AN EXPLORATION OF THE INFLUENCE OF PUBLIC-PRIVATE-PARTNERSHIPS ON THE LIFE CYCLE DESIGN DECISION-MAKING PROCESS OF HIGHWAY PROJECTS

By

ERIC ISRAEL ANTILLÓN

B.S., University of Colorado Boulder, 2010

M.S., University of Colorado Boulder, 2010

A thesis submitted to the
Faculty of the Graduate School of the
University of Colorado in partial fulfillment
of the requirement for the degree of
Doctor of Philosophy

Department of Civil, Environmental and Architectural Engineering

2016

This thesis entitled:

An Exploration of the Influence of Public-Private Partnerships on the Life Cycle Design Decision-Making Process of Highway Projects

written by Eric I. Antillón

has been approved for the Department of Civil, Environmental and Architectural Engineering

____

Dr. Keith R. Molenaar
(Co-Committee Chair)

____

Dr. Amy Javernick-Will
(Co-Committee Chair)

____

Dr. James E. Diekmann

____

Dr. Paul M. Goodrum

____

Dr. Michael J. Garvin

Date________________

The final copy of this thesis has been examined by the signatories, and we find that both the content and the form meet acceptable presentation standards of scholarly work in the above mentioned discipline.

IRB Protocol #: 14-0001

ABSTRACT

Antillón, Eric Israel (Ph.D., Civil, Environmental, and Architectural Engineering)

An Exploration of the Influence of Public-Private Partnerships on the Life Cycle Design Decision-Making Process of Highway Projects

Dissertation directed by Professor Keith R. Molenaar and Professor Amy Javernick-Will

In recent years, Public-Private Partnerships (P3s) have become a prevalent solution to deliver highway projects across the United States (US). Over the last two decades, 22 design-build-finance-operate-maintain (DBFOM) highway projects have been implemented, with half of these projects being awarded between 2011 and 2015 alone. The use of P3s for the delivery of highway projects is driven by many factors, including: the ability to help close the increasing gap between declining funds and infrastructure costs; the ability to reduce pressure on government budgets; the ability to expedite financing; and the opportunity to facilitate innovation. Of interest in this dissertation, however, is the ability of P3s to improve life cycle-oriented design strategies during design and construction. Previous studies have addressed certain advantages and disadvantages of P3s found *within* a particular life cycle phase in P3s. Other studies have explored how innovation is affected by the implementation of P3s. However, there are research gaps that include an exploration of: 1) advantages and disadvantages *throughout* a project's overall P3 life cycle phase; 2) life cycle design innovations and contract timing; and 3) life cycle design decision-making processes as a function of P3 organizational structures.

This dissertation increases the understanding of these three gaps through case study analyses. The case study design includes both single and multiple-case study analyses. The overarching research question posed for this dissertation is: *How do P3s influence the life cycle design decision-making process of highway projects?* To further understand and explore this research question, three research sub-questions were further broken down as: 1) *What are the relative advantages and disadvantages of P3s over conventional design-bid-build (DBB) delivery across a project's P3 life cycle?* 2) *How does contract timing influence the ability to realize life cycle design innovations in P3 highway projects?* 3) *How do P3 organizational structures influence the life cycle design decision-making process of highway projects?* In response to these questions, Chapter 2 provides a holistic comparison of advantages and disadvantages of P3s across a project's P3 life cycle. Through a single case study, the perceived advantages and disadvantages found in the literature are verified and organized in a conceptual P3 life cycle framework. A 'grounded theoretical model' is produced to explain the relative advantages and disadvantages of P3s

over conventional DBB delivery. Chapter 3 addresses the second question by employing a multiple-case study of three P3s and classifies life cycle design innovations through an 'innovative lens.' This approach provides a conceptual model that illustrates when more 'radical' life cycle design innovations can be realized, and how contract timing can influence the ability to realize life cycle design innovations in P3s. Chapter 4 addresses the third question, through a multiple-case study of the same three P3s. This chapter first identifies intended organizational approaches shown through mechanisms of coordination that increase P3 project integration. These intended approaches are then thoroughly analyzed against what was actually implemented to explore how the life cycle design decision-making processes were affected.

This dissertation contributes to a better understanding of how P3s influence the life cycle design decision-making process in highway projects. P3 project delivery has been purported to improve life-cycle design decision-making, but this research found that this advantage is not always realized. This dissertation presents frameworks and models that researchers and practitioners can use as a reference to successfully execute future P3s. It will help to insure that the intended P3 advantages are realized, while disadvantages are mitigated or improved at best.

ACKNOWLEDGEMENTS

I would like to acknowledge the many individuals who have helped me get to where I am today, and who have inspired me to pursue and finish a PhD.

First and foremost, I want to thank my parents and brothers who have always been there for me. My parents decided to move to Denver back in the summer of 1999, from Mexico, to give me and my brothers a better future. I will forever be grateful and acknowledge their sacrifice in doing so. Fast forward 17 years to the summer of 2016 and never would I have imagined I would be defending and submitting a PhD dissertation, from the University of Colorado at Boulder. Gracias mama, papa, Jaco, y Edwin.

Words cannot express how grateful I am and will continue to be for the guidance (and patience) my two co-advisors have given me over the past four and a half years, Dr. Keith Molenaar and Dr. Amy Javernick-Will. Keith, thank you for everything you have done for me. I will always be indebted with you. You always saw the potential in me to pursue a PhD from when I first considered it, and your guidance has been invaluable. Amy, thank you for all your help and support, I would not have been able to complete this without your guidance, and I am very grateful. It truly is an honor and I am humbled to have had the opportunity to be guided by two outstanding individuals who are role models to many around the world and who have already left the world in a much better place because of who they are. I will always look up to you both. I look forward to one day being as awesome as you two are, and I must say that your passion and dedication is part of the inspiration that has helped me finish strong.

I want to thank Dr. James Diekmann and Dr. Paul Goodrum, from the University of Colorado at Boulder, and Dr. Michael Garvin, from Virginia Tech, who willingly gave their time and energy to serve on my dissertation committee. The feedback and guidance that you have provided throughout my journey has been invaluable. I am humbled to have had the opportunity to have you serve on my committee. Your work has shaped the Construction Engineering and Management research field into what it is today, and I could have not asked for a more perfect committee. Thank you.

I would like to thank the many individuals who have been part of my PhD journey throughout these years. I have had the unique opportunity to collaborate and work with many different organizations, but most importantly, it has been the individuals in these organizations that have all influenced my work and who I am today. Starting with Dr. John B. Miller with whom I collaborated during my first year in the program populating the Barchan Database. His work, my exposure to his knowledge, and his wisdom opened my eyes to the world of P3s, and also laid the foundation of what my research would become. My friend Erick

Oechler who from a casual meeting and conversation in Boulder, it led to me working in Mexico City in the summer of 2012 with Hermes Infraestructura, while providing consulting services. This was the beginning of what would become a strong financial, analytical understanding of infrastructure projects for me. Matt Morris with whom I had the pleasure and opportunity to conduct a unique research project on prefabrication as part of an internship with Mortenson Construction the summer of 2013. We really did a great piece of work together that summer, and our work was later acknowledged in ENR as part of a special issue. Thank you for sharing your wisdom with me.

I would like to thank Professor Raymond Levitt from Stanford University who hosted me during the spring of 2014. What an honor it was to have had the chance to share my thoughts and ideas on my proposed research, and to get feedback from him during the time I was there. It was also quite humbling to be part of the Global Projects Center and collaborate with all the visiting researchers and graduate students that spring. I also want to thank Bob Masys, Lee Saage, and Shari Tavafrashti from the San Francisco County Transportation Authority who were so welcoming and supportive while hosting me when conducting the research on the Presidio Parkway project that same spring. And Professor Qingbin Cui and my friend Amir Ghorban from the University of Maryland with whom I had the pleasure of partnering and conducting the research for the Presidio Parkway project. It truly was a memorable spring in the Bay Area, and I have no doubt our paths will cross again in the future. Thank you.

Finally, I also want to extend my appreciation and gratitude to all my fellow classmates and friends that I have had the opportunity of meeting during these years. I want to acknowledge all the memorable times and laughs in ECCE 153. Also, you are all awesome people who inspire and push each other tremendously, and you have all been part of my work in one way or another. I will always be grateful for having had the opportunity to interact with all of you during my time here, and I look forward to seeing many of you in the years to come. Starting with the Construction Engineering and Management research group, former and current students, Dr. Nat Sobin, Dr. Dan Tran, Dr. Christopher Harper, Tim Mcguire, Dr. Wesam Beitelman, Dr. Harrison Mesa, Scott Stanford, Arthur Antoine, and Doug Alleman. From the Global Projects and Organizations research group, Dr. Elizabeth Jordan, Dr. Jessica Kaminsky, Dr. John Wanberg, Dr. Kaitlin Litchfield, Dr. Jeff Walters, Aaron Opdyke, Kyle Kwiatkowsky, Cristina Poleacovschi, Erin Arnerson, and Shaye Palagi. And also many other officemates and friends from other offices and outside CU that I do not mention here, but you all know who you are.

Thank you.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: Introduction

The United States (US) is facing an 'infrastructure funding crisis.' Outdated and aging infrastructure that serves as the engine to the US economic activity continues to deteriorate, while needed upgrades and new expansions continue to be delayed (ASCE 2013a). In the transportation sector, highway spending makes up approximately 70% of all spending in surface transportation. The most up-to-date comprehensive data on highway spending shows a declining trend in the last decade for highway funding, while operations and maintenance (O&M) spending continues to increase (CBO 2015a). Public transportation agencies, particularly at the state and local level, are looking for alternative project delivery methods that enable them to keep up with the urgent need to deliver highway projects and to maintain an infrastructure system that can support the rapidly growing economy (CBO 2012).

Public-Private Partnerships (P3s) are a group of alternative delivery methods that have become increasingly attractive in recent years. The use of P3s seems to be a promising solution to help close this increasing gap between declining funds and infrastructure costs (Buxbaum and Ortiz 2009). The reason why P3s are implemented for the delivery of large and complex transportation projects are many, including, the ability to reduce pressure on government budgets, expedite financing, and facilitate innovation (FHWA 2013a). Public-Private Partnerships are defined as a long-term contractual arrangement between the public and private sectors where the private sector ultimately provides management and operating services and puts private finance at risk (Garvin and Bosso 2008). Of interest in this dissertation is the ability of P3s to improve life cycle-oriented design strategies during design and construction to improve the overall life cycle performance of these projects. Blanc-Brude et al. (2009) state that P3s incentivize the private partner to use life cycle design strategies because of the bundling of design, construction and O&M into a single contract - a key defining characteristic of P3s.

As of June 2015, half of the 22 existing transportation design-build-finance-operate-maintain (DBFOM) highway projects in the US were awarded between 2011 and 2015 alone (FHWA 2015; PW Financing 2015). While a variety of factors can contribute to improved life cycle performance, this study explores how the implementation of P3s, as a project delivery mechanism for highway projects, influences the life cycle design decision-making process. The overarching conceptual research question explored in this dissertation is: *How do P3s influence the life cycle design decision-making process of highway projects?* To study this phenomenon, an in-depth, multiple-case study approach of three US P3 projects was conducted.

Research Context

The following section sets the backdrop for how this research has taken shape. It starts with *the broader context* of the research, primarily focused on the issues surrounding the current deficient state of surface transportation infrastructure in the US, and highlights the trends that have led to the consideration and use of P3s. The background then transitions into a more refined overview, *the narrow context*, providing a concise synopsis of the main dissertation research thrusts. In this section, the research gaps identified and the research sub-questions are provided.

The Broader Context: Closing the Infrastructure Gap

Infrastructure investment and infrastructure condition are related to quality of life in a society (Miller 2000). Unfortunately, the current state of the US infrastructure as a whole is considered to be performing at a poor condition. As rated by the the Report Card on America's Infrastructure (ASCE 2013b), America's infrastructure is considered to be performing at an average grade of "D+," which is considered to be a 'poor' condition, below standards. Infrastructure systems are considered to be outdated and are failing to meet the needs of our society. Many of the infrastructure systems in the nation are deteriorating, and such conditions and performance have an economic impact on both households and businesses (ASCE 2011).

The rating of surface transportation infrastructure in this report, which includes critical highways (including tunnels), bridges, rail, and transit systems, rates the performance of each transportation type as D, C+, C+, and D respectively (see Figure 1-1). In 2010, this deficiency in surface transportation was estimated to cost households and businesses approximately $130 billion per year. The primary costs are those imposed on cars because of the deteriorated conditions and performance, which lead to an increase in operating costs, travel time delays, safety and environmental costs, among others (ASCE 2011).

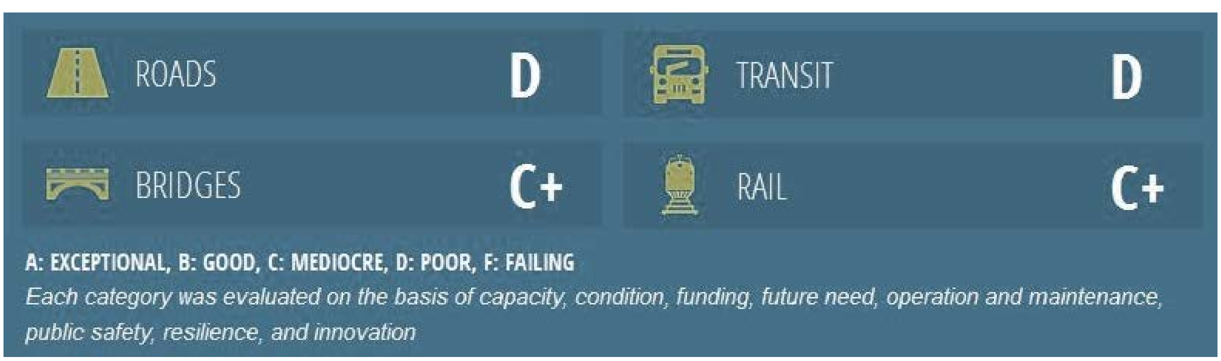


Figure 1-1: Surface Transportation Infrastructure Grades 2013 (Source: ASCE 2013b)

Surface transportation infrastructure enables people and goods to access the markets, services, and inputs of production essential to the nation's economic vitality. However, the current deficient state of surface transportation infrastructure in the US, and more specifically the deteriorated conditions and performance of highways, coupled with the critical roads that need to be reconstructed, is affecting the nation's economy (ASCE 2013a). It is estimated that the cost to maintain all of the nation's highways at their current conditions would cost an annual investment of $196 billion ($2010) from 2010 to 2040. This same estimate points out that by the year 2020, out of a $1,510 billion estimated cost to maintain the current highway system, only $754 billion, or approximately 50%, would be available. This does not even consider improvement of the existing system as is, it is only the cost to *maintain* existing highway pavement and bridges (ASCE 2011).

Figure 1-2 shows the approximate breakdown of the type of spending on surface transportation for the year 2014. In 2014, approximately $233 Billion was spent on surface transportation. Highways, including bridges and tunnels, account for approximately $165 Billion, or 70% of the total investment in surface transportation. Approximately 44% of this investment was also spent on operation and maintenance costs (CBO 2015a).

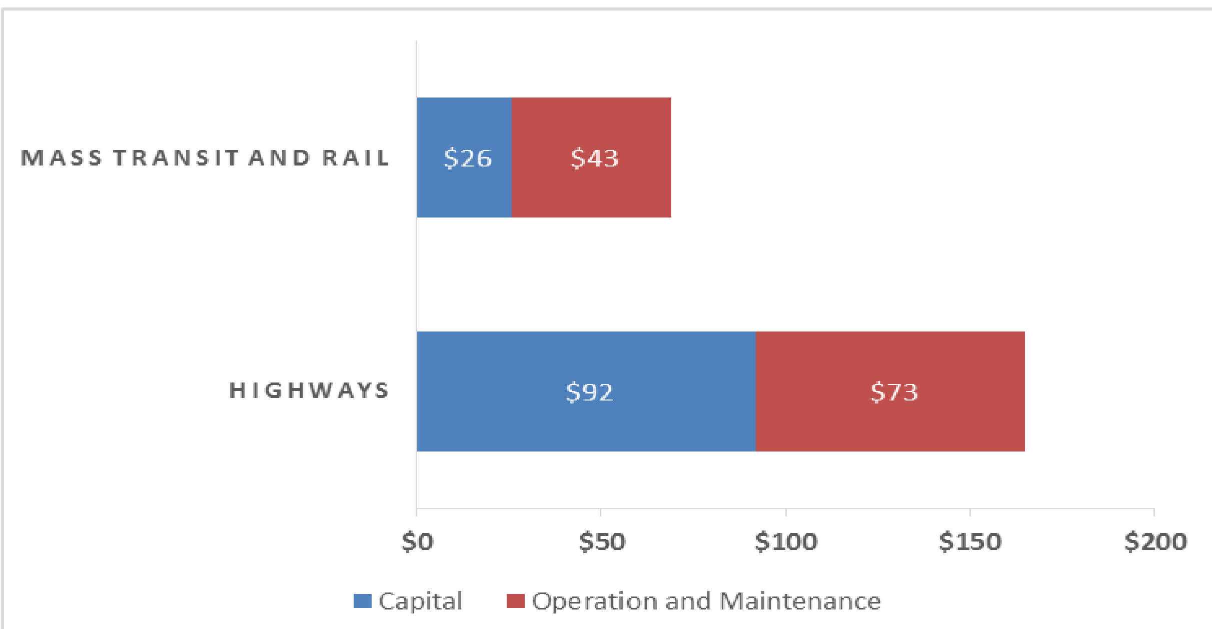


Figure 1-2: Pubic Spending in Surface Transportation in 2014 ($2014 Billions) (Source: CBO 2015b)

Recent data on public spending since 1956 for highways, the year construction of the Interstate Highway System began, show a deteriorating condition of highways and roads in the US. The data also show how the current funding crisis continues to get worse. In the last decade, the US has experienced a steady increase in O&M spending, as a percentage of total spending for highways, going from approximately 36% in 2003 to 44% in 2014. Coincidentally, total public spending has been decreasing, having peaked in 2002 at approximately $203 Billion ($2014) to the approximate $165 Billion spent in 2014 (see Figure 1-3).

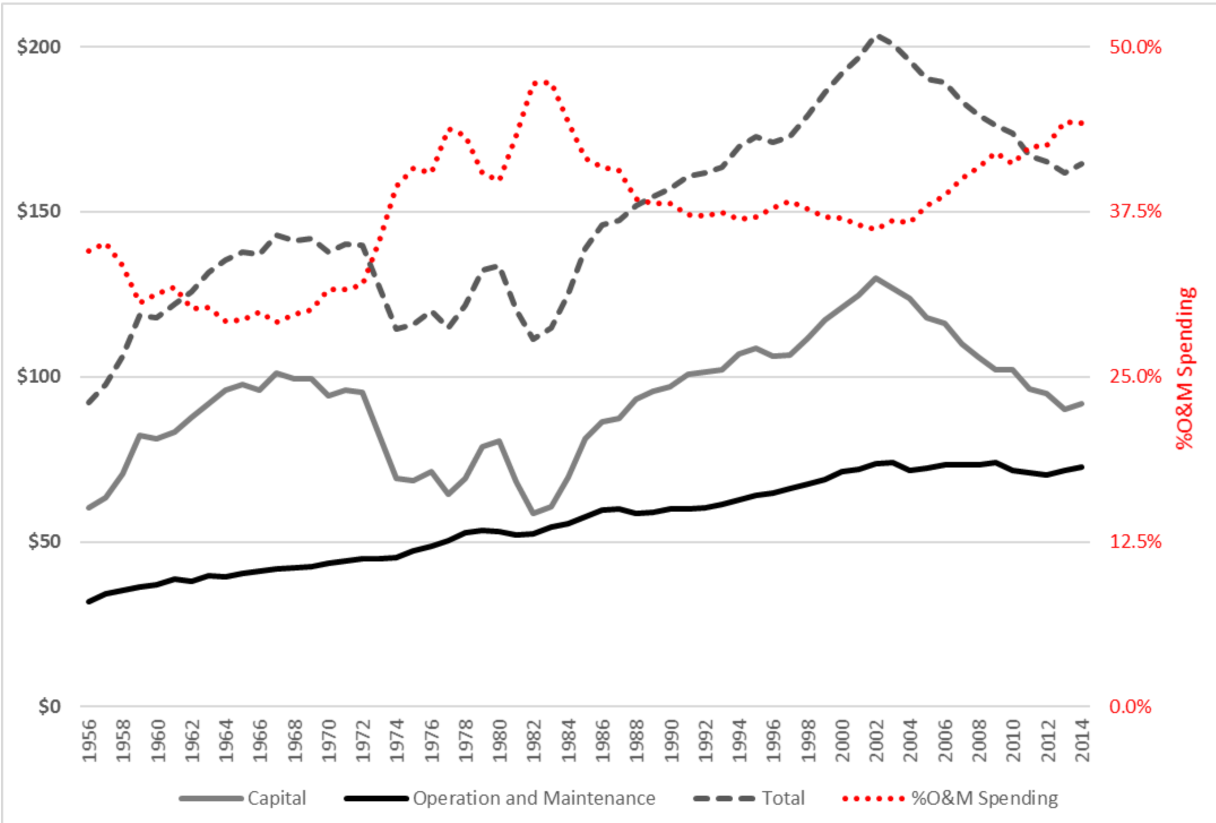
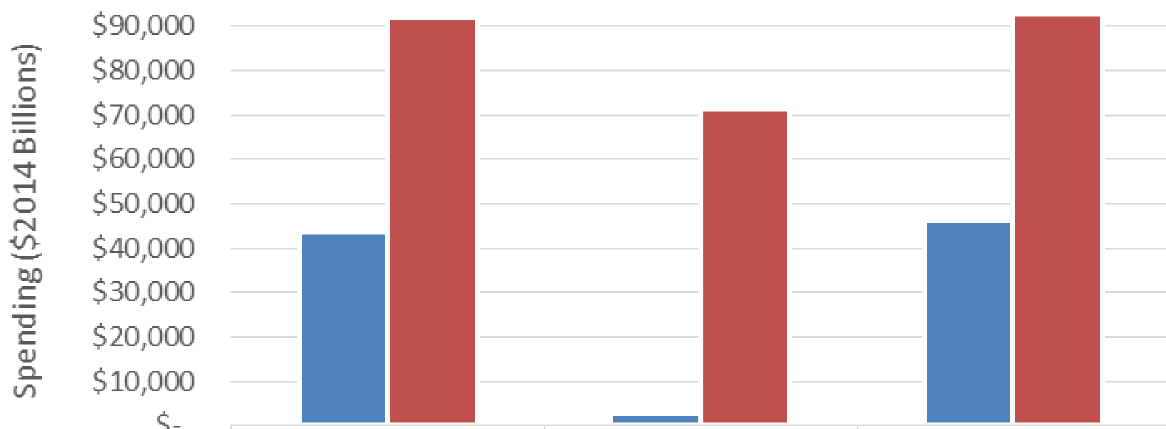


Figure 1-3: Capital vs. O&M Highway Spending in the US, 1956 – 2014 ($2014 Billions) (CBO 2015b)

What can be observed from these trends is that an aging infrastructure highway system continues to deteriorate, requiring the steady increase in O&M spending, while available funding for capital investment declines as a consequence of the total funding available for highway spending. Therefore, the gap between transportation costs and funding continues to grow every year as shrinking sources of funding disappear and the need for infrastructure investment grows. While the sources of funding come from federal, state, and local sources, O&M costs have historically been covered by state and local sources of funding. In 2014, state and local sources covered 96% of all O&M costs (CBO 2015b), as shown in Figure 1-4.



	Capital	Operation & Maintenance	Total
Federal	$43,583	$2,735	$46,318
State & Local	$91,908	$71,289	$163,197
Federal	32.2%	3.7%	22.1%
State & Local	67.8%	96.3%	77.9%

Figure 1-4: Share of Public Spending in Highways, by Level of Government, 2014 (Source: CBO 2015b)

Over the past two decades, public agencies in the US have become increasingly interested in P3s. This trend has been particularly prominent in surface transportation projects. A capital investment of approximately $35.5 billion, including current projects under construction, has been invested across 32 surface transportation projects since 1993 (PW Financing 2015), most of which has been in highway projects. The lack of available public funding is often attributed to be one of the driving reasons for considering P3s for the delivery of infrastructure projects. Through P3s, public agencies benefit from the private sector's ability to raise additional capital through innovative financing. P3s can close the funding gap to deliver projects needed today and provide a consistent cost for maintenance, as opposed to traditional pay-as-you-go financing that significantly lengthens the time to deliver these projects (Deloitte Research 2007).

To put into perspective the increasing trend of P3s to deliver major transportation project in the US, PW Financing (2015) published a summary of all transportation P3s in the US since the early 1990's (see Table 1-1). In this summary, 22 DBFOM transactions represent approximately $26.7 billion (YOE) of this overall P3 activity. From 2008 on-wards, DBFOM type of P3s have really begun to emerge in the US transportation sector.

Table 1-1: US Transportation P3s 1993-2015 (Source: PW Financing Database, June 2015)

!	PROJECT STATUS (06/2015)	NTP DATE	PROJECT NAME	PROJECT SPONSOR	DELIVERY TYPE	INVESTED CAPITAL (Nominal $M)	INVESTED CAPITAL** (Adj. $2015 M)
1	Operation	Jul-93	91 Express Lanes, CA	Caltrans	DBFOM (toll)	$ 130	$ 195
2	Operation	Sep-93	*Dulles Greenway, VA	Virginia DOT	DBFOM (toll)	$ 350	$ 525
	Operation	May-99	*Foley Beach Express, AL	City of Foley, AL	BOO (toll)	$ 44	$ 60
	Operation	Jun-99	*Camino Colombia Bypass, TX	Texas DOT	BOO (toll)	$ 90	$ 122
	Operation	Oct-00	*Las Vegas Monorail, NV	Clark County, NV	DBFOM (farebox)	$ 343	$ 451
3	Operation	May-03	*South Bay Expressway (SR 125), CA	Caltrans	DBFOM (toll)	$ 773	$ 971
	Operation	Jan-05	*Chicago Skyway, IL	City of Chicago	99-yr lease (toll) #	$ 1,830	$ 2,187
	Operation	Jun-06	*Pocahontas Parkway Lease, VA	Virginia DOT	99-yr lease (toll) #	$ 611	$ 702
	Operation	Jun-06	*Indiana Toll Road, IN	Indiana Finance Authority	75-yr lease (toll) #	$ 3,850	$ 4,422
	Operation	May-07	*Northwest Parkway Lease, CO	Northwest Parkway Authority	99-yr lease (toll) #	$ 603	$ 674
4	Operation	Mar-08	*SH 130 segments 5-6, TX	Texas DOT	DBFOM (toll)	$ 1,358	$ 1,497
5	Operation	Jul-08	*I-495 Express Lanes, VA	Virginia DOT	DBFOM (toll)	$ 1,998	$ 2,178
6	Operation	Feb-09	I-595 Managed Lanes, FL	Florida DOT	DBFOM (avail.)	$ 1,814	$ 1,969
7	Operation	Oct-09	Port of Miami Tunnel, FL	Florida DOT	DBFOM (avail.)	$ 914	$ 991
8	Operation	Dec-09	North Tarrant Express, TX	Texas DOT	DBFOM (toll)	$ 2,047	$ 2,220
9	Construction	Jun-10	IH 635 (LBJ) Managed Lanes, TX	Texas DOT	DBFOM (toll)	$ 2,800	$ 3,012
10	Construction	Aug-10	Denver Eagle PPP Rail, CO	Denver RTD	DBFOM (avail.)	$ 2,100	$ 2,249
	Operation	Jan-11	Jordan Bridge, VA	Chesapeake , VA	BOO (toll)	$ 140	$ 149
	Operation	Sep-11	PR-22/PR-5 Lease, Puerto Rico	Gov't Development Bank	40-yr lease (toll) #	$ 1,136	$ 1,189
11	**Construction**	**Apr-12**	**Midtown Tunnel, VA [1]**	**Virginia DOT**	**DBFOM (toll)**	**$ 2,088**	**$ 2,161**
12	**Construction**	**Jun-12**	**Presidio Parkway (phase 2), CA [1]**	**Caltrans**	**DBFOM (avail.)**	**$ 365**	**$ 378**
13	Construction	Aug-12	I-95 Express Lanes, VA	Virginia DOT	DBFOM (toll)	$ 940	$ 969
14	Construction	Mar-13	East End Bridge (Ohio River Bridges), IN	Indiana Finance Authority	DBFOM (avail.)	$ 1,180	$ 1,207
	Construction	Jun-13	Cline Ave. Bridge, IN	Indiana DOT	BOO (toll)	$ 200	$ 204
15	Construction	Sep-13	North Tarrant Express (3A/3B), TX	Texas DOT	DBFOM (toll)	$ 1,400	$ 1,422
16	Construction	Nov-13	Goethals Bridge, NY-NJ	Port Authority NYNJ	DBFOM (avail.)	$ 1,500	$ 1,519
17	**Construction**	**Feb-14**	**US 36 (phase 2), CO [1]**	**CDOT/HTPE**	**DBFOM (toll)**	**$ 181**	**$ 182**
18	Construction	Jul-14	I-69 Upgrade (Section 5), IN	Indiana DOT	DBFOM (avail.)	$ 370	$ 370
19	Construction	Sep-14	I-4 Ultimate, FL	Florida DOT	DBFOM (avail.)	$ 2,323	$ 2,324
20	Construction	Jan-15	Pennsylvania Rapid Bridges, PA	PennDOT	DBFOM (avail.)	$ 899	$ 899
21	Construction	Apr-15	Portsmouth Bypass, Ohio	Ohio DOT	DBFOM (avail.)	$ 550	$ 550
22	Construction	Jun-15	I-77 Managed Lanes, NC	North Carolina DOT	DBFOM (toll)	$ 648	$ 648
	KEY				**P3s TOTAL:**	**$ 35,575**	**$ 38,596**
	* underperforming/bankrupt				! DBFOM P3s TOTAL:	$ 26,728	$ 28,436
	# upfront lease payment						
	! Numbered DBFOM P3s comparable in this study						
	[1] PWF Financial Data Internally Verified w/ Project Documents in this study						
	**Nominal cost adjusted to $2015 M using the GDP price deflator (BEA 2015)						

The projects in this database are considered to be P3s because of both the long-term transfer of O&M responsibility to the private sector and the private finance risk. Table 1-1 provides an insight into the relative youth of the US P3 market. The number of projects that have actually been delivered as DBFOM P3s, since DBFOM contracts are the most commonly implemented P3 contract structures in the US, is limited (see Figure 1-5 on the next page). The P3 projects that have been implemented are large, complex projects that add new capacity to heavily-travelled corridors, or reconstruct deteriorating capacity on the interstate highway system (Reinhardt 2011).

