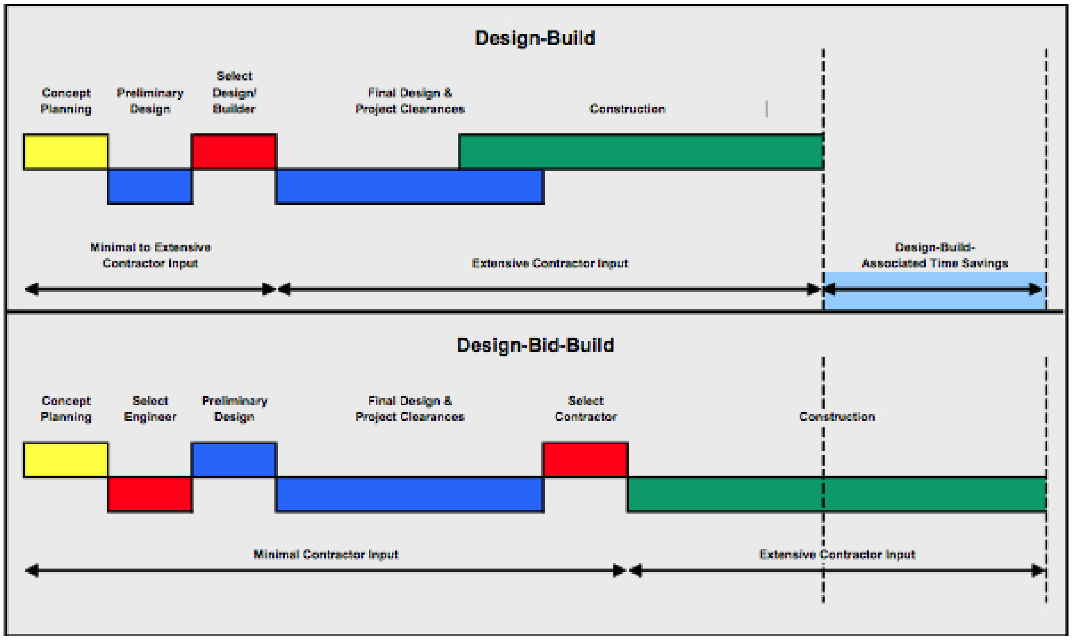

Figure 10. Workflow in DB and DBB projects

Source: USDOT, FHWA, Design-Build Effectiveness Study, 2006

1.3 PROBLEM STATEMENT

Policymakers in the North America are in search of a delivery method for the transportation infrastructure industry that would make the construction and maintenance of these structures more efficient in cost, time and quality. The issue is most critical with large highway projects which require large amounts of time and money yet have to deal with limited availability of resources.

Delivery methods like Design-Build and Design-Bid-Build are traditional delivery methods that have been popular in North America for decades and many studies have been conducted comparing the performance of DB versus the DBB method as mentioned further in this study.

On the other hand, Public-Private Partnership delivery method is gaining attention as it serves as an alternative technological, methodological and funding source for a public project from a private source. This long-term delivery method needs to be assessed for its performance and efficiency in cost and time, compared to the Traditional delivery methods like DB and DBB.

1.4 RESEARCH OBJECTIVE

The objective of this research is to assist practitioners determine the level of performance and efficiency of the Public-Private Partnership delivery approach. The P3 model considered in this research includes all five elements of delivery – Design, Build, Finance, Operation and Maintenance. The parameters for studying the performance of the delivery approach are chosen as cost and schedule of Construction portion of selected projects from an exhaustive list of highway DBFOM projects. Inference will be made on the cost and schedule performance of Public-Private Partnership approach as compared to the Design-Build and Design-Bid-Build delivery methods.

1.5 RESEARCH LIMITATIONS AND SCOPE

This research has its criteria for selection of completed projects which allows it to have the sample of Public-Private Partnership projects accomplished between 1990 and 2010 in the North American continent which are greater than $90 million. The sample of projects does not include projects using DBFO or DBOM delivery approach or any project that at any stage was funded by a public entity. This research is based on DBFOM model of Public-Private Partnership. This study focuses only on highway projects with roads and bridges and not projects involving significant tunnels, as tunnels involve a different level of complications and engineering and can affect the overall cost and schedule estimation in a dramatic way.

The study concentrates only on the construction aspect of the DBFOM delivery approach because there are not enough projects available at present to analyze the Operation and Maintenance portions of the P3 delivery approach. Also, the data collected in this research is primarily gathered from Public agencies and other publicly available sources. As with other similar studies, the private sector is reluctant to share information and requested data that might provide insight into their operations.

CHAPTER 2: LITERATURE REVIEW

Thorough review was done on the studies accomplished in the US that compare the cost and schedule performance of completed DB and DBB projects in the US. The studies similar to the criteria for selection of projects as used in this research were selected. Various reports are available in the US giving definitions of P3s and information on its advantages and disadvantages as compared to the Traditional delivery approach which are included in this literature review giving an insight on the apprehensions and view of public and private entities about P3s. Also, studies comparing the cost and schedule performance of P3s with the DB and DBB methods in other mature markets such as Europe and Australia were also reviewed.

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

Four previous studies were found relevant to this research, comparing DBB and DB delivery methods in North American highway construction industry. These are the studies that provide a statistical comparison of cost and schedule performance of DB and DBB projects. The Warne study and Shrestha study have the sample of projects that match the criteria outlined for this P3 study. The FHWA and the Gransberg study compare that could compare the performance of small scale DB and DBB projects. The FHWA study projects are less than $20 million and Gransberg projects fall under $10 million in final construction cost.

The most extensive performance assessment of DB highway projects was completed by Tom Warne and Associates in 2005. However, in this study they did not compare any completed DBB projects with the DB projects. They reviewed 21 projects across the US that ranged in size from US$83 million to US$1,300 million and were constructed between 1990 and 2005. The four aspects that were studied for each of the projects were schedule, cost, quality and owner satisfaction. The study collected data on the 21 projects and then asked the project managers hypothetical questions: for example, “Provide an estimate of how much time the project would have taken if the DBB project delivery process had been followed in place of the DB approach”. The answer was a professional estimate, but no direct comparisons could be made between the DB and DBB projects. The Schedule analysis showed that thirteen out of the twenty one DB projects indicated that schedule was the principle reason behind selecting DB as the project’s delivery method. The results showed that a hundred percent of the selected projects were built faster with the DB method than they would have been with the DBB method, and seventy six percent of the projects were finished ahead of schedule. One of the key findings of the study by Warne was that DB offers greater price certainty and reduced cost growth than DBB. Also, the cost growth for these projects ranged from zero percent growth to twelve percent growth with an average cost growth of less than four percent. Seven out of the twenty one DB projects were partially funded using toll revenues because of the lack of financing available upfront to initiate the project (Warne, 2005).

Shrestha in 2007 compared the performance of four DB and four DBB highway projects. The DB projects were selected from across the US, while the DBB projects were selected from Texas. The author tried to select the comparable

DB projects from Texas. However, only two would match. The shortlisted four DB and four DBB projects had construction completion dates between 2000 and 2006, and involved construction of roadways with design and construction cost greater than US$100 million. The two Texas DB projects identified were under construction; hence various out-of state FHWA DB projects approved under SEP-14 were selected. The design and construction cost of these 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 DB projects chosen were the most similar to the SH 130 in Texas (the largest DB project of Texas) but could not be included in the study because it was under construction. Sixteen project characteristics were studied for various DB projects and a sample of four DB projects was selected. The sample projects were comparable to the chosen DBB projects from Texas and were also similar to SH 130 of Texas. The average percentage cost change for DB and DBB projects was reported as 1.49 percent and 12.71 percent, while the average percentage schedule change was found to be 11.04 percent and 4.34 percent for DBs and DBBs respectively. Due to unavailability of complete data about the DBB projects, only schedule growth, cost growth and change order cost factor were considered for the statistical analysis in this study. The projects in Srestha's study are comparable with the criteria for this study on P3 projects, allowing a comparison of DBB, DB, and P3 project delivery (Shrestha, 2007).

The FHWA completed a study in 2006 on the effectiveness of the Special Experimental Projects No. 14 (SEP-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). This study obtained data on 11 pairs of DB and DBB projects regarding cost and schedule growth. All costs for all projects were less than US$20 million — much smaller than this study's target projects. The average percentage change in planned versus Actual Total Project Duration for DB projects was found as -4.2 percent while for DBB projects was 4.8 percent. The average percentage change in planned versus actual construction phase duration for DB project was found as -1.2 percent and for DBB projects was 11.6 percent. The average percentage change from the Award project cost to the Final project cost for DB projects was found as 6.0 percent while for DBB projects was found to be 4.3 percent. And, the average change in the construction cost for DB projects was found as 8.1 percent while for DBB projects was found as 4.3 percent. The leading reason for the increase in project costs was the change orders which were due to the requests for additions or subtractions made by the owner, while the second main reason was the changes suggested by the design-builder or contractor (FHWA, 2006).

Gransberg et al. in 2000 compared the cost and schedule performance of several alternate delivery method projects from Florida DOT, Indiana DOT and Texas DOT. A total of 280 DBB projects were studied - with an average of 3.93 percent increase in cost from the original contract amount and 28.25 percent increase in schedule from the original completion date. Gransberg's study included 21 DBB and 11 DB projects, completed by the Florida Department of Transportation, with an average cost of $8,829,271 for the 21 DBB projects and

$2,771,715 for the 11 DB projects. Although all the projects were under US$10 million, much smaller than this study target projects, DB still showed improvement of both cost and schedule growth over DBB. The average percentage cost growth and time growth for the 21 DBB projects by FDOT was reported as 10.64 percent and 33.50 percent respectively - greater when compared to the 11 DB projects by the FDOT where the average cost growth was reported as -1.99 percent and average schedule growth was -35.70 percent. The time growth performance for DB and DBB projects are shown polar opposite in this study and the difference is an enormous 69.2 percent in total. This study shows that the DB performance for projects under $10 million is very good and it saves delivery time to a large extent over the traditional delivery methods (Gransberg, 2000).

Table 1. Research Summary of Design-Build versus Design-Bid-Build

Research Study	**Research Abstract**	**Delivery Method**	**Percent Cost Change**	**Percent Schedule Change**
Warne	21 DB projects across the US with the individual project costs greater than US$83 million	DB	4	−11
Shrestha	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	11 pairs of DBB and DB projects Cost of individual projects under US$20 million	DB	6.0	−4.2
		DBB	4.3	4.8
Gransberg	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

Of all the studies mentioned above, the Warne study shows the cost and schedule performance of DB projects; but only the Shrestha study has DB and DBB projects that match to the size and other criteria of the projects studied in this research on P3s.

2.2 P3 STUDIES IN NORTH AMERICA

A number of P3 studies have been conducted in North America but none shows the performance (cost and schedule containment) of North American transportation P3 projects.

In 2007 a report that focused on P3 applications to transportation projects in the US was prepared by AECOM for the Office of Policy & Government Affairs, FHWA. This report mentions that the comprehensive evaluation of completed P3 projects is often restricted or incomplete due to the commercial and political nature of P3 arrangements (FHWA, 2007). It also states that the personnel associated with the projects disperse as soon as their role finishes in the delivery method and limits the amount of information that could have been derived from these personnel if they were available. It has always been difficult to reach the private sector for information and even if contacts were successful, many were reluctant to answer questions regarding issues that arose during the project and the means and ways to overcome them. On the other hand, the public sector was willing to share the information and answered all questions asked. International transportation P3 projects that were included in this study were from England, Australia, China, Denmark, Sweden, India, Israel, and Argentina. A majority of the P3 projects which were planned and funded since 1985 were road projects which accounted for 37 percent of the total investment in various sectors such as rail, road, airport, seaport, water and buildings. P3s have been more widespread overseas highway, with concessions and Build-Own-Transfer/Build-Transfer-Operate being the forms of P3 approaches that were used. The report states that over the last 20 years Europe has the largest P3 infrastructure in terms of cost for road and rail projects; Asia being second and North America being third. This report by FHWA indicates that all the projects that have a private entity involved in its delivery approach comes under the umbrella of P3, be it DB or DBOM or DBFO or concession.

Another study on ‘The Role of Private Investment in Meeting U.S. Transportation Infrastructure Needs’ was published in May 2011 by The American Road and Transportation Builders Association (ARTBA). It gives an overview of the P3 projects in the US. The definition of P3 in the ARTBA study includes the DB delivery method as a P3 delivery approach. According to this study, in the past 22 years $54.3 billion of transportation P3 projects have been let. Out of this $54.3 billion, 79 projects (accounting for $31.5 billion) were either Design-Build (DB), Design-Build-Finance (DBF) or Design-Build-Operate-Maintain (DBOM) contracts. Eleven transportation P3 projects worth of $12.4 billion are let by the Design-Build-Finance-Operate-Maintain (DBFOM) contract or as concession agreements. The authors were in support of the P3 delivery approach and provided recommendations for increasing private investment in the needed U.S. transportation infrastructure. Suggestions include: 1) The USDOT to develop a “National Strategic Transportation Business Plan” for expansion of existing facilities and reconstruction of aging infrastructure. 2) To support private investors by asking to enhance the Transportation Infrastructure Finance and Innovation Act (TIFIA) and Private Activity Bond (PAB) tools. 3) To attract Pension Funds from insurance companies and others. 4) Education of the Public side is needed so that appropriate projects are delivered with the private financing toolbox without hindrance 5) Ease of federal restrictions is needed. Federal law has four pilot programs to allow tolls on interstate mileage for specific purposes. The restrictions should be relaxed and allow this tolling and pricing program to be applied in all the states (ARTBA, 2011).

In July 2011 the Office of Inspector General (OIG) report by the FHWA gave the financial analysis of P3 transportation projects. The objectives of the report were to identify the disadvantages of P3 as well as the financial value of the P3s to the public as compared to the traditional delivery methods, and to assess the extent to which P3s can bridge the infrastructure funding gap of $138 billion for 2008-2035 (Figures from the National Surface Transportation Infrastructure Financing Commission, 2009). The key disadvantage for the P3s according to the study was the higher cost of capital - because of the taxes on private money for P3s as compared to the public debt which is tax free. P3s incorporate equity financing which generally has very high interest rates. Additionally, the private entity has to pay federal, state and local taxes; which is exempt in the case of public debt. The efficiency in the operation and maintenance portion of the delivery does not contribute much to the magnitude of cost disadvantages. The disadvantages with the P3 financing can be overcome with the help of innovative, less costly financing programs like TIFIA and PABs, and with more flexible sources of capital. The report also states that P3s change the timing of funding by providing the funds for the project upfront but does not reduce the amount of the funds required. Every project is different in risk allocation and expediency of project delivery and hence, decision of the project delivery method should be made on a case by case basis by identifying specific project requirements and in-depth project analysis (OIG, 2011).

The National Conference of State Legislatures (NCSL) published a report on P3s for Transportation in 2010 which would act as a toolkit for the legislators considering P3 project delivery. This report indicates that P3 projects differ based on mission (the focus of the project) and on method (the project delivery model) and source of financing. The project could be a brownfield project (operation, maintenance or improvement of existing infrastructure), or, a greenfield project (development of new facility), or, it could be a combination of greenfield and brownfield project, (an addition of a new toll lane onto an existing facility). The NCSCL study provided a number of models for the P3 delivery method. This includes Design-Build (DB), Design-Build-Operate-Maintain (DBOM), Design-Build-Finance (DBF), Design-Build-Finance-Operate (DBFO), Design-Build-Finance-Operate-Maintain (DBFOM). The private entity could assume any of the roles in a P3 delivery, be it design, build, operate, maintain or finance, or even ownership for a limited term. This interpretation of P3 by NCSL is different from the one used in this study which defines DBFOM model as the P3 model for study. The other characteristic of a P3 mentioned is the source of financing which unlike this study could be from any private or public or a combination of both the entities rather than being from the private entity only. After having studied the P3 delivery approach, the NCSL come up with nine principles to be implemented and decision makers to come up with sound decisions (Figure 11). P3s should be analyzed in a broader perspective, looking out for long term public interest and should be considered as a support to the state's transportation mission and not just as a source of revenue. A comparison with the traditional approach to determine the best option for delivering the project, clarity in financial issues and transparency in procurement process were principles mentioned in the NCSL report for improving the P3 delivery approach (NCSL, 2010).

Principles for State Legislators

Principle 1: Be informed.
State decision makers need access to fact-based information that supports sound decisions.

Principle 2: Separate the debates.
Debates about the PPP approach should be distinct from issues such as tolling, taxes or specific deals.

Principle 3: Consider the public interest for all stakeholders.
State legislators will want to consider how to protect the public interest throughout the PPP process.

Principle 4: Involve and educate stakeholders.
Stakeholder involvement helps protect the public interest, gain support and mitigate political risk.

Principle 5: Take a long-term perspective.
State legislators will want to approach PPP decisions with the long-term impacts in mind.

Principle 6: Let the transportation program drive PPP projects—not the other way around.
PPPs should be pursued to support a state's transportation strategy, not just to raise revenue.

Principle 7: Support comprehensive project analyses.
Before pursuing a PPP, it should be shown to be a better option than traditional project delivery.

Principle 8: Be clear about the financial issues.
States will want to carefully assess financial goals, an asset's value and how to spend any proceeds.

Principle 9: Set good ground rules for bidding and negotiations.
Legislation should promote fairness, clarity and transparency in the procurement process.

Figure 11. Principles For State Legislators for successful P3
Source: NCSL, 2010

The Congressional Budget Office (CBO) in January 2012 reported that public-private partnerships have built highways slightly less expensive and slightly faster when compared to the traditional procurement approach. This report explains that most of the financial risks are handled by the public entity in the traditional approach (DBB). The funding for these highway projects is primarily allocated from taxes on fuel (18.3 percent per gallon for gasoline and 24.3 percent per gallon for diesel) by the federal government. Also, taxes from truck tires and heavy motor vehicles (>55,000 pounds) are a source of funding to the Highway Trust Fund. These funds have not been sufficient to support the construction of new infrastructure and the maintenance of existing facilities. This federal funding is allocated to the states for construction of highway projects on a matching rate as dictated in the Federal-Aid Highway Program. State revenues for highway projects are primarily collected from the gasoline taxes which range from 8 cents per gallon in Alaska to 50 cents per gallon in California with an average of 31 cents per gallon for states and localities (American Petroleum Institute, May 2011). Vehicle license fees, highway tolls and other taxes such as driver's license fees are also collected by certain states to pay for highway projects. These sources of funds are still not enough to provide for the financial needs in the highway construction industry.

The delivery approach that encompasses the broadest set of private roles is the Design-Build-Finance-Operate-Maintain method. Ten such projects have been let in the US between 1989 and 2011 where the private entity is responsible for building, financing and also operating and maintaining the facility for a long term as contracted with the public entity. These 10 North American P3 projects cost a total of $12.7 billion (2010 dollars) while P3 has been applied as a delivery method for projects of approximately $653 billion (excluding projects in US) of which $327 billion projects were road projects (Public Works Financing, Oct 2010). The CBO report states that there is a scarcity of studies on the performance of P3s in North America and it has commented on the performance of P3s based on those limited studies. The report concludes that for a successful P3 implementation "… the government involved must design, implement, and monitor contracts that allocate risk and control between the public and private partners" (CBO, 2012).

The Conference Board of Canada (CB of Canada) in Jan 2010 assessed the performance of major P3 projects that reached financial closure between early 1990s and 2004, a period regarded as the first wave of P3s in Canada. The important lesson learned from the first wave of P3 projects in Canada was the off-balance-sheet treatment of public sector liabilities which reduced transparency of public sector accounts. The revenue risk for most of the projects was completely transferred to the private sector which was not really tackled well by the private sector as it could not influence the flow of traffic to a great extent. Consequently this risk was realized and shared before the second wave of P3 projects. In some of the P3 projects, the financial risks associated with the projects were not fully transferred to the private consortium for which the public sector owners incurred higher costs of private financing without arguably enjoying its full benefits. The key findings on the P3 projects under consideration in this study were based on a thorough review of the literature and publicly available data on those projects, number of interviews with P3 practitioners from public as well as private sector and gathering data on key points in the procurement process. Nineteen projects of the 55 P3 projects studied had reached substantial completion. The data collected for those 19 projects showed that only two projects out of the 19 were late, up to two months, in delivery. The other 17 projects were delivered either ahead or on schedule, while all the 19 projects were accomplished within the stipulated public sector budget. These benefits of cost and time savings are associated with additional costs like the costs of transferring selected risks to the private partner, higher costs of private financing and higher transaction costs. Only 12 projects have already entered their operational stage and it is, therefore, too early to comment on the operational performance of P3 projects (CB of Canada, 2010).

2.3 P3 STUDIES IN EUROPE AND AUSTRALIA

The Public-Private Partnership delivery method has been adopted by policymakers around the globe with Europe and Australia among the mature markets for P3 projects. Following is an overview of the research relevant to the study of cost and schedule comparison of transportation projects delivered through P3 and the traditional delivery method in these mature markets.

As Flyvbjerg et. al. mentioned in their 2002 report, the difference between geographical areas in terms of cost development is highly significant ($p<0.001$) and geography matters for cost escalation. They collected data for 258 transportation projects (rail, fixed-link and road) around the globe and studied the inaccuracies in cost estimates. They reported that the average cost escalation for the road projects was less when compared to rail or fixed-link projects worldwide. They considered 167 road projects, 58 rail projects and 33 fixed-link projects in this study. Out of the 167 road projects in their study, they reported the cost escalation for 143 road projects in Europe to be 22.4 percent on average, and 8.4 percent for twenty four (24) North American road projects. This indicates that it is necessary to develop statistics on performance of delivery methods to determine their efficiency and their credibility when applying them to future projects. It was found that in nine out of ten transportation infrastructure projects, cost was underestimated. Also, in this study they explained that the reason for cost escalation for these projects was not because of technical deficiencies, inadequate data or lack of expertise, as cost underestimation has not decreased over the past 70 years. They concluded in their research that cost underestimation could be best explained by strategic misinterpretation, i.e., lying (Flyvbjerg et. al., 2002).

In 2003, the National Audit Office (NAO) of UK did a construction performance assessment for twenty five hospitals, seven prisons, nine roads and other departmental office accommodations and training facilities. The parameters chosen for assessment in this study were price containment, timing of construction delivery and quality of design and construction for projects which were due to be completed by summer, 2002. According to the NAO study only 22 percent of the thirty seven Private Finance Initiative (PFI) projects exceeded the price agreed in the contract and only 24 percent of those projects were delivered late to the public sector. This is in contrast to a 1999 UK Government study on non-PFI projects that indicated only 30 percent of non-PFI projects were delivered on time and only 27 percent were completed within budget. In only eight percent of the projects, i.e. three projects, there was delay of more than 2 months, and six projects were delayed by two months or less. In this sample of projects, all seven of the road projects were reported to be completed ahead of schedule. It was also mentioned that the increase in the PFI prices was due to changes that the government made in some of the specifications after the bidding was complete (NAO, 2003).

A study completed by the European Investment Bank (EIB) in 2009 examined a sample of 66 P3 operational projects in Europe. Most of the projects in this study were from the United Kingdom, Spain and Portugal. The methodology in this study comprised of three key elements: (1) an analysis of the performance of the EIB P3 projects, (2) a literature review by other entities that have expressed their experiences with P3s and (3) interviews with their own staff to describe the lessons they learned from their P3 exposure. The sample of 66 operational projects consisted of 41 P3 road projects. Actual and expected cost data was gathered for 51 projects and it was reported that 85 percent of the 51 projects were delivered within or under budget. Schedule performance information was available for 48 projects from the sample of 66 projects and it was reported that 63 percent of the P3 projects were delivered either on time or ahead of schedule. Seventeen percent of the 48 projects had minor delays of up to one month (EIB, 2009).