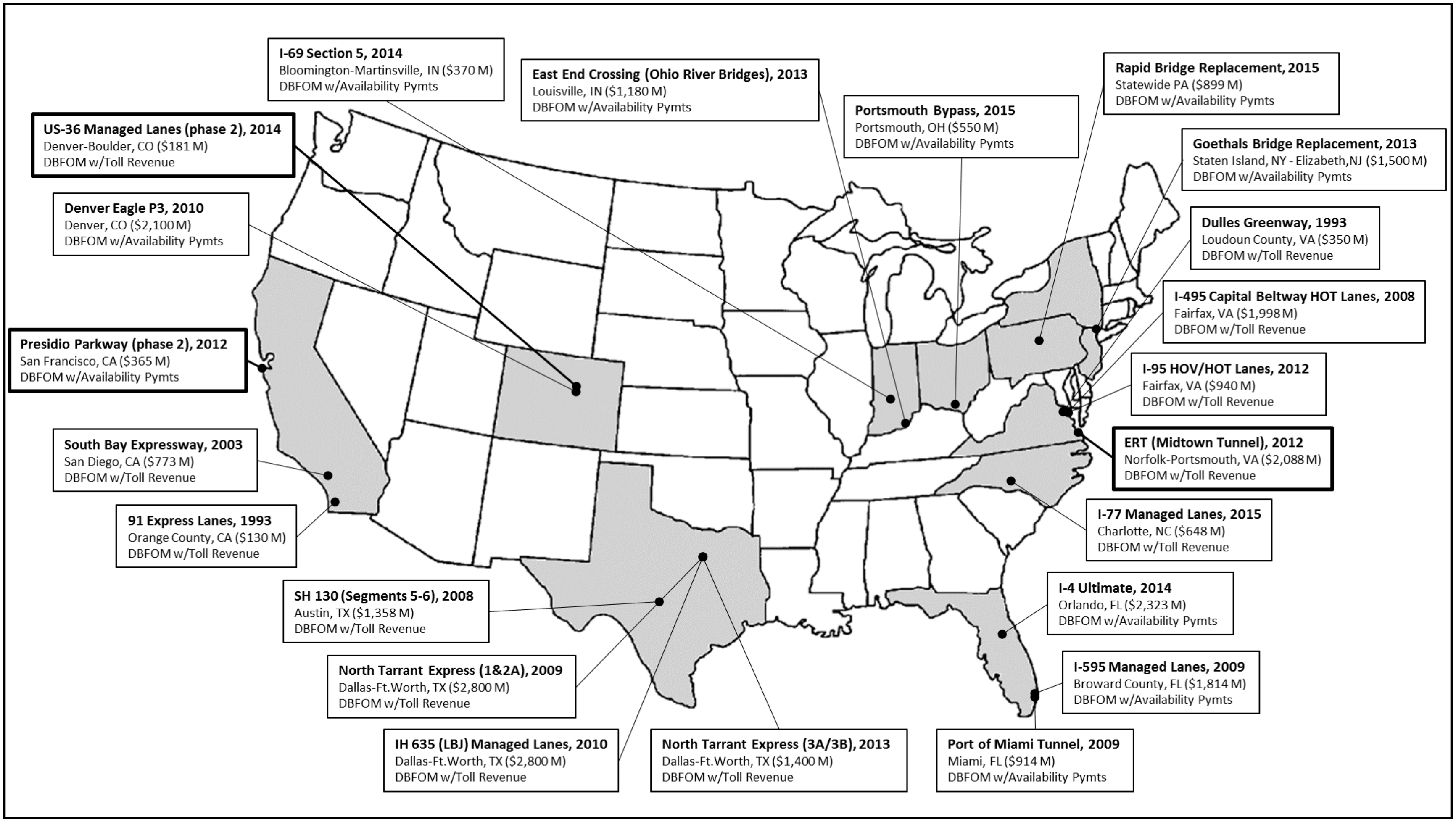


Figure 1-5: Overview of DBFOM Transportation P3s in the US (1993-2015) (PW Financing 2015)

The Narrow Context: Research Gaps and Research Questions

The previous section introduced the broader context discussing how P3s have become an increasingly attractive delivery method for highway projects in the US, and presented an overview of the existing P3 projects across the US. This section provides a concise synopsis of the main dissertation research thrusts that focus on addressing the overarching research question of "*How do P3s influence the life cycle design decision-making process of highway projects?"* The research gaps found in the literature are provided, and the research sub-questions are established to address each research gap. First, Chapter 2 focuses on identifying the *relative advantages and disadvantages of P3s* across a P3 project's life cycle. Second, Chapter 3 focuses on *contract timing* as one of the salient issues that influence the ability to realize life cycle design innovations in highway projects. And third, Chapter 4 focuses on *P3 organizational structures* and how they influence the life cycle design decision-making process of highway projects.

Chapter 2: Relative Advantages and Disadvantages of P3s

While this dissertation focuses on the perceived ability of P3s to perform an improved life cycle design process, Chapter 2 provides a broader discussion of P3 advantages and disadvantages for context. Previous studies have indicated the advantages that P3s offer to the public sector, such as: the ability to access multiple sources of financing to deliver larger and complex projects sooner; the ability to transfer project risks to the party that is best able to manage them; and establishing strong incentives to ensure that the project is delivered 'on-time' and 'within-budget,' among others. Commonly cited disadvantages include: legal and/or regulatory restrictions in implementing a P3; complex procurement and transaction processes that are not familiar to public agencies; and institutional inertia, or fear of change, and loss of control, among others (AECOM Consult Team 2007; Blanc-Brude et al. 2009; Deloitte Research 2007; NCSL 2010).

Previous studies have focused on certain advantages or disadvantages found within a specific phase in a project's P3 life cycle, and some have made comparisons to the traditional delivery approach. For example, some have focused on the discussion of risk transfer (Grimsey and Lewis 2002), or the 'value for money' approaches and evaluation techniques implemented in the *transaction phase* of P3 projects (Morallos and Amekudzi 2008; Morallos et al. 2009; OECD 2008). Others have focused on measuring both cost and schedule project performance in the delivery of P3s (Raisbeck et al. 2010), or cost performance only (Bain 2010; Chasey et al. 2012; MacDonald 2002; Ramsey and Mounir 2015), while comparing performance to traditional DBB projects during *the design and construction phase* of P3s. And others have focused on policy and public interest considerations (Buxbaum and Ortiz 2009; Grout 1997) typically considered during the *planning phase* before the transaction even begins. None of these studies, however, have performed an assessment to fully understand what the relative advantages and disadvantages across a project's *P3 life cycle* are, and, how they compare to traditional delivery approaches.

In order to understand the relative advantages and disadvantages from implementing a P3 over conventional DBB delivery, a comparison across a project's P3 life cycle needs to be carried out. There is a practical need for identifying and evaluating the relative advantages and disadvantages of implementing a P3 over a project's life cycle, as public officials throughout the country are currently evaluating many of these factors while considering P3s. Given this context, the research gap and research question that Chapter 2 explores are:

- ***Research Gap 1:*** *A need to explore the relative advantages and disadvantages of P3s over conventional DBB delivery across a project's P3 life cycle.*
- ***Research Question 1:*** *What are the relative advantages and disadvantages of P3s over conventional DBB delivery across a project's P3 life cycle?*

Chapter 3: Contract Timing

The cost to operate and maintain infrastructure facilities, which have life spans that can range anywhere from 25 to 100 years or more, is said to be roughly 8-10 times the cost to initially deliver them. Figure 1-6 depicts the costs experienced by the public for one of these major infrastructure projects throughout their life cycle. Shown as a 1:10:100 ratio for infrastructure life cycle costs, for example, it means that for each dollar spent on design, 10 dollars will be spent in construction, which will result in 100 dollars spent in O&M throughout the life cycle of a facility (Miller and Gerber 2012).

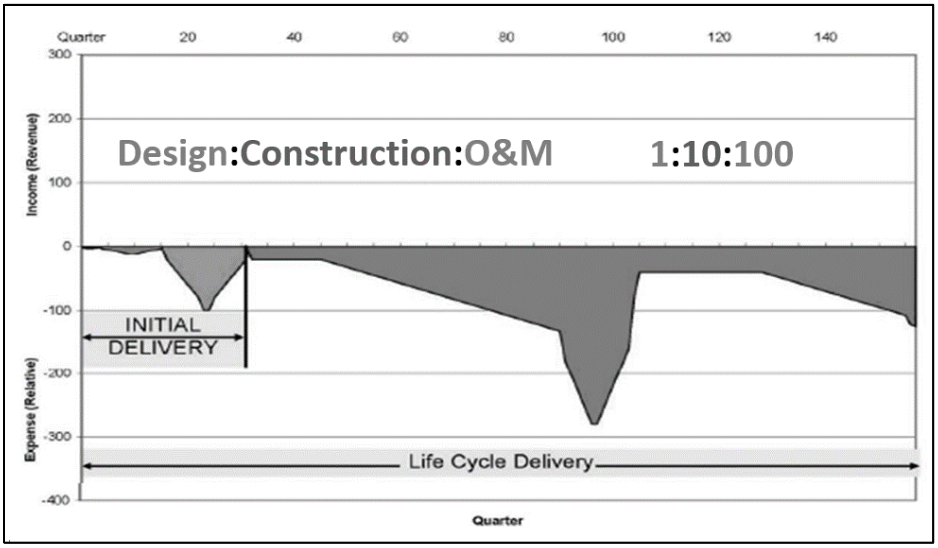


Figure 1-6: Infrastructure Facility Life Cycle Cost (adapted from Miller and Gerber 2012)

A highway project's life cycle begins with planning, goes through design, construction, operations, maintenance and the eventual end-of-life decommissioning/disposal (Ma et al. 2009; Sarja 2002). The major life cycle decisions are made during the initial delivery of a facility through the completion of the construction phase. Design decisions made in the earlier phases of a project have a greater influence on project outcomes. Paulson (1976) states that earlier decisions are made at a fraction of the cost of decisions made later in the project. Extending Paulson's concept to the highway project development phases and life cycle design decision-making, project stakeholders have the greatest ability to influence the long-term life cycle performance and outcomes in the planning, programming and preliminary design phases of a project.

Taking this concept of the timing in which design decisions are expected to have the greatest influence, *P3 contract timing* is defined as the point in which the private P3 concessionaire becomes contractually involved in the project. Design decisions that strategically benefit or improve the long-term life cycle performance of a project are prioritized and implemented with the intent of providing a better overall life cycle performance. Such design decisions are termed 'life cycle design' decisions in this dissertation. At the completion of final design or during construction, late 'timing,' any life cycle design decisions are likely to have a minimal impact, if any. In order to assess the magnitude of life-cycle oriented design changes that are carried out in a project or component, an innovation classification 'lens' can be implemented, thereby enabling to distinguish between 'radical' life cycle design changes, or innovations, and 'incremental' life cycle design changes.

In Russell et al. (2006), and Tawiah and Russell (2008), innovations based upon procurement mode were explored. Russell et al. (2006) hypothesized that "innovation in an infrastructure project is a function of the procurement mode adopted and innovation that is realized in P3s is greater." However, in both case studies the innovations found were incremental and the relationship between innovation potential and the procurement method adopted was 'tenuous'. Neither of these case studies, however, indicated how the contractual timing in these projects was managed and whether that affected the level of innovation that the projects accomplished, nor were they focused on 'life cycle-oriented' design innovations. Previous studies that have focused on exploring innovations in P3s (Eaton et al. 2006; Leiringer 2006; Russell et al. 2006; Tawiah and Russell 2008) have not explored life cycle design innovations.

To address the above gaps, this dissertation explores how contract timing affects the level of life cycle design innovation that the private sector can accomplish in P3s. More specifically, this study focuses on the contractual timing of the involvement of the private sector and on how this timing influences life cycle design innovations in P3s. The research gap and research question explored in Chapter 3 are:

- ***Research Gap 2:*** *A lack of understanding of the perceived ability to realize life cycle design innovation in P3s, given contract timing.*
- ***Research Question 2:*** *How does contract timing influence the ability to realize life cycle design innovations in P3 highway projects?*

Chapter 4: P3 Organizational Structures

The effectiveness of the organizational structure established in P3s is important to the realization of effective life cycle design. Previous studies have explored how P3 organizational structures increase integration (Davies and Salter 2006; Roehrich and Caldwell 2012). Increased integration among the project team members in P3s is perceived to create a motivating operational environment, and thus have the potential to decrease fragmentation and increase integration between the main project stakeholders and across project life cycle phases (Fergusson and Teicholz 1993; Sheffer and Levitt 2012). This integration should ultimately improve the life cycle design process. In comparison to the DBB design process, often viewed as a linear and fragmented process, the P3 design process works in an iterative 'whirlpool' process, with significant 'over-the-shoulder' design reviews by the P3 concessionaire, the design-build contractor, the O&M operator, financier, and, to some extent, the owner (Hatem and Gary 2013).

When a P3 project team is formed, this formalizes the organizational structure of the project. The roles and responsibilities of all project team members are defined, dividing the labor and allocating project risks. The hierarchy of the project team, indicating the expected lines of communication within the project team, and the boundaries of the organization are also established. In addition, coordination mechanisms, or formal rules and procedures, are defined with which the project team members are enabled to execute a project and expected to collaborate (Yescombe 2007).

The ability to have input into the design by project stakeholders typically involved in later phases of the project life cycle, downstream, provides the opportunity to better optimize and improve a project's overall life cycle performance. None of the previous studies, however, have explored how P3 organizational structures affect life cycle design decision-making. By taking a focus on the organizational structure of P3s, the research gap and research question explored in Chapter 4 are:

- ***Research Gap 3:*** *A lack of understanding of how P3 organizational structures affect the life cycle design decision-making process.*
- ***Research Question 3:*** *How do P3 organizational structures influence the life cycle design decision-making process of highway projects?*

Research Method

As discussed, there is a limited number of DBFOM highway P3 projects that have been implemented in the US, and an even smaller sample size of P3 projects that were going through the design and construction stage during the two-year data collection period of this study. Therefore, a case study research approach was selected for multiple reasons, including a limited sample size, the research question's focus on explaining and exploring 'how' P3s influence the life cycle design decision-making process, and because such phenomenon must be explored within its real-life context, in an on-going P3 project (Yin 2009).

To explore and answer the research questions, this research method implements a *case study research methodology* (Yin 2009). The central research question has been developed with the intent of exploring and implementing an *inductive research approach*. In general, an inductive approach builds from the data to broad themes to generalized models or theory, while deductive research tests or verifies theory (Creswell, 2009, p. 8). As Eisenhardt and Graebner (2007) discuss, "inductive and deductive logics are mirrors of one another, with inductive theory building from cases producing new theory from data and deductive theory testing, completing the cycle by using data to test theory." The research design was built upon this interpretation, depicted in Figure 1-7.

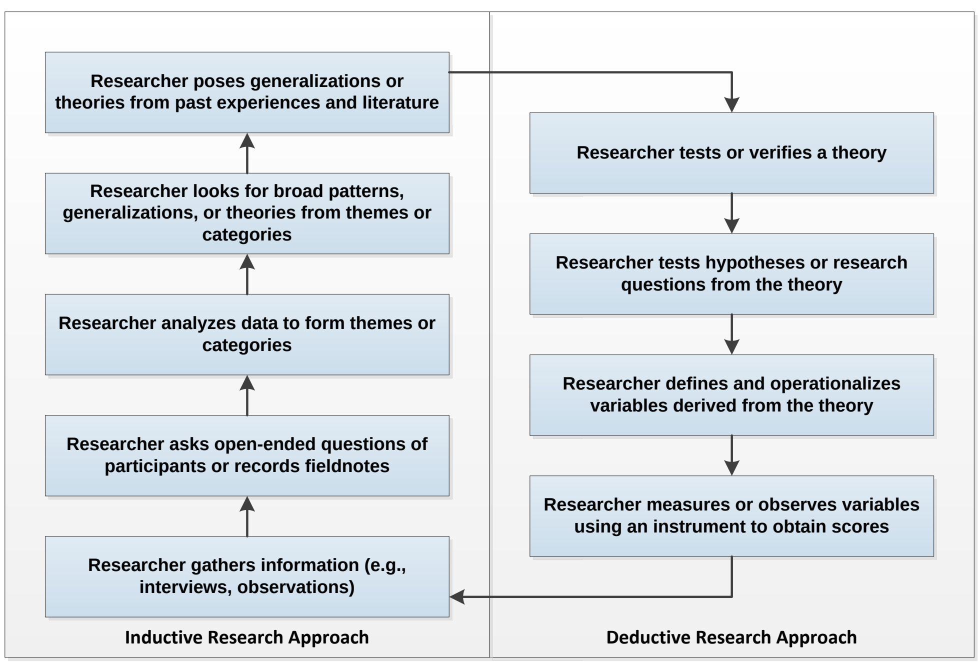


Figure 1-7: Inductive vs. Deductive Logic, "Completing the Cycle" (adapted from Creswell 2009)

A case study explores an issue through one or more cases within a *bounded system* (i.e. a setting, a context) through detailed, in-depth data collection involving *multiple sources of information* (i.e. interviews, documents and reports) (Creswell 2007, p. 79). As Yin (2009) explains, a case study serves well when one is trying to understand a real-life, contemporary phenomenon in depth (i.e., the design-decision making process) within its real-life context (i.e., P3 project cases), and when the boundaries between the phenomenon and its context are not clearly evident. Yin (2009, p. 8) frames three general conditions about the type of research being conducted to determine whether a case study is appropriate for a study. These conditions are (1) the type of research question posed, (2) the extent of control an investigator has over actual behavioral events, and (3) the degree of focus on contemporary as opposed to historical events. Given these conditions, the research question posed for this study, which is "*How do Public Private Partnership influence the Life Cycle Design Decision-making Process of Highway Projects in the US?,"* fits the exploratory format to implement a case study methodology; the design decision-making processes are events that cannot be controlled, they are behavioral events that this study is trying to further understand; and the design-decision making processes are considered to be *contemporary events*.

Case study methodology has recently become a prevalent research method within the Construction Engineering and Management (CEM) domain. Given the conditions that characterize the CEM domain (i.e. uniqueness of projects, duration, complexity), case studies allow CEM researchers to answer questions of how and why, and to contextualize a phenomenon and then define how it plays out under different contexts (Taylor et al. 2011).

Case Study Selection

The case studies were selected to represent a varied sample of representative highway P3 projects in the US. Given the existing DBFOM population of 22 completed or ongoing projects in the US, these three projects capture 14% of the potential population. Each P3 project is unique. The way in which the projects evolve to become 'P3s' introduces contextual differences. The cases were selected based upon four factors: (1) projects differed in contract timing; (2) projects had ongoing design and construction during our data collection periods; (3) projects varied in size, scope complexity and location, and (4) projects varied in P3 contractual structures, such as payment mechanisms and internal subcontracting (i.e. O&M subcontracting versus self-performing). Table 1-2 shows the three case study projects selected with respective project characteristics.

Table 1-2: Case Study P3 Highway Projects' Characteristics

PROJECT CHARACTERISTICS	PRESIDIO PARKWAY (PHASE II)	US-36 MANAGED LANES (PHASE II)	ELIZABETH RIVER TUNNEL (DT/MT/MLK EXTENSION)
LOCATION	San Francisco, CA	Denver-Boulder, CO	Norfolk-Portsmouth, VA
NTP DATE	2012	2014	2012
CONTRACT VALUE ($M)	$365 (ph.2) $496 (ph.1)*	$181 (ph. 2) $319 (ph. 1)*	$2,088
PROJECT DELIVERY METHOD	DBFOM w/APs	DBFOM w/tolls	DBFOM w/tolls
LEVEL OF ENVIRONMENTAL (NEPA) CLEARENCE	-EIS/ROD (Dec. 2008)	-EIS/ROD (Dec. 2009) -ROD 2 (Sept. 2012)	**Prior to P3 PDA:** -DT: EIS/ROD (July 2007) -MT: CE (May 2009) -MLK: EA/FONSI (Feb. 2009) **After P3 PDA:** DT/MT/MLK: EIS/ROD (March 2011)
CONSTRUCTION PHASING	Phase I, DBB Construction: Oct. 2009 – August 2013 Phase II, P3 Procurement: Feb. 2010 – June 2012 Phase II, P3 Construction: March 2013 - Nov. 2015 (est.)	Phase I, DB Construction: July 2012 – July 2015 Phase II, P3 Procurement: March 2012 – Dec. 2013 Phase II, P3 Construction: Jan 2014 – March 2016 (est.)	P3 Procurement: May 2008 – January 2010 P3 Interim Agreement: January 2010 – Nov. 2011: P3 Construction: Jan. 2012 – May 2018 (est.)
DESIGN (RELATIVE % COMPLETE AT BIDDING)	50% ('indicative' drawings)	30% (preliminary drawings)	10% (conceptual/schematic)
CONSTRUCTION PERIOD	2013-2015	2014-2016	2012-2018
CONCESSION PERIOD	30 Years	50 years	58 Years
PROJECT TYPE	Greenfield Reconstruction	Greenfield Reconstruction Brownfield Rehabilitation	Greenfield Construction Brownfield Rehabilitation
TRANSPORTATION MODES INCLUDED	Highway	Highway Bus Transit Bike/Pedestrian	Highway

Notes:
*Phase I (non-P3 scope) data provided for reference
P3 Procurement for Presidio and US 36 is from RFP Release to reaching Financial Close.
P3 Procurement for ERT is from RFP release to IA agreement execution.
PDA = Pre-Development Agreement in the ERT Project, also referred to as an Interim Agreement (IA).

The three case study projects selected are the Presidio Parkway project, the US-36 Managed Lanes project, and the Elizabeth River Tunnel project. Each project has a varied organizational structure that captures current highway P3 practices, and each project's unique setting for life cycle design opportunities to be implemented are also a factor that allows for different life cycle considerations to be explored. Data was collected on all three projects during their implementation, design-build phase, with the design being recently completed or close to being completed. Appendix A provides additional detailed information on the US-36 and Elizabeth River Tunnel projects. Chapter 2, the in-depth single case study, has detailed comparable information on the Presidio Parkway. Figure 1-8 1-8 shows the general case study research process for this study, which is further described throughout the rest of this section.

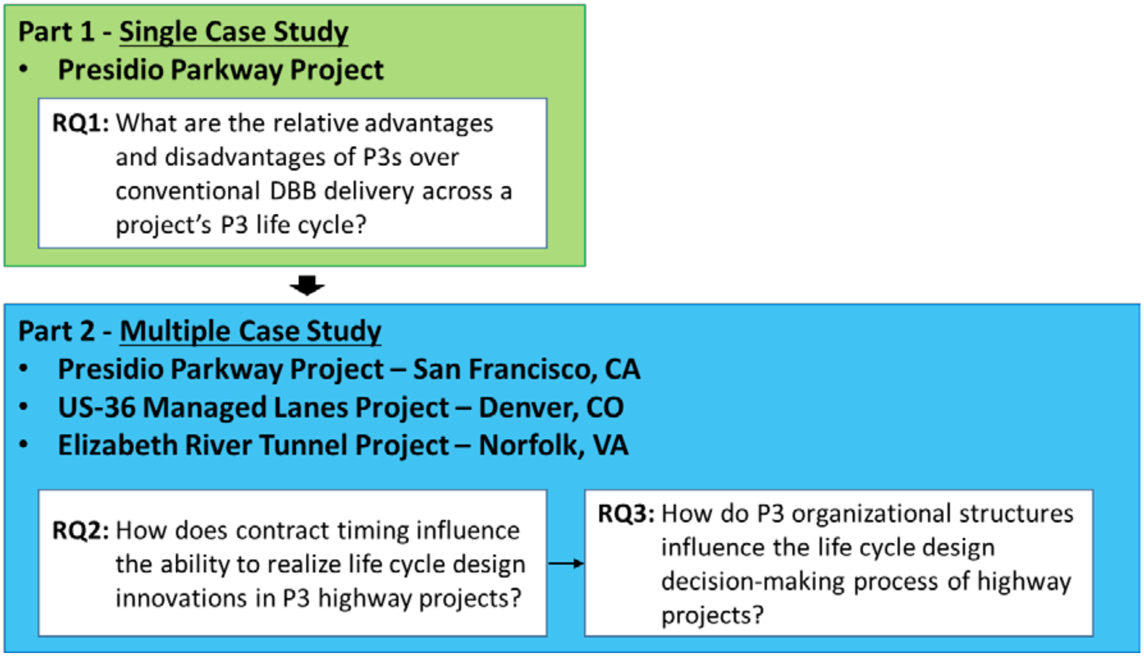


Figure 1-8: Case Study Research Method Process

The data collection period began in the Spring of 2014. The first part of the research process focused on conducting the single-case study of the Presidio Parkway project. During this period, a semester was spent on-site in San Francisco. The San Francisco County Transportation Authority (SFCTA) facilitated the data collection process of this particular project by helping to identify and contact the interviewees needed, and requesting the project documentation needed. The data gathered from this 'pilot' case study helped to structure the subsequent data collection process for the second part of the research process. Through a preliminary analysis of this first case study, emergent themes and findings set up the focus of the interviews for Part 2 data collection, which involved the US-36 Managed Lanes project and the Elizabeth River Tunnel project. The following sections provide details on the data collection and analysis processes.

Data Collection

The main sources of data were semi-structured interviews with project participants and content analysis of project documentation. Semi-structured, in-depth interviews with key decision-makers in each respective project were conducted to explore the main research questions. Appendix B provides a sample of the project interview protocol with which all project interviewees were provided with when asked for participation to be interviewed – an *External* and *Internal* protocol sample is provided. The interviewees were selected based upon their organizational role, current role in the projects, or former roles during the design development process of the projects. A total of 32 interviews were conducted, including single person (N=26) and two-person interviews (N=6), for a total of 38 interviewees. Table 1-3 lists the respective stakeholder organizations for each of the three projects that were interviewed, along with the number of interviewees from each respective role.

Table 1-3: Overview of the Interviewee Perspectives Covered Across the Three Projects

Interviewee Perspectives	Presidio Parkway	US-36 Managed Lanes	Elizabeth River Tunnel	Total
Private Stakeholders				
P3 Concessionaire	1	2	2	5
P3 Design-Build Constructor	1	1	1	3
P3 Design-Build Designer	2	1	1	4
P3 O&M Operator	1	1	1*	2
Public Stakeholders				
Project Sponsors	11	5	4	20
State Agency P3 Unit	1	1	2	4
Total Interviewees	**17**	**11**	**10**	**38**

*Note: The P3 Concessionaire for the Elizabeth River Tunnel project self-performs O&M.

In addition to interviews, primary and secondary project documentation was also collected. The documents included procurement documents, responsive proposals, and contract agreements including all appendices and amendments. This information helped to triangulate the evidence from the interviews with official legal, technical or financial documents. The other main type of documents were secondary sources of information, such as studies that were previously conducted on each respective project, and article 'clippings' related to the project for example. Table 1-4 shows the type of comparative project documentation collected across the three projects.

Table 1-4: Primary Project Documentation Collected

Document Type	Presidio Parkway	US-36 Managed Lanes	Elizabeth River Tunnel
Procurement Documents			
Request for Proposal	√	√	√[1]
P3 Concessionaire's Proposals (response to RFPs)			
Financial Proposal[2]	√	√	√[3]
Technical Proposal[2]	√	√	√[3]
- Subsection: Design & Construction	√	√	√
- Subsection: O&M / Service	√	√	√
- Subsection: Mgmt. / Organization	√	√	√
Pre-development Agreement (PDA)			
Interim Agreement	X (n/a)	X (n/a)	√[4]
Project Agreements (incl. corresponding appendices)			
P3 Concessionaire Agreement (CA)	√	√	√
P3 Design-Build Contract	√	√	√
P3 O&M Agreement	√	√	X (n/a)

Document Type	Presidio Parkway	US-36 Managed Lanes	Elizabeth River Tunnel
P3 Tolling Services Agreement	X (n/a)	√	√
Interface Agreements	√	√	√
Project Technical Requirements			
Project Management Requirements	√	√	√
Design and Construction Requirements	√	√	√
O&M / Handback Requirements	√	√	√
Tolling Requirements	X (n/a)	√	√
Project Management Plan (PMP)			
FHWA-required Project Sponsor PMP for Major Projects[5]	√	√	√
Environmental Review Documentation and Other Studies			
NEPA-related Documentation	√	√	√
Value For Money Studies	√	√	X (n/a)[6]

Notes: √ = Obtained; X = Not Obtained
1. VDOT released a Solicitation for Conceptual Proposal.
2. Original proposal sections indicated for the Presidio Parkway and US-36 projects are available in each respective project agreement's appendices/schedules.
3. For the ERT project, there is a single and comprehensive proposal with each respective section noted.
4. An 'Interim Agreement' phase was part of the ERT project prior to the development of the formal P3 Contract Agreement.
5. These PMPs reflect each respective state DOT's project management approach – this is different than the P3 Concessionaire's internal PMP.
6. No value for money or related project delivery evaluation was conducted for the ERT project (Regimbal 2012).

Data Analysis

A qualitative analysis software, QSR Nvivo (Bazeley and Jackson 2013), was implemented to organize and analyze all the data collected. The 34 interviews were audio recorded and transcribed, with over 31 hours in recorded audio, resulting in approximately 400 pages of transcribed text. The transcribed interviews, along with the project documentation selected for analysis, was then systematically coded. The coding process that was implemented in this study was guided by the recommended approaches in Miles et al. (2013) and Saldaña (2009). A two-level coding process was implemented, in which the first level of coding focused on organizing the data to sort appropriate data into 'macro-categories' related to the organizational structure of each project, and related issues that were identified through the interviews.

Finally, as part of the multiple-case study design process that was established, a within-case analysis was first performed on the three projects to gather and provide an internal understanding of each project's unique setting and longitudinal development. Second, a cross-case analysis was performed, with the identified themes, to develop and provide an explanation across the three projects, and thus to deepen the understanding and explanation for the findings. Throughout Chapters 2, 3, and 4, this data collection and analysis process is reiterated.

Dissertation Summary

This dissertation follows a three-journal-paper format, where the middle chapters (Chapter 2, 3, and 4) are stand-alone manuscripts intended to be submitted for publication in archival journals. This chapter, Chapter 1, provides an overview of the dissertation, highlighting the major need for the research, and breaking down the overarching research question into three papers, with identified research gaps, research questions, and contributions. An overview of the research method is also provided. Figure 1-9 illustrates each of these chapters. Given the independent format for each chapter, some degree of overlap exists for literature reviewed and methods employed. Chapter 5 presents and summarizes the practical and theoretical contributions of the research, notes limitations, and provides suggestions for future work.

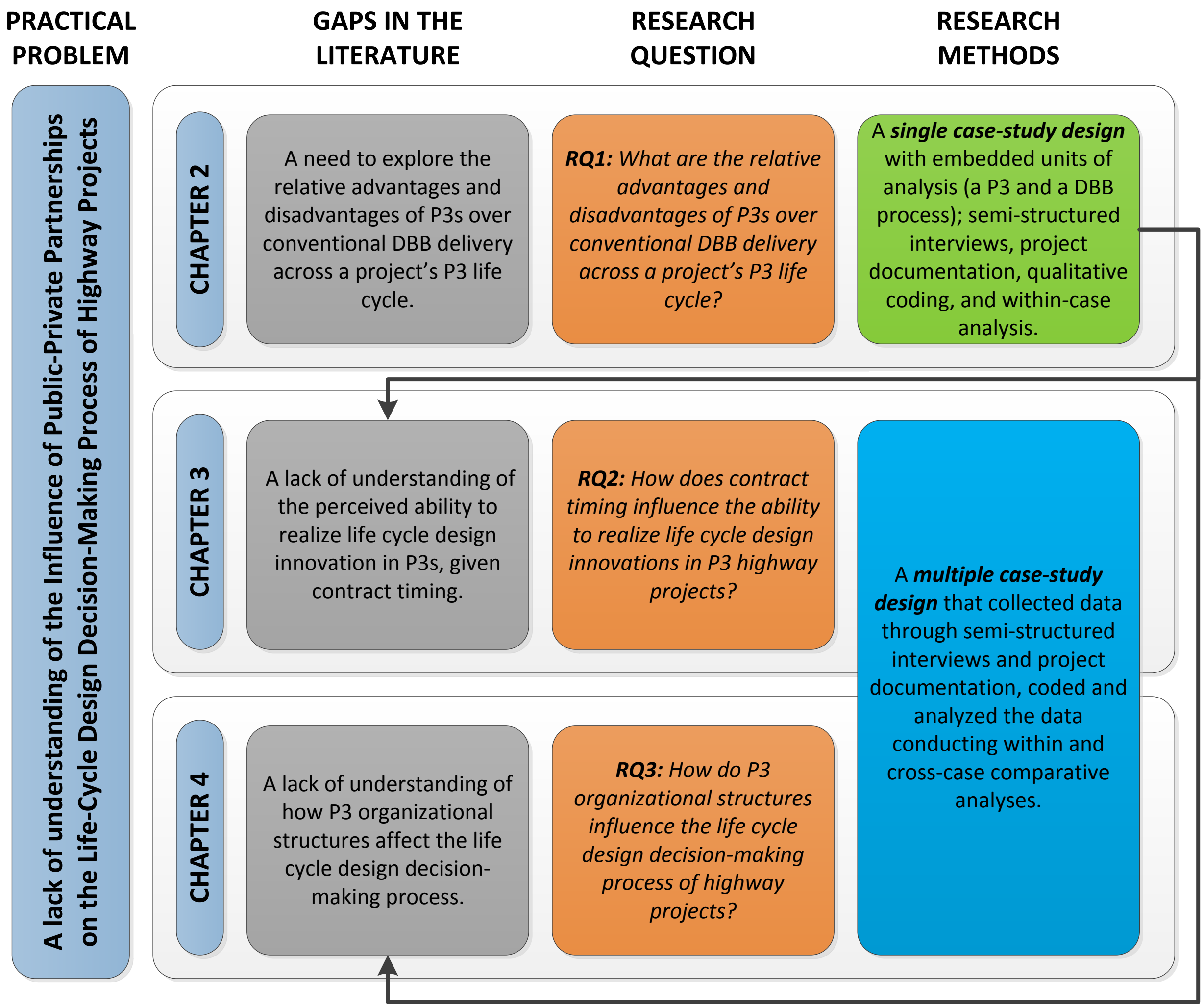


Figure 1-9: Dissertation Summary

In Chapter 2, an in-depth single-case study of the Presidio Parkway project is conducted to identify and compare the relative advantages and disadvantages of P3s as compared to DBB. The project, noted for its unique contractual structure in which two different delivery approaches (P3 and DBB) were implemented side-by-side within the project, allowed for a comparison of the advantages and disadvantages of P3s over DBB across the P3 life cycle of the project to be conducted. The 'P3 life cycle' is broken up into the front-end *policy and planning phase*, the *transaction phase*, and the *implementation phase* of a P3 project.

Chapter 3 explores how contract timing in P3s influences the ability of the private sector to realize life cycle design innovations. A comparative case study of the project life cycle design examples across the three projects, viewed through the lens of innovation theory, illustrate how P3 contract timing provides for, or inhibits, the ability to realize the promise of life cycle innovation. Chapter 4 presents a comparative case study of how project team integration and the allocation of risk has influenced the life cycle design decision-making process based on each of the three P3 organizational structures.

Chapter 5 provides a holistic discussion of the findings and conclusions of this dissertation. A discussion of the theoretical and practical contributions, limitations of the research, and suggestions for future research is provided. Closing remarks on what this dissertation has accomplished and what it implies for a broader audience is also provided. And finally, there are appendices which are referenced throughout Chapter 1, including additional case study project information for reference, data collection tools, and IRB approvals that could not be included in some of the chapters presented due to space limitations.

References

AECOM Consult Team. (2007). User Guidebook on Implementing Public- Private Partnerships for Transportation Infrastructure Projects in the United States, Final Report, Work Order 05-002. Washington, D.C.

ASCE. (2011). Failure to Act: The Economic Impact of Current Investment Trends in Surface Transportation Infrastructure. Washington, D.C.

ASCE. (2013a). Failure to Act: The Impact of Current Infrastructure Investment on America's Economic Future. Washington, D.C.

ASCE. (2013b). ASCE's 2013 Report Card on America's Infrastructure. Washington, D.C.

Bain, R. (2010). "Construction risk – what risk?" Project Finance, (February), 46–50.

Bazeley, P., and Jackson, K. (2013). Qualitative Data Analysis with NVivo. SAGE Publications, Inc, London, UK.

Blanc-Brude, F., Goldsmith, H., and Välilä, T. (2009). "A Comparison of Construction Contract Prices for Traditionally Procured Roads and Public–Private Partnerships." Review of Industrial Organization, 35(1-2), 19–40.

Buxbaum, J. N., and Ortiz, I. N. (2009). Public-Sector Decision Making for Public-Private Partnerships: A Synthesis of Highway Practice, NCHRP Synthesis 391. Washington, D.C.

CBO. (2012). Using Public-Private Partnerships to Carry Out Highway Projects. Congressional Budget Office.

CBO. (2015a). Public Spending on Transportation and Water Infrastructure, 1956 to 2014 (March 2015). Washington, D.C.

CBO. (2015b). "Public Spending on Transportation and Water Infrastructure, 1956 to 2014 (March 2015) - Data and Supplemental Information." <https://www.cbo.gov/publication/49910> (Aug. 31, 2015).

Chasey, A. D., Maddex, W. E., and Bansal, A. (2012). "A Comparison of Public-Private Partnerships and Traditional Procurement Methods in North American Highway Construction." TRB Annual Meeting 2012, Transportation Research Board, Washington, D.C.

Creswell, J. W. (2007). Qualitative Inquiry and Research Design: Choosing Among Five Approaches. Sage Publications, Inc, Thousand Oaks, California.

Davies, A., and Salter, A. (2006). "The Great Experiment: Public-Private Partnerships and Innovation in Design, Production, and Operation of Capital Goods in the UK." Flexibility and Stability in the Innovating Economy, M. McKelvey and M. Holmén, eds., Oxford University Press, New York, 73–95.

Deloitte Research. (2007). Closing America's Infrastructure Gap: The Role of Public-Private Partnerships - A Deloitte Research Study.

Eaton, D., Akbiyikli, R., and Dickinson, M. (2006). “An evaluation of the stimulants and impediments to innovation within PFI/PPP projects.” Construction Innovation: Information, Process, Management, 6(2), 63–67.

Eisenhardt, K. M., and Graebner, M. E. (2007). “Theory Building From Cases: Opportunities and Challenges.” Academy of Management Journal, 50(1), 25–32.

Fergusson, K. J., and Teicholz, P. M. (1993). “Impact of Integration on Industrial Facility Quality.” Stanford University.

FHWA. (2013). “FHWA Office of Innovative Program Delivery: P3 Defined.” <http://www.fhwa.dot.gov/ipd/p3/defined/index.htm>.

Grimsey, D., and Lewis, M. K. (2002). “Evaluating the risks of public private partnerships for infrastructure projects.” International Journal of Project Management, 20, 107–118.

Grout, P. (1997). “The economics of the private finance initiative.” Oxford Review of Economic Policy, 13(4), 53–66.

Leiringer, R. (2006). “Technological innovation in the context of PPPs: incentives, opportunities and actions.” Construction Management and Economics, 24(March 2006), 301–308.

Ma, J., Chen, A., and He, J. (2009). “General framework for bridge life cycle design.” Frontiers of Architecture and Civil Engineering in China, 3(1), 50–56.

MacDonald, M. (2002). Review of Large Public Procurement in the UK. London, UK.

Miles, M. B., Huberman, A. M., and Saldaña, J. (2014). Qualitative Data Analysis - A Methods Sourcebook. SAGE Publications, Inc, Thousand Oaks, California.

Miller, J. B. (2000). Principles of public and private infrastructure delivery. Springer.

Miller, J. B., and Gerber, J. K. (2012). “Advanced Project Delivery: Improving the Odds of Success - How Roles Differ for Owners and Lenders with Changes in Delivery Method.” 2012 Annual Meeting of the ABA Forum on the Construction Industry, Las Vegas, NV.

Morallos, D., and Amekudzi, A. (2008). “The state of the practice of value for money analysis in comparing public private partnerships to traditional procurements.” Public Works Management & Policy, 13(2), 114–125.

Morallos, D., Amekudzi, A., Ross, C., and Meyer, M. (2009). “Value for Money Analysis in U.S. Transportation Public-Private Partnerships.” Transportation Research Record: Journal of the Transportation Research Board, 2115, 27–36.

NCSL. (2010). Public-Private Partnerships for Transportation: A Toolkit for Legislators. Denver, CO.

OECD. (2008). “Public-private partnerships: In pursuit of risk sharing and value for money.” Organisation for Economic Co-operation and Development, Organisation for Economic Co-operation and Development.

Paulson, B. (1976). “Designing to reduce construction costs.” Journal of the Construction Division, ASCE, 102(4), 587–592.

PW Financing. (2015). “Public Works Financing - Volume 306, July-August 2015.” Public Works Financing, 306.

Raisbeck, P., Duffield, C., and Xu, M. (2010). “Comparative performance of PPPs and traditional procurement in Australia.” Construction Management and Economics, Routledge, 28(4), 345–359.

Ramsey, D. W., and Mounir, E. A. (2015). “Cost and Schedule Performance Benchmarks of U.S. Transportation PPP Projects.” TRB Annual Meeting 2015, Transportation Research Board, Washington, D.C.

Regimbal, J. J. J. (2012). An Examination of the Virginia Public-Private Transportation Act of 1995 (November 2012).

Reinhardt, W. (2011). “The Role of Private Investment in Meeting U.S. Transportation Infrastructure Needs (May 2011).” American Road & Transportation Builders Association.

Roehrich, J. K., and Caldwell, N. D. (2012). “Delivering integrated solutions in the public sector: The unbundling paradox.” Industrial Marketing Management, Elsevier Inc., 41(6), 995–1007.

Russell, A. D., Tawiah, P. A., and De Zoysa, S. (2006). “Project innovation - a function of procurement mode?” Canadian Journal of Civil Engineering, 33(12), 1519–1537.

Saldaña, J. (2009). The Coding Manual for Qualitative Researchers. SAGE Publications, Inc, Thousand Oaks, California.

Sarja, A. (2002). Integrated Life Cycle Design of Structures. Spon Press - Taylor & Francis Group, London, UK.

Sheffer, D. A., and Levitt, R. E. (2012). CRGP Working paper #0069: Fragmentation inhibits innovation : Overcoming professional and trade lock-in.

Tawiah, P. a., and Russell, A. D. (2008). “Assessing Infrastructure Project Innovation Potential as a Function of Procurement Mode.” Journal of Management in Engineering, 24(3), 173–186.

Taylor, J., Dossick, C., and Garvin, M. J. (2011). “Meeting the burden of proof with case-study research.” Journal of Construction Engineering and Management, ASCE, 137(4), 303–311.

Yescombe, E. (2007). Public-private partnerships: principles of policy and finance. Elsevier Ltd.

Yin, R. K. (2009). Case study research: Design and methods. Sage Publications, Inc, Thousand Oaks, California.

CHAPTER 2: A Comparison of the Advantages and Disadvantages of Public-Private Partnerships over Conventional Design-Bid-Build Delivery - The Presidio Parkway Project Case Study Report

Executive Summary

The Presidio Parkway project, located in the northern tip of the San Francisco Bay in California, consists of the reconstruction of a mile-and-half long segment of U.S. Route 101 that runs through the Presidio to the southern end of the iconic Golden Gate bridge. Built in 1936, three years after the construction of the Golden Gate bridge, this critical link to the regional transportation system was 73 years old in 2009 when reconstruction of the project began. The project has drawn attention to transportation officials throughout the state, and across the country, having implemented a public-private partnership (P3) delivery approach to complete the second phase of the project. The project began construction of Phase I in the fall of 2009, and has reached substantial completion of Phase II in the fall of 2015.

This project reflects many of the current issues and questions that public transportation officials are asking themselves when considering the implementation of a P3 to deliver much needed, complex and large infrastructure projects. Such projects encounter funding constraints, or may lack technical expertise or innovation that would greatly boost the approach to deliver the project. In addition, these projects are expected to significantly improve the mobility, safety, and economic vitality of the region when complete. Every project is unique in its own way, particularly when the size and complexity of such projects is of a magnitude that is unusual for the region. Given the similarities of projects to the Presidio Parkway in this perspective, this project presented an unusual scenario to conduct a side-by-side comparison of the most commonly used delivery approach by transportation agencies, the traditional design-bid-build (DBB) delivery approach, and a P3 approach. Through an in-depth case study of this project, a comparison of DBB to P3 under similar economic, institutional, and technical setting, among many others, has been conducted.

The primary goal of the case study is to compare the relative advantages and disadvantages of conventional DBB vs. a P3 delivery method. With the direct comparison of Phase I of the project, delivered using a DBB, to Phase II, delivered with a P3, the advantages and disadvantages typically encountered across the life cycle of a P3 project were evaluated. The results demonstrate how public officials can overcome and prepare for some of the most notable disadvantages that P3s encounter, while also learning how to ensure some of the main advantages, for which a P3 might be considered in the first place, can be achieved. The following summary of those advantages and disadvantages that have been identified in this study, and are presented in a 'P3 Life Cycle Framework', with three general life cycle phases: the *Policy and Planning Phase*, the *Transaction Phase*, and the *Implementation Phase*.

The Policy and Planning Phase

The policy and planning phase is where potential projects are considered for the implementation of a P3 delivery approach. Potential projects are tested to ensure that the decision to pursue and implement a P3 achieves the *state's public policy objectives and meets transportation needs*. It is during this phase that the ability of the state to implement a P3 is evaluated, and hence, to be able to proceed to a formal *development and procurement* of the P3 project, in the following transaction phase. The advantages and disadvantages that have been identified and evaluated in the policy and planning phase of the project are:

Advantages

Private Financing:
Proponents of P3s often emphasize the advantage of having the ability to obtain alternative sources of funding to deliver a project, particularly in large and complex infrastructure projects such as the Presidio Parkway whose funding sources often take many years, if not decades, to secure. *The Presidio Parkway was able to secure and use private financing sources for the design and construction of Phase II, and thereby secured with certainty the rest of the needed funding to deliver the second half of the project.* Although funding sources had been identified, for Phase I and Phase II of this project, given the decade worth of negotiation that it took for the project to secure the funding, a legitimate concern with the state's historic cost overruns for mega-projects in the bay area prompted transportation officials to consider the use of a P3. Having implemented a P3 for Phase II has served as a safeguard to be able to deliver the project within-budget, and without being exposed to significant cost overruns.

Accelerated Delivery:
The ability to accelerate the delivery of a project by having the ability to secure funding faster to begin a project is noted to be a major advantage of P3s. *This advantage is not captured in this project given the phasing of the project, since a P3 was not implemented from the beginning of the project. On the other hand, given the inherent efficiencies gained through the bundling of four rather complex contracts for Phase II, further potential delays were prevented for a project already behind in its intended original accelerated schedule.* These efficiencies are primarily related the reduction of design error and omission lengthy approvals and the reduction of multiple different contractors working in a constrained and complex site. Phase II's initial schedule at contract execution experienced unforeseen delays. However, in addition to the additional procurement and transaction time needed for the P3 transaction phase, the project was able to realize those inherent efficiencies when bundling the contracts and that offset the initial transaction delay.

Reduced Debt Constraints and Optimal Use of Public Funds:
P3s allow for the public sector to avoid adding to their long-term obligations given that the private sector is responsible for financing the project. In addition to this, "freeing up" public funds that would have otherwise been allocated for the delivery the project can be used to speed up the construction of other infrastructure projects. The debt for the project is then considered to be 'off' the public sector's "books", allowing the public to stretch its limited borrowing capacity further for the delivery of other vital projects. In the Presidio Parkway project, from the funds that were initially identified and secured, the funding was technically allocated to the project,

regardless of the developer having financed the design and construction of the project. *Perhaps where the reduced debt constraint for the public sector is visible, however, is through the cost savings captured given the P3 delivery, in addition to the cost certainty established and reduction (or complete avoidance) of cost growth in Phase II. Furthermore, Phase II's ability to deliver the project within budget, in comparison to Phase I, shows the efficiency in the use of public funds, and it has reduced the risk of burdening public taxpayers with cost overruns.*

<u>**Disadvantages**</u>

Regulatory Constraints and Opposition:
Pubic owner(s) must have the legislative and statutory authority to be able to procure and implement P3 projects within their respective region or state. From a legal and regulative standpoint, a favorable legal framework allowed for a P3 to be implemented for the project with California's most recent P3 enabling law (SBX2 4). More specifically, *a recently passed P3 enabling law allowed for SFCTA and Caltrans to partner as co-sponsors, and to procure and enter into a P3 agreement. However, the project encountered opposition from the public sector's employees who filed a lawsuit against Caltrans challenging the validity of the agreement under the state's P3 law.*

Lack of P3 Maturity:
P3s requires new and complex processes than it might be traditionally done where most of the work performed is tailored to a more traditional, DBB or design-build approach. The use of P3s is relatively new for the state of California, since the earlier highway P3s implemented were done in 2003 and in the early 1990s. Being the first project delivered under the new and recently established P3 procedures and guidelines developed by Caltrans, both the public and private sector were exposed to a "learning curve" in adapting to the P3 approach. *P3 projects require new expertize and adjustments (institutional and cultural) to adapt to the P3 approach. In Phase II, signs of institutional inertia and fear of cultural change were identified during the delivery of the project, resulting in inefficient management and oversight processes.*

The Transaction Phase

The transaction phase of P3s is where a comprehensive evaluation of development and procurement processes are performed, while making sure that these are robust enough and that they maintain a competitive environment to ultimately capture the best value from executing a potential P3. In addition to this, proper contract requirements, processes, and optimal risk allocation is established to be implemented and to monitor the project during the subsequent phase, the implementation phase. The advantages and disadvantages that have been identified and evaluated in the transaction phase of the project are:

<u>**Advantages**</u>

Competitive Procurement Process:
The procurement process for the project is considered to have a had an appropriate and competitive process. *Following the evaluation of the Statement of Qualifications for the project,*

the sponsors shortlisted three teams for the procurement of the project. An adequate competitive process that managed to optimize value, even with the project's unique complex setting, was provided.

Optimal Risk Allocation:
The risk allocation accomplished for Phase II was ultimately beneficial to the project as a whole. The ability to fully transfer some of the risks was limited given the project's unique setting, and therefore the sponsors had to share or retain some of those risks typically transferred in P3s.

- **Design and Construction Risk:** *Risks transferred to the developer were appropriate given the non-ideal and complex setting of the project site, and the phasing of the construction contracts. However, third party stakeholders interface (particularly the Presidio Trust) is a risk that has affected the project more than expected.*
- **Financing Risk:** *Upfront costs are estimated to have saved approximately 24% from the initial budget approved for Phase II of the project. Long-term O&M costs are estimated to have saved an additional 37% per year from the initial availability payments set, or over $400M over the 30-year concession period. These savings are a result of the favorable bidding environment and the positive financial market conditions that the developer was able to capture and take advantage of, having been transferred this responsibility.*
- **O&M Risk:** *The state has established a payment mechanism ensuring that sufficient funding is available throughout the concession period, and the concessionaire's responsibility for performance of the facility, per the predefined O&M requirements, is tied to the availability payments set.*

Life Cycle Cost Evaluation:
The concept of looking at projects from a life-cycle cost perspective, switching to a 'value for money' mindset in terms of evaluating the costs of delivering a project, is a significant transition from the traditional mindset of evaluating projects. *The project underwent a rigorous life-cycle cost evaluation and realized better than expected life-cycle cost performance through its competitive procurement process.* The ex-ante and ex-post comparison of this performance is discussed in details in a forthcoming Ex-post Value for Money report.

<u>Disadvantages</u>

Complex Procurement Process:
Being the first P3 to proceed under the latest P3 enabling legislation, the project has served to establish many of the guidelines and procedures for future P3s in California. *This is the 'pilot' P3 project for this legislation in a way, and even though guidelines were developed concurrently, the procurement process went through a rigorous process, and underwent an extensive review and approval process by several state agencies. The project has managed this complexity appropriately given the circumstances.*

The Implementation Phase

The public agency's role in a P3 project changes from being responsible for the delivery of the facility, to an oversight and monitoring role to ensure compliance of the developer in delivering and meeting the contract obligations established in the transaction phase. There are two primary implementation stages in which a project is generally broken up into, and those are the Design and Construction stage, and the Operations and Maintenance stage.

The advantages and disadvantages that have been identified and evaluated in the implementation phase, for the ***design and construction stage*** of the project are:

Advantages

Improved Quality:
In highway construction, quality management processes have been predominately developed to be implemented in traditional DBB delivery of projects. In a P3, with the design and construction risks being shifted to the concessionaire, the concessionaire, or its design-builder, assumes responsibility for the 'day-to-day' QA/QC activities in the project and the role of the owner changes to an 'oversight' role. *A misalignment between the project sponsors' and developer's expectations for the quality management methods and processes implemented to ensure and verify quality standards for the project has resulted in difficulties in ensuring quality is met for Phase II. While this does not define the level of quality achieved, QA/QC processes are important in achieving and maintaining the quality standards established for the project, and the project has suffered from inefficient quality management processes.*

Cost and Schedule Certainty:
The *incentives* established in a P3 agreement drive the developer to deliver a project on-time (schedule certainty) and within-budget (cost certainty), and therefore the developer performs a much more efficient and cost-effective delivery. There is less tolerance for cost overruns and project delays given these financial incentives when the developer needs to repay the private debt borrowed to finance the project, and begin operations as soon as possible to deliver profit to its investors and shareholders.

- **Cost Performance:** *Phase II has experienced a 0% contract cost growth, and has remained within budget, while capturing cost savings from the budgeted amount (this does not reflect pending NOPCs). Phase I experienced a contract cost growth of 56%, and the initial cost savings captured have been offset by the cost overruns.*
- **Schedule Performance:** *Phase II has experienced significant delays, which have impacted the schedule performance of the project, with an approximate contract schedule growth of 16%. However, the 'construction-only' duration of Phase II is expected to be reduced by 4 months. Phase I experienced an approximate contract schedule growth of 66%.*

Disadvantages

Project Governance:
Project governance issues in P3s are considered to be quite complex given the long 'shaping phase' of such complex projects, and are prone to encounter multiple misunderstandings and uncertain scenarios where decision-making among the project participants results in inefficient and often frustrating situations. The complex project governance inherent in these type of projects, in addition to the additional complexity added given the project's location within a

National Park, has affected the implementation of the P3 agreement during design and construction. *Throughout the interviews, it has been argued that this 'additional layer' in the project has caused the developer to coordinate with the Presidio Trust in a greater level than anticipated.*

Organizational Inertia:
Organizational inertia refers to the tendency of a mature organization to continue on its current trajectory, and this can apply to both public and private organizations in their approach to managing P3s. *The project sponsor has shown significant 'rigidity' in adapting to the new role of providing oversight management in the project. This has been evident in the design review process for Phase II's design, where an oversight role encountered difficulties in being implemented.*

The advantages and disadvantages that have been identified and evaluated in the implementation phase, for the ***operations and maintenance stage*** of the project are:

Advantages

Improved Life-Cycle Design:
Given the earlier involvement of the O&M parties responsible for the on-going O&M responsibilities, design and construction practices may be tailored to improve specific long-term life cycle considerations that would otherwise not be considered. However, the advanced state of the design development in this project limited the ability to perform significant design changes by the developer.

Dedicated and Committed O&M Budget: *The project sponsors have established a dedicated O&M budget for the course of the concession period, which will be used to make availability payments to the P3 developer for their performance-based service of the facility.*

Improved Asset Condition: *The facilities' conditions are strategically structured to be provided regular maintenance and major rehabilitation or replacement tasks are also scheduled throughout the concession period.*

Improved Level of Service: *The facilities' operational conditions are ensured through contractual requirements such as required response times for incidents and emergencies, as well as required regular maintenance to ensure an acceptable asset condition.*

Hand Back Renewal Process: *The contractual requirements for minimum asset condition at the end of the concession period and transition and education plans ensure a smooth handover to the Agency and acceptable asset condition at the end of contract term.*

Disadvantages

Cost of Maintenance: *Economies of scale can be lost in the implementation of a P3 operations and maintenance program.*

Summary

The young P3 market in the US can benefit from the experience of the Presidio Parkway project, the implementation of a P3 in a unique and complex environment. The institutional structure of the project and the context-sensitive environment for the design and construction of the project, are among some of the complexities exhibited in this project. The P3 approach has proven to be beneficial and has managed to deliver many of the anticipated advantages of a P3. Given the complex and 'non-ideal' set up for a P3 to be implemented, however, the project has encountered many issues that could have been mitigated more appropriately.

From these advantages and disadvantages that have been explored for the project, four cross-cutting themes are provided:

1. **The timing of implementation of a P3 should not be underestimated**
2. **A rigorous P3 Development and Procurement process sets a strong foundation**
3. **Project specifications need to be clear – the expected vs. specified level of flexibility needs to be carefully evaluated**
4. **The cultural change and adaptation to a P3 should be prioritized by public owners**

The identified themes are for future transportation projects to consider them and to apply them to the greatest extent possible throughout the life cycle of a P3 project. As the P3 market matures, so will the P3 processes that are key for the successful execution of P3 projects in the future. The P3 delivery approach has the potential to achieve and unlock the much needed value for the delivery of large, highly-complex, and vital infrastructure projects that cannot be delivered using traditional delivery approaches today, within a reasonable time. However, this value will not be captured if these important issues are not consciously taken into account. The detailed description and discussion of each of these advantages and disadvantages identified in this report provide more information for consideration.

Introduction

The San Francisco County Transportation Authority (SFCTA), serving as a co-sponsor with the California Department of Transportation (Caltrans) on the Presidio Parkway project, has requested a longitudinal, case study of the project. The objective of the case study is to compare the relative advantages and disadvantages of two project delivery methods, the Phase I traditional Design-Bid-Build (DBB) method, and the Phase II Public-Private Partnership (P3) method. The Presidio Parkway project provides a unique context to study the two delivery methods side-by-side, given the similarities found in both phases. From an institutional perspective, both phases share the same stakeholders and sponsors. Given the parallel scope of work for each respective phase, similar design and construction issues are expected. Also, from an economic standpoint, both phases are built around a relatively close time period. As so, SFCTA requested this study given the rare opportunity and ideal setting to perform a study like this.