The Allen Consulting Group along with the University of Melbourne did a study that was one of its kinds in Australia in 2007, comparing the cost and schedule performance of P3 and traditional projects in that country. Twenty one P3 projects were compared with 34 traditionally built projects and the information collected for this study was public information. These projects were all undertaken around the year of 2000 with matching levels of complexity and were either fully completed or largely completed. The 21 P3 projects were AUD$4.9 billion in total and the net cost overrun was reported as AUD$58 million while the 33 traditionally procured projects were AUD$4.5 billion and the net cost overrun amounted to AUD$673 million. The cost overrun for traditional projects was reported as 14.8 percent while that for the P3s was reported as 1.2 percent. The raw data on schedule-overrun for Traditional projects was reported to be 17.6 percent, better than the P3 projects which was 24.3 percent. However, on a value-weighted basis (between the signing of the final contract and project completion), traditional projects were likely to be 23.5 percent behind schedule while P3s were found to be 3.4 percent ahead of schedule. Also, construction timeliness and contractual cost adherence was studied at three key stages of completion for the projects in the sample. This sample of 21 P3s consisted of seven P3 transportation projects and 16 traditionally constructed transportation projects out of 33 traditional procurement projects.

The National PPP forum of Australia in 2008 undertook a study on the PPP cost and schedule performance for projects greater than $20 million which were initiated after January 1, 2000. The total P3 projects in this study were 25 and traditional projects were 42 making a total of 67 projects which were from different categories including 32 social infrastructure projects, 23 transportation projects, eight sustainability (water, energy and waste) projects and four Information Technology projects. The 23 transportation projects consisted of four P3 and 19 Traditional projects. The average cost overrun for Traditional projects from all categories was found out to be 52 percent, while for the P3 projects the cost overrun was 23.8 percent. Hence, comparing the estimated cost to the final cost of the project, P3s perform 28.3 percent better than the Traditional projects. Also, 16.7 percent more P3s were completed per the cost estimate when compared to traditional projects. The average time overrun for traditional projects was reported as 15.4 percent and for P3 projects it was 17.4 percent. The figures on schedule performance of P3s and traditional projects in this study showed that these projects were delivered with the same confidence in the overall time performance. These results of time and cost overruns in this study which are completely different from the results on P3 performance in other studies from other region also support the statement in the 2003 Flyvbjerg study that commented on the geographical conditions playing an important role in determining the project performance. In addition, the Australian traditional projects have better cost performance with 43.3 percent of those completed within five percent of the expected cost compared to a mere 27 percent of the UK Traditional projects as reported by NAO in 2003 (National PPP Forum, 2008).

The above mentioned studies are the only ones with a portion devoted to transportation P3 project performance. None of the studies seem to focus on cost and schedule performance of large scale (greater than $100 million) highway projects. This study paves the way towards increased research in this area when more data is made available for a better indication on cost and schedule performance of P3.

Also, other studies have reported cost and schedule performance of P3s in infrastructure projects, though not specifically for the transportation sector, which demonstrates the general efficiency of the P3 delivery method. These studies have been mentioned in brief below. The Her Majesty’s (HM) Treasury study in 2003 took a sample of 37 completed PFI projects with capital values below £20 million.

The study reported that there was a considerable difference between the construction and operational performance of larger projects when compared to smaller projects. The larger projects had a better performance than the smaller projects with the reason that the smaller projects would also have to bear the same costs of third-party finance, legal and technical advisors as the much larger projects. On the whole, 88 percent of the PFI projects considered in the HM Treasury study were delivered on time or ahead of schedule while only eight percent of the PFI projects were delayed by more than two months. The track record of the conventional government infrastructure projects has not been so impressive with 70 percent of the non-PFI projects delivered late as reported in the NAO study of Modernising Construction in 2001. The cost performance of PFI projects was equally good as only one-fifth of the projects from the HM Treasury sample experienced changes in the unitary charge which were due to changes initiated by the public sector client (HM Treasury, 2003).

The NAO study on PFI projects in October 2009 is an extension to the report published by NAO in 2003 on the PFI performance. This report considers projects completed between 2003 and 2008 with a capital cost over £20 million that were constructed in England. Questionnaires were prepared for 153 projects to be surveyed out of which 114 completed the questionnaire. The 114 PFI projects studied in this research were from various sectors but not a single project was a road project. It was reported that out of 114 PFI projects 69 percent of the projects were delivered on time which is a reduction of seven percent from the data obtained in the NAO 2003 study. As mentioned before, this study had no road projects in the sample of 114 PFI projects and the significant change of 7 percent is partially due to that. Data on cost performance was gathered for 91 PFI projects and it was found that 64 percent of the projects were delivered per the contracted price. Also, it was reported that 94 percent of the projects were delivered with, or less than, five percent cost overrun and the remaining six percent reported price increases of five percent and more. The report also gave performance data for Non-PFI projects with capital value greater than £20 million completed within the period 2003 to 2008. A population of 225 Non-PFI projects was shortlisted for survey but only 22 percent of the total population responded to the questionnaires. The survey report indicates that 63 percent of these Non-PFI projects were delivered on time and 54 percent of the projects were delivered within the contracted price.

2.4 GAPS IN LITERATURE AND SUMMARY

Comparison studies have been accomplished on large-scale DB and DBB projects in North America such as the Warne (2005) and the Shrestha (2007) study and also on small scale DB and DBB projects like the FHWA (2006) and the Gransberg (2000) study. The studies mentioned above do not give a comparison of the P3 delivery method with the traditional delivery methods. Studies have been successfully completed in Europe and Australia which give a comparison of P3s with the DBs and DBBs and similar studies are required in North America which could fill in this gap in the North American highway construction industry.

CHAPTER 3 : METHODOLOGY

In this study, the following key steps were followed to compare the Public Private Partnership delivery method to the Traditional delivery methods of Design-Bid-Build and Design-Build:

1. Literature review of previous studies on 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

3.1 LITERATURE REVIEW OF PREVIOUS STUDIES ON DBB AND DB HIGHWAY PROJECTS

In depth literature review was done to identify previously conducted studies that were relevant to this study. A couple of studies have been accomplished in the North American highway construction industry analyzing the performance of Design-Build and Design-Bid-Build delivery methods. The studies concentrated on Cost and Schedule performance of the projects accomplished through these delivery methods. These studies will act as the benchmark to compare the traditional delivery methods with the Public-Private Partnership approach.

3.2 DEVELOPMENT OF INPUT AND OUTPUT METRICS

This research is focused on two performance parameters of the project delivery approaches - Cost and Schedule. This will determine the project performance for transportation projects regarding cost and schedule adherence, and the two key metrics used are cost change and schedule change.

3.2.1 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.

$$\text{Percent cost change} = \frac{(\text{Actual project cost} - \text{Estimated project cost}) \times 100}{\text{Estimated project cost}}$$

Percent cost change of:

- zero indicates that the project was delivered at the same cost as estimated,
- less than zero indicates that cost-savings have been made,
- greater than zero indicates a cost-overrun from the estimated cost.

3.2.2 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.

$$\text{Percent schedule change} = \frac{(\text{Final construction duration} - \text{Estimated construction duration})}{\text{Estimated construction duration}} \times 100$$

Percent schedule change of:

- zero indicates that project was delivered per the estimated schedule,
- Less than zero indicates that project was completed earlier than estimated,
- Greater than zero indicates that project had a schedule-overrun from the estimated schedule.

3.3 CRITERIA FOR SELECTION OF SAMPLE PROJECTS

Sample Public-Private Partnership projects were shortlisted from a large pool of available listed projects. A general trend of the highway construction industry in the past few decades was observed which is mentioned in the Chapter 1 showing the requirement for funding of large scale transportation infrastructure projects in the US; and accordingly the criteria for the selection of projects for this research were developed. The research study project list was obtained from “Public Works Financing, September 2010”. From this list, the highway transportation projects meeting the following criteria were considered in this study.

3.3.1 Projects Constructed in North America

Public-Private Partnership has been a popular delivery approach in many mature markets around the globe, e.g. Europe, Australia. Studies have been conducted on P3 performance and efficiency for those regions; however, no similar studies have been accomplished for North America.

3.3.2 Projects Constructed Between 1990 and 2010

Legislation passed over the past 20 years has allowed alternative project delivery approaches such as P3 and DB. With these new laws, states have utilized different project approaches to seek better cost and schedule control and this study is to compare the performance of these delivery methods and also the DBB approach. Most of the large P3 highway construction projects have been constructed between the time frame of 1990 and 2010.

3.3.3 Projects with Construction Costs above US$90 Million

Research by the Federal Highway Administration compared 11 pairs of projects under US$20 million using the DB and DBB methods (FHWA, 2006). The percent cost change for DBB (3.6 percent) was lower than that for DB (7.4 percent). However, when Shrestha compared four large (over US$100 million) transportation projects, the cost change was significantly higher for DBB (12.71 percent) compared to DB (1.49 percent). The difference in the results, show that any one single delivery method cannot be applied to all ranges of projects. Also, it is evident from the statistics that cost containment for large-scale infrastructure projects is more difficult in the DBB project delivery approach as compared to the DB approach. Under SEP-14, in July 2003 the Federal Highway Administration came up with the following conclusion - only seven per cent, i.e. a small percentage, of the projects approved to be completed by Design Build approach, were greater than $100 million each in value. However, the investment in these large scale projects constitutes 73 percent of the total investment in all approved projects. Hence, it is important to concentrate on the efficiency of projects with those scales. This research examines whether or not the P3 approach better controls cost on these large-scale projects with construction cost above $90 million.

3.3.4 Highway and Bridge Projects Without a Large Signature Tunnel

As noted by Blanc-Brude et. al., “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” (Blanc-Brude et. al., 2009) Flyvbjerg et al. also documents 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 (Flyvbjerg et. al., 2003). To ensure comparable sample projects, transportation projects without large signature tunnels were selected.

3.3.5 Projects Procured Under a DBFOM Procurement Model

The incentive for private industry to finance a project is to complete the work on time and begin receiving funds for the completed work. The incentive to produce a better quality project is due to the private partner accepting the long-term operations and maintenance (O&M) risks when O&M responsibilities are bundled with the DB work. Hence, this study focuses on projects that encompass the Design, Build, Finance, Operation and Maintenance portion of delivery. Projects that do not have any of the five elements to be delivered by the private entity (DBFO, DBOM, DBF) are not included in this research. Although none of the studied projects have had enough time to complete the entire contractual cycle of the DBFOM procurement model, this study will lay the foundation for future research — the construction costs have been studied, to which the O&M risk and reward to the outcome can be added. Also, the definition of Public-Private Partnership that is considered in this study includes all five aspects of the project - Design, Build, Finance, Operate and Maintain.

3.4 DATA COLLECTION FOR SAMPLE PROJECTS

Data was gathered and the projects were confirmed to be DBFOM through a thorough literature review and a survey with personnel involved with the selected projects.

3.4.1 Literature Review

Initial data on the P3 projects was gathered from various databases found on the Internet. Afterwards, a comprehensive list of eligible P3 projects from the US and Canada was prepared. The list of transportation projects from the “Public Works Financing, September 2010 edition” was taken and compared with the initial project list and each project was studied individually to determine if it could be shortlisted in the study as per the criteria. Also, the P3 Project database from “The Canadian Council for Public-Private Partnerships” was reviewed to prepare a list of all North American P3 highway construction projects with construction costs over $90 million and with construction stage completion between 1990 and 2010. Information gathered from these websites and databases was verified by gathering more information on individual projects from their respective official websites. Maximum information about the two study parameters: cost and schedule was compiled from official websites of the respective projects and state departments of transportation. To determine the cost change of a project under study, data was collected on the estimated and the actual project costs. To determine the schedule change of the project, data was collected on the estimated construction duration per the contract and the final construction duration.

3.4.2 Survey

After collecting the data on the projects available from the Internet, a set of questions were prepared to survey public and private agencies involved in the selected P3 projects. Getting data from the private sector was a challenge, because of their reluctance to share information. The survey concentrated on the size, location, type, scope, procurement, force majeure and unanticipated risks associated with the project. The key emphasis was on the input and output variables: the estimated & actual construction cost, and, the estimated and actual construction time of the project that would determine the cost and schedule performance of the projects. This questionnaire included clear definitions of terms used in this research. The copy of the questionnaire used for the survey is available in the appendix.