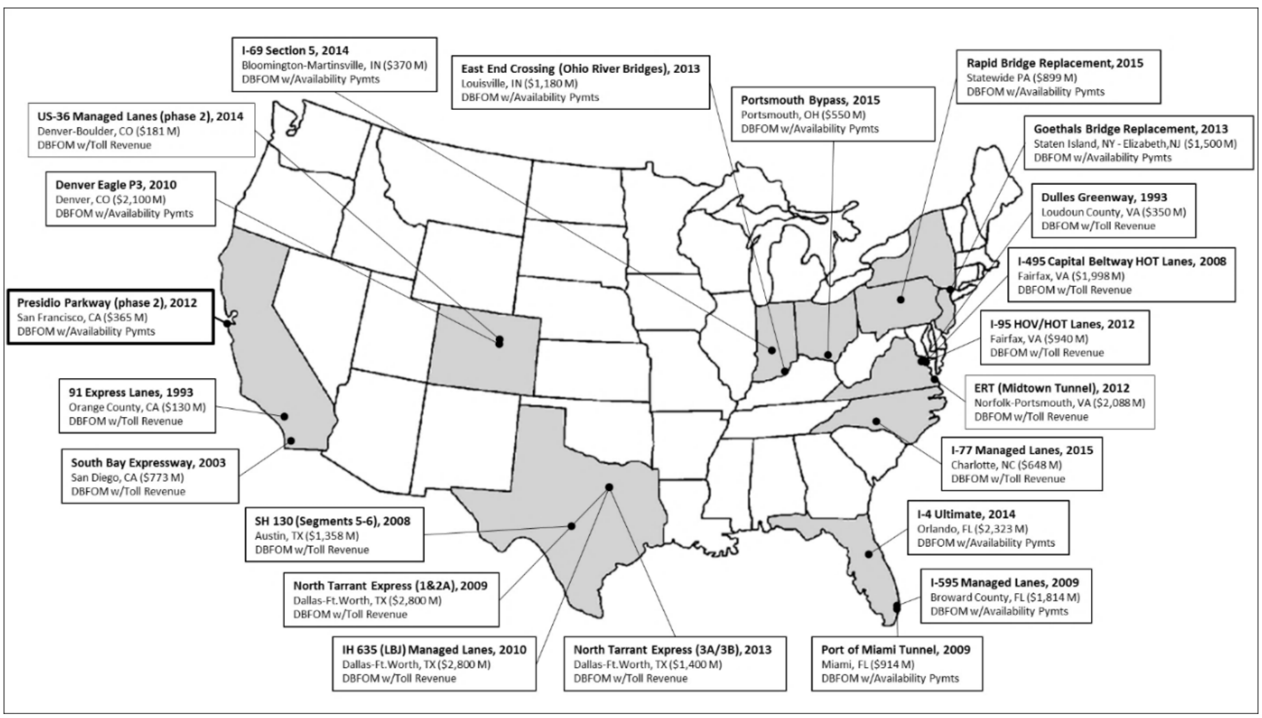


Figure 2-1: Overview of DBFOM Transportation P3s in the US (through 2015)

Over the past two decades, there has been increased interest from state agencies to implement P3s to deliver high-cost, complex infrastructure projects, like the Presidio Parkway project. Since the early 1990's 22 design-build-finance-operate-maintain (DBFOM) type of P3s have been delivered in 10 states[1], some of which are currently under construction (see Figure 2-1). Currently, 33 states have enacted statutes that

[1] Public Work Financing – September 2015 Issue

enable the use of P3 approaches for the development of transportation projects in the US[2]. One the first highway P3s implemented in the US was sponsored by Caltrans, the State Route (SR) 91 project in Orange County. A decade later, SR 125 near San Diego, also known as the South Bay Expressway, was also another P3 sponsored by Caltrans in 2003. Both of these projects were DBFOM P3s with toll revenue risk, and both were authorized under an earlier state law (Chapter 107, Statutes of 1989) that allowed Caltrans to enter into up to four P3s. The Presidio Parkway project, now the third P3 delivered in California, was authorized under the state law enacted in 2009 (SB 2X 4), which amended Caltrans P3 authority, and authorized Caltrans and regional transportation agencies (such as SFCTA) to enter into unlimited P3s through December 31, 2016.

Public-Private Partnerships are financing and procurement tools that allows for the public sector to enter into a contractual agreement with the private sector, and where the private sector has greater participation in the delivery of public infrastructure projects than traditional. More specifically, a P3 is a long-term contractual arrangement where the private sector provides management and operating services and puts private finance at risk. From the public sector's perspective, P3s have the potential to improve overall value when comparted to the traditional delivery approach. Commonly cited P3 advantages include faster delivery, lower costs, and improved life cycle performance, among others. On the other hand, disadvantages to the public sector in implementing P3s include higher and complex contracting and transaction costs, the long-term commitment inherent in the contract, and the organizational and institutional changes that must be implemented to deliver a P3.

The Presidio Parkway project is a high-profile P3 project. The P3 market in the US is considered to be young in some respect, in comparison to other more mature countries that have been using P3s and have more established and robust P3 processes. Therefore, **this study focuses on exploring the perceived advantages and disadvantages of P3s in comparison with traditional DBB delivery. The study involves an objective, longitudinal case study of Phases I and II of the Presidio Parkway.** This report focuses on the *second level of analysis* of this study, which is the qualitative analysis. A great deal of the data collected for this study consists of 'non-numerical' data, or qualitative in nature. Throughout the data collection period of more than two years, over 40 key project participants from the public and private parties were interviewed and substantial amounts of project documentation were collected. With this vast amount of qualitative data collected, this report summarizes the main findings regarding the relative advantages and disadvantages identified, as experienced by the Presidio Parkway project. The main findings and

[2] http://www.fhwa.dot.gov/ipd/p3/state_legislation/

observations can serve as a reference to other transportation agencies who are considering the use of P3s and may benefit from the to deliver future transportation projects.

Research Approach

The primary goal of this study is to compare the relative advantages and disadvantages of conventional design-bid-build (DBB) project delivery vs. a public-private-partnership (P3) delivery method. A single case-study design has been implemented to study the project. This case study allows us to compare two project delivery methods under a similar context and environment. Using a case study methodology, a case study protocol was first established to provide a guiding framework to organize the data collected (see Appendix A: Case Study Protocol, March 2014).

Starting in the Spring of 2014, the researchers began to conduct interviews with principal project participants that were involved on the project at the time, or that had been involved in the past. In addition, a great deal of project documentation began to be collected by the researchers. Table 2-1 shows a summary of the total number of interviewees that were consulted over 3 rounds of interviews conducted during the Spring and Summer of 2014, and Fall of 2015.

Table 2-1: Summary of Case Study Interviews

Interviews Completed	Spring 14	Summer 14	Fall 15	Total
Public				
3rd Party Stakeholder & Others	1		2	3
Project Co-Sponsors	10	5	5	20
Project Sponsor Consultants	3	5		8
Project Sponsor P3 Program/Unit	1	3		4
Public Total	**15**	**13**	**7**	**35**
Private				
P3 Concessionaire (developer)	1	1		2
P3 Design-Build Joint Venture	1			1
P3 Designer	2			2
P3 O&M Provider	1	2		3
Private Total	**5**	**3**		**8**
Grand Total	**20**	**16**	**7**	**43**

Interviews were arranged to capture varying perspectives from the main project stakeholders, as well as 3rd party stakeholders, and external stakeholders that did not have an active role in the project. Figure 2-2 shows the organizational structure of the project for Phase II, from which the roles noted in Table 2-1 can be appreciated. The structured interviews were organized to capture different perspectives from key informants, considered to be the key decision-making participants in the project.

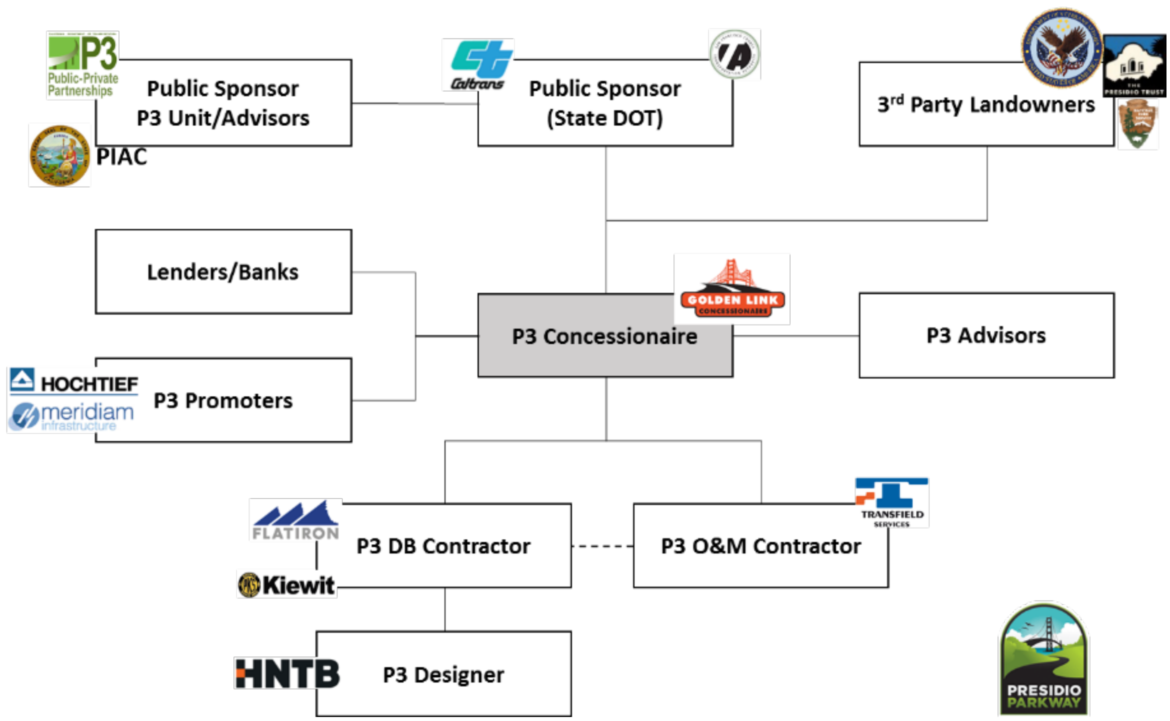


Figure 2-2: Overview of Presidio Parkway Project, Phase II Key Stakeholders

To complement the interviews, project documentation served as a triangulation strategy to verify and enhance the initial findings from the interviews. These documents are noted throughout the report as footnotes, or have been included in the references. All the data, transcribed interviews and project documentation, has been cross-tabulated using matrix coding queries structured in Nvivo (Bazeley and Jackson 2013), a qualitative research software, to perform the analysis. The data was first coded through this software to organize general themes or findings. A second coding process was conducted to identify the relative advantages and disadvantages within the context. This report presents the most interesting advantages and disadvantages.

Project Background and History

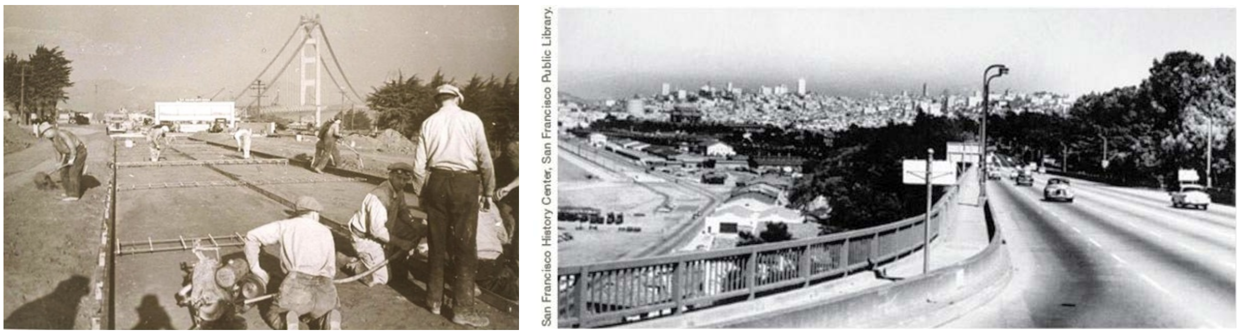


Figure 2-3: Historic Pictures of Doyle Drive (Source: www.presidio.gov)

The Presidio Parkway Project is located in the northern tip of the San Francisco Bay in California. Formerly known as the Doyle Drive Replacement project, the project consists of the reconstruction of a mile-and-half long segment of U.S. Route 101 that runs through the Presidio to the southern end of the iconic Golden Gate bridge. Doyle Drive was built in 1936, three years after the construction of the Golden Gate bridge. By the time construction began for the project in 2009, this critical link to the regional transportation system was 73 years old, which was approaching, or already over its useful life. The first intermodal report conducted on the project in 1996[3] indicated that the road has experienced heavy traffic and exposure to salt water over the years, and that contributed to the deterioration of the structures supporting the elevated roadway, in addition to its age. Furthermore, **Doyle Drive was considered to be seismically deficient, and given the importance of the road to the region, achieving seismic safety, along with the inherent improvement in structural and traffic safety, was of chief importance to the project**[4].

[3] "Final Report: Doyle Drive Intermodal Study, November 1996", prepared for the San Francisco County Transportation Authority
[4] "Final Environmental Impact Statement/Report (FEIS/R), September 2008"

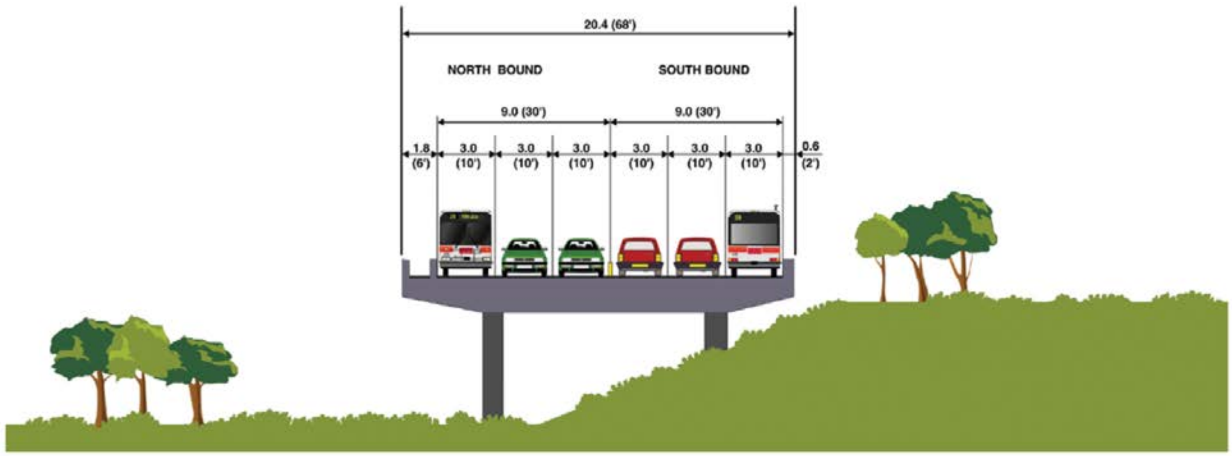


Figure 2-4: Former Doyle Drive Roadway Design Cross Section (No Build Alternative)[5]

Doyle Drive's design from 1933 did not meet today's safety standard. The design included three ten-foot lanes in each direction separated by painted double stripes, no barrier separating opposing traffic flow, and no shoulders (see Figure 2-4). There were several attempts to improve Doyle Drive throughout the years before a formal environmental study began in 2000, as shown in Figure 2-5. In 1955, the Golden Gate Bridge Highway and Transportation District (GGBHTD) made the first request for the State to widen and reconstruct Doyle Drive to handle increasing congestion. In 1962 a specific 8-lane divided roadway was proposed, and was ultimately rejected by the public. Following other significant milestones that kept on pushing for the reconstruction of Doyle Drive, it wasn't until 1991 that the establishment of the Doyle Drive Task Force, consisting of representatives from various local governments and public and private organizations, when the project began to gather momentum to move forward. **In 1996, the San Francisco County Transportation Authority (SFCTA), headed by Jose Luis Moscovich at the time, finished and released the Doyle Drive**

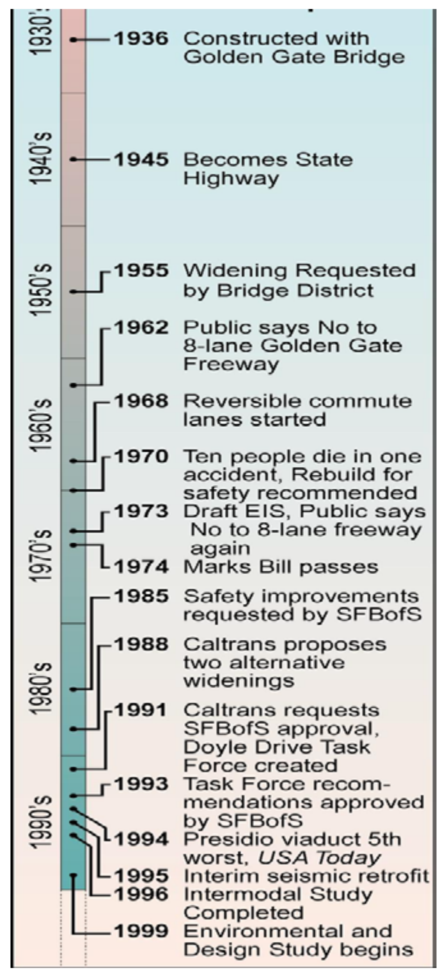


Figure 2-5: Historic Efforts to Improve Doyle Drive since it's Construction in 1936.

[5] Preferred Alternative Briefing Booklet, August 2006, pg. 7

Intermodal Study[6], which outlined the initial design requirements for a realistic and fundable project, and introduced and recognized the need for a scenic "parkway" design for the project. "This goes back to the very genesis of the project, SFCTA, and more specifically its former Executive Director José Luis Moscovich. It would not be an overstatement to say that they created the project, they invented the idea of doing the Presidio Parkway," commented one of the sponsor's executives regarding the significant role SFCTA, and its former Executive Director played on the project.

Environmental and Planning Process

> *"Michael Painter is a San Franciscan, he is a landscape architect and he loves the Presidio. And so the story has it that, honestly, he came out with this kind of design and vision by being on top of the Palace of Fine Arts, on the roof, overlooking the Presidio, and that he could just see where he could put the tunnels ultimately. The tunnels are tunnels for cars but bridges for pedestrians. And it is this connectivity that everybody has been kind of craving, you don't want a highway, it is a 'Parkway,' not a freeway." – Project Sponsor's Consultant*

After many years, and the countless efforts to replace or improve Doyle Drive, in 2000, the preparation of the Draft Environmental Impact Statement (DEIS) began. The DEIS effort was led by Caltrans and SFCTA. The Presidio Parkway concept emerged as an alternative design from the many that were being considered, and eventually it became a top alternative in the DEIS completed in 2005. This alternative, designed by local landscape architect Michael Painter, was introduced earlier in the process and was received with some skepticism. Painter, who is also the former designer of San Francisco's Great Highway, came up with a design concept that would be accepted by all stakeholders for the project to move forward. **One of the leading architecture, design and engineering firms in the world, Arup, was asked to review Painter's plan to provide their opinion on its feasibility and cost, to which they came back stating that it had fewer impacts on the national park, it was a better design and it was also less costly**[7]. Following the DEIS, the Presidio Parkway was then chosen as the Preferred Alternative in September 2006. The Final Environmental Impact Statement (FEIS) was released 2 years later in 2008 with a refined design for the preferred alternative, and it received its Record of Decision (ROD) in December 16, 2008. Making

[6] See Note 3

[7] "From Doyle Drive to Presidio Parkway: How a Landscape Architect Reinvented a Road", by Michael Alexander, July 25, 2012 http://www.spur.org/blog/2012-07-25/doyle-drive-presidio-parkway-how-landscape-architect-reinvented-road

the project happened required committed leaders that stayed behind the project, ‘project champions’ that had the vision and the drive to make it happen. One of the interviewees shared, “it was an interesting partnership between those two, I mean, Michael Painter had the vision and Jose Luis had the drive."

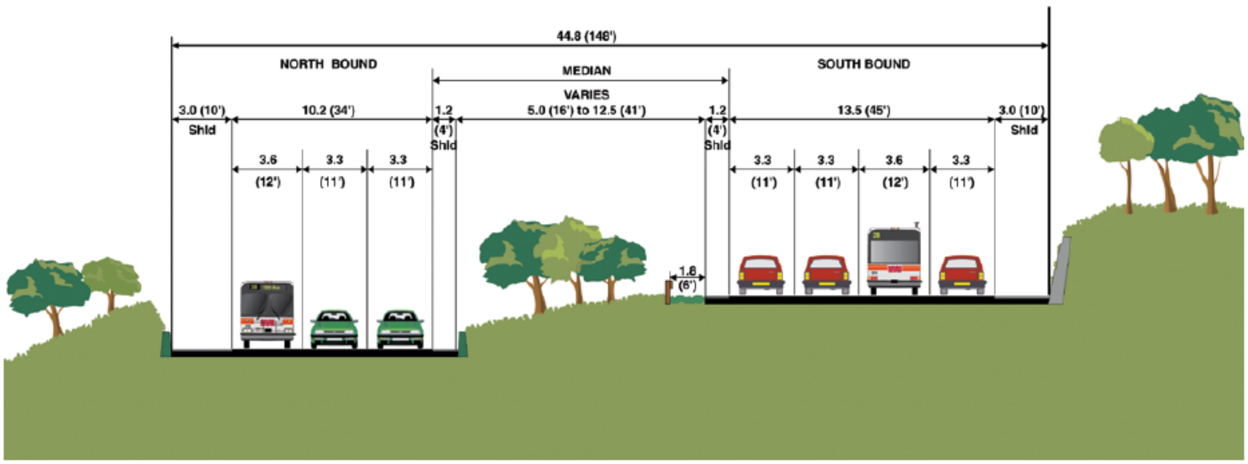


Figure 2-6: Presidio Parkway Design Cross Section (Preferred Alternative)[8]

The Presidio Parkway design introduced a new, traffic and seismically safe, six-lane facility with an auxiliary lane in the southbound direction (see Figure 2-6). The new design included a median barrier to separate traffic traveling in opposite directions (where needed), reducing the potential for head-on collisions. There are now inside and outside shoulders that were non-existent before, and the lane widths were increased to 11-foot for interior lanes and 12-foot for outside lanes. Another key attribute of this design was the Presidio Parkway’s ability “to preserve the natural, cultural, scenic and recreational values of affected portions of the Presidio,” as noted in the DEIS, which was a major objective of the Doyle Drive Replacement Project from the very beginning. The road ran along the existing cemetery in the Presidio, through its two cut-and-cover tunnels with landscaped tops, allowing for better integration of the topography and uses of the park, with less obstruction of views (see Figure 2-7). Over 100 design exceptions were approved for the project, including the narrower 11-foot lane widths designed to further reduce the road’s footprint on the environment.

[8] Preferred Alternative Briefing Booklet, August 2006, pg. 11

Figure 2-7: Presidio Parkway Design Overview[9]

Strict design criteria, and a context-sensitive design process was needed given the historic relationship to the Golden Gate bridge, which made the project more complex. The design also had to be structurally and aesthetically related to the 'character' of the of the Golden Gate bridge[10]. "The project was not intended to merely meet a function; it was intended to meet aesthetic goals," commented one of the sponsor's executives, "**the aesthetic goals were probably equal to the functional goals**, and because the aesthetics were such an important component of the project, it dramatically limited the ability of any designer to find innovative ways of meeting some functional goal."

Institutional Context

*"**The character of the roadway and the way it sits in the landscape has an overlay of values that are pretty unusual for most freeway projects**. It has to be sensitive to both the national park values which according to our legislation are the natural, cultural, scenic and recreational resources of the park. And **it also has to be sensitive to the cultural landscape and make sure that whatever is built doesn't have a significant impact on the integrity of the Presidio Landmark District**." – Presidio Trust Executive*

The Presidio Parkway Project is located on a former military base and a national park. Located in the northern tip of the San Francisco peninsula, the main land owners are the Presidio Trust (the Trust), accounting for approximately 80% of the land, and the National Parks Service (NPS), accounting for the other 20%. The GGBHTD is also another important 3rd party stakeholder that has jurisdiction within the

[9] Preferred Alternative Briefing Booklet, August 2006, pg. 22
[10] "South Access to the Golden Gate Bridge, Doyle Drive Architectural Criteria Report", August 2008

project area, being the south access to the Golden Gate bridge. **Given this complex ownership of adjacent property, a complex institutional environment within the project area added another layer of complexity to the project** (see Figure 2-8)**.**

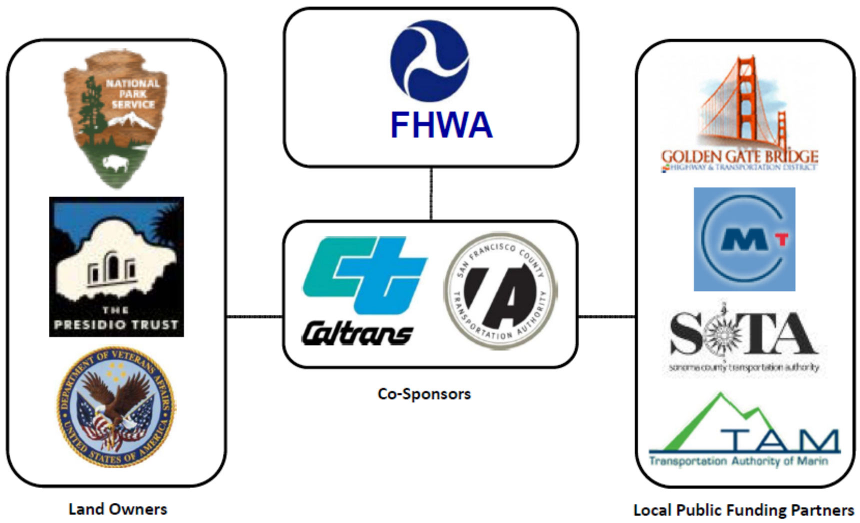


Figure 2-8: Principal Public Stakeholders in the Presidio Parkway

The two project co-sponsors, Caltrans and SFCTA, had many other third party stakeholders to coordinate work with than it might be typical for any other project. The fact that the landowners and the sponsors for the project were different entities, the process became "more cumbersome for the developers" as one interviewee shared, as well as for the sponsors during Phase I. "[The Presidio Trust], they are commissioned by Congress directly, they report to practically no one other than Congress and their mandate is to look after that piece of land and make sure its historical integrity is protected," commented one of the sponsors' project managers, "and any time you try to build a road through, you are going to have a lot of issues, I mean they are charged with protecting the historical view of it, so any time you bring disturbance there, it is going to have a lot of coordination" he added.

Project Construction Overview

The Presidio Parkway project has a significant amount of structures relative to at-grade roadway pavement, primarily four cut-and-cover tunnels and two large viaducts along with interchanges. Phase I of the project consists of the new southbound high viaduct bridge, the southbound battery tunnel (first of the four cut-and-cover tunnels built) and a temporary bypass (see Figure 2-9). Substantial completion of Phase I was achieved on May 2012 when traffic was then shifted from the old roadway onto the new alignment with the southbound (SB) battery tunnel and high viaduct structure, and the temporary bypass. This achieved seismic safety for the project. Phase II of the project consists on the removal of the remaining old roadway, construction of the remaining 3 tunnels of the project (NB Battery Tunnel and SB & NB Main Post Tunnels), the NB high viaduct bridge, NB and SB low viaducts on the eastern end, and an interchange with direct access to the Presidio. Traffic from the temporary bypass was shifted onto the permanent facilities on July 2015, and Phase II achieved substantial completion in September 2015.

Figure 2-9: Project Overview (Source: PresidioParkway.org)

The approach to building the project in phases, part of the design proposed by Michael Painter, was also something invaluable to the project. Given the importance of the road to the regional network, if the road was to be closed for the project, "you might as well close the Golden Gate bridge" commented an article on the project[11]. Given this, building half the width of the new road first, transferring traffic on to the new road, then demolishing the old road and building the other half of the project on the old footprint was the approach that shaped the project construction process. This approach dictated the phasing of the project, and hence, how the project was programmed to be split into eight separate contracts.

Delivery of the Project

The Presidio Parkway was originally planned to be delivered using Caltrans' traditional DBB approach. The project was broken up into eight construction contract packages to be delivered in two phases, as shown in Table 2-2:

[11] See Note 7

Table 2-2: Project Contracts (Source: IFP 2009)

Contract	Project Description
Phase I:	
Contract 1	Advanced Environmental Mitigation – (wet land, biological, tree removal). Mitigation prior to construction activities. Environmental mitigation during construction is accounted for in the individual contract budgets.
Contract 2	Utility Relocation Prior to Construction Activity, including private utility relocation for items owned by the Presidio. (Public utility relocations included in the ROW data sheet)
Contract 3	Ruckman, Southern PPL, SB High Viaduct.
Contract 4	SB Battery Tunnel, At Grade Detour, RW#6, RW#8, Permanent Roadway Sections, Long Weekend Closure, Partial Demo of Low Viaduct Structures & Open At-Grade Detour to Public Traffic.
Phase II:	
Contract 5	Girard UC, Main Post Tunnels, Low Viaduct, Includes Fill Over Tunnels, Electrical and Mechanical Substations, Demo Existing Low Viaduct, Maintain and Removal At Grade Detour, Open Permanent Roadway to Public Traffic.
Contract 6	NB Battery Tunnels and related roadwork, includes fill over tunnels, conform to existing high viaduct.
Contract 7	NB High Viaduct, Northern Park Presidio Interchange, NB Roadway to Merchant Road.
Contract 8	Highway Planting.

During Phase I of construction, the first two contracts, contracts 1 and 2, were on-site project-wide activities that were awarded as Emergency Limited Bids (ELBs) in early 2009 to prepare the site for construction and accelerate the start of construction by one year. Contracts 3 and 4 were then procured during the summer and fall of 2009, and awarded October 2009 and March 2010 respectively. Both contracts were delivered through the DBB approach as two separate contracts with two different contractors. Construction for contract 3 began that fall and achieved substantial completion in April 2012 when traffic was transferred onto the new completed SB high viaduct and battery tunnel, and the temporary bypass (see Figure 2-10).

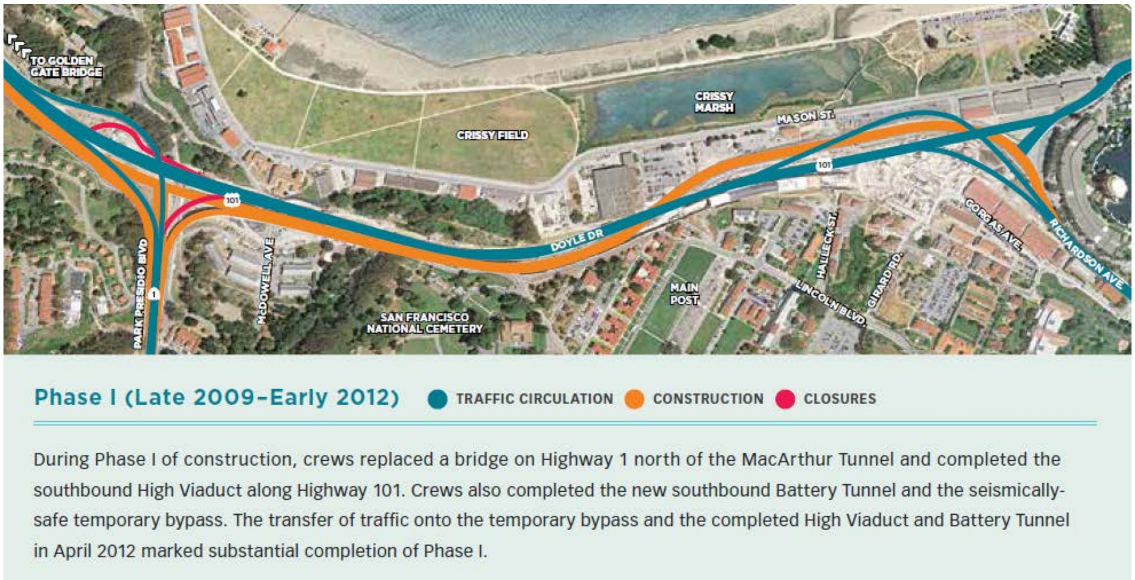


Figure 2-10: Phase I Design-Bid-Build Project Construction Overview (Source: PresidioParkway.org[12])

At the time the project began its first two project-wide contracts, during an extraordinary session of the California Senate, a P3 enabling legislation was signed by the Governor in February 2009. The new legislation, Chapter 2, statutes of 2009 (SB X2 4), authorized Caltrans and regional transportation agencies, such as SFCTA, to enter into unlimited P3 agreements for a broad range of highway, road, and transit projects through the end of 2016. It was during this time that the sponsors decided to conduct an assessment to determine the feasibility of delivering the second phase of the project through a P3 agreement. The sponsors requested the Engineering Joint Venture between Arup and Parsons Brinkerhoff (Arup/PB) to conduct a Value for Money study on the project. During this time, the Presidio Parkway project, although it had already begun construction for the first phase of the project, seemed to be the most appropriate project that was "shovel-ready" to be delivered as a P3. One of the interviewees commented "they needed a project that was already environmentally cleared in order to meet the timeline, and that had certain other characteristics; it needed to be sufficiently large to justify the transaction costs associated with doing a P3, and it needed to be a project that was eligible under the legislation. Basically it needed to be a transportation project and Doyle Drive was it, that was the only project that met all those criteria."

[12] PresidioParkway.org. (2014). "Presidio Parkway: San Francisco's Gateway (Booklet)." http://www.presidioparkway.org/project_docs/files/pp_booklet_oct2014.pdf

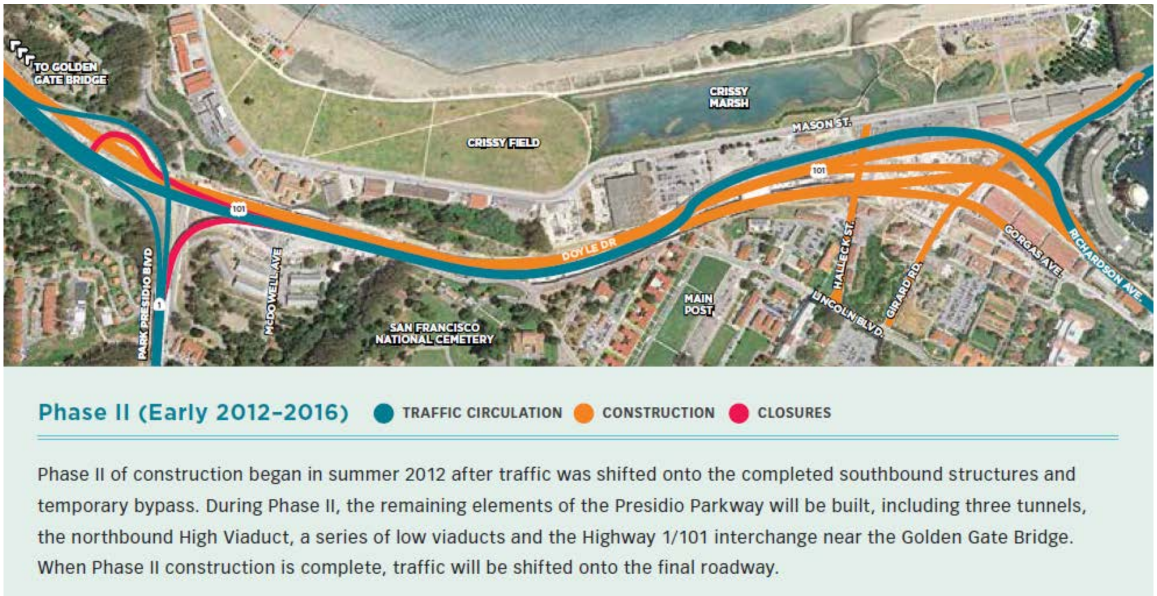


Figure 2-11: Phase I Public-Private-Partnership Construction Overview (Source: PresidioParkway.org)

At that point, in the spring of 2009, contracts 5 through 8 were studied to determine if it would be a better option to use an alternative delivery approach for the design and construction of those four contracts bundled together, in addition to the operation and maintenance (O&M) of all complete facilities (contracts 3 through 8). The report noted that a DBFOM option was a better option to meet the objectives of the sponsors, than using the DBB approach with four separate contracts. The DBFOM approach offered the sponsors:

- Better value for money over the life of the facility
- Optimal risk transfer
- Greater cost and schedule certainty
- Best use of public funds
- Optimal level of operation and maintenance services

The Arup/PB report, reported a potential value for money (VfM) of \$147M (NPV) from delivering the second phase of the project using the DBFOM (P3) delivery option. This P3 cost was estimated to be approximately 23% lower than the traditional DBB option. This measure of the cost savings from the P3 option provides the potential quantitative benefits. However, this quantitative measure does not take all of the qualitative benefits into account from transferring the financial risks. "The value of qualitative benefits must be taken into consideration when considering the VfM delivered by each [delivery] option" noted the report (Arup/PB Joint Venture 2010 p. 46).

Advantages and Disadvantages

The advantages and disadvantages of implementing a P3 for Phase II, and in being compared to Phase I, are organized in a P3 project life-cycle framework. A life-cycle view allows the researchers to take a holistic perspective on the project, and to discuss how Phase II has performed. There are three major phases found along a P3 project's life-cycle, the Policy and Planning phase, the Transaction phase, and the Implementation phase. Figure 2-12 shows a general overview of the life cycle framework along with a brief description of the general function of each phase from the public sector's perspective.

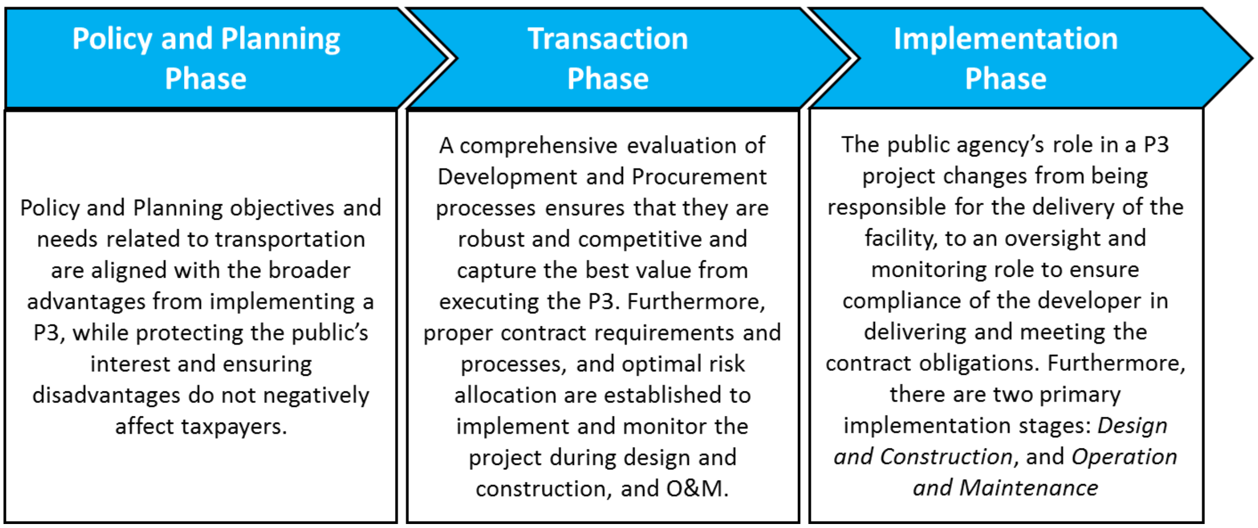


Figure 2-12: P3 Project Life-Cycle Framework

Policy and Planning Phase

A fundamental tenet in the policy and planning phase of P3s, where P3s are initially being contemplated, is to ensure that the decision to pursue and implement a P3 achieves the state's public policy objectives and meets transportation needs (Deloitte Research 2007). A recent report focused on the effects of P3s in the planning and environmental review process of highway projects (Parsons Brinckerhoff et al. 2015), noted that the decision of a public agency to procure a project as a P3 can be made at any point along a project's development process. In the US, the timing of this decision is highly influenced by the timing of the National Environmental Policy Act (NEPA) process. A P3 procurement may begin prior to the conclusion of the NEPA process, and may begin as an unsolicited proposal in some instances or a pre-development agreement solicited by the sponsoring agency in others. If procurement is initiated after the NEPA process has reached its record of decision, then an RFQ/RFP process is initiated.

The decision to implement a P3 in the Presidio Parkway project is considered to have been further along its project development process than what is considered to be ideal. Phase I of the project had already begun construction under a traditional DBB approach, and a significant amount of the design for the project as a whole, including Phase II, had already been completed (~50%)[13]**.** Given this unique and complex setting, with the project's advanced state, advantages and disadvantages found in P3s during the policy and planning phase have had mixed results in this project, as shown in Table 2-3.

Table 2-3: P3 Advantages and Disadvantages - Policy and Planning Phase

ADVANTAGES
Private Financing: *Private financing sources were secured and used through the design and construction of Phase II, allowing the public sector to secure funding with certainty.*
Accelerated Delivery: *Phase II's initial schedule at contract execution experienced unforeseen delays. However, in addition to the additional procurement and transaction time needed for P3s, the project realized inherent efficiencies in the bundled contracts that offset the delay.*
Optimal Use of Public Funds: *Phase II's ability to deliver the project within budget, in comparison to Phase I, shows an effective use of public funds, and reduces the risk of burdening public taxpayers with cost overruns.*
DISADVANTAGES
Regulatory Constraints and Opposition: *Phase II was implemented through the recently approved P3 enabling law that authorized Caltrans and regional transportation agencies to enter into P3 agreements; however, public opposition from public sector employees delayed Phase II from continuing as a P3, on the basis of challenging the validity of the P3 agreement under the state's P3 law.*
Lack of P3 Maturity: *P3 projects have inherently more complex processes than traditional delivery, and require new expertize and adjustments (institutional and cultural) to adapt to the P3 approach. In Phase II, signs of institutional inertia and fear of cultural change were identified during the delivery of the project, resulting in inefficient management and oversight processes.*

Private Financing

The ability to access all sources of financing allows for larger projects to be delivered sooner and benefits the users sooner. This is particularly relevant when comparing the P3 delivery of large and complex projects, such as the Presidio Parkway, with a 'pay-as-you-go' traditional approach. Many large projects

[13] The advanced state of design, relative to what is considered to be a preliminary design (~30% of design), has been noted by several studies on the project, including the Value for Money report on the project (Arup/PB Joint Venture 2010 p. 40), and the California Transportation Commission's assessment of the project (CTC 2009 p. 25), among others. It has been noted as being nearly 50% complete when released for procurement.

are built in phases or increments as funds become available over a period of years. Projects can be brought forward by many years with private financing (Deloitte Research 2007). Larger projects are often postponed indefinitely because of state and local fiscal constraints (NCSL 2010), and this can become even more expensive over time given the impact of material price escalations and other sources of inflation (Reinhardt 2011). Through private financing mechanisms, however, scarce public resources can be 'leveraged' (AECOM Consult Team 2007). Private financing is a key form of innovative financing that is greatly boosted in P3s. Through innovative financing models, projects can begin construction much sooner as the needed upfront capital is made available earlier.

> *"The motivations for the P3, I think, were cost and schedule certainty. A lot of effort had gone into it, over many years, lining up a lot of public sources. On paper, it was probably enough to cover the estimate of doing the whole project, but* ***the challenge was that the timing of funds didn't line up to allow you to actually deliver fully funded upfront pay-as-you-go design and construction****." – Project Sponsor Consultant*

In the case of the Presidio Parkway project, sources of funding to cover the estimated cost of the project, as presented in the Initial Finance Plan in May 2009 (SFCTA and Caltrans 2009), had been identified. There was a total amount of funding of approximately \$954.8M (\$2009), consisting of \$878.8M committed and \$76M anticipated sources of federal, state and local funds, to cover the estimated total cost of the project of \$928.5M (SFCTA and Caltrans 2009 p. 26). With the economic recession between 2008-2012, funding uncertainties began to be a major concern. In the summer of 2009, the sponsors decided to proceed with an assessment (a value for money study) to determine whether an alternative delivery approach for Phase II of the project would be practical, rather than the initially proposed 8-contract DBB delivery of the project**. Given the decade worth of negotiation it took for the project to secure the funding needed for this project, there was a concern with the state's historic cost overruns for mega-projects in the bay area. Considering an alternative project delivery approach could serve as a safeguard to be able to deliver the project within-budget, and without being exposed to significant cost overruns.** "The Transportation Authority was legitimately concerned about the history of large cost overruns on state projects, so that was a big anxiety because we had gone to a lot of effort to secure funding for the project" commented a former sponsor project manager.

Table 2-4: Final Funding Sources through Construction ($M YOE) (SFCTA and Caltrans 2014 p. 35)

Source of Fundings:	Phase I	Phase II	Total
Federal Earmarks and Discretionary Grants	$ 70.8	$ 5.9	$ 76.7
American Recovery & Reinvestment Act	$ 85.8	$ 46.0	$ 131.8
MTC STP/CMAQ	$ -	$ 34.0	$ 34.0
Total Federal Funds	**$ 156.6**	**$ 85.9**	**$ 242.5**
State Highway Operations & Preservation Program	$ 198.0	$ 72.2	$ 270.2
Traffic Congestion Relief Program	$ 15.0	$ -	$ 15.0
Prop K Sales Tax	$ 29.6	$ 36.0	$ 65.6
Regional Improvement Program (SFCTA)	$ 17.1	$ 67.0	$ 84.1
State Local Partnership Program	$ -	$ 19.4	$ 19.4
MTC Bridge Tolls	$ 80.0	$ -	$ 80.0
GGBHTD1	$ -	$ 75.0	$ 75.0
Transportation Authority of Marin	$ -	$ 4.0	$ 4.0
Sonoma County Transportation Authority	$ -	$ 1.0	$ 1.0
Total State and Local Funds	**$ 339.7**	**$ 274.6**	**$ 614.3**
Total Project Funds	**$ 496.3**	**$ 360.5**	**$ 856.8**

Phase I of the project was delivered on a traditional 'pay-as-you-go' basis using the department's traditional DBB strategy. Table 2-4 shows the final sources of funding expected to be disbursed for Phase I and Phase II. Approximately 28% of the funding secured for the expected cost comes from federal funds, and the other 72% comes from state and local funds. For Phase II, however, the initially estimated $550M[14] scope of work was financed through other sources of financing. Significant cost savings were also captured for Phase II (discussed further in Section 0). The sponsors did not make a payment until substantial completion of the project was reached for Phase II. Through this structure, the developer financed Phase II through private financing sources, shown in Table 2-5, which includes a private construction loan (45.5%), private equity (12.5%), and two TIFIA (federal) loans (42%).

Table 2-5: Private Financing Sources of Funding ($M YOE)

Private Financing Sources of Fund	Amount ($M)	% Amount
TIFIA LT Tranch B (+ interest)	$ 62.0	17.0%
TIFIA ST Tranch A (+ interest)	$ 90.9	24.9%
Construction Loan (5 Banks at 20% each = $33.3M each)	$ 166.6	45.6%
Equity	$ 45.6	12.5%
TOTAL	**$ 365.1**	**100.0%**

While the private sector finances the design and construction of Phase II, the cost to the public sector is approximately $360.4M. These expenditures cover a milestone payment of $185.4M made to the contractor upon completion of construction and an additional $91M to cover the short-term Tranch A TIFIA loan (see Table 2-6). In addition to this, approximately $37.5M were estimated for department

[14] See Initial Finance Plan of May 2009.

construction and design support costs throughout the project, and a risk reserve was also established for an initial amount of $46.5M.

Table 2-6: Uses of Funds through Construction ($M YOE) (Source: SFCTA Update[15])

Uses of Funds:	Phase I	Phase II	Total
Environmental	$ 27.8	$ -	$ 27.8
Development and Design	$ 51.9	$ -	$ 51.9
Right of Way	$ 83.8	$ -	$ 83.8
Transaction and Oversight	$ 57.2	$ 37.5	$ 94.7
Construction	$ 281.5	$ -	$ 281.5
Construction Completion Milestone	$ -	$ 185.4	$ 185.4
TIFIA Tranche A Loan Repayment	$ -	$ 91.0	$ 91.0
Risk Reserve	$ (5.9)	$ 46.5	$ 40.6
Total Uses of Funds	**$ 496.3**	**$ 360.4**	**$ 856.7**

The Presidio Parkway Project was able to capture the advantage of leveraging the funds needed to complete Phase II of the project's design and construction through private financing provided by the developer. In addition to having had access to other sources of funding through which the developer was responsible for arranging and securing through construction, the public sector was able to suspend uses of funding for Phase II until substantial completion of the project.

Accelerated Delivery

For Phase I, achieving seismic safety was of major importance. Contract 3, with which the traffic from the existing facility was switched onto the new and seismically safe structures, experienced a delay of approximately 8.4 months from the original target date set (August 19, 2011) to the actual traffic switch and completion achieved for contract 3 on May 1, 2012 – this is a 39% contract schedule growth (see Section 0). Furthermore, Contract 4, experienced an 82% contract schedule growth from the original target date set (February 12, 2012) to its final completion date achieved on August 21, 2013 - approximately an additional 18 months. Although an accelerated delivery to achieve seismic safety was among the chief goals for the project, particularly for Phase I, the project experienced major schedule delays.

One of the former sponsor's project managers for the project commented "I know that we had challenges ourselves, we had a delay ourselves in Phase I, but I think most of what we learned in Phase I could have easily been avoided in contracts 5, 6, 7, & 8 if we continued as design-bid-build," referring to their ability to perform better in terms of schedule if the project had continued as a DBB. "We learned a lot in Phase

[15] (SFCTA 2015, Table 1)

I, that if we continued Phase II, there would be a lot of lessons learnt that we would have avoided in Phase II," he added, "so of course, **nobody will know for sure how it would have turned out if we had done contracts 5, 6, 7 & 8 as design-bid-build, but my thinking is that it would have gone much smoother for us than Phase I because of all the lessons learned**."

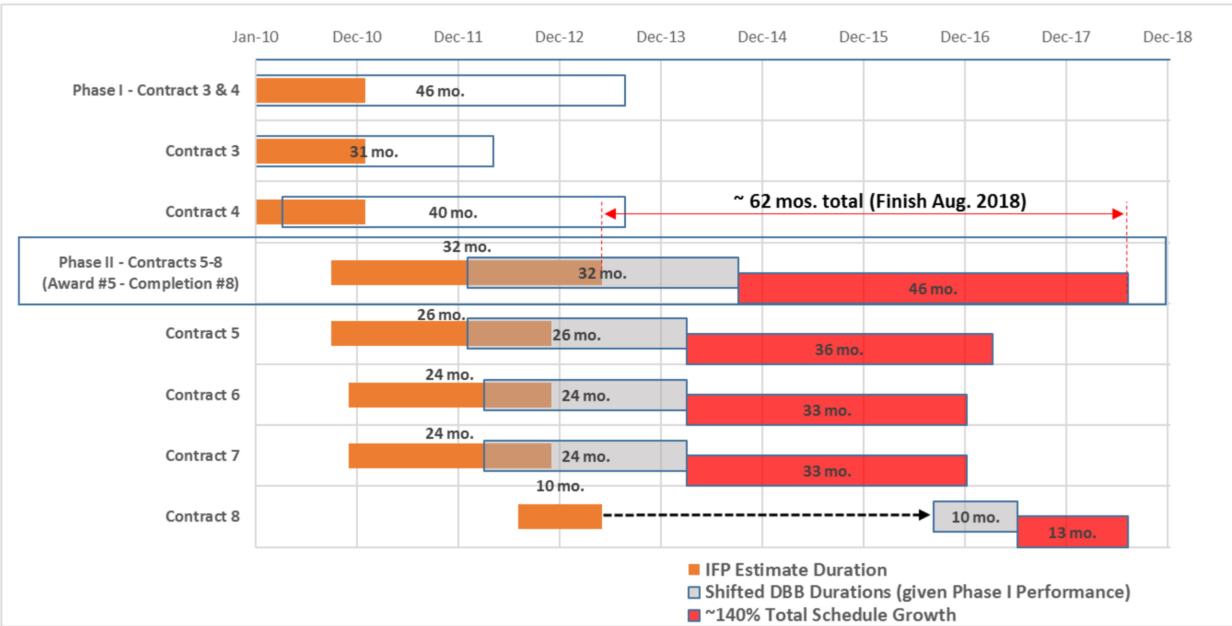


Figure 2-13: Hypothetical Phase II DBB Delivery (assumes Phase I's avg. Schedule Growth of 140%)

Figure 2-13 shows a hypothetical delivery of Phase II with the four additional DBB contracts. Making a comparison to Phase II being delivered as a DBB, a delay extending construction time through 2018 would be expected if the average delays experienced in Contracts 3 and 4 were carried through. A 140% total schedule growth, which measures schedule duration growth from the initial schedule estimate to the final contract schedule duration, was experienced in Phase I (see detailed discussion in Section 0). Given the delay experienced in Phase I, the actual start and site availability for the subsequent Phase II contracts was already expected to be shifted, shown as Shifted DBB Durations in Figure 2-13, for which the original accelerated durations are carried through. Contracts 5-7 would have not been able to begin construction given that contract 4, which held the critical path for the project schedule, was delayed. However, assuming that Contract 5 and subsequent contracts were actually able to begin as originally programmed close to the substantial completion of Contract 3 (having the traffic switched into the temporary bypass), an approximate early start date in early 2012 is assumed. In addition to this, contract 8, the landscaping, would have also been shifted until substantial completion of the proper scope of work in contracts 5-7 was reached including the delays. Taking into account that average of 140% total schedule growth experienced in contracts 3 and 4, as the worst-case scenario, then a DBB approach could have experienced a duration lasting through August 2018.

One of the major issues with having 4 additional DBB contracts delivered separately in Phase II is the inefficiency because of interference between contracts in such complex projects. “If you see in how many areas we are working on, if they would have put contracts 5, 6, 7 and 8 [as DBB contracts], I think it would have taken a lot more time. I think that by giving the contracts to one [contractor], as the client, you minimize the risk of different contracts interfering with each other and having to work with each other, and blame each other that they are being delayed by the other” commented Phase II design-builder’s project manager. **The advantage of accelerated delivery given that Phase II implemented a P3 is not a captured by allowing the project to begin early. The P3 was not implemented for the whole project from the beginning. On the other hand, given the inherent efficiencies gained through the bundling of 4 rather complex contracts for Phase II of the project, further potential delays were prevented for a project already behind in its intended original accelerated schedule. Such efficiencies are primarily related to design and construction activities being parallel and not sequential, reduction of design error and omission lengthy approvals, and the reduction of multiple different contractors working in a constrained and complex site.**

Given the implementation of a P3 for Phase II, however, other delays were experienced, primarily the suspension of Phase II during litigation due to a lawsuit filed to stop the project from implementing the P3 (see Section 0). This process delayed the start of the project by approximately 12 months, and another department-caused delay of approximately 2 months in issuing its construction notice to proceed added to these delays[16]. Furthermore, pre-construction activities for a P3 are generally longer given the additional transaction processes inherent in the process. For the Presidio Parkway, the procurement process for the two DBB contracts were on average 3 months from the time they released a Request for Proposal to the time the contracts were awarded, followed by construction soon after. Note that a 100% design is provided in this case. The P3 procurement, on the other hand, took approximately 11 months from the time the first Request for Qualifications was released to commercial close (see Appendix B: Phase II P3 Procurement Schedule). Then, in addition to the procurement process, after reaching commercial close, an additional 6 months to reach financial close is scheduled followed by a 2-month period to prepare for construction, assuming the notice to proceed is issued accordingly. **From the time the initial RFQ for Phase II was released to the beginning of construction for Phase II, close to 3 years elapsed (35**

[16] See Section 0 for detailed data and information regarding this measurements.

months) in this period. This is being inclusive of the delays encountered due to litigation and department-caused delays, and on-going design by the P3 designer (see Figure 2-34 in Section 0). **Considering the possible points of discontinuity in having 4 additional separate DBB contracts for the project, and the delays experienced in Phase I, the P3 delivery offsets the risk of experiencing further delays that could be up to 140% times longer than the initial estimated durations.**

Reduced Debt Constraints and Optimized Use of Public Funds

P3s allow for the public sector to avoid adding to their long-term obligations, typically regarding public bonding debt outstanding, given that the private sector is responsible for financing the project (Sabol and Puentes 2014). In addition to this, "freeing up" public funds that would have otherwise been allocated for the delivery the project can be used to speed up the construction of other infrastructure projects (LAO 2012). The fact that the financing debt is being incurred by the developer, the debt for the project is considered to be 'off' the public sector's "books", and hence the government can stretch its limited borrowing capacity further for the delivery of other projects.

In the Presidio Parkway project, from the funds that were initially identified and secured, the funding was technically allocated to the project, regardless of the developer having financed the design and construction of the project. **Perhaps where the reduced debt constraint for the public sector is visible, however, is through the cost savings captured, given the P3 delivery, in addition to the cost certainty established and reduction (or complete avoidance) of cost growth in Phase II.**

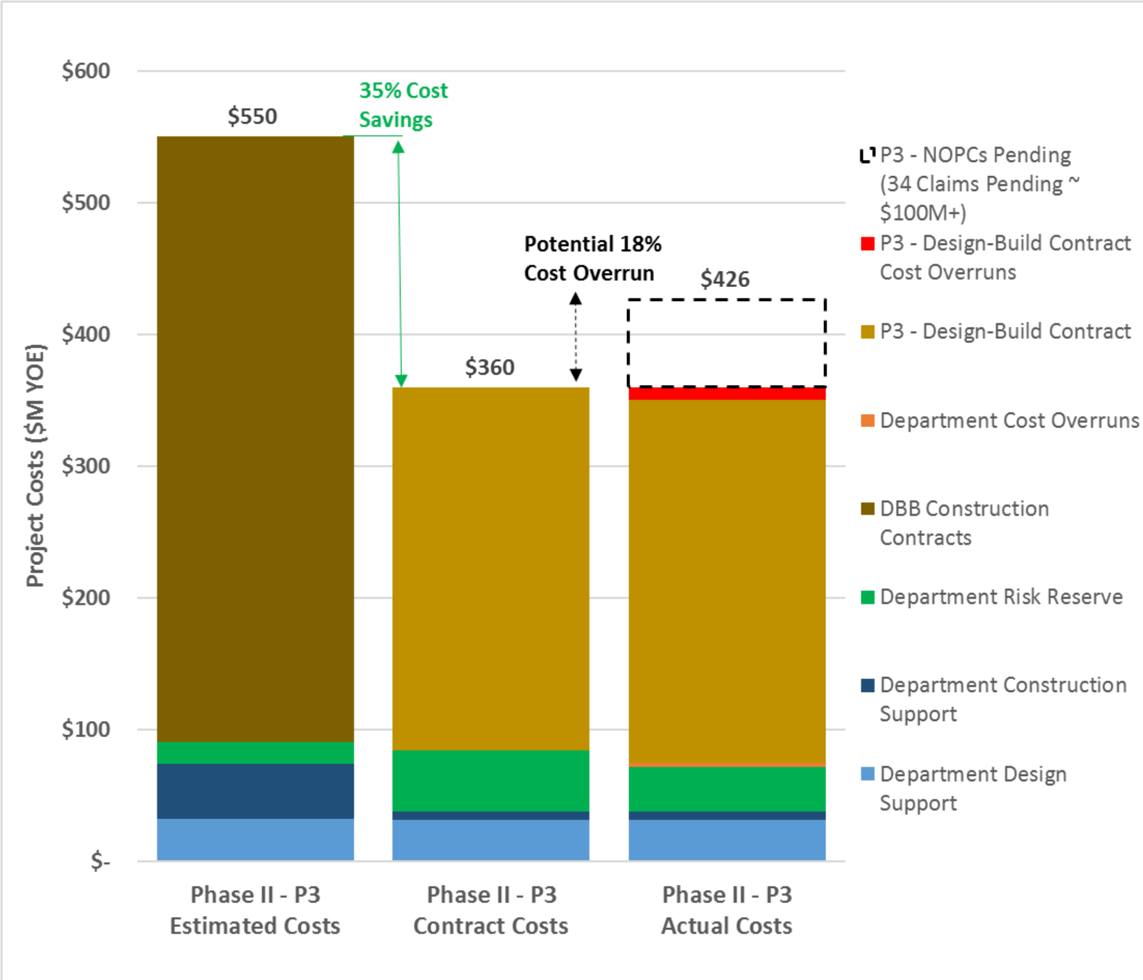


Figure 2-14: Phase II Design and Construction Cost Performance

Figure 2-14 shows an overview of the cost performance for Phase II, which is discussed in detail in Section 0. A comparison of the initially estimated cost to final expected contract cost can be observed. An initial budget for Phase II of approximately $550M was estimated in the initial financial plan of May 2009. **After deciding to proceed with Phase II as a P3, a cost of $360M was then captured for the design and construction of Phase II when the contract was awarded, which is 35% in cost savings from the initial budget. As the project stands, a portion of the $46.5M risk reserve established for the project has already been used to cover approximately $12.5M in construction cost orders (CCOs) that have been approved for the project thus far. However, the project has not experienced a cost overrun yet.** In addition to this, it has been noted that 34 claims worth $100M+ for design and construction issues for Phase II are pending. Even if, worst-case scenario, $100M of these claims materialize, the rest of the remaining risk reserve would be consumed, and an additional $66M would bring the cost of Phase II to $426M (an estimate), which is a cost overrun of 18% from the awarded contract amount.