Interviews were conducted with government agencies officials involved in the construction and procurement of the projects under consideration. The interviewed individuals were project directors and/or project managers who had intimate knowledge of the project. The in-person interviews included similar questions as the written questionnaire, and the definitions of terms were thoroughly discussed and precisely put forward to the interviewee, as well.

3.5 DATA ANALYSIS OF COLLECTED DATA

Data collected from the literature, written questionnaires and interviews was analyzed for percentage of cost and schedule change per the input and output metrics determined as the criteria of interest. 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 in order 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. The overall cost and schedule containment for the 12 projects was also analyzed.

3.6 COMPARISON OF P3 RESEARCH RESULTS WITH PREVIOUS STUDIES ON DBB AND DB HIGHWAY PROJECTS

The literature review of previously published studies containing performance data for traditional DBB and DB project delivery approaches was then compared to the data collected on the above mentioned P3 projects. As stated before, the comparison between these delivery methods was done on cost/ schedule change parameters.

CHAPTER 4: ANALYSIS & RESULTS

4.1 ANALYSIS

The cost and schedule performance of twelve transportation P3 large scale projects in North America have been studied. These projects range from $90 million to US$840 million and are from California, Texas and Canada. These P3 projects form an exhaustive list of large scale projects starting with an initial list from the Public Works Financing 2010, (see Appendix B). The projects categorized as DBFO and DBFOM were taken and a survey done to shortlist the large-scale DBFOM projects in North America. The focus was on DBFOM for the reason that this research follows the P3 model that encompasses all the five elements of delivery, namely, Design, Build, Finance, Operation and Maintenance. The project if delivered through DBFOM model or not was confirmed through further research from official project websites as well as various state Department of Transportation websites and surveys of Project and DOT officials. Finally a list of 12 P3 projects was developed which followed the DBFOM delivery approach (Table 3).

Table 3. List of P3 Projects Selected for this Study

Project Code	Project Name	Location
A	Okanagan Bridge / William R. Bennett Bridge	BC, Canada
B	Anthony Henday Drive	Alberta, Canada
C	Northeast Stoney Trail	Alberta, Canada
D	Phase 2 – Kicking Horse Canyon	BC, Canada
E	CPTC 91 Express Lanes	CA, US
F	South Bay Expressway	CA, US
G	Sea to Sky Highway	BC, Canada
H	Fredericton Moncton Highway	NB, Canada
I	Camino Columbia Bypass	TX, US
J	Golden Ears Bridge	BC, Canada
K	Confederation Bridge	PEI, Canada
L	Highway 104 Cobiqued Pass	NS, Canada

Data was collected for these projects per the questionnaire (see Appendix A) that focused on cost and schedule information of the projects under consideration. The construction cost for these projects ranged from US$90 million (Project I) to US$840 million (Project K). The details on the project characteristics, construction cost and construction schedule for each of the projects have been attached in Appendix G.

This research is using cost and schedule as the two parameters to evaluate the performance of the P3 project delivery. The average change in cost and schedule data for the 12 P3 projects are calculated to eventually compare them with the results of the DBB and the DB delivery method performance obtained from previous research studies.

4.1.1 COST CONTROL

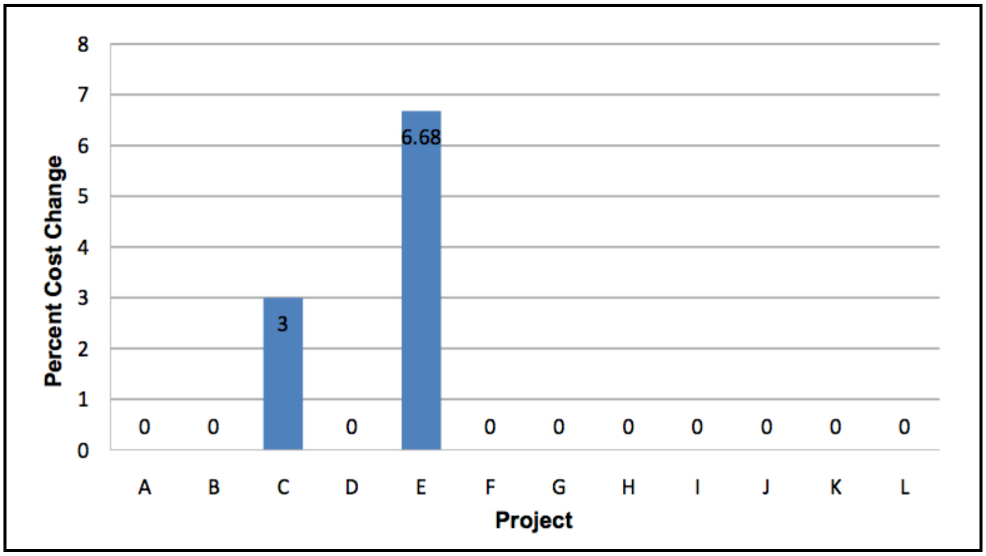

Figure 12. Percentage Cost Change for P3s

In this research of 12 P3 projects, ten of the projects exhibited cost containment and were completed within the contract amount, while Project C and Project E showed an increase in the construction cost compared to the contract amount (Figure 12). The reason for the increase cost for Project C was due to the Geotechnical issues that were not envisaged earlier. The construction cost for Project C was US$396 million and an increase of 3% accounted for an increase of US$12 million in the construction cost which made the final construction cost of the project as US$408 million. While, Project E reported an increase of 6.68 percent in the construction cost for which the estimated construction cost was US$125.6 million and the final construction cost was US$134 million.

The average of the cost performance for the 12 P3 projects under this study showed a cost increase of 0.81 percent. The average cost increase for DB projects in the Shrestha study is reported to be 1.49 percent, while the DBB projects were reported to be 12.71 percent. The Warne study indicated an average cost increase for DB projects of 4 percent for the 21 projects in that sample. From this comparison it is evident that cost containment is better in the DB projects as compared to the DBB projects but it is even better for the P3 projects which are DBFOM than the DB projects. The cost increases mentioned for these 12 DBFOM projects are only for the construction costs and not the FOM (Finance-Operate-Maintain) portion of the project delivery. The data on the cost performance of the projects indicates that more than 80 percent of the projects in the study were completed per the original contract cost.

4.1.2 SCHEDULE CONTROL

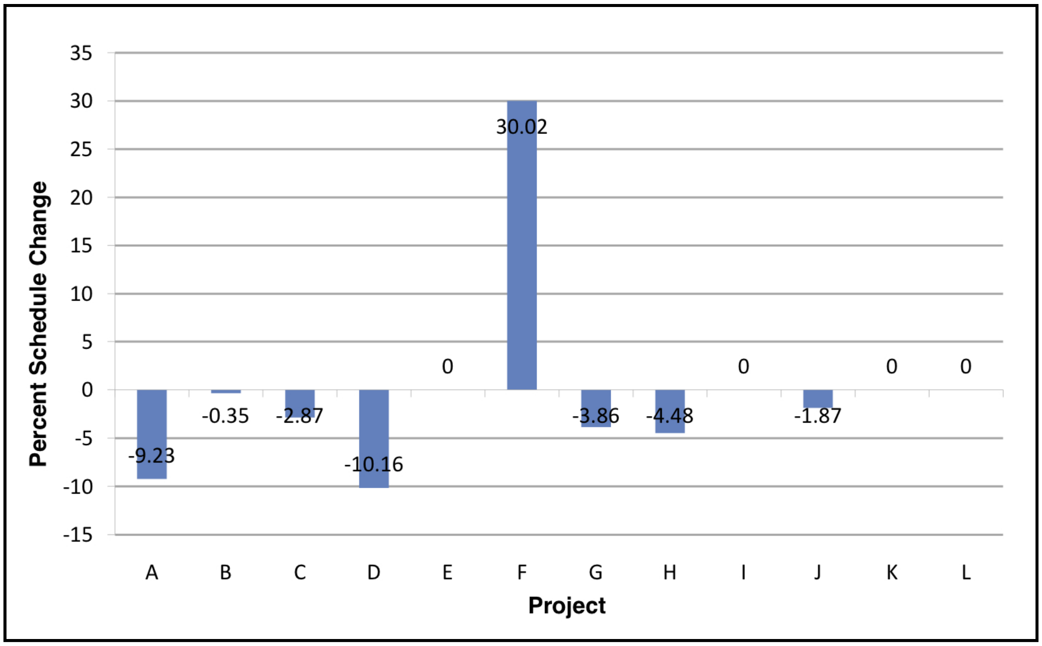

Figure 13. Percentage Schedule Change for P3s

Unlike the cost performance, the schedule performance was in the negative (indicating construction finished ahead of schedule) as well as the positive region of the graph (Figure 13). Seven projects were delivered ahead of schedule but the reason for these projects to be completed early did not involve incentives to the private entity in terms of early progressive payments or early toll collection from the contract schedule. The incentive of investment return would not begin until after the project is available for public use and the operational portion of the contract begins. Thus, progressive payment or toll could not be collected until the O & M portion of the project started per the contract. Also, four of the 12 projects were delivered on schedule. Seven of the 12 projects were completed ahead of schedule. Only Project F exhibited a schedule overrun of

30.02 percent due to technical issues associated with the project – Major construction challenge was the big bridge of the project - a 1200m (3/4 mile) long eleven span bridge on a double row of columns going to a height of 55m (180ft) over the Otay River. Curving throughout its length and built of 644 precast segments up to 70 tons each the post-tensioned structure was an intricate work that seems to have proven more difficult and expensive than envisaged.

The average schedule change for the twelve projects was found out to be -0.23 percent. The Shrestha study reported the average schedule growth for four DBB projects to be 4.34 percent and for the four DB projects, 11.04 percent. When comparing the schedule results of the P3 sample in this study with the DB and DBB projects in the Shrestha study, both DBB and DB show greater delay in schedule when compared to the P3 project schedule performance, but the Tom Warne study on the other hand reported a -11.00 percent schedule change for the 21 DB projects. Although the sample is rather small to allow an inference for future projects, the available data indicates that more than 90 percent of the P3 projects were completed early or on schedule.

4.1.3 COMBINED PERFORMANCE

Taking the cost and schedule performance collectively for the 12 projects, 9 out of 12 projects did not have to any cost change or schedule increase. Project C and E showed an increase in cost of three and 6.68 percent respectively, however Project C was completed ahead of schedule and Project E was completed as per schedule. And, Project F exhibited a schedule increase of 30.02 percent without affecting the contractual agreement of project construction cost. The public entity was not entitled for any cost changes and the construction cost of the project was determined per the contract.

None of the 12 P3 projects exhibited an increase in cost as well as schedule. If we check the cost and schedule containment together for the projects, this accounts for a success rate of 75 percent for the P3 delivery method. The combined cost and schedule performance for the 12 projects in the sample could be better explained as shown in Figure 14.

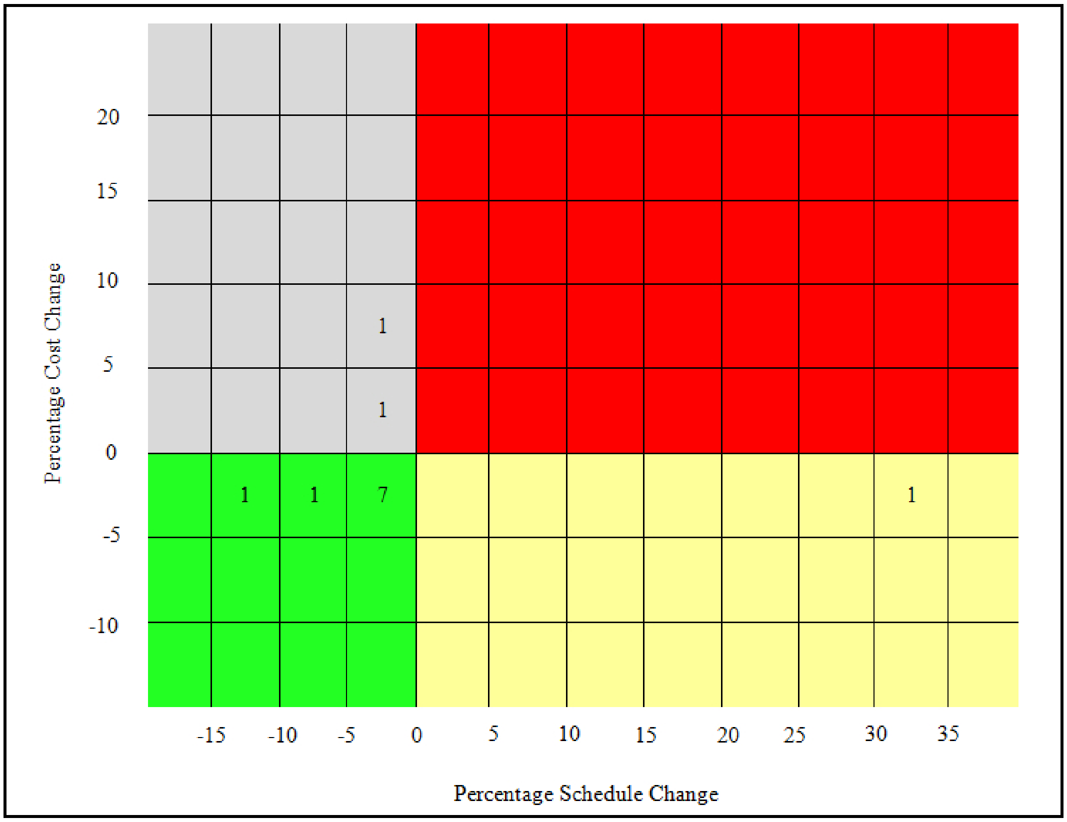

Figure 14. Overall Cost & Schedule performance of P3s

The X-axis in the figure shows the average percentage schedule change for projects while the Y-axis shows the average percentage cost change for the projects. The numbers in each of the boxes represents the number of projects falling in that performance interval. For example, the number "7" in the green region represents the number of projects and shows that each of the 7 projects lie in the interval of (-5, 0] for average percentage cost change and in the interval of (-5, 0] for average percentage schedule change. The numbers in green region in the figure indicate that these projects did not show an increase in cost or schedule during the construction phase while the red region symbolizes increase in cost as well as schedule. Similarly, projects in the yellow region show only an increase in schedule, but no increase in cost while the grey region shows that the projects had an increase in cost, but not in schedule.

The above graph more clearly shows that none of the P3 projects lie in the red region indicating that no single project had a cost and schedule increase while 9 projects contained well under cost and ahead of schedule. Together cost and schedule performance of P3 projects also shows a very good percent (75 percent) of projects being delivered successfully pertaining to cost and schedule containment.

4.2 RESULTS

Table 2. Percent Cost & Schedule Change for P3 projects

Research Study Projects	**Delivery Method**	**Percent Cost Change**	**Percent Schedule Change**
Twelve projects between US$90 and $840million	DBFOM	0.81	-0.23

The percentage cost increase for the 12 P3 projects in this study showed an average of 0.81 percent while the average percentage schedule increase was calculated as -0.23 percent. These statistics on cost and schedule performance of P3s can now be compared with the cost and schedule performance of DBs and DBBs taken from similar research carried out by Shrestha and Warne (Figure 15). DB and DBB projects in these studies also lie within the same timeframe as the P3 projects in our study and all are large scale projects, i.e. approximately more than US$90 million. Additionally, the projects in the Shrestha and Warne studies are major road projects as are the projects in this study.

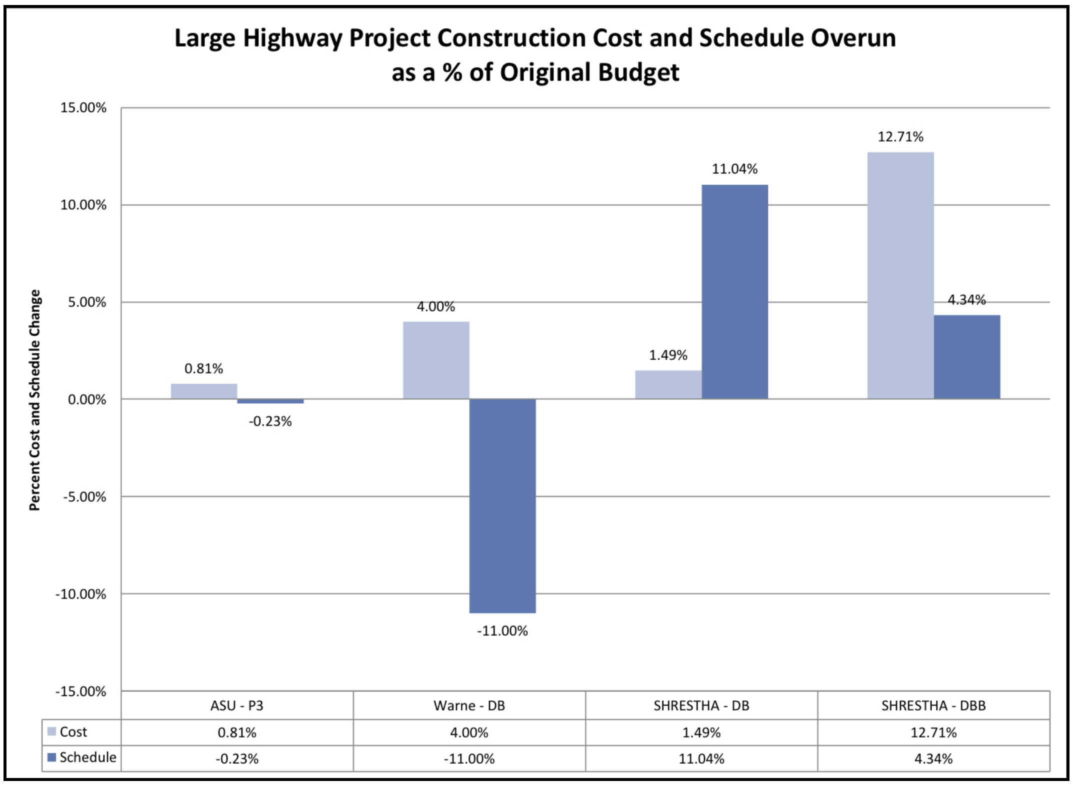

Figure 15. Percent Cost & Schedule Change comparison with previous studies

The results for the cost and schedule performance of these 12 projects are compared to similar research studies on DB and DBB projects in North America with cost and schedule as the performance parameters. One of the previous studies that could be compared to this research is the Shrestha study of 2007 in which 4 North American DB mega projects were compared with 4 North American DBB mega projects on cost and schedule parameters. The cost of the projects in the Shrestha study is greater than $100 million ranging from $165 million to $1150 million for DB projects and from $146 million to $301 million for DBB projects and they fall in the same time period as the projects under this study.

The other research that was relevant to our present work was the Warne study of 2005 which is widely accepted by the transportation agencies and practitioners all over the US of America. Our research also takes into account the 21 DB projects in North America whose budgets exceed $83 million thus making them fall in the category of the large scale projects.

CHAPTER 5: CONCLUSION

5.1 SUMMARY

The research studies on P3s around the world have exhibited results that differ from each other quite significantly which highlighted the need to initiate this study on P3s in North America. The key parameters that determine the performance of a delivery method are the cost and schedule containment during the construction phase of the project. This research paves the way towards an analysis of a P3 performance study in North America for the highway construction industry using 12 large scale highway P3 projects from Canada and US with focus on cost and schedule performance during their construction phase. The results of this research indicate P3 have good cost and schedule performance with a success rate of 75 percent.

Although the financing of P3 projects which is taken care of by the private sector is more expensive than the projects that are funded by the public, due to the taxes and interest associated with private money (OIG, 2011; CB of Canada, 2010), P3s have shown great adherence to the contractual cost and time of the project which has made this delivery approach popular amongst policymakers. It is clear that the combination of faster delivery with very tight control over 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. The average percent cost increase of 12.71 percent for DBB as mentioned in the Shrestha study, 1.50 percent and

4.00 percent for DBs as found in the Shrestha and Warne studies, and 0.81 percent in this study for the P3s shows the way towards improvement in structuring of innovative delivery approach. The average percent schedule increase of P3s in this study came out as -0.23 percent which is better than the 4.34 percent and 11.04 percent for DBBs and DBs, respectively, as reported by Shrestha. However, the schedule control figure of -11.00 percent for DBs by Warne which is a polar opposite to the 11.04 percent for DBs by Shrestha shows the need to analyze a larger sample of projects. Then again, the -11.00 percent schedule change by Warne could also be due to the incentives and profit that the contractor could earn by finishing the project early and taking it to the operational stage. On the other hand, no incentives are given to the private sector for completing the construction of a P3 project early, and as the return on investment only begins once the project is open for public use and the operational portion of the contract begins.

5.2 RECOMMENDATIONS FOR FUTURE RESEARCH

Substantial amounts of money are being invested in large scale transportation projects in North America, therefore, choosing the correct delivery method that could improve the efficiency of cost control of projects would \ help the economy and would save public money collected through taxes which is spent on these projects. P3s have shown to be cost and time effective in this research. The limitation of this study is that it deals only with the construction phase of the project delivery with a small sample of projects and not the Operation and

Maintenance portion of the P3 approach. Hence, research can be continued in this area on the following:

- This research provides the foundation for research which should be expanded by adding more projects to the list giving strengthened performance statistics.
- Not only the construction phase but also the Operation and Maintenance portion of the delivery method should be assessed as the projects complete their operation and maintenance phase. This would have to be a long term project as the O&M phase can last for 30-50 years.
- This study lays foundation for the cost per lane mile comparison of the P3s with the DBs and DBBs. It would require a list of similar P3, DB and DBB projects (similar project characteristics) for which the cost per lane mile through each delivery approach could be compared.
- An insight on the comparison of life-cycle asset management costs from a P3 compared to government costs.
- Differences between availability of travel lanes between a project delivered as a P3 and a government-operated road built using traditional methods.
- Net effects on carbon footprints of a roadway built and operated as a P3 compared to a government-operated road built using traditional methods.
- Economic benefits of wider use of the P3 model on large projects, and the lines of demarcation that separate the sensible decision point to engage a P3, DB, or DBB method of delivery.

This research points out that significant work is yet to be done in comparing the design build, design-bid-build, and P3 project delivery approaches that are currently being utilized by highway agencies.

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APPENDIX A

P3 SURVEY

Introduction and Purpose

The purpose of our study is to compare the cost and schedule control performance of Public-Private Partnership (P3) projects to those procured under traditional methods such as Design-Bid-Build (DBB) or Design-Build (DB). We are limiting the scope of our study to the construction phases of large-scale completed transportation projects in North America. As you were involved in one project under consideration, would you be able to answer a few questions and provide clarification?

Name

____

Company

____

Project Name

____

Project Description

____

____

____

____

Estimated (Budget) Cost

At time of Project Financial Close (DBFOM)

____

Estimated Schedule (construction)

At time of approval of Project Financial Close (DBFOM)

____

Final Construction Cost

____

Reasons for increase? (if any)

____

____

Scope Increase? (if so, what)

____

____

____

Unanticipated Risks? (is so, what?)

____

____

____

Construction Time

____

At Financial Close (Substantial Completion and Final Acceptance Dates)

____

At completion (Actual Substantial Completion and Final Acceptance

Dates) ____

Reasons for increase in construction duration (if any)

____

Owner's Delays?

____

Scope Changes?

____

Unanticipated Risks?

____

Force Majeure?

____

Definitions:

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 the construction of the project

Capital Expenditure: construction-related costs, does not include operation and maintenance (O&M)

Change Order: a component of the change management process whereby changes in the Contract agreed to by the Sponsor(s) and Developer(s) are implemented, often involve the change of Contract Value and/or scope of work.