The ability of the P3 delivery for Phase II to deliver the project within budget, in comparison to Phase I (see Section 0), shows an effective use of public funds. Having a 0% contract cost growth is proving certainty in the cost established for the project at the time it was awarded. If additional cost overruns are to be experienced past the set budget, the project will still perform within the initial budget established, and has reduced the risk of burdening public taxpayers with high and unexpected cost overruns. The cost overrun is likely to be minimal in comparison (see Figure 2-14 above for worst-case scenario) to the cost overrun experienced in Phase I.

Regulatory Constraints and Opposition

When a public agency is considering the implementation of a P3 for the delivery of a specific project, in this case the project co-sponsors being Caltrans and SFCTA for the Presidio Parkway, the pubic owner(s) must have the legislative and statutory authority to be able to procure and implement P3 projects (Parsons Brinckerhoff et al. 2015). In California, there are currently 4 existing P3 enabling laws that allow transportation projects and public buildings to be delivered via a P3 structure (see Figure 2-15). As discussed in Section 0, **the authority of Caltrans and regional transportation agencies to enter into P3 agreements was expanded with the enactment of Senate Bill 4 (SBX2 4), passed by the California legislature and signed into law by Governor Schwarzenegger on February 20, 2009.** This was concurrent with the preparation and implementation of the first phase of the project.

Summary of State Public-Private Partnership (P3) Authority

State Department	Type of Infrastructure	State Law	Brief Description	Projects To Date
Caltrans	Highways	Chapter 107, Statutes of 1989 (AB 680, Baker)	Allowed Caltrans to enter into up to four P3s.	State Route (SR) 91 and SR 125
Caltrans and regional transportation agencies	Highways, local roads, and transit	Chapter 2, Statutes of 2009 (SB 2X 4, Cogdill)[a]	Allows Caltrans and regional agencies to enter into an unlimited number of P3s through 2016.	Presidio Parkway
High-Speed Rail Authority (HSRA)	High-speed rail	Chapter 796, Statutes of 1996 (SB 1420, Kopp)	Allows HSRA to enter into P3 contracts for the proposed rail system.	High-speed train system
Administrative Office of the Courts (AOC)	Court facilities	Chapter 176, Statutes of 2007 (SB 82, Committee on Budget and Fiscal Review)	Establishes process for review of AOC P3 projects.	Long Beach Courthouse

[a] Replaced the P3 authority previously provided to Caltrans under Chapter 107.

Figure 2-15: California P3 Enabling State Laws (LAO 2012 p. 7)

The premise of the Presidio Parkway being a candidate under this law was that it was a project that had already been environmentally cleared, having reached its ROD in December of 2008, and that it was a sufficiently large project, estimated at $550M then, to be able to justify the costs associated with a P3 transaction. As so, the Presidio Parkway, having gone through its Value for Money study to determine its feasibility as a P3, was then procured as a P3 over the course of 2010. The project received three competing proposals, from which a preferred proposer was selected, Golden Link Concessionaire, in October 2010, and commercial close for the project was completed soon after on January 3, 2011.

During this period, on November 2011, the Professional Engineers in California Government (PECG), a union representing Caltrans employees, filed an action to stop the project from implementing a P3 for Phase II of the project. PECG's lawsuit claimed that Caltrans violated the Streets and Highways Code section 143, which is the statute authorizing Caltrans to enter into P3 agreements. First, PECG argued that Caltrans would not be the responsible public agency managing the project, because Caltrans' engineers would not be performing the engineering work for Phase II of the project. Second, it was argued that the project did not qualify as a P3 project because the funding for the project did not require the use of tolls or user fees[17]. "The challenge we had was one of definition about what a P3 should be," commented one of the sponsors executives, "when the law passed in 2009, we were able to read it and figure out what we think the law allows us to do and that is how we implemented Presidio Parkway. Others felt like the law had some other specific requirements, like it had to have tolling, so that was a conflict, that is how they define it so there was opposition from there." The California Court of Appeals rejected both of these arguments, first stating that the law *requires Caltrans to be responsible for the performance* of the work, but *it does not require that Caltrans actually perform the engineering services*. And second, section 143 *authorizes* the use of tolls and user fees, but does not *require* it in every P3 as a necessary funding source. Following this decision, PECG, again, appealed in November 2011, but the California Supreme Court declined to hear the case[18].

From a legal and regulative standpoint, a favorable legal framework allowed for the P3 to be implemented for the project with California's most recent P3 enabling law (SBX2 4). More specifically, it allowed for SFCTA and Caltrans to partner as co-sponsors, and to procure and enter into a P3 agreement. However, the project encountered opposition from the public sector's employees who filed a lawsuit against Caltrans challenging the validity of the agreement under the state's P3 law.

---

[17] "California Court of Appeal Decision "Paves the Way" for Additional Public Private Partnerships in California", Morris, Polich & Purdy LLP, August 2011 http://www.mpplaw.com/files/upload/CA-Court-Of-Appeal-Decision-Paves-Way-For-P3.pdf

[18] "Report On P3 Projects And Legislation In California", Eric M. Gruzen, Pecker and Abramson, P.C. http://www.pecklaw.com/images/uploads/communications/P3bulletinCAprojects.pdf

Lack of P3 Maturity

"So if you are the state, you are Caltrans, you have a great temptation to tell the contractor not just what to deliver, but how to deliver it. And when you start telling them how to deliver it, you lose all of your leverage… but those things are harder to control if you are the organization that is overseeing what the contractor is doing and is very set on a particular way of doing things, because then ***the people in the organization will be tempted to lecture the contractor about how you should do things, 'because that is how we do it here' and then you immediately grab all that risk and bring it back unto yourself. You just violated that main rule, which is you need to tell them what the ultimate product is or what the performance justification is, and let them figure out how to deliver that performance specification****." – Project Sponsor Executive*

The implementation of P3s requires new and complex processes than it might be traditionally done where most of the work performed is typically done in a DBB basis (AECOM Consult Team 2007; Parsons Brinckerhoff et al. 2015). The use of P3s is considered to be relatively new for the state of California, since the two previous highway P3s implemented were done in 2003 and in the early 1990s[19]. In addition to this, given it is the first project delivered using this approach, under new and recently established P3 procedures and guidelines developed by Caltrans[20], both the public and private sector are exposed to a "learning curve", as some interviewees shared, in adapting to the P3 approach. "That is interesting in some regard," commented one of the public sectors' consultants, "and may reflect some of the struggles why some of the coordination takes longer than expected at times. Key members from the two organizations, Caltrans and the Design-Build Joint Venture, are primarily made up of people who are experienced with traditional projects and there are inevitable adjustments as they adjust to a P3 approach."

The *P3 transaction processes* require new and additional steps that rely on highly specialized skills. This is done with the assistance of consultants to perform the needed analyses and processes to complete legal, technical, financial, and commercial parts of these processes (discussed in the following section). The

[19] See "Public-Private Partnerships for Infrastructure Delivery," by Carollo et al. (2012), a detailed case study description that describes these two projects: https://gpc.stanford.edu/sites/default/files/wp075_0.pdf
[20] See Caltrans' "Public-Private Partnerships Program Guide," Revised January 1, 2013: http://www.dot.ca.gov/p3/documents/p3_guide.pdf

procurement process, has received criticism, particularly for its selection process and the robustness, or lack of, in the value for money study conducted for the project (LAO 2012). The *P3 design and construction processes* (discussed in Section 0) have demonstrated signs of institutional inertia and fear of cultural change, which are themes highlighted by project interviewees, which result in inefficient contract management and oversight. The *P3 operation and maintenance processes* (discussed in Section 0) are also guided by the new procedures and guidelines established.

Transaction Phase

The transaction phase of P3 projects is not only a necessary step to prepare and select the project, and to procure and execute the P3 agreement, but an important phase to ensure the successful delivery of the project and a functioning partnership. The procurement processes, shown in Figure 2-16, can take anywhere from 18 months up to 24 months, on average, depending on the requirements of the project. This duration, as shown, is from the initial consideration of a project to be developed as a P3 (noted as Development in Figure 2-16), to reaching financial close. For a detailed schedule of the project's actual P3 procurement schedule, refer to Appendix B: Phase II P3 Procurement Schedule. The time it took from the release of the RFQ to financial close was approximately 29 months, including the delays encountered due to the lawsuit and other delays.

- **Development** – Obtain environmental and other approvals; assess the value of P3 versus public procurement; develop institutional capability; hire financial, legal and other advisors; and develop drafts of RFQs, RFP, comprehensive development lease agreement, and other project documents.
- **RFQ/RFP** – Host Industry Review meetings, issue RFQ, receive Statement of Qualifications (SOQs), shortlist Proposers, issue preliminary-draft RFP, conduct one-on-one meetings, consolidate feedback, issue final RFP, receive detailed proposals, select winning Proposer based on evaluation criteria.
- **Commercial Close** – Execute Contract Documents.
- **Financial Closing** – Developer finalizes financing package, developer and lenders execute financing agreements, developer draws on financing and funding commitments.
- **Term of Agreement** – Developer completes design work and constructs the facility, developer operates and maintains the facility, public sector responsible for ongoing oversight and monitoring responsibilities, facility reverts to public sector at the end of the term.

Figure 2-16: P3 Transaction Steps in California (Source: Caltrans' P3 Program Guide)

There are some major advantages and disadvantages typically attributed to P3s during the transaction phase of the P3 project. **The first advantage, or disadvantage, is whether the procurement process is considered to be competitive, and the best value is captured by providing a competitive field.** A typical disadvantage of the P3 procurement process is the limited competition inherent in P3 projects, as very few companies have the capacity to compete and therefore only a few bidders are able to participate. **The second advantage analyzes how risk is strategically allocated and transferred, and if done properly, if it is the optimal approach to manage risk in the project.**

A third advantage is the use of a life-cycle cost evaluation in these projects, which is often a discussion within the detailed 'value for money' studies conducted for these projects. Newer agencies implementing P3s for the first time encounter complex procurement processes that require new and highly specialized technical, financial, and legal processes that are not typically performed in traditional procurement processes. **Given the complexity found in these processes, the implementation of these processes can be seen as a disadvantage.** How these processes are handled and their robustness can affect the outcome of the project. Table 2-7 summarizes the advantages and disadvantages found in the project.

Table 2-7: P3 Advantages and Disadvantages – Transaction Phase

ADVANTAGES
Competitive Procurement Process: *The sponsors shortlisted three teams for the procurement of the project and provided an adequate competitive process that managed to optimize value, even with the project's unique complex setting, considered to be non-ideal for P3 procurement.*
Optimal Risk Allocation: *The risk allocation accomplished for Phase II was ultimately beneficial to the project as a whole. The ability to fully transfer some of those risks was limited given the project's unique setting, and therefore the sponsors had to share or retain some of those risks typically transferred in P3s:* • **Design and Construction Risk:** Risks transferred to the developer were appropriate given the non-ideal and complex setting of the project site, and the phasing of the construction contracts. However, third party stakeholders interface (particularly the Presidio Trust) has been a risk that has affected the project more than expected. • **Financing Risk:** Upfront costs are estimated to have saved approximately 24% from the initial budget approved for Phase II of the project. Long-term O&M costs are estimated to have saved an additional 37% per year from the initial availability payments set, and over $400M over the 30-year concession period. These savings are a result of the favorable bidding environment and the positive financial market conditions that the developer was able to take capture and take advantage of having been transferred this responsibility. • **O&M Risk:** The state has established a payment mechanism ensuring that sufficient funding is available throughout the concession period, and the concessionaire's responsibility for performance of the facility per the predefined O&M requirements is tied to the availability payments set.
Life Cycle Cost Evaluation: *The concept of looking at projects from a life-cycle cost perspective, switching to a 'value for money' mindset in terms of evaluating the costs of delivering a project, is a significant transition from the traditional mindset of*

evaluating projects. The project underwent a rigorous life-cycle cost evaluation and realized better than expected life-cycle cost performance through its competitive procurement process.
DISADVANTAGES
Complex Procurement Process: *Being the first P3 to proceed under the latest P3 enabling legislation, the project has served to establish many of the guidelines and procedures for future P3s in California. This is the 'pilot' P3 project for this legislation, and even though guidelines were developed concurrently, the procurement process went through a rigorous process, and underwent an extensive review and approval process by several agencies. The project managed this complexity appropriately.*

Competitive Procurement Process

> *[The bidders] came in and they found that we had really thought through some of the most important stumbling blocks, one of them being those elements of design that were controversial in our relationship with Caltrans because it required design exceptions. We had really run all of them practically, I mean there were a few more things that had to be done, but largely that wasn't an unknown anymore. And you know how it is, when a bidder, especially in something new like a P3 that was just being tried in this state, somebody comes and bids on it, they bid all of the risks so the price goes up commensurably.* ***So doing all of that leg work in the environmental process was actually the right thing to do, it costs money but it completely leveled the playing field, in terms of bidders coming in and realizing that all of those uncertainties had been removed****." – Project Sponsor Executive*

The procurement process for the project is considered to have a had an appropriate and competitive process that is typical for the complexity and size of such P3 projects. Following the evaluation of the Statement of Qualifications submitted by interested teams to compete for the project, the sponsors shortlisted three proposers to participate in the RFP process[21]. "I think it is what is normally regarded as reasonable competition for public bids, and you know, there is a substantial cost for each concessionaire, you don't want 100 people preparing proposals because it is very expensive," commented one of Public Infrastructure Advisory Commission (PIAC) members, "so there has got to be maybe a 1 in 3, or a 1 in 5,

[21] "Short List of Proposers for Presidio Parkway Project," April 10, 2015: http://www.dot.ca.gov/docs/presidioparkwayfirms.pdf

chance of winning to justify the cost for the concessionaires competing for this thing, you can't have hundreds of people bidding on it, it isn't practical."

Whether it was the 'ideal' P3 to be put out for bidding in the market, that is a different argument, and one used to criticize the process. Analyst Mac Taylor of the Legislative Analyst's Office (LAO), in a report requested by state senator Alan Lowenthal (D-Long Beach)[22], commented that "*we do not think the Presidio project is a good fit for a P3 procurement approach because the project is already very far along in its schedule* and it does not rely on a toll or user fee to fund the work." As argued, the project had a very unique setting, given that half the project was being built with a different delivery approach. Furthermore, the institutional complexity inherent in the project because of its location within a National Park, created a constrained and complex setting for a P3.

However, as a former project sponsor executive argued, "**the fact that we got the bids we got, it showed that there was still plenty of value and interest, in part by the private sector, because we went to the California Transportation Commission and we got a ceiling in terms of what that initial availability payment could be, that we would be willing to pay, and the project came in, I think, something like 23%-24% under that**." The value captured upfront for the design and construction of the project was also significant, in addition to the life-cycle cost, which are both discussed in depth in the following sections. The PIAC noted in its review (PIAC 2010) that the process managed competitive tension to optimize value, "and a well-organized evaluation process ensured that the results maximized cost savings, innovations, and performance criteria in the Agreement."

Optimal Risk Allocation

> *"Under a traditional arrangement about the only risk that the contractor is responsible for is constructional risk, which is actually of all the risks on a project, probably the easiest one to manage, and the owner retains all the other risks. Well, in the P3 there is a little bit, even on this project, a little bit of rearranging of that risk so that the classic conflicts or interfaces between design and construction, now rests with one entity. So that risk was effectively transferred." – Project Sponsor Executive*

[22] "Letter to Senator Alan Lowenthal, regarding the P3 Agreement between Caltrans and Golden Link Concessionaire LLC," December 9, 2010 (LAO 2010) http://www.lao.ca.gov/handouts/transportation/2010/P3_letter_12_22_10.pdf

In P3s the public sector transfers project risks to the party that is best able to manage them. Certain risks may be more effectively managed by the private sector, while the public sector can retain the risks in which they are better positioned to manage them (AECOM Consult Team 2007). Typically, the public sector is better positioned to manage risks associated with environmental clearance, permitting, and right-of-way acquisition, whereas the private sector will assume those risks associated with the phases of the project, including design, construction costs and schedule, O&M, and in some cases the demand (traffic and revenue) risk (NCSL 2010). For Phase II, the P3 agreement allocates many risks to the developer that are typically retained by the public sector in a traditional DBB process. In this project, the following risks are among the salient risks transferred to the developer:

- **Design and Construction Risks**
    - Design-construction interface risk
    - Design errors and omissions risk
    - Construction cost overruns risk (contractor-caused)
    - Project time delay risk (contractor-caused)
    - Quality of construction (warranty and latent defects)
- **Financial Risk**
    - Securing and providing financing sources for design and construction
    - Keeping a Maximum Availability Payment below the established affordability limit (ceiling), and as low as possible
    - Financing costs risk (costs being higher than anticipated at financial close given market conditions)
- **O&M Risk**
    - O&M cost escalation risk
    - Rehabilitation and replacement cost risk
    - Level of service

The developer is responsible for design and construction risks, financing risks, and long-term O&M risks related to the performance of the facility during its 30-year concession period. There is no traffic and revenue risk transfer in this project, as the project is structured with an availability-based payment mechanism (see Figure 2-17).

Delivery Option	Design Risk	Construction Risk	Financial Risk	O&M Risk	Traffic & Revenue Risk	Asset Ownership	
Design-Bid-Build (DBB)		Partial					Phase I
Design-Build (DB)	X	X					
Design-Build-Finance (DBF)	X	X	X				
DBFOM w/Availability Payment	X	X	X	X			Phase II
DBFOM w/Toll Revenue	X	X	X	X	X		
Build-Own-Operate (BOO)	X	X	X	X	X	X	

Figure 2-17: High-level Risk Allocation Overview, Phase I vs Phase II

Design and Construction Risks

The risks associated with the design and construction in Phase II were effectively transferred and allocated in the agreement. The sponsors, however, did retain risks that would have otherwise been completely transferred under a normal or 'ideal' P3 setting. For example, although the timely completion of the design rests with the developer, Caltrans had already designed a significant amount of Phase II prior to suspending the design to pursue it as a P3, nearly a 50% complete design[23]. Because of this, many of the risks resulting from design criteria established by the sponsors, such as aesthetic design features and choices made for contracts 3 and 4, can cause an increased scope of work or disputes. These risks are effectively taken back by the sponsors in this manner. In addition to this, achieving more of a 'performance-based' design given the relatively advanced and more prescriptive design established under this circumstance, it has limited the developer from being able to optimize the design – a key advantage in P3s. A developer may be able to innovative design decisions tailored to improve construction means and methods, and to either lower upfront costs or improve overall life-cycle costs. However, as discussed in Section 0, the strict site-specific design criteria and context-sensitive design process established in Phase I has limited the developer's ability to find innovative design and construction solutions in Phase II.

As the LAO (2012) report noted, the project was "**too far along to transfer many of the project's risks to a private partner. This is because the Presidio Parkway's first phase of construction was already underway using a design-bid-build procurement when the second phase of the project was selected for P3 procurement. As a result, potential private partners had limited access to the construction site,**

[23] See Note 13

which in turn made them less willing to take on many of the project's construction risks" (LAO 2012 p. 18). Some of those construction risks retained by the sponsors are costs or other problems that could result from the discovery of hazardous materials, endangered species, and archeological or cultural artifacts[24]. The sponsors are often in a better position to manage these risks too.

In addition to this, other risks that have been encountered throughout the construction period of Phase II, are those related to the interface with third party stakeholders, particularly in dealing with the Presidio Trust. The Presidio Trust being the land owner and entrusted steward by Congress in protecting the National Park values of the Presidio, has caused the developer and the sponsors to deal with additional construction permitting and approval processes, unusual design standards, and design and construction issues arising from the Presidio Trust's requirements. "I don't think they anticipated the kind of difficulty they would have working with the Presidio Trust, and in fact, the Presidio Trust itself directly or indirectly is a source of most claims," commented one of the project sponsor's executive. An issue that the developer has had to deal with, for example, is the development of a site-specific soils management plan for approval by the Trust, which delayed issuance of several excavation permits for the developer. "I think the fundamental difficulty we are having with this situation is that we continue to own the land you know," commented one of the Trust's executives, "they are building a highway through a National Park, but it is still a National Park, and this is unlike building a freeway, say, in the middle of the central valley or anywhere else where Caltrans owns the land."

To conclude, regarding the risks related to design and construction of Phase II, the sponsors have recognized that risks would still be retained regardless of the project being delivered as a P3. Through a risk assessment of this alternative structure to deliver Phase II, they estimated such risks to be approximately $47M, and have established the 'retained risk reserve' incorporated as part of the P3 agreement[25]. The risks transferred to the developer for design and construction were appropriate given the non-ideal and complex setting of the project site and phasing of construction. However, the risks pertaining to third party stakeholder interface has been a risk that has affected the project more than expected.

---

[24] See list of risks noted in the Arup/PB Value for Money report on the project, Appendix D, for a detailed risk allocation matrix: www.presidioparkway.org/project_docs/files/presidio_prkwy_prjct_bsnss_case.pdf

[25] See the estimated public sector retained risk reserve comparison of DBB ($125M) vs. DBFOM ($47M) for the Presidio Parkway, found in the project's value for money report (Arup/PB Joint Venture 2010).

Financial Risks

*"So when you compare those [upfront costs], it looks like you could make a 24% savings and that is significant**. I mean we were saying anything above 10%, even 5%, would be a strong indication of considering that option of a P3. So 10% was what we were looking at and in this case we were able to show in our analysis that that was going to be 24%.** Now, on top of that 24%, when we finally closed the deal at financial close, we saved another almost $400M in the total lifecycle costs [in Year-Of-Expenditure terms]. By the time we closed, the availability payment going into the deal was set at $35M a year, and when we closed the deal we had an AP at $22M per year. So, we were able to save a significant amount, $13M savings a year, over a 30-year period." – Project Sponsor Executive*

Having transferred the financial risks to the developer for the project has resulted in better than expected overall upfront cost savings, and life-cycle costs over the 30-year concession period. To put it into perspective, the upfront design and construction cost savings captured as a result of procuring Phase II as a P3 are approximately $107M. This is the upfront cost savings from a budget perspective, and it compares those final funds approved at financial close of $360M for Phase II (see Table 2-4) to those initially approved to deliver Phase II as a DBB in May 2010, which were approximately $467M[26]. These cost savings also include the increased costs due to the litigation delay, approximately $21.5M, and the discussed retained risk reserve of $47M.

[26] See Table 1 in Attachment E, of the FPAU 2014 (SFCTA and Caltrans 2014 p. 110)

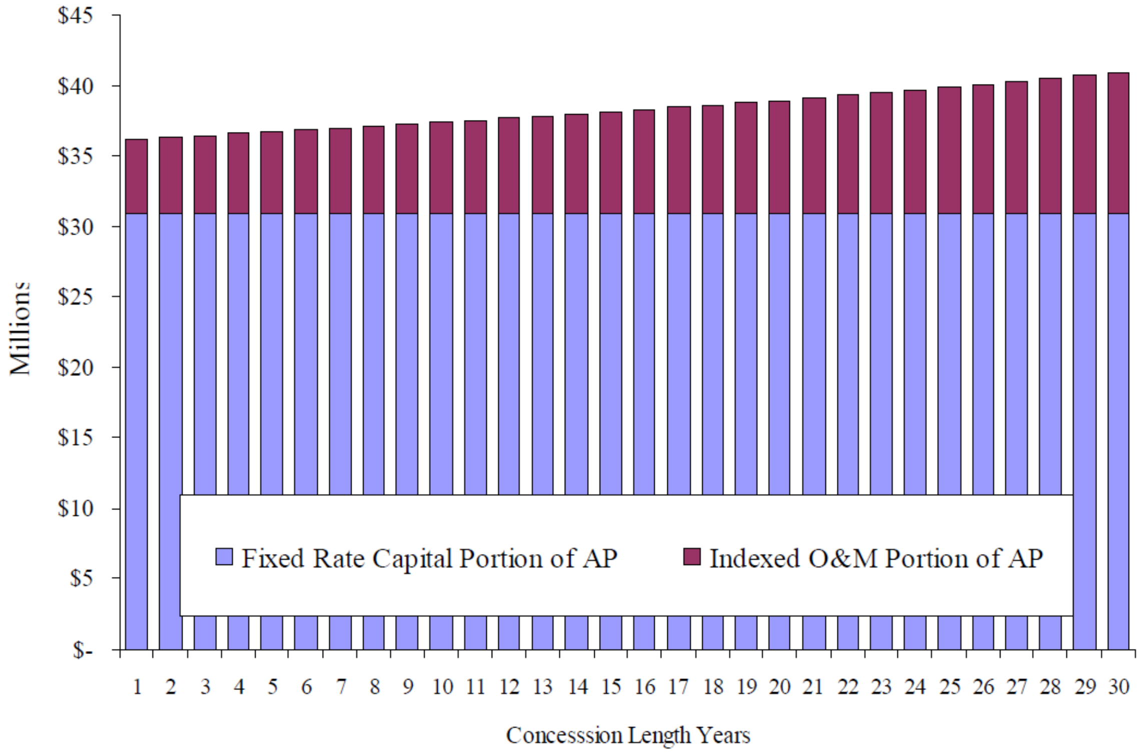


Figure 2-18: Initial Maximum Availability Payments ($M YOE) (Caltrans 2010, fig. 11)

Looking at the life-cycle cost savings captured, the availability payments established for the project were also considerably lower than what was initially expected. "The favorable bidding environment at the time of proposal submittal, improvements to the financial structure and positive financial market conditions at the time of Financial Close," as noted in a CTC memo summarizing the total budget approved and revised after financial close[27], were some of the reasons these savings were captured at financial close. The CTC established an 'affordable ceiling' limit of $35M for the Maximum Availability Payment (MAP) the state would be willing to pay, which would be the annual payment made to the developer commencing late 2013 (from the original schedule) once the final configuration of the Presidio Parkway initiated the O&M phase. This MAP would then be adjusted annually with 85% of the MAP fixed, for construction and financing costs, and the other 15% portion is indexed to an inflation rate of 2.2%, for O&M costs (see Figure 2-18). The winning concessionaire submitted an initial MAP of approximately $22.1M at Financial Close in June 2012, which is considerably below the ceiling limit set and provides approximately $13M in savings per year. Figure 2-19 shows the actual availability payments expected to be paid out to the

[27] See Attachment E of the FPAU 2014 (SFCTA and Caltrans 2014 p. 112)

concessionaire, adjusted for inflation too, in which the highest payment reached (assuming a 2.2% inflation rate) will be no more than $26M (see Appendix C: Estimated O&M Costs and Payments).