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 U.S. 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

Developer(s): the private entity that is entering the contract with Sponsor(s) to deliver the project per the specifications and requirements set forth in the Contract

Estimated Project Costs: Contract Value of the Capital Expenditure specified in the Contract at Financial Close

Final Acceptance: the occurrence of all events and satisfaction of all conditions set forth in the final acceptance clause of the Contract, as and when confirmed by the Sponsor's issuance of a notice. Typically includes these activities following Substantial Completion:

- Completion and acceptance of all construction work
- Completion and acceptance of all design and construction submittals
- Completion and acceptance of all punch-list items
- Acceptance of as-built drawings

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). It is the moment when the Developer(s) has/have successfully raised the financing needed to build the project

Sponsor(s): the governmental agency or related authority that is awarding the Contract to the Developer(s)

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

APPENDIX B

PUBLIC WORKS FINANCING SCORECARD OF PPP

U.S. & Canadian Transportation Projects Scorecard

Contract Amount in nominal $ ($ millions)	Project Name	Owner	Private Risk	Notice to Proceed	Sponsors (DB component)
3,850	Indiana Toll Road, IN	Indiana Finance Authority	75-yr lease	6/06	Cintra Concessions/Macquarie
2,800	I-635 Managed Lanes, TX	Texas DOT	DBFOM	6/10	Cintra/Meridiam ($2.1 bn Ferrovial Agroman)
2,600	ETR 407, Toronto, Ont.	Ontario Ministry of Trans.	99-yr lease	5/99	Cintra Concessions/Macquarie
2,460	Port Mann Bridge, BC	BC Ministry of Transportation	DB	2/09	Kiewit/Flatiron
2,100	Denver Eagle P3 Rail. CO	Denver RTD	DBFOM	8/10	Fluor/Laing/Uberior ($1.27bn Fluor/BBRI)
2,047	North Tarrant Express, TX	Texas DOT	DBFOM	12/09	Cintra/Meridiam ($1.46bn Ferrovial)
1,998	I-495 HOT Lanes, VA	Virginia DOT	DBFOM	7/08	Transurban/Fluor ($1.4bn Fluor/Lane)
1,830	Chicago Skyway, IL	City of Chicago	99-yr lease	1/05	Cintra Concessions/Macquarie
1,814	I-595 Managed Lanes, FL	Florida DOT	DBFOM	2/09	ACS Infrast. ($1.2bn Dragados/EarthTech)
1,674	Hudson-Bergen Lt. Rail , NJ	NJ Transit	DB/Equip+O&M	10/96	Wash. Group/Itochu ($1.15bn Perini/Slattery)
1,650	Canada Line, Vancouver, BC	Gr. Vancouver Transit Auth,	DBFOM	8/05	SNC Lavalin/Serco ($1.2bn SNC Lavalin)
1,430	A-30, Montreal, Quebec	Ministry of Transport	DBFOM	9/08	Acciona/Iridium (Dragados/SICE/Arup)
1,376	I-15 Reconstruction, UT	Utah DOT	DB	3/97	Kiewit/Granite/Washington Group
1,369	SH 130 Seg. 1-4, TX	Texas DOT	DB	7/02	Fluor/Balfour Beatty/DMJM + Harris
1,358	SH 130 Segments 5-6, TX	Texas DOT	DBFOM	3/08	Cintra/Zachry
1,340	Edmonton Orbital (NW), AB	Alberta Transportation	DBFOM	7/08	Bilfinger Berger (Flatiron/Parsons/Graham)
1,186	I-25 T-REX Road/Rail Exp., CO	Colo. DOT/RTD	DB	5/01	Kiewit/Parsons Trans. Group
1,100	I-15 South	Utah DOT	DB	9/09	Fluor/Ames/Wadsworth + HDR
1,002	DFW Connector	Texas DOT	DB	10/09	Kiewiit/Zachry
980	Jamaica-JFK Airtrain, NY	Port Auth. NY/NJ	DB/Equip+O&M	9/99	Skanska/Bombardier ($980m Slattery/Perini)
914	Port of Miami Tunnel, FL	Florida DOT	DBFOM	10/09	Meridiam ($607m Bouygues/Jacobs)
814	Golden Ears Bridge, BC	TransLink/Partnerships BC	DBFOM	3/06	Bilfinger BOT ($746m Bilfinger/CH2M Hill)
803	Foothill Eastern Toll Road, CA	Trans. Corridor Agencies	DB	6/95	Flatiron/Wayss & Freitag/Sukut/Obayashi
790	San Joaquin Hills Toll Rd., CA	Trans. Corridor Agencies	DB	9/91	Kiewit/Granite
773	SR 125 So. + Connectors, CA	San Diego Expressway L.P.	DBFOM	5/03	Macquarie ($653m Washington/Fluor)
765	Southeast Stoney Trail, AB	Province of Alberta	DBFOM	5/10	SNC Lavalin/Acciona (same DB)
730	Confederation Bridge, PEI	Public Works Canada	DBOM	10/93	Vinci/BPC Marine/Ballast Nedam/SCI
712	Alameda Corridor, CA	Alameda Corridor Trans. Auth.	DB	11/98	Tutor-Saliba/O&G Indus/Pars. Grp + HNTB
705	So. Fraser Perimeter Road, BC	BC Ministry of Transportation	DBFOM	7/10	ACS/Ledcor ($650m Dragados/Ledcor)
689	JFK Terminal 4, NY	Port Auth. NY/NJ	DBFOM	5/97	Schiphol/LCOR ($689m Fluor/Morse Diesel)
645	Foothill South Toll Road, CA	Trans. Corridor Agencies	DB	11/98	Flatiron/HBG/Sukut/Fluor Daniel
615	Tacoma Narrows Bridge, WA	Washington State DOT	DB	11/02	Bechtel/Kiewit
611	Pocahontas Parkway Lease, VA	Virginia DOT	99-yr lease	6/06	Transurban ($45m Fluor/WGI)
603	Northwest Parkway Lease, CO	Norhwest Parkway Authority	99-yr lease	5/07	BRISA/CCR
600	Eastside Light Rail, CA	Los Angeles County MTA	DB	7/04	Washington Group/Obayashi/Shimmick
597	Sea-to-Sky Highway, BC	BC MInistry of Transportation	DBFOM	9/05	Macquarie ($354m Kiewit/Miller/Capilano)
555	Northeast Stoney Trail, AB	Province of Alberta	DBFOM	2/07	Bilfinger ($345m Flatiron/Graham/Parsons)
541	Cooper River Bridge, SC	SC DOT	DB	7/01	Flatiron/Skanska + Parsons Brinckerhoff
538	A25 Montreal	Quebec Ministry of Transport	DBFOM	9/07	Macquarie (Kiewit/Parsons $207m)
530	BART SF. Airport Ext., CA	Bay Area Rapid Transit Dist.	DB	5/98	Tutor-Saliba/Slattery + HNTB
508	Trenton River Light Rail, NJ	NJ Transit	DB/Equip+O&M	6/99	Bechtel/Conti/Foster/Bombardier
500	Trans Canada Highway, NB	NB Trans Ministry	DBOM	11/98	Dragados-FCC/Vinci/Miller Paving
500	Route 1, NB	Province of New Brunswick	DBFOM	4/10	Dexter Group (Dexter Construction)
464	Intercounty Connector, MD	Maryland DOT	DB	6/07	Granite/Corman/GA & FC Waggoner
446	Western Wake Freeway, NC	NC Turnpike Authority	DB	8/09	Archer Western/Granite + The LPA Group
431	IROX I-75, FL	Florida DOT	DBF	6/07	Anderson Columbia/Ajax Paving
420	I-64 St. Louis, MO	Missouri DOT	DB	12/06	Granite Construction
414	Highway 161, TX	No. Texas Tollway Auth.	DB	8/09	Fluor/Balfour Beatty + AECOM
395	Edmonton Orbital SE, AB	Alberta Min. of Trans.	DBOM	1/05	Macquarie/PCL/LaFarge
390	SR 22 Improvements, CA	Orange Cty CA Trans. Auth.	DB	9/04	Granite/C.C. Myers/Steve P. Rados Inc.

U.S. & Canadian Transportation Projects Scorecard

Contract Amount in nominal $ ($ millions)	Project Name	Owner	Private Risk	Notice to Proceed	Sponsor Constructors (DB component)
390	LA Expo Lt. Rail, CA	Expo Line 1 Const. Auth.	DB	9/06	Flatiron/Fluor/Parsons
386	Conway Bypass Highway, SC	SC DOT	DB	3/98	Fluor Daniel
385	Route 3 North, MA	Mass. Highways	DBF/Maint.	8/00	Modern Continental/Roy Jorgenson
350	Dulles Greenway Toll Road, VA	TRIP II	DBFOM	9/93	TRIP II ($150m Brown & Root)
348	John James Audubon Br., LA	LA DOTD	DB	5/06	Flatiron/Granite/Parsons
343	Las Vegas Monorail, NV	L.V. Monorail LLC	DB/Equip+O&M	10/00	Bombardier/Granite
328	281 North Toll, TX	Alamo Reg. Mobility Auth.	DB	5/08	Fluor/Balfour Beatty
324	E-470 Beltway, Seg. 2&3, CO	E-470 Public Hway Auth.	DB	8/95	Washington Group Intl/Fluor Daniel
300	Ontario Service Centres	Ontario Min. of Transportation	DBFOM	8/09	HMS Host/Kilmer Van Nostrand (Ellis Don)
295	US 550 (was SR 44), NM	New Mex. SH&TD	D/CM/Warranty	9/98	Koch Materials ($295m CH2M Hill/Flatiron)
291	Hiawatha Light Rail, MN	Minn. DOT	DB	9/00	Granite/C.S. McCrossan
267	Gold Line Light Rail, CA	LA-Pasadena Blue Line Const.	DB	4/00	Kiewit/Washington Group
260	Anacostia River Bridges, DC	Washington DC DOT	DB	9/09	Skanska/Facchina
243	I-10 Bridges Escambia Bay, FL	Florida DOT	DB	4/05	Tidewater Skanska/Flatiron
238	TH 212, MN	Minnesota DOT	DB	8/05	Fluor/Edward Kraemer/Ames
236	Rt. 288, VA	Virginia DOT	DB/Warranty	12/00	Koch/APAC/CH2M Hill
234	St. Anthony Falls Bridge, MN	MinnDOT	DB	11/07	Flatiron/Manson + FIGG
233	E-470 Beltway, Seg. 4, CO	E-470 Public Hway Auth.	DB	1/00	Kiewit/Washington Group
232	Palm Beach-Ft. Laud. Rail, FL	Tri-County Commuter Rail Auth	DB	8/01	Herzog/Granite/Washington Group
232	US 52 Reconstruction, MN	Minnesota DOT	DB	2/03	Fluor/Edward Kraemer/Ames
226	Carolina Bays Pkwy, SC	SC DOT	DB	11/99	Flatiron/Tidewater
323	E-470 Seg. 1, CO	E-470 Public Hway Auth.	DB	7/89	Fluor/Morrison Knudsen
238	I-15 Bridge Replacements, UT	Utah DOT	DB	1/06	Granite/Ralph L. Wadsworth Const.
220	Blue Line Extension, DC	WMATA	DB	4/02	Lane/Granite/Slattery Skanska
211	I-95 Widening	Florida DOT	DBF	12/07	Community Ashpalt
200	Kicking Horse Canyon, BC	BC Min. of Trans.	DBFO	2005	Bilfinger ($114m Flatiron/Parsons)
198	Rt. 28 Corridor, VA	VDOT	DB	9/02	Clark Const./Shirley Contracting Corp.
195	Disraeli Freeway Bridge, MB	City of Winnipeg	DBFM	3/10	Plenary Group (PCL Constructors)
192	US 17 Washington Bypass, NC	NC DOT	DB	2/06	Flatiron/United Contractors
191	Southern Connector, SC	Connector 2000 Assn.	DB/F	2/98	Interwest ($na Thrift Bros.)
191	Atl. City-Brigantine Tunnel, NJ	NJ DOT	DB/F	10/97	Mirage Resorts ($191m Yonkers/Granite)
184	U.S. 60 Upgrade, AZ	Arizona DOT	DB	5/01	Granite/Sundt
180	Northwest Parkway, CO	NWP Public Highway Auth.	DB	6/01	Washington Group/Kiewit Western
178	US 183, Austin, TX	Central Tex. Mobility Auth.	DB	12/04	Granite/J.D. Abrams + URS175
175	York, ON BRT	Regiional Muni of York	DBFOM	6/02	Nine firms (Kiewit/Delcan)
177	Palmetto Exp. Widening FL	Florida DOT	DBF	8/08	Condotte-De Moya j.v.
171	Reno ReTRAC, NV	City of Reno	DB	7/02	Granite/Parsons Trans. Group
148	US Route 1, Key West, FL	Florida DOT	DB	11/04	Granite w/Jacobs
138	Triangle Parkway	NC Turnpike Authoriity	DB	8/09	S.T. Wooten
136	I-494 Reconstruction, MN	Minnesota DOT	DB	8/04	Granite/C.S. McCrossan
132	U.S. 64 Knightdale Bypass, NC	North Carolina DOT	DB	6/02	Flatiron/Lane Const. Corp.
130	CPTC 91 Express Lanes, ,CA	CalTrans	DBFOM	7/93	Level 3/Cofiroute/Granite (sold 1/03)
130	U.S. 20, OR	Oregon DOT	DB	7/05	Granite/TY Lin International
129	U.S. 70, NM	New Mex. SH&TD	DB	7/02	Granite/Sundt/James Hamilton+URS
125	Portland Airport Max Rail, OR	Tri Met	DB	10/98	Bechtel
121	95 Express Lanes, FL	Florida DOT	DBF	1/08	FCC/MCM
120	Okanagan Bridge, BC	BC Dept. of Transport	DBFOM	5/07	SNC Lavalin
111	US-1 Improvements, FL	Florida DOT	DBF	11/07	Community Asphalt
102	I-4 Over St. John's River, FL	Florida DOT	DB	1/01	Granite/PCL Civil Constructors

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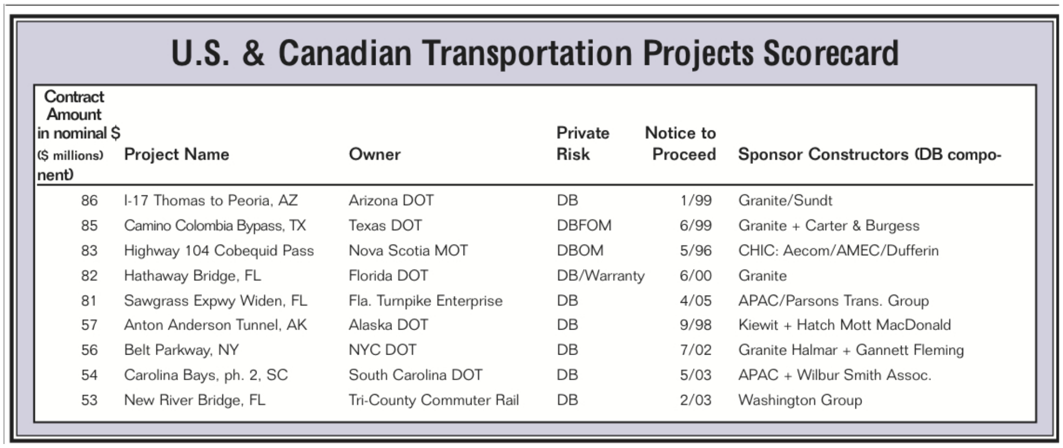

U.S. & Canadian Transportation Projects Scorecard

Contract Amount in nominal $ ($ millions)	Project Name	Owner	Private Risk	Notice to Proceed	Sponsor Constructors (DB component)
86	I-17 Thomas to Peoria, AZ	Arizona DOT	DB	1/99	Granite/Sundt
85	Camino Colombia Bypass, TX	Texas DOT	DBFOM	6/99	Granite + Carter & Burgess
83	Highway 104 Cobequid Pass	Nova Scotia MOT	DBOM	5/96	CHIC: Aecom/AMEC/Dufferin
82	Hathaway Bridge, FL	Florida DOT	DB/Warranty	6/00	Granite
81	Sawgrass Expwy Widen, FL	Fla. Turnpike Enterprise	DB	4/05	APAC/Parsons Trans. Group
57	Anton Anderson Tunnel, AK	Alaska DOT	DB	9/98	Kiewit + Hatch Mott MacDonald
56	Belt Parkway, NY	NYC DOT	DB	7/02	Granite Halmar + Gannett Fleming
54	Carolina Bays, ph. 2, SC	South Carolina DOT	DB	5/03	APAC + Wilbur Smith Assoc.
53	New River Bridge, FL	Tri-County Commuter Rail	DB	2/03	Washington Group

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APPENDIX C

COST AND SCHEDULE GROWTH RESULTS FROM SHESTHA STUDY IN 2007

Table 6.1: Total Cost Growth for DB and DBB

Parameters	Design-Build	Design-Bid-Build	Total Sample
Sample Size	4	4	8
Mean	1.49%	12.71%	7.10%
Median	-5.73%	23.28%	10.17%
Maximum	30.98%	31.87%	31.87%
Minimum	-13.53%	-27.60%	-27.60%
Standard Deviation	20.88%	27.43%	23.35%

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Table 6.3: Total Schedule Growth for DB and DBB

Parameters	Design-Build	Design-Bid-Build	Total Sample
Sample Size	4	4	8
Mean	11.04%	4.34%	7.69%
Median	6.70%	2.54%	2.54%
Maximum	34.48%	18.61%	34.48%
Minimum	-3.70%	-6.32%	-6.32%
Standard Deviation	18.06%	10.40%	14.10%

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APPENDIX D

COST AND SCHEDULE GROWTH RESULTS FROM WARNE STUDY IN 2005

Table 4-Cost Comparison						
	Engineer's Original Estimate	Bid Amount	Bid vs. Engineer's Estimate	Final Amount	Final vs. Bid Amount	Final vs. Engineer's Estimate
AZ I-17 DB	$75	$80	$5	$85	$5	$10
AZ SR 51	$68	$76	$8	$86	$10	$18
AZ US 60	$224	$187	-$37	$200	$13	-$24
CA Eastern Toll	$678	$678	$0	$777	$99	$99
CA San Joaquin	Note 1	$793	$0	$795	$2	
CO E470 Segment 4	$230	$233	$3	$250	$17	$20
CO E470 Segment 2 & 3	$321	$321	$0	$321	$0	$0
CO I-25 Road Rail Expansion		$1,200		$1,200	$0	
CO NW Parkway Denver	$189	$189	$0	$191	$2	$2
FL Hathaway Bridge	$85	$82	-$3	$84	$2	-$1
MN ROC 52	$238	$232	-$6	$238	$6	$0
SC Carolina Bays		$232		$250	$18	
SC Conway Bypass		$386		$386	$0	
SC Cooper River Bridge	$531	$531	$0	$539	$8	Note 2
SC Southern Connector for Toll Road	$205	$192	-$13	$192	$0	-$13
TX SH130	$1,200	$1,200	$0	Note 2		
UT I-15 UDOT	$1,095	$1,325	$230	$1,297	-$28	$202
VA Dulles Greenway Toll Road				$325		
VA Rt. 28 Corridor Improvements	$198	$198	$0	$198	$0	$0
VA Rt. 288	$236	$236	$0	$237	$1	$1
VA Rt. 895 Corridor	$318	$318	$0	$318	$0	$0
All amounts shown in millions of dollars Note 1- Initial bid included optional work, final amount included other impacts, Note 2- Project not complete						

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Table 3-Schedule Comparison for Design-Build and Design-Bid-Build			
Project	**Design-Build Time**	**Design-Bid-Build Time**	**Notes**
AZ I-17 DB	20	60	5 year under conventional design bid build
AZ SR 51	24**	60	3 projects together - 4 ½ - 5 years
AZ US 60	24	54	4 ½ years
CA Eastern Toll	40	N/A*	n/a
CA San Joaquin	32	56	Add 2 years for design
CO E470 Segment 4	30	N/A*	Projected 4 years, finished in 3, no analysis for design-bid-build
CO E470 Segment 2 & 3	46	N/A*	n/a
CO I-25 Road Rail Expansion	56**	N/A	Original schedule end of 2008 never analyzed time for Design-Bid-Build
CO NW Parkway Denver	27	N/A*	If CO DOT process was used it would have doubled the time if the money was available.
FL Hathaway Bridge	48	72	Project would not have started yet. Total time approximately the same as the Design-Build project plus 24 months for design.
MN ROC 52	49		The project would have started construction two years later and the construction would have taken a minimum of 5 years vs. the current 3 years schedule..
SC Carolina Bays	84	240	
SC Conway Bypass	36	180	15 years for design, right of way and construction in segments
SC Cooper River Bridge	48**	96	8 years
SC Southern Connector for Toll Road	40	N/A*	No comparison would still be in planning stages.
TX SH130	60**	N/A	No analysis, but would have required 300 additional people to administer.
UT I-15 UDOT	51	96	Eight years
VA Dulles Greenway Toll Road	24	N/A*	No analysis, formed team then approached VDOT
VA Rt. 28 Corridor Improvements	24**	36	If not for design build, the TI would not have been started .
VA Rt. 288	48	*	It would have been broken up into several projects.
VA Rt. 895 Corridor	60	N/A	It wasn't in the program to be designed until 2012-2015. There is no idea how long it would actually take to complete construction.
*** design bid build not an option due to financial constraints**			
**** not complete**			

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APPENDIX E

COST AND SCHEDULE GROWTH RESULTS FROM FHWA IN 2006

Exhibit IV.21 Supporting Data for Reported Changes in Project Costs for Similar Design-Build and Design-Bid-Build Projects

Design-Build Projects

Dimension	Award Growth ((Award-Budget)/ Budget)	Contract Growth ((Final-Award)/ Award)	Total Growth ((Final-Budget)/Budget)
Responses	11	11	11
Average	**1.9%**	**6.0%**	**7.4%**
Median	2.4%	1.6%	2.4%
Mode	N/A	N/A	N/A
Maximum	23%	21%	40%
Minimum	-41%	-4%	-28%
Standard Deviation	**17%**	**9%**	**17%**

Design-Bid-Build Projects

Dimension	Award Growth ((Award-Budget)/ Budget)	Contract Growth ((Final-Award)/ Award)	Total Growth ((Final-Budget)/Budget)
Responses	9	9	9
Average	**-1.4%**	**4.3%**	**3.6%**
Median	-0.9%	0.4%	-3.9%
Mode	N/A	N/A	N/A
Maximum	27%	29%	64%
Minimum	-18%	-3%	-13%
Standard Deviation	**15%**	**10%**	**24%**

Source: similar D-B and D-B-B project surveys: Q16

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Exhibit IV.16 Average Percent Change in Planned Versus Actual Total Project and Construction Phase Durations For Similar Design-Build and Design-Bid-Build Projects

Project Phase	Average	Maximum	Minimum	Standard Deviation
D-B Constuction Phase	**-1.2%**	30.6%	-54.7%	27.3%
D-B-B Construction Phase	**11.6%**	71.7%	-27.2%	28.7%
D-B Total Project	**-4.2%**	23.1%	-42.5%	20.8%
D-B-B Total Project	**4.8%**	30.6%	-20.9%	14.9%