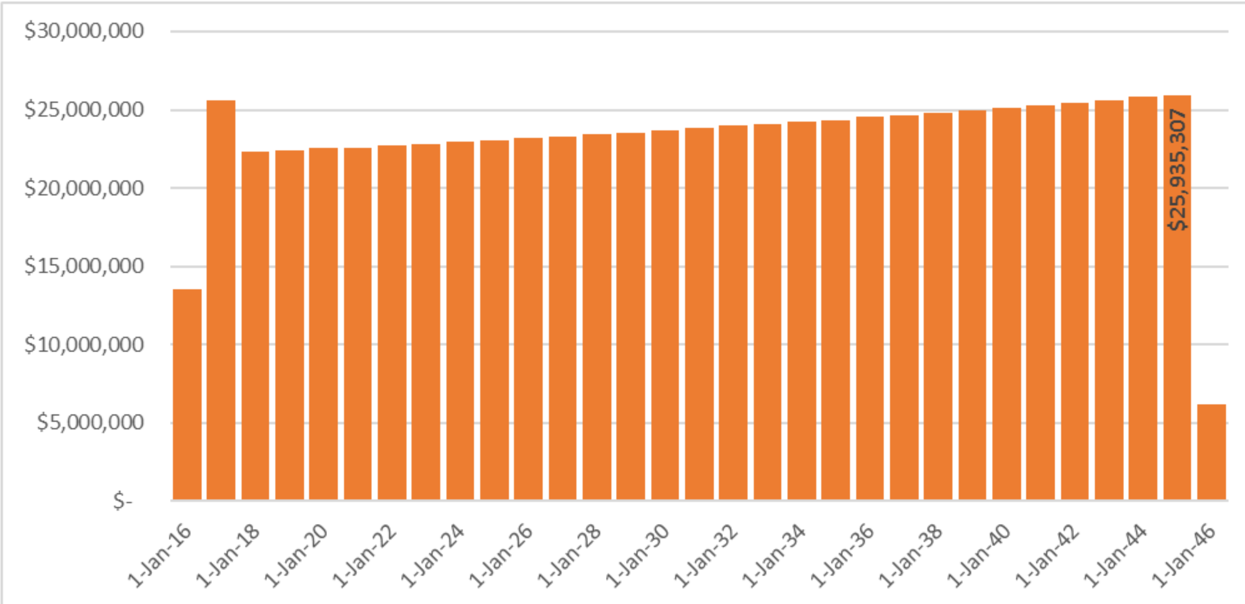


Figure 2-19: Availability Payments Scheduled per Year (YOE) (see Appendix C: Estimated O&M Costs and Payments)

Table 2-8 below shows the estimated total amount of availability payments to be paid (noted as Planned) over the 30-year concession period, along with the total amount of funding Available, which is the total estimated funding approved using the $35M MAP initially set. The difference between the cumulative initial MAPs set, and the actual amount executed at financial close, is approximately $414M (YOE).

Table 2-8: Availability Payments Total (YOE) (SFCTA 2015, Table 3)

Source	Available	Planned
State Highway Account (Federal Trust Fund)	1,030,100,000	616,500,000
State Highway Account (State Transportation Fund)	100,000,000	100,000,000
TOTAL	**1,130,100,000**	**716,500,000**
Source: Presidio Parkway Financial Plan Annual 2014 Update, Table 31		

The financial risk transferred to the developer had a positive impact, from a cost and budget perspective, that was beneficial to the public sector. Upfront costs are estimated to have saved approximately 24% from the initial budget approved for Phase II of the project. Long-term O&M costs are estimated to have saved an additional 37% per year from the initial MAP ceiling set, and over $400M over the 30-year concession period. These savings are a result of the favorable bidding environment, present in both Phase I and Phase II, and the positive financial market conditions that the developer was able to take advantage of. The financial risk was rewarding to both the developer and the sponsors.

Operation and Maintenance Risks

The operation and maintenance risks that have been transferred are tied to the escalating availability payments the developer receives, discussed in the previous section. The availability payments are performance-based payments subject to deductions if the concessionaire fails to perform, to make the facility 'available', per the predefined requirements for O&M set in the P3 Agreement[28]. Failure to meet those minimum requirements results in non-compliance events, for which depending on the classification of each non-compliance, a point system established calculates the ultimate penalty accessed to the O&M contractor, and the deduction from the availability payments. Figure 2-20 shows a section of Table 4.2 of the O&M requirements in the P3 agreement.

TABLE 4.2 - OPERATING PERIOD O&M WORK REQUIREMENTS						
Element Category	**Required Task**	**ID**	**Minimum Performance Requirements**	**O&M Noncompliance Event Classification**	**Cure Period**	**Interval of Recurrence**
Rigid Pavement and Bridge Deck						
Rigid Pavement and Bridge Deck	Maintain rigid pavement and bridge deck at acceptable condition and level of safety for traveling public.	25	Ride quality to be maintained at International Roughness Index (IRI) of less than or equal to 95.	C	90 Days	5 Days
		26	Repair all cracks greater than or equal to 0.25 inches in width.	B	90 Days	5 Days
		27	Repair all settlement/depression greater than 1.5 inches in depth over any 50 ft. length.	C	30 Days	5 Days
		28	Level adjacent slabs if the deviation at the joint exceeds 0.5 inches.	C	90 Days	5 Days
		29	Repair all spalls exceeding 4 inches.	B	90 Days	5 Days
		30	Repair all pot holes and slippage areas greater than 0.5 square feet in area and/or 1.5 inches deep.	C	24 Hours	24 Hours
		31	Inspect pavement surface in accordance with Maintenance Manual Volume II, Section 4 for the B Family.	B	N/A	5 Days
		32	Meet all other technical requirements for rigid pavement set forth in Maintenance Manual Volume I, Section B and Maintenance Manual Volume II, Section 4.	A	90 Days	5 Days

Figure 2-20: Example of O&M Work Requirements set in the P3 Agreement[29]

This mechanism effectively manages the performance of the facility and ensures that the O&M responsibilities are met and maintained to those minimum set requirements throughout the 30-year concession period. "The P3 agreement takes maintenance of this facility out of the political arena, in which governmental budgets are hotly contested, and in which infrastructure maintenance needs often lose out to other budget priorities," commented the PIAC's review of the project. The estimated costs associated with the O&M phase are provided in Appendix C: Estimated O&M Costs as an overview of the types costs expected - note that these are the estimates provided and do not reflect actual costs. Approximately $112M in operational expenses (OpEx) are estimated to be spent over the 30-year concession period, and another $80M in major renewal and rehabilitation expenses (CapEx).

[28] Public Private Partnership Agreement for the Presidio Parkway Project between Caltrans and GLC dated January 3, 2011 - Division II, Section 4, Tables 4.1 & 4.2.
[29] See Note 28

Furthermore, the state has appropriated the funds to secure the availability payments over the course of the concession period, and this makes the availability payment part of the state's annual transportation spending budget. This ensures that sufficient funding is available for the availability payments throughout the 30-year period and the state agrees to prioritize the payments. **The state has established a payment mechanism ensuring that sufficient funding is available throughout the concession period, and the concessionaire's responsibility for performance of the facility per the predefined O&M requirements is tied to the availability payments.**

Life Cycle Cost Evaluation

> *"**I think that just having the concept of value for money on the table is quanta leap from where we were from a public policy standpoint, because once you put that on the table and you start making comparisons between one delivery method and the other, it becomes inescapable that one method is better than the other.** So just having the metrics is fundamental because you can't have these discussions on a one-year budget, which is why it is so important to burst that discussion open in state legislatures, and at national levels, that you can't have a 30-year infrastructure program one year at a time." – Project Sponsor Executive*

In the value for money report for the project, it was reported that a potential value for money (VfM) of \$147M (NPV) from delivering Phase II using the DBFOM delivery option could be captured. This P3 cost was estimated to be approximately 23% lower than the traditional DBB option in net present value terms. The concept of looking at projects from a life cycle perspective, switching to a 'VfM' mindset in terms of evaluating the costs of delivering a project is a significant transition from the traditional mindset of evaluating projects. When a value for money focus is emphasized, decisions are made based on a life cycle cost basis, as opposed to an initial cost mentality.

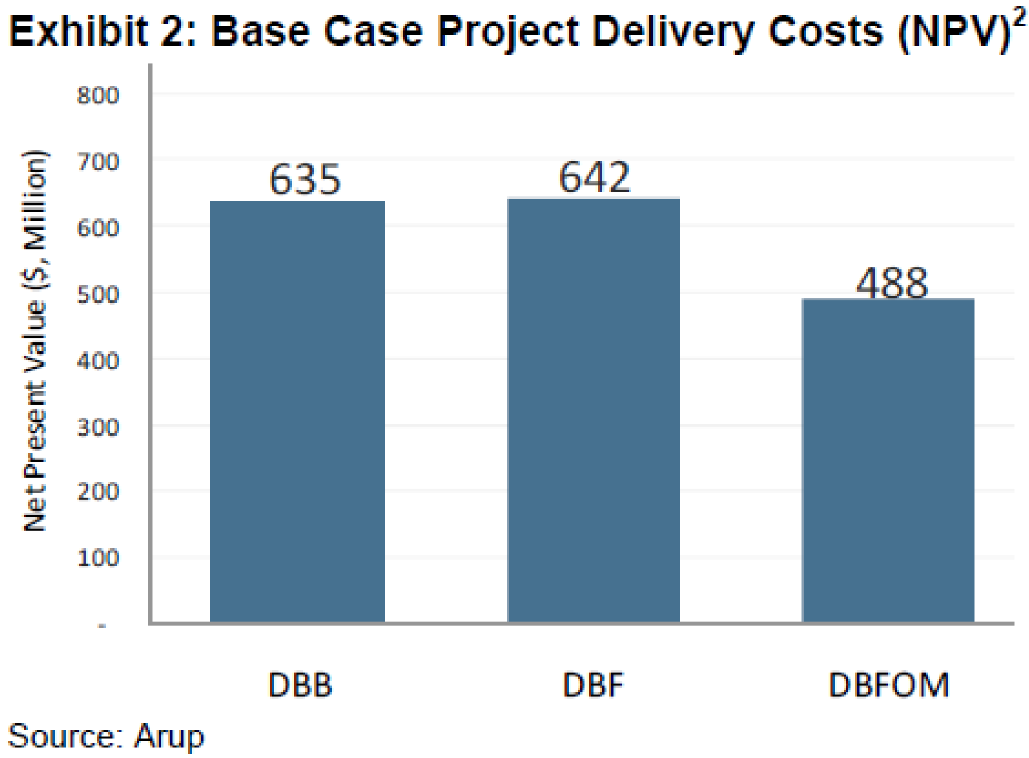


Figure 2-21: NPV Cost Comparison from Value for Money Report (Arup/PB Joint Venture 2010)

A value for money analysis allows the public sector to select a delivery approach that ultimately provides 'the most bang for the buck.' The department initially considered that anything above 10% cost savings would be a strong indication to consider a P3 delivery option. Figure 2-21 shows a potential of 23% cost savings (NPV) that was calculated in the value for money report.

An ex-post value for money analysis was completed for the purpose of evaluating the assumptions and results of the ex-ante value for money discussed above. The completed analysis shows high net benefits for P3 compared to traditional delivery at $241 million, higher than those anticipated in the initial completed analysis. The assumed time frame for this analysis is substantial completion; however, there are still significant unresolved claims at the time of this analysis. Due to this uncertainty, outstanding claims were incorporated as a risk at a value of $40 Million. This analysis confirms that significant value for money has been achieved by pursuing Phase II of the Presidio Parkway Project as a public-private partnership.

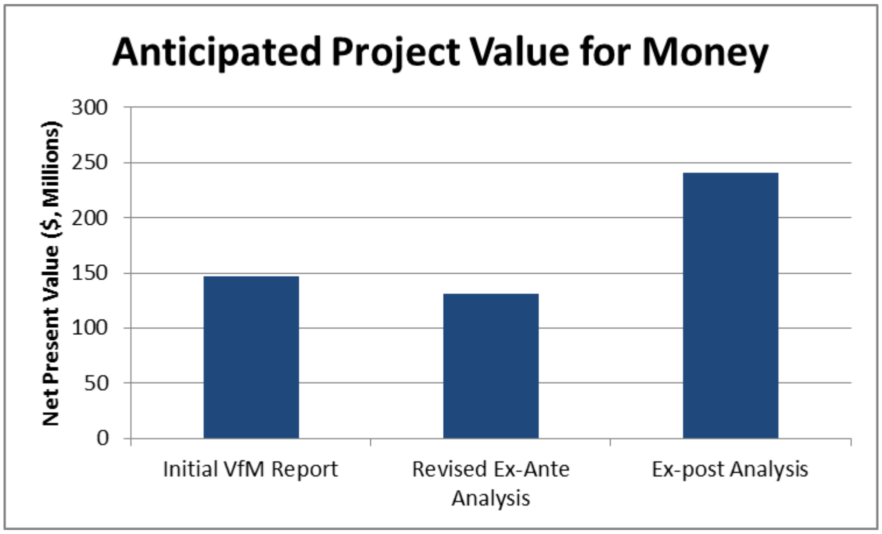


Figure 2-22: Comparison of Project VfM Analyses

In addition to the value for money analysis, a project delivery benefit cost analysis was conducted. The results of this analysis show anticipated net project benefits of $2.34 Billion with a benefit cost ratio of 3.43. As with the ex-post value for money analysis, the assumed time frame for this analysis was also substantial completion. The project delivery benefit cost analysis shows that beyond the financial value for money that was previously anticipated and validated via the ex-post analysis, there are additional economic benefits that will be realized by completing the project, and completing it as a P3.

All assumptions, methodology and results outlined briefly above are discussed in detail in a forthcoming *Ex-post Value for Money* report.

Complex Procurement Process

> *"The procurement process is probably an order of magnitude more complex for a P3 than it is for traditional projects for a couple of reasons, one is that in California the procedures for doing a traditional design-bid-build project are well established. There is a lot of precedent history and court cases, we know exactly how to do that and it is quite straightforward. The P3 was new so we were inventing procedures at the time which is more difficult. Well, the contracts are much more complicated so there was a great deal more effort involved in preparing a contract that addresses all of the features included in a P3, the financing, the design and the O&M over a 30-year concession period. So it was a pretty big effort to do that especially when you are the first one under this new legislation." – Project Sponsor Executive*

The P3 procurement process implemented for the selection of the Presidio Parkway by Caltrans received criticism by a report from the Legislative Analyst's Office (LAO 2012), particularly noting that the selection process used to select the Presidio Parkway in the beginning lacked "transparent frameworks and clear processes." In addition to this, the report also considered the value for money analysis prepared for the project to lack robustness and to have used assumptions that favored P3s in the analysis. The Presidio Parkway not being an ideal project for a P3 is mainly concerned with those risks discussed for design and construction, for which a non-ideal and complex setting was in fact a big part of the project. Those risks, as discussed in Section 0 above, were addressed and thoroughly evaluated to determine the potential risks that could remain with the public sector. Furthermore, the value for money analysis has been noted to be among some of the most detailed and comprehensive value for money reports performed to date in the US (Carollo et al. 2012).

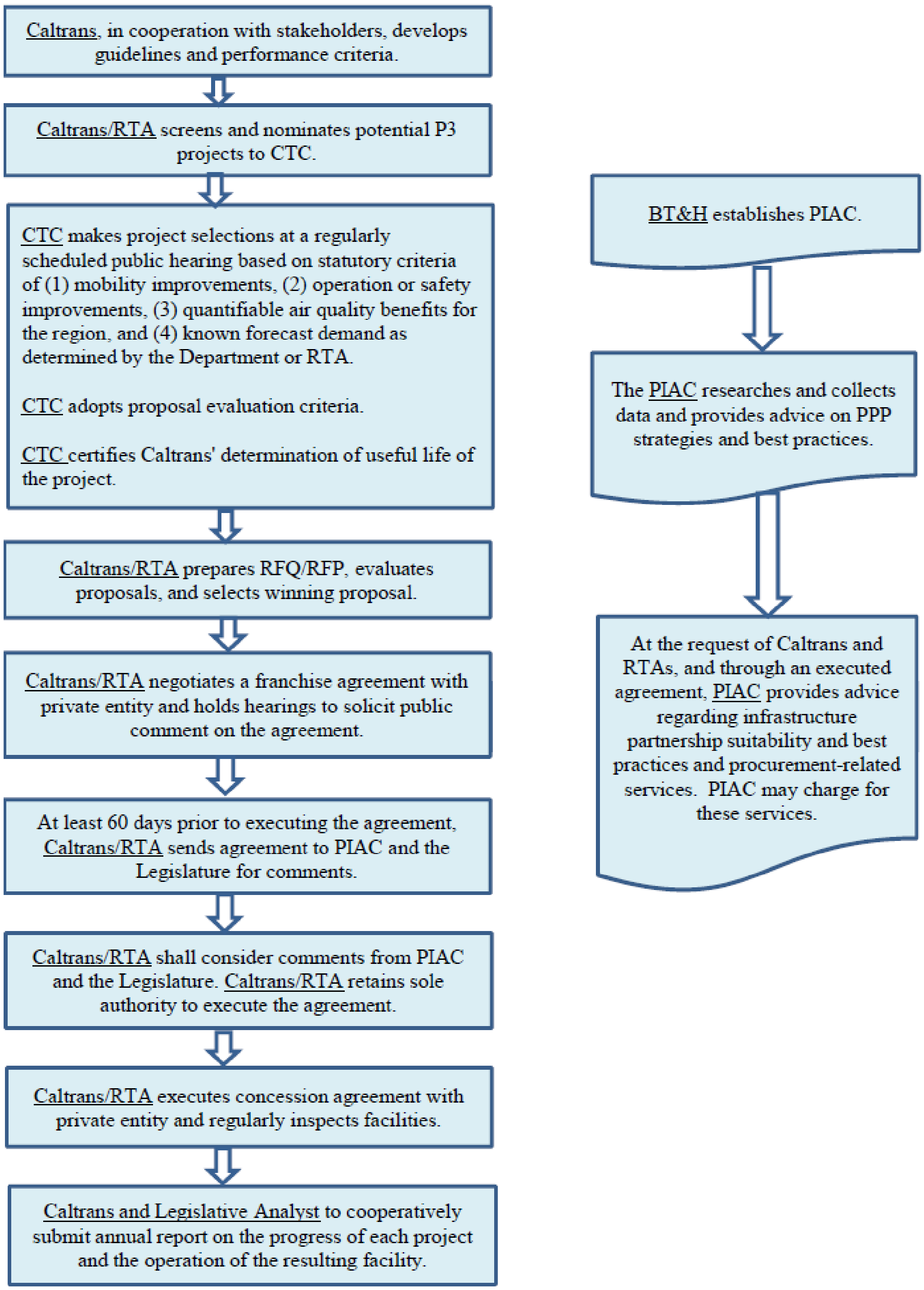


Figure 2-23: General P3 Project Selection Process Overview[30]

Being the first P3 to proceed under the latest P3 enabling legislation, the project has served to establish many of the guidelines and procedures for future P3s in California. This is the 'pilot' P3 project for this

[30] See Note 20

legislation, and even though guidelines were developed concurrently, the procurement process went through a rigorous process, including all the steps shown in Figure 2-23, and underwent an extensive review and approval process by the CTC (2009) and PIAC (2010). The PIAC report notes that given the extensive review process evaluated, the P3 approach for the project is good for the residents of the Bar Area and California. Furthermore, they highlight that P3 agreements in the future should adopt a similar performance assessment and incentive structure as used in Presidio Parkway's P3 agreement.

Implementation Phase

The Implementation Phase of the P3 project begins once the transaction phase has been completed. It has been noted that P3 projects may in effect focus too much on the front-end policy and planning, and transaction phases, which can result in poor *operational* focus during the implementation phase once the P3 agreement is executed (Deloitte Research 2007). The completion of the transaction phase is denoted by the formal execution of the P3 agreement, when the project's commercial close is achieved, the contracts are signed, and financial close is reached. At this point the P3 developer is given its notice to proceed with design work, followed by concurrent construction activities, upon which the implementation phase begins (see Figure 2-24). Operation and maintenance activities can be performed during construction, and routine O&M activities during long term Operations continue after substantial completion is achieved. The implementation phase is finished when the P3 concession term ends. The private developer performs its required hand back renewal processes towards the end of the concession term, and transfers the facility's O&M responsibility back to the project sponsors upon acceptance of the project's assets' condition.

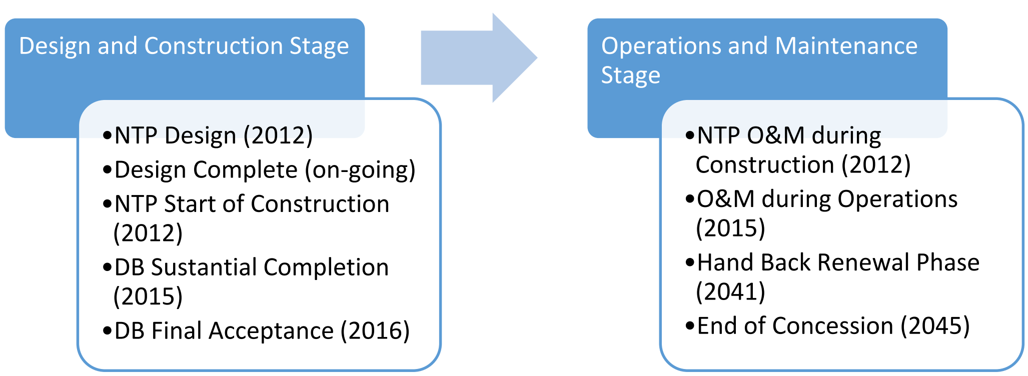


Figure 2-24: Overview of Implementation Phase Major Milestones for Presidio Parkway

Implementation Phase: Design and Construction Stage

During the Design and Construction stage of the project, the project sponsors assume an Oversight role for which they administer the P3 contract, provide assistance to the developer, and perform what is described as “Independent Quality Assurance (IQA)” processes. Through this role, the project sponsors are responsible for ensuring that the developer implements proper quality assurance and quality control (QA/QC) procedures and that the project’s technical requirements are also likely to be met[31]. The P3 developer must meet the design and construction obligations, as well as the O&M obligations discussed further in the next section, and a Design-Build contract is executed with a Design-Build Joint Venture (DBJV) to perform those design and construction obligations.

Given the significant amount of risk undertaken by a private developer, **improved quality in design and construction is attributed to be a significant advantage of P3s**. Improved quality in design and construction is assumed to be achieved given the incentives established through the O&M and financial risk transferred, where the concessionaire might undertake more a more meticulous approach to ensure higher quality during design and construction that will benefit the long term O&M performance of the facility. This is often noted to be different from the *initial delivery-only* focus that a contractor might take in a DBB or DB delivery approach. **Another notable advantage attributed to implementing a P3 delivery approach is the ability to *achieve greater cost and schedule certainty***. In comparison to project performance for design and construction in a traditionally delivered DBB project, P3s are expected to achieve improved cost and schedule growth performance. The financial incentives established drive the developer to ensure the project is delivered on-time and within-budget, as cost overruns and project delays can have very significant financial impact on the developer’s bottom line.

Disadvantages encountered in P3s are non-technical aspects of a project, organizational issues in nature that require adjustments in the way both the public and private partners manage the project. For example, **the project governance established through contracts is can be quite complex** given the expected long-lived and complex governance structure of P3s. The required adjustments of a public agency used to function in a DBB manner, for example, is prone to experience **inefficient management processes given the organizational rigidity** displayed by the public agencies managing a P3 project. Table 9 summarizes the advantages and disadvantages found in the project related to the design and construction stage of the project.

[31] Caltran’s Presidio Parkway P3 Staffing and Management Plan, dated July 20, 2012

Table 2-9: P3 Advantages and Challenges – Implementation Phase: Design and Construction

ADVANTAGES
Improved Quality: *A misalignment between the project sponsors' and developer's expectations for the quality management methods and processes implemented to ensure and verify quality standards for the project has resulted in difficulties in ensuring quality is met for Phase II. While this does not define the level of quality achieved, QA/QC and IQC processes are important in achieving and maintaining the quality standards established for the project, and the project has suffered from inefficient quality management processes.*
Cost Certainty: *Phase II has experienced a 0% contract cost growth, and has remained within budget, while capturing cost savings from the budgeted amount (this does not reflect pending NOPCs). Phase I DBB contracts have experienced a contract cost growth of 56%, and initial cost savings have been offset by cost overruns.*
Schedule Certainty: *Phase II has experienced significant delays, which have impacted the schedule performance of the project, with an approximate contract schedule growth of 16%. However, the construction-only duration of Phase II is expected to be reduced by 4 months. Phase I DBB contracts have experienced an approximate contract schedule growth of 66%.*
DISADVANTAGES
Project Governance: *The complex project governance inherent in these type of projects, in addition to the additional complexity added given the project's location within a National Park, has affected the implementation of the P3 agreement during design and construction more than it was expected, or anticipated.*
Organizational Inertia: *The project sponsor has shown significant 'rigidity' in adapting to the new role of providing oversight management in the project. This has been evident in the design review process for Phase II's design, where an oversight role encountered difficulties in being implemented.*

Improved Quality

"One other area where we have felt that sort of prescriptive culture is in quality management. In our team's proposal to the sponsors, we had proposed to have the design-builder take charge of both quality control and quality assurance activities, and then have the [developer's] team provide sort of high-level quality oversight for the project. And one of the early sources of disagreement between our team and Caltrans was over that quality structure. Because Caltrans typically provides its own quality assurance staff, they don't pay much attention to what the QC people of the

contractor do because they don't really trust them, so they undertake a lot of hands-on QC work themselves even though they call themselves quality assurance staff." – Developer's Staff

A recent report on alternative quality management systems (QMS) for highway construction (Molenaar et al. 2015) has noted the how 'hard coded' and culturally embedded standards for how to approach quality management are for any project, and within any agency. Quality is defined as "the totality of features and characteristics of a product or service that bears on its ability to satisfy given needs" (Molenaar et al. 2015 p. 2), and thus a project sponsor must articulate its 'given needs' adequately in order for a project's contractor to be able to satisfy those needs appropriately too. In highway construction, quality management processes have been predominately developed to be implemented in the traditional DBB delivery of projects. As so, the quality management approach that has become the standard is tailored for DBB delivery.

The baseline quality management approach, referred to as 'deterministic quality assurance organization', is the type of approach Caltrans implements for DBB delivery. This approach is an appropriate for DBB delivery because the design is performed within the agency, as was the case for Phase I, where Caltrans developed the design. As shown in Figure 2-25, in a deterministic quality assurance organization for a project, the owner is responsible for providing all design and construction QA/QC activities and acceptance of the work, and it is considered to be a 'controlled environment' for the construction contractor to work on. The owner-provided design also specifies the construction methods to be used (a prescriptive specification) and watches over construction directly.

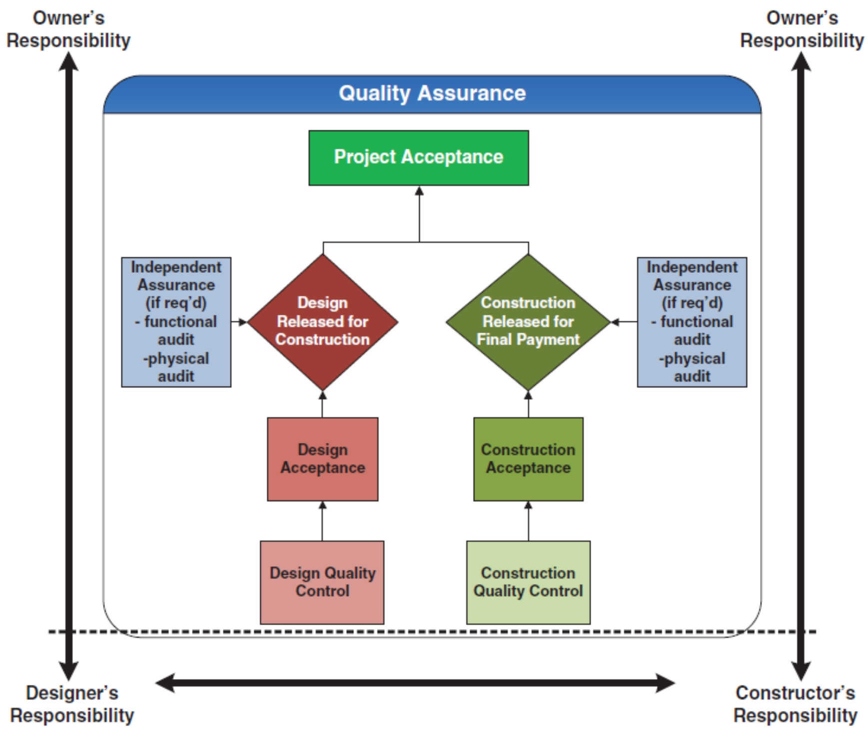


Figure 2-25: Deterministic Quality Assurance Organization (Molenaar et al. 2015, Figure 6)

In a P3, with the design and construction risks being shifted to the concessionaire, the risks are also associated with the quality of the design and construction for the project, and the concessionaire, or its design-builder therefore assumes responsibility for the 'day-to-day' QA/QC activities in the project. The role that the owner, the project sponsors, have for quality management activities changes drastically in a P3 where they now assume an 'oversight' role. As shown in Figure 2-26, the owner's oversight 'IQA' role is responsible for ensuring that the concessionaire, or its design-builder, are effectively meeting the agency's quality requirements stipulated in the contract and implementing their quality plans properly.

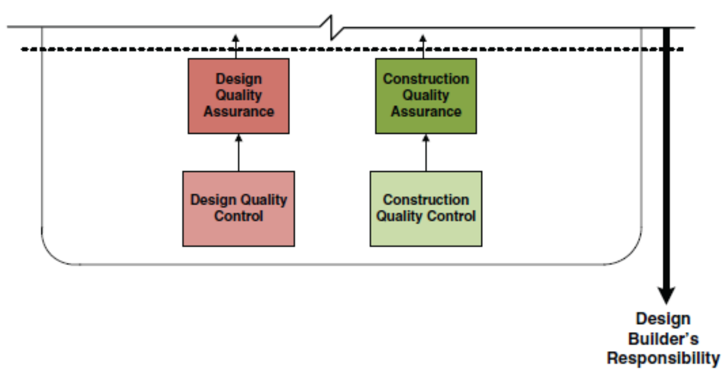


Figure 2-26: Oversight Quality Assurance Organization (Molenaar et al. 2015, Figure 14)

In Phase II of the presidio parkway, having such a drastic change in responsibility for the project from Phase I to Phase II has resulted in what can be described as a 'misalignment' of quality management approach expectations. The project sponsors' construction staff shared that they felt they were "doing a little bit more than what we thought with the IQA, we are doing more inspections, we just want to make sure that it is getting built correctly too," they commented reflecting on how they felt the IQA approach was working for the construction activities of Phase II. "We aren't trying to like micro-manage the design-build joint venture, I think that Caltrans is a little bit more unique, we have a lot of in-house experience and other states… [the other states] have kind of been doing more oversight, but we do a lot of QA because we have been here a long time," this same interviewee added. Such responses show this 'hard coded' and embedded standards that might override the quality management approach that the project sponsors anticipated and provided in their project management plans for Phase II. In a similar fashion, one of the design-builder's staff commented how the oversight quality management approach "is a lot better with a state that doesn't have a heavy DOT with a lot of designers, there are states in the country that don't do much design themselves, therefore, they go out and hire a design-builder for their knowledge right? So they can just kind of stand back and let it happen."