Source: similar D-B and D-B-B project surveys: Q15, 11 responses per survey type

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APPENDIX F

COST AND SCHEDULE GROWTH RESULTS FOR GRANSBERG ET AL. IN 2000

Table 1—Summary of Study Results

	Agency	Type	Final Const Cost	Award Growth	Cost Growth	Time Growth
Total	Mass Highway	DBB	$117,540,219			
Average			$3,176,763	-6.39%	5.57%	91.88%
Total #			37	37	37	37
Total	FDOT	DBB	$185,414,681			
Average			$8,829,271	-9.93%	10.64%	33.50%
Total #			21	21	21	21
Total	INDOT	DBB	$235,221,860			
Average			$11,201,041	-7.56%	7.32%	-11.94%
Total #			21	21	21	2
Total	TxDOT	DBB	$1,048,971,964			
Average			$5,218,766		2.57%	16.39%
Total #			201		201	201
Total	**DBB**		**$1,587,148,723**			
Average	**Summary**		**$5,668,388**	**-7.64%**	**3.93%**	**28.25%**
Total #			**280**			
	Agency	**Type**	**Final Const Cost**	**Award Growth**	**Cost Growth**	**Time Growth**
Total	FDOT	DB	$30,488,867			
Average		[3]	$2,771,715	4.59%	-1.99%	-35.70%
Total #			11	11	11	11
Total	FDOT	A+B	$34,159,000			
Average			$6,831,800	-6%	5%	14%
Total #			7	7	5	5
		A+B vs DBB		4.08%	-5.83%	-19.10%
Total	INDOT	A+B	$80,105,001			
Average			$10,013,125	-10.95%	-14.10%	-21.44%
Total #			8	8	8	8
		A+B vs DBB		-3.39%	-21.42%	-9.50%
Total	TxDOT	Partnered	$1,025,572,095			
Average		Low Bid	$5,027,314	NA	5.23%	6.87%
Total #			204		204	204
		Part vs Non-Part			2.66%	-9.53%
Total	TxDOT	A+B	$95,482,602			
Average		[8]	$31,827,534	NA	NA	-7.97%
Total #			3			3
		A+B vs DBB				-24.36%
Total	**Alternative**		**$1,265,807,565**			
Average	**Summary**		**$5,147,776**	**-3.00%**	**4.20%**	**3.99%**
Total #			**230**			

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APPENDIX G

INFORMATION ON P3 PROJECTS SELECTED FOR THIS STUDY

Project Code	A
Project Name	Okanagan Bridge / William R. Bennett Bridge
Location	British Columbia, Canada
Estimated construction cost ($ million)	US$144.5
Final construction cost ($ million)	US$144.5
Estimated construction schedule	June 30, 2005 – July 1st, 2008
Final construction schedule	June 30, 2005 – May 31st, 2008
Reasons for schedule change	The unanticipated events were negotiated for 73 days addition to the estimated final construction date. The project was completed 108 days ahead of the adjusted schedule. This shows the high efficiency in schedule control of P3 delivery model.
Project characteristics	The new, 5-lane William R. Bennett Bridge (WRBB) will replace the existing 3-lane bridge and form part of Highway #97, crossing Okanagan Lake (approx. 1 km (0.62 miles)). Also, upgrading the east and west approaches to the bridge to improve traffic flow, with additional lanes and intersection improvements. 1.1 km (0.68 miles) of approach roads of 5 lanes.
Lane miles	6.5
Cost per lane mile (US$ million/mile)	22.23

Project Code	B
Project Name	Anthony Henday Drive
Location	Alberta, Canada
Estimated construction cost ($ million)	US$365
Final construction cost ($ million)	US$365
Estimated construction schedule	June 25th 2005 – Oct 26th, 2007
Final construction schedule	June 25th, 2005 – Oct 23rd, 2007
Project characteristics	11 kms (6.84 miles) will be constructed. Including multiple lanes and bridge structures this represents 50 lane kms (31 lane miles). It includes 22 separate bridge structures. The major structures are five interchanges, three overpasses, and three flyovers: Interchanges (on and off access to and from the ring road) at Gateway Boulevard/Calgary Trail, 91 Street, 50 Street, 17 Street and Highway 216 Overpasses (same as a fly over except over rail road tracks instead of a roadway) at the CPR tracks/Parsons Road, CNR tracks/Highway 216 and CNR track/Highway 14. Flyovers (bridges over the highway with no on or off ramps) at 66 Street, 34 street and 34 Ave.
Lane miles	31
Cost per lane mile (US$ million/mile)	11.77

Project Code	C
Project Name	Northeast Stoney Trail
Location	Alberta, Canada
Estimated construction cost ($ million)	US$396
Final construction cost ($ million)	US$408
Estimated construction schedule	April 1st, 2007 – Nov 30th, 2009
Final construction schedule	April 1st, 2007 - Nov 2nd, 2009
Reasons for cost change	Change orders of 3%. This was because of Geotechnical issues.
Project characteristics	The total length is 21km (13.05 miles). Work for the project includes: Six-lane sections from Deerfoot Trail to Metis Trail (44 Street NE) and McKnight Boulevard to 16 Avenue NE (other sections are four-lane) Interchanges at Deerfoot Trail, Metis Trail, Country Hills Boulevard, Airport Trail, McKnight Boulevard, and 16 Avenue NE Signalised t-intersection at 17 Avenue SE (an interchange will be built when Stoney Trail is extended south of 17 Avenue SE). Construction of two new railway bridge structures and rehabilitation of two existing railway bridge structures
Lane miles	58.92
Cost per lane mile (US$ million/mile)	6.92

Project Code	D
Project Name	Phase 2 - Kicking Horse Canyon
Location	British Columbia, Canada
Estimated construction cost ($ million)	US$143
Final construction cost ($ million)	US$143
Estimated construction schedule	Oct 28th, 2005 – Nov 15th, 2007
Final construction schedule	Oct 28th, 2005 – Aug 31st, 2007
Project characteristics	Converting existing 2 lane to 4 lane for 5.8 kms (3.6 miles). Phase 2 improvements involve the design, construction and financing of a 5.8 km segment of the Kicking Horse Canyon including the replacement of the existing Park Bridge.
Lane miles	14.4
Cost per lane mile (US$ million/mile)	9.93

Project Code	E
Project Name	CPTC 91 Express Lanes
Location	California, United States
Estimated construction cost ($ million)	US$125.6
Final construction cost ($ million)	US$134
Estimated construction schedule	July 1st, 1993 – Dec 27th, 1995
Final construction schedule	July 1st, 1993 – Dec 27th, 1995
Project characteristics	10 mile 4 lane expressway. The 91 Express Lanes are located in the median between the eastbound and westbound lanes of the SR-91 Freeway between the junction of SR-55 and the Orange/Riverside County Line. The 91 Express Lanes provide two extra lanes in each direction for most of the 10 mile length of SR-91.
Lane miles	40
Cost per lane mile (US$ million/mile)	3.35

Project Code	F
Project Name	South Bay Expressway
Location	California, United States
Estimated construction cost ($ million)	US$635
Final construction cost ($ million)	US$635
Estimated construction schedule	May 1st, 2003 - Oct 31st, 2006
Final construction schedule	May 1st, 2003 - Nov 19th, 2007
Reasons for schedule change	The work was complicated by the bracketing of an untolled 3.5km (2.2 miles) Connector Interchange (with SR54) and Gap expressway project at the northern end for Caltrans with the 15km (9.3 mile) SBE toll road to the south. Major construction challenge was the big bridge of the project - a 1200m (3/4 mile) long eleven span bridge on a double row of columns going to a height of 55m (180ft) over the Otay River. (The height was needed to limit highway grades on the approaches - no ocean-going ships though they'd fit!) Curving throughout its length and built of 644 precast segments up to 70 tons each the post-tensioned structure was an intricate work that seems to have proven more difficult and expensive than envisaged. There were complex 'community development projects' such as hiking, bicycle and equestrian trails and an athletics complex worth $18m and nearly $20m of 'environmental mitigation' as part of the deals done to overcome opposition to the project from local groups and federal regulators (EPA).
Project characteristics	The SR 125 South project will initially be constructed as a four-lane, 11.5-mile limited access highway. The project includes a two-mile non-tolled segment funded by SANDAG, known as the San Miguel Connector, and a 9.3-mile privately-financed toll road.
Lane miles	37.20
Cost per lane mile (US$ million/mile)	17.07

Project Code	G
Project Name	Sea to Sky Highway
Location	British Columbia, Canada
Estimated construction cost ($ million)	US$450
Final construction cost ($ million)	US$450
Estimated construction schedule	August 1st, 2005 – Nov 30th, 2009
Final construction schedule	August 1st, 2005 – Sept 30th, 2009
Project characteristics	Highway Improvement project - Total lane length = 296.70 kms (184.36 lane miles) which includes Temporary lanes = 155.7 kms (96.74 lane miles)
Lane miles	184.36
Cost per lane mile (US$ million/mile)	2.44

Project Code	H
Project Name	Fredericton Moncton Highway
Location	New Brunswick, Canada
Estimated construction cost ($ million)	US$585
Final construction cost ($ million)	US$585
Estimated construction schedule	April 1st, 1998 - Nov 30th, 2001
Final construction schedule	April 1st, 1998 - Oct 1st, 2001
Project characteristics	195 kilometres (121.17 miles) of four-lane highway from Longs Creek to Magnetic Hill. 21 interchanges (including four high speed interchanges). Five structures across rivers. St. John River bridge - fourth longest in province - 1,063 metres. Jemseg River bridge - fifth longest in province - 977 metres. 37 standard structures - (378 concrete beams). 26 open arch structures.
Lane miles	484.64
Cost per lane mile (US$ million/mile)	1.21

Project Code	I
Project Name	Camino Columbia Bypass
Location	Texas, United States
Estimated construction cost ($ million)	US$450
Final construction cost ($ million)	US$450
Estimated construction schedule	Jan 30th, 1997 - Oct 1st, 2000
Final construction schedule	Jan 30th, 1997 - Oct 1st, 2000
Project characteristics	SH 255 begins at the Colombia Solidarity International Bridge on the United States-Mexico border northwest of Laredo in Webb County. It heads northeast from the border as a 4-lane divided highway to an intersection with FM 1472. The highway continues to the northeast as a 4-lane divided highway but merges down to a 2-lane road just west of the former toll barrier. SH 255 continues northeast to an intersection at FM 3338 and a diamond interchange with US 83. It continues to the northeast to its eastern terminus at I-35
Lane miles	54
Cost per lane mile (US$ million/mile)	8.33
Notes	Decided as a lifetime toll road but project failed in 6 years. An independent auditor predicted that the Camino Colombia road would generate $9 million in revenue within the first year, but instead it only received $500,000. By 2004, the toll road had failed and bondholders foreclosed on the remaining $75 million note. The road was sold at an auction for $12.1 million to John Hancock Financial Services Inc. TxDOT had initially bid $11.1 million for the road, but was unwilling to increase its offer. After purchasing the roadway, John Hancock Financial Services, Inc. immediately closed the road to all traffic. This move forced TxDOT to pay the private company $20 million to purchase the road, allowing it to finally reopen the route after five months.

Project Code	J
Project Name	Golden Ears Bridge
Location	British Columbia, Canada
Estimated construction cost ($ million)	US$808
Final construction cost ($ million)	US$808
Estimated construction schedule	June 1st, 2006 – June 30th, 2009
Final construction schedule	June 1st, 2006 – June 9th, 2009
Project characteristics	Consisting of approximately 40 lane-km (24.85 lane miles) of grade-supported roadway and 20 lane-km (12.42 lane miles) of roadway on bridge structures
Lane miles	37.5
Cost per lane mile (US$ million/mile)	21.55

Project Code	K
Project Name	Confederation Bridge
Location	PEI, Canada
Estimated construction cost ($ million)	US$840
Final construction cost ($ million)	US$840*
Estimated construction schedule	Oct 7th, 1993 - May 31st, 1997
Final construction schedule	Oct 7th, 1993 - May 31st, 1997
Project characteristics	Spanning the Northumberland Strait at a length of 12.9 kms (8 miles) it is the longest bridge of its kind in the world
Lane miles	16
Cost per lane mile (US$ million/mile)	52.50
Notes	*Unsubstantiated information on cost overrun of US$300 million in construction which could make the final construction cost of the project to be US$1140 million

Project Code	L
Project Name	Highway 104 Cobiqued Pass
Location	Nova Scotia, Canada
Estimated construction cost ($ million)	US$112.9
Final construction cost ($ million)	US$112.9
Estimated construction schedule	March 1st, 1996 - Nov 15th, 1997
Final construction schedule	March 1st, 1996 - Nov 15th, 1997
Project characteristics	45 kms (27.96 miles) between Masstown and Thomson - Twinned, four lanes. Wide median: 22.6 metres. 18 kms (14 miles) of access roads. Five full interchanges. 21 bridges including river crossings. Five lateral access tunnels.
Lane miles	111.84
Cost per lane mile (US$ million/mile)	1.01