On the other hand, in terms of the perceived quality and implementation of the quality management plans provided by the concessionaire, the projects sponsors felt that they were not adequate and did not meet the expectations that they had to ensure that the facility was being designed and built to meet the quality requirements established. "So the quality assurance that we are seeing in the field is a pale shadow of what we expected to see, and certainly what you see on a traditional project," commented one of the project sponsor's executives, "there is really no evidence that the construction is suffering as a result, but we are accustomed to seeing detailed record keeping and detailed inspections, and a lot of care and sort of signing and approval of certain things before other things happen in the construction." Similar responses to this one have alluded to the fact that from the project sponsor's perspective, the quality management organization that was established by the concessionaire was considered to be inadequate for the level of effort that was needed for the project, was lacking resources.

In terms of the measured quality of the facility's design and construction, particularly in comparing Phase I to Phase II's delivery, we do not assess final construction conditions in this report. Our assessment is rather limited to making the observations presented here in the approach that was implemented to ensure the concessionaire was able to satisfy the project sponsors' quality requirements for Phase II. However, the quality management approach that was intended from both the project sponsor's and concessionaire's quality management plans have encountered difficulties during implementation, which may inhibit achieving quality levels intended for the project. There are culturally embedded standards that may limit taking a more 'hands-off' approach, from the project sponsors' perspective, in managing the project, as would be expected in a P3. In addition to this, the concessionaire may have also implemented a weak quality management organization that lacks significant resources (more people and more processes) for a project of with the size and complexity of the Presidio Parkway.

One of the developer's executives made a profound comment on this issue, which provides advice for future P3s. "We still have disagreements over the level of activity that required quality assurance and there are on-going disagreements in some respect over that issue, but it is another example of where in hindsight, *if a project sponsor wants something organized in a certain fashion, and managed in a certain fashion, it is okay as long as you say so upfront, the procurement phase, and everybody else knows the ground rules and you price it accordingly*," commented this interviewee. Perhaps the project documents did not accurately specify the level of effort of quality standards that were expected for this project, nor were the intended approaches implemented accordingly.

Cost and Schedule Performance

The incentives established in a P3 agreement drive the developer to ensure the project is delivered on-time (schedule certainty) and within-budget (cost certainty), and therefore perform a much more efficient and cost-effective delivery. There is less tolerance for cost overruns and project delays given the financial incentives established when the developer needs to repay the private debt borrowed to finance the project, and begin operations as soon as possible to deliver profit to its investors and shareholders. Within the P3, we measure the completion of the initial project delivery (design and construction) based upon the cost and schedule performance of the design-build subcontract. Doing so only includes the design and construction phase, and does not account for financing, demand risks, or user fees that are inherent in P3s (Whittington 2012).

This section analyzes and compares the initial delivery performance accomplished in Phase I vs. Phase II for the Presidio Parkway Project. To begin, we first describe project performance measurements and then provide an overview of the performance metrics used to conduct the analysis for the project. We then present the results for cost and schedule performance within the design and construction phase.

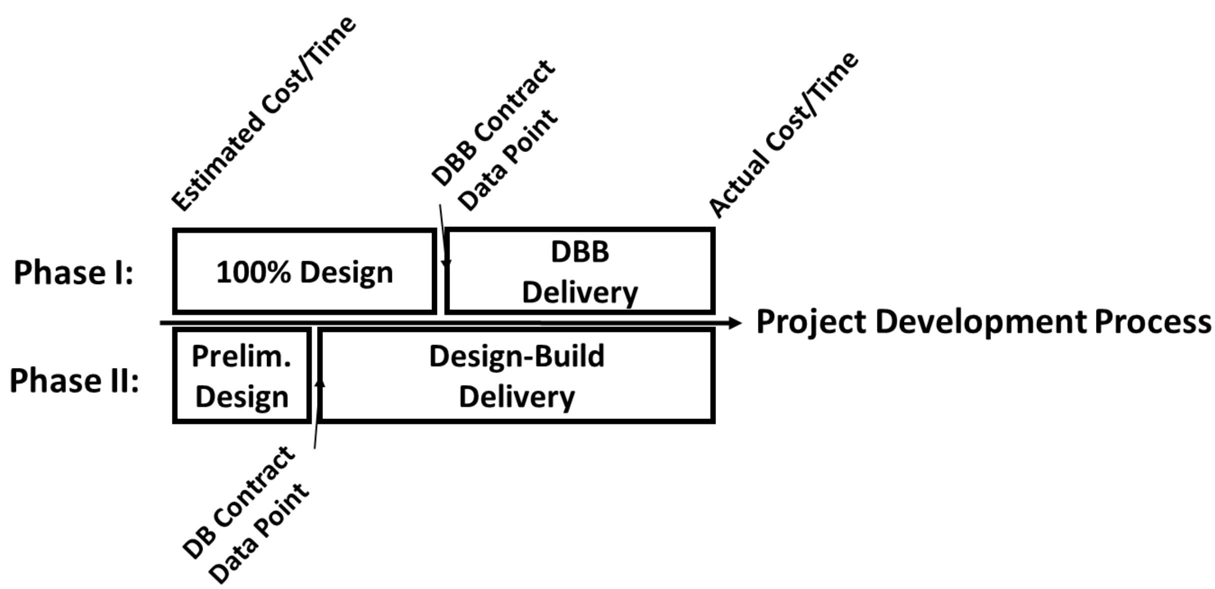


Figure 2-27: Conceptual Overview of Project Performance Data Measurements

Project cost and schedule performance measurements are an important piece of project management and the project control process (Gransberg et al. 2003), and are the most common performance measurements used when evaluating projects. Project performance metrics are calculated using cost and time data obtained at different stages, or project milestones, throughout a project's development process

(Raisbeck et al. 2010). Care must be taken to collect data points that allow a direct comparison of projects. As shown in Figure 2-27, the first data point developed in any given project is the initial estimate established at the time of decision to build the project, prior to commencement of design work, which is often referred to as the *budgeted* or *forecasted* estimate, or the 'engineer's estimate'. In this report, we refer to this data point as the **Estimated Cost** or **Estimated Time** in this report. The contract data point is the cost and schedule awarded through a contract to a private party to deliver the project. In a DBB, the contract is typically awarded after the project's design has been developed (100% design). In a DB contract within a P3 delivery, the contract is typically awarded after a project has developed a preliminary set of drawings (30%-50% design). In this report, we refer to this data point as the **Contract Cost** or **Contract Time** at project award. The final data point is the final cost and schedule at project completion and close-out of a project's contract. This data point is referred to as the **Actual Cost** or **Actual Time** at the conclusion of the design and construction of the project.

Cost and schedule performance metrics measure the difference between these three data points based upon percent differences between data points. The following table shows the different performance metrics that are typically used and included in this study, along with the calculation used to measure each of them.

Table 2-10: Project Performance Metrics Used in this Study

Performance Metric	Metric Calculation
Total Cost Growth	$= 100\% \times \frac{Actual\ Cost - Estimated\ Cost}{Estimated\ Cost}$
Total Time Growth	$= 100\% \times \frac{Actual\ Time - Estimated\ Time}{Estimated\ Time}$
Award Cost Growth	$= 100\% \times \frac{Contract\ Cost - Estimated\ Cost}{Estimated\ Cost}$
Award Time Growth	$= 100\% \times \frac{Contract\ Time - Estimated\ Time}{Estimated\ Time}$
Contract Cost Growth	$= 100\% \times \frac{Actual\ Cost - Contract\ Cost}{Contract\ Cost}$
Contract Time Growth	$= 100\% \times \frac{Actual\ Time - Contract\ Time}{Contract\ Time}$

Total Growth uses the actual and estimated costs to measure cost and time growth from project conception to project completion, and is often referred to as the international standard for measuring cost and time performance for a project (Flyvbjerg et al. 2002). The **Award Growth** measurements are often useful to determine the accuracy of the public sector's estimate in comparison to the awarded contract. The **Contract Growth** measurements are often referred to as simply cost or schedule growth; however, here we define this as the relative difference between contracted and final time and cost. This performance metric measures cost and time changes from construction start to construction completion in the case of DBB, or from preliminary design through construction completion for DB.

We have provided some of the most recent and notable studies that have performed project performance comparative analyses between P3s, DB and traditional DBB highway projects, for reference, in Appendix D: Previous Project Performance Comparative Studies. These studies are meant to provide a baseline of previous benchmark studies. Comparative studies of vertical buildings have been omitted.

Cost Performance

Historic data in Caltrans-led DBB projects has shown that as project size and complexity increases, larger cost overruns are experienced. Arup/PB conducted a data analysis on Caltrans projects, which shows the historic trends in cost overruns experienced in California. In this analysis, 83 projects with a cost value of $50 up to $100 million, experience an average of 3% cost overruns; 26 projects between $100 to $300 million experienced an average of 25% cost overruns; and 5 projects over $300 million experience an average of 76% cost overruns (Arup/PB Joint Venture 2010 p. 115). The dataset excluded outliers from the data analysis, including the San Francisco-Oakland Bay Bridge Replacement project whose cost budget overrun was approximately 2,500%[32]. A representative of the Project Sponsor commented: "the Transportation Authority was legitimately concerned about the history of large cost overruns on state projects, so that was a big anxiety because we had gone to a lot of effort to secure funding for the project", when discussing the main drivers for the consideration of finishing the project as a P3 vs the DBB approach.

Phase I DBB Contracts 3 & 4 experienced a *total cost growth* of approximately 9%. This was measured from the cost estimate provided in the initial financial plan, to the final cost at completion and close-out of Phase I contracts. Phase II, the P3 scope of work, experienced a -35% *total cost growth*, meaning that there was 35% overall cost savings. In comparing total cost growth for Phase I vs Phase II, the scope of work delivered in Phase I through DBB contracts required 9% more than the budgeted amount in the IFP estimate, whereas the P3 scope of work was delivered with approximately 35% in budgeted cost savings. Table 2-11 shows a summary of the cost performance measurements for Phase I and Phase II. In addition

[32] "From $250 Million to $6.5 Billion: The Bay Bridge Cost Overrun", by Eric Jaffe, October 13, 2015 http://www.citylab.com/politics/2015/10/from-250-million-to-65-billion-the-bay-bridge-cost-overrun/410254/

to this, Phase II shows current cost performance and the potential cost overruns with estimated cost of the pending Notice of Potential Claims (NOPCs).

Table 2-11: Design and Construction Cost Performance for Phase I vs. Phase II Summary

Design and Construction Cost Performance	Estimated Cost ($M)	Contract Cost ($M)	Actual Cost ($M)	Award Growth (%)	Contract Growth (%)	Total Growth (%)
Phase I - DBB Final Costs	$283	$198	$309	-30%	56%	9%
Phase II - P3 Current Costs 05/2015	$550	$360	$360	-35%	0%	-35%
Phase II - P3 (w/NOPCs Pending)	$550	$360	$426	-35%	18%	-23%

Note: The additional potential cost overrun with an estimate of the pending claims is shown for reference.

Cost savings from the initial cost estimates were captured when the DBB contracts (Phase I) and the P3 contract (Phase II) were awarded. Phase I captured approximately 30% cost savings, whereas Phase II, captured an overall 35% cost savings (see Figure 2-28). This shows that both phases were able to capture savings given the market conditions at the time (2010 and 2012 respectively). However, Phase I experienced a contract cost growth of 56%, whereas Phase II has not experienced any cost overruns yet[33]. This indicates that from a contract cost growth standpoint, Phase II has a cost growth of 0%. The comparative performance measurements shown include all final costs incurred taking into account scope additions and shifts added to Phase I, delays, and approved construction change orders (CCOs) for both phases. In addition to this, an additional potential cost overrun due to the pending NOPCs for Phase II has been calculated. The most recent estimate indicated a total of 34 pending claims with an approximate potential value of $100M[34]. The research team has assumed this potential amount of $100M and has provided a cost overrun after taking into account the remaining risk reserve amount to account for this, which could result in an 18% cost overrun, as shown in Figure 2-28. Further details for each respective phase are discussed in the following sections.

[33] Approximately $12.7M in CCO's have been approved through May 2015 for Phase II (both Department Support and Design-Builder Cost Overruns). However, this has been taken from the Risk Reserve of $46.5M established for Phase II Design and Construction-related risks, bringing this risk reserve down to $33.9M (CTC 2015).

[34] A risk of supplemental funds to complete construction was noted in Caltrans' 2014-2015 Q1, Project Delivery Quarterly Report to the California Transportation Commission (Caltrans 2015 p. 4)

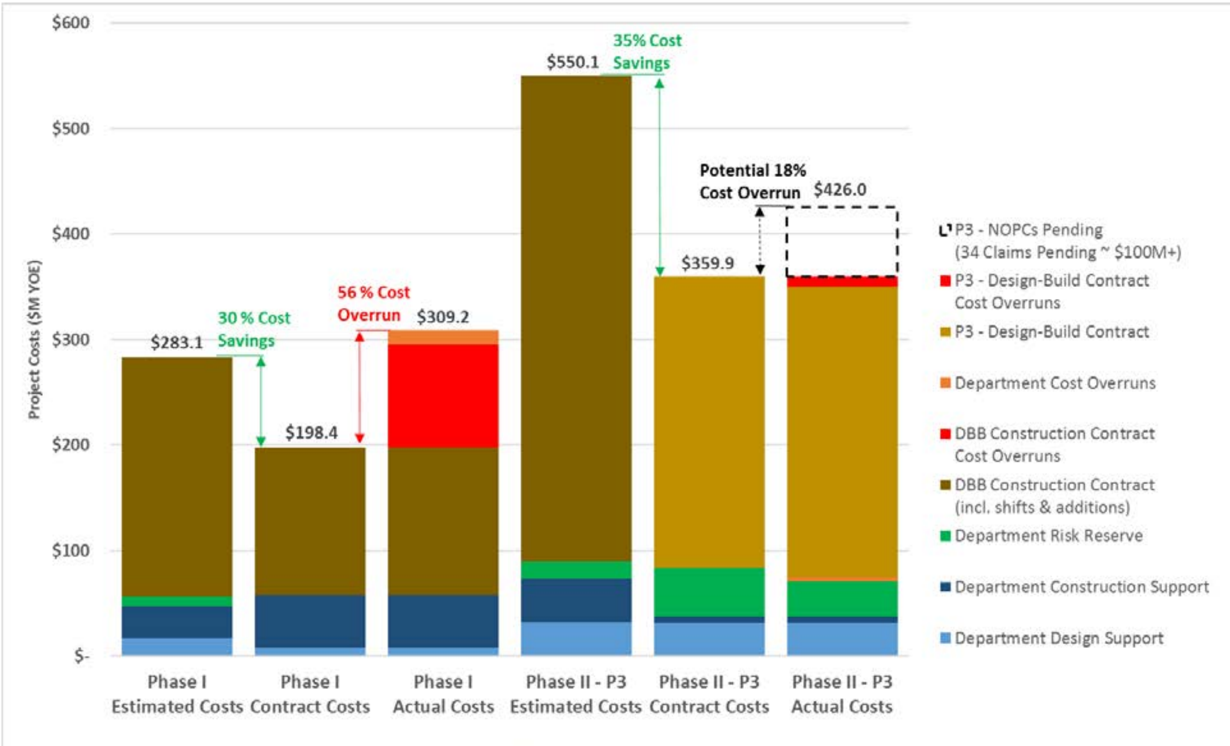


Figure 2-28: Comparison of Cost Performance of Phase I vs. Phase II

In Table 2-12, a detailed breakdown of the costs for each respective phase is provided. The initial finance plan estimate had initially programmed the projects to be delivered in 8 separate DBB contracts. Phase II's original scope of work consisting of Contracts 5 through 8 are the estimated costs used as the budgeted estimate for Phase II. The awarded cost for Phase I is based upon the DBB contract amounts, not the construction capital costs report in the Financial Plan Annual Updates. This captures the costs that are part of the design and construction phases for both phases based upon the costs reported from the beginning of design through completion of construction, including department support costs, to establish a means for comparing overall cost between Phase I vs Phase II.

Table 2-12: Detailed Cost Breakdown for Phase I vs. Phase II Design and Construction Costs

Design and Construction Project Costs	Phase I - DBB			Phase II - P3		
	Estimated Cost[35]	Award Cost[36]	Actual Cost	Estimated Cost[37]	Award Cost[38]	Actual Cost
Department Design Support	$17.0	$7.6	$7.6	$32.3	$31.4	$31.4
Department Construction Support	$30.5	$50.2	$50.2	$41.4	$6.1	$6.1
Department Risk Reserve	$9.4	$0.0	$0.0	$16.7	$46.5	$33.9
DBB Construction Contract (incl. shifts & additions)	$226.2	$140.6	$140.6	$459.7	N/A	N/A
DBB Construction Contract Cost Overruns	N/A	N/A	$96.6	N/A	N/A	N/A
Department Cost Overruns	N/A	N/A	$14.2	N/A	N/A	$3.1
P3 - Design-Build Contract	N/A	N/A	N/A	N/A	$275.9	$275.9
P3 - Design-Build Contract Cost Overruns	N/A	N/A	N/A	N/A	N/A	$9.5
P3 - NOPCs Pending (34 Claims ~ $100M+)	N/A	N/A	N/A	N/A	N/A	$66.1
Total Cost	**$283.1**	**$198.4**	**$309.2**	**$550.1**	**$359.9**	**$426.0**

Note: Phase I cost data is only for Contracts 3 and 4. It excludes project-wide costs, contract 1, and contract 2. Contract 4.A has been added as additional scope, along with 2 scope shifts, reflected in the awarded DBB Construction Contract amount. Phase II shows an estimate of pending NOPCs noted to be approximately $100M, the potential additional cost overrun due to these pending claims is assumed to be $100M minus the remaining risk reserve of $33.9M (see Note 34).

Phase I – DBB Cost Performance

Phase I costs, as described in the initial finance plan estimate, includes project-wide costs that are also associated with the costs incurred for the development of the Phase II scope of work in the project. These costs include environmental and right-of-way costs and are considered to be project-wide costs that were incurred for the project as a whole. Furthermore, Contracts 1 and 2, which were awarded as Emergency Limited Bids (ELBs) are also contracts that are considered to be project-wide costs, where Contract 1 is for Environmental Mitigation work of the project, and Contract 2 deals with Utilities Relocation to prepare the project for construction, which were carried out throughout both Phase I and II (see Figure 2-29).

[35] (SFCTA and Caltrans 2009)
[36] (SFCTA and Caltrans 2014)
[37] (SFCTA and Caltrans 2009)
[38] (SFCTA and Caltrans 2014)

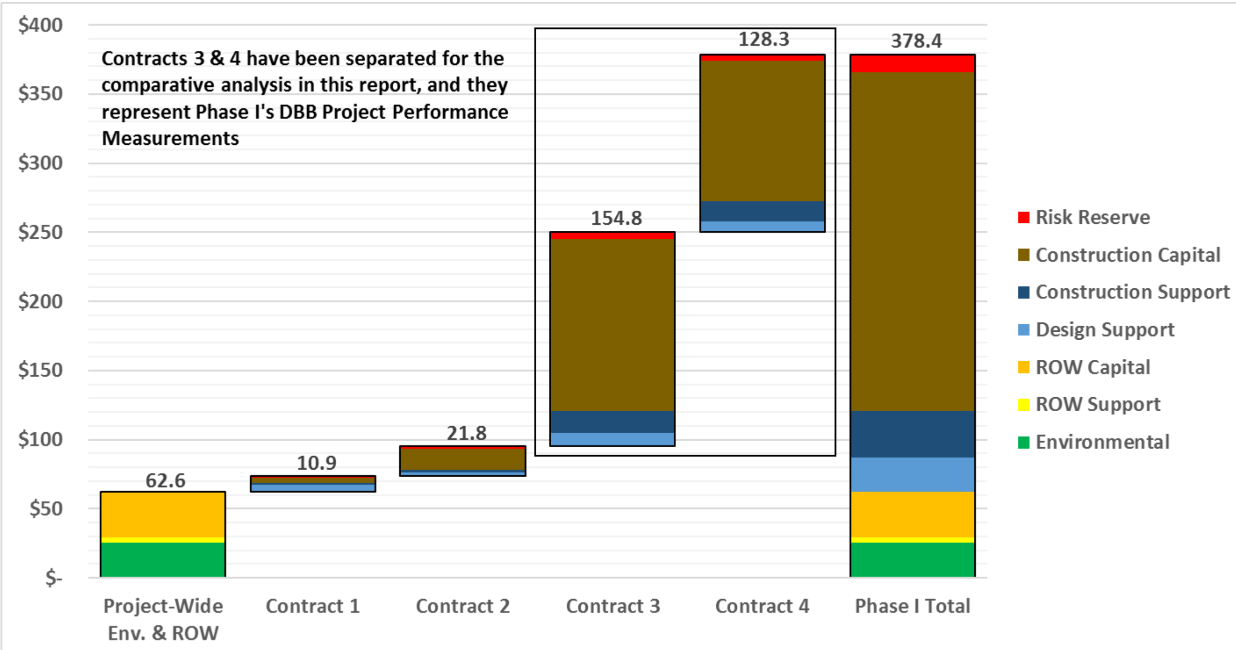


Figure 2-29: Phase I Cost Breakdown showing Contracts 3 and 4 used for the analysis

Contracts 3 and 4, on the other hand, were awarded as two separate DBB contracts for comparable construction work to Phase II (discussed further). The estimated DBB construction costs shown in the IFP are considered to be those related to the *Construction Capital* costs. Costs associated with the Department's support costs during the design and construction of Contracts 3 and 4 are those noted as *Design and Construction Support* costs, respectively. In addition, a risk contingency cost is allocated for each contract, as shown in Table 2-13.

Table 2-13: Phase I Initial Cost Estimate Breakdown ($M YOE)

	Project-Wide					
Phase I Costs	**Env. & ROW**	**Contract 1**	**Contract 2**	**Contract 3**	**Contract 4**	**Phase I Total**
Environmental	25.6					**25.6**
ROW Support	4.0					**4.0**
ROW Capital	33.0					**33.0**
Design Support		5.0	2.7	9.3	7.7	**24.7**
Construction Support		1.0	2.0	16.0	14.5	**33.5**
Construction Capital		3.7	15.0	124.5	101.7	**244.9**
Risk Reserve		1.2	2.1	5.0	4.4	**12.7**
IFP Estimate (May 2009)	**62.6**	**10.9**	**21.8**	**154.8**	**128.3**	**378.4**

Both contract 3 and contract 4 were awarded in November 2009 and March 2010 respectively, and a considerable amount of savings were realized due to the economic downturn at the time. Contract 3 was awarded for $48.4M (October 2009), whereas Contract 4 was awarded for $57.7M (March 2010). Both were awarded from a pool of eight bidders[39][40]. These amounts are the DBB construction contracts for each respective contract. In order to isolate these costs further, the construction scope of work shown in the IFP estimate for contract 3 and 4 was estimated to be approximately $125M and $102M. Therefore, the bids that were received are approximately 61% and 43% below these costs, or 47% together. The FPAU 2014 indicates that there were 159 CCO's totaling 37.8M for contract 3, which explains part of the cost increase for contract 3, and 141 CCO's totaling $58.8M for contract 4 respectively (SFCTA and Caltrans 2014 p. 18). We note that contract 4.A, which was for an additional scope of work of $12M, was added to the cost awarded for Phase I (versus a cost overrun). In addition to this, two scope shifts, estimated at $26M are also added to the cost awarded, as opposed to a cost overrun, and shown in Table 2-14.

Table 2-14: Phase I DBB Contracts, Design and Construction Cost Performance Overview ($M YOE)

	Contract 3	*Contract 4*	*Contract 4.A*	*Phase I DBB Total*	*% Award Amount*
Department Design Support	$1.3	$4.3	$2.0	**$7.6**	4%
Department Construction Support	$27.5	$21.3	$1.4	**$50.2**	25%
Construction Capital (DBB Contracts)	$48.4	$57.7	$8.2	**$114.3**	58%
Contract Scope Shifts[1]		$26.3		**$26.3**	13%
Total Award Amount[2]	**$77.2**	**$109.6**	**$11.6**	**$198.4**	**100%**
Approved CCO's[3]	$37.8	$58.8	$0.0	**$96.6**	49%
Other Cost Overruns[4]	$9.3	$4.9	$0.0	**$14.2**	7%
Total Cost Overrun Amount	**$47.1**	**$63.7**	**$0.0**	**$110.8**	**56%**
Total Final Cost	**$124.3**	**$173.3**	**$11.6**	**$309.2**	**156%**

NOTES:

1. Two scope shifts added to Contract 4 (from Contract 5) are noted: a mobile barrier-moving machine and associated barriers costing approximately $3.5m, and the demolition of the Marina Viaducts (low viaducts) after the traffic switch to the new facility and temporary detour, estimated at $22.8m (FPAU 2014, pg. 11).

2. This reflects the total original contract amount for design and construction of Phase I DBB awarded contracts, including department support costs.

3. There were a total of 159 CCO's executed in Contract 3, totaling approximately $37.8, and 141 CCO's executed in Contract 4, totaling approximately $58.8M (FPAU 2014, pg. 18).

4. 'Other Costs' have been calculated as the residual value between the total reported in the FPAU 2014 for Contracts 3 and 4, and total costs obtained from Department Support Costs, Initial DBB Contract Awards ($48.4M and $57.7M), Scope Shifts, and CCO's. These are assumed to be additional department support costs ($9.3M for Contract 3 and $4.9M for Contract 4) and treated as cost overruns.

---

[39] "Caltrans Realizes Big Savings in Construction Economic Downturn" by Robert Carlsen, ENR, May 6, 2010.
[40] "From 'Drive' to 'Parkway': San Francisco's Doyle Drive replacement rolls on" by Greg Aragon, ENR, July 1, 2010.

Contracts 3 and 4 were estimated to be approximately $198M at the time the contracts were awarded, inclusive of design work. The actual cost of Contract 3 and 4 when contract 4 was completed and closed-out, was $309M. Scope shifts, scope additions, and change orders are noted to have cause many of the cost changes in Phase I, particularly some shifting of scope in preparation for consolidating contracts 5 through 8 into the design-build contract for Phase II (SFCTA and Caltrans 2014 p. 11). In addition to this, it is noted that some of the costliest change orders were due to delays from inclement weather, utility delays, acceleration to meet a seismic safety date, and complying with Presidio Trust and National Park Service requirements in accordance with the Section 106 Programmatic Agreement (SFCTA and Caltrans 2014 p. 18). The largest change order, for $10M, was a result of the structural steel fins for the southbound high-viaduct, which resulted as a misinterpretation of the Buy-American requirement for all steel to be made in the US, and was initially ordered from a fabricator from the UK.

The total cost growth experienced from Phase I's Contracts 3 and 4 was 9%, which, when compared to previous studies of DBB projects, this is within range, and is lower than Caltrans historic cost overruns for projects between $100M to $300M, which have averaged 25% (Arup/PB Joint Venture 2010). Previous studies have indicated that total cost overruns for highway projects or major transportation projects delivered as DBB ranged from 3.6% up to 25.7%. The contract cost growth (56%), however, is within the higher range identified in previous studies, which ranged from 4% to 66% for DBB highway projects in the US (See Appendix D: Previous Project Performance Comparative Studies).

Phase II – P3 Cost Performance

In Phase II, a single P3 contract bundled the scope of work previously planned for 4 contracts (contracts 5 through 8). In the IFP estimate, the total cost estimate for Phase II was $550M. The costs shown in Table 2-15 show the costs estimated by Caltrans for design and construction support costs, the estimated DBB contract amounts, and the risk contingency allocated for each of the contracts in Phase II.

Table 2-15: Phase II Initial Cost Estimate Breakdown ($M YOE)

Project Costs	Contract 5	Contract 6	Contract 7	Contract 8	Phase II Total
Design Support	18.1	5.2	8.1	0.9	**32.3**
Construction Support	22.0	8.0	9.5	1.9	**41.4**
Construction Capital	285.5	69.0	96.7	8.5	**459.7**
Risk Reserve	8.9	4.2	3.3	0.3	**16.7**
IFP Estimate (May 2009)	**334.5**	**86.4**	**117.6**	**11.6**	**550.1**

When the P3 reached financial close in June 2012, the contract was awarded for $360M, representing a 35% cost savings from the initial estimate. As of May 2015, a total of $12.7M in CCO's has been approved for the Phase II scope of work, resulting from both the project sponsor-related change orders and the P3 contractors (see Table 2-12). Given the current amount of change orders to date (through May 2015), the actual cost is estimated to be $360M, given that those $12.7M CCO's have been covered by the risk reserve established for Phase II to account for design and construction-related risks. As discussed, with an estimated cost overrun of $66M (if the pending 34 claims materialize for an approximate $100M, effectively draining the rest of the risk reserve for the project plus the remaining $66M), the contract cost overrun would then be approximately 18% (see Figure 2-28). One of the former project managers from the sponsors commented "I believe that the P3 is likely to give us better cost control and dramatically better schedule performance and I believe that if the developer won every claim they have submitted at the full value that they were going to submit it at, it will still come out cheaper than if Caltrans had used DBB. For one thing Caltrans had estimated the cost of the project for Phase II at 495M; it was bid at $271M (design-build contract), so even if we have $100M in claims we would still be $100M cheaper than Caltrans would have built it for under a traditional approach." The numbers this interviewee referenced were approximate values from those shown in Table 2-12.

Presidio Parkway Project Cost Performance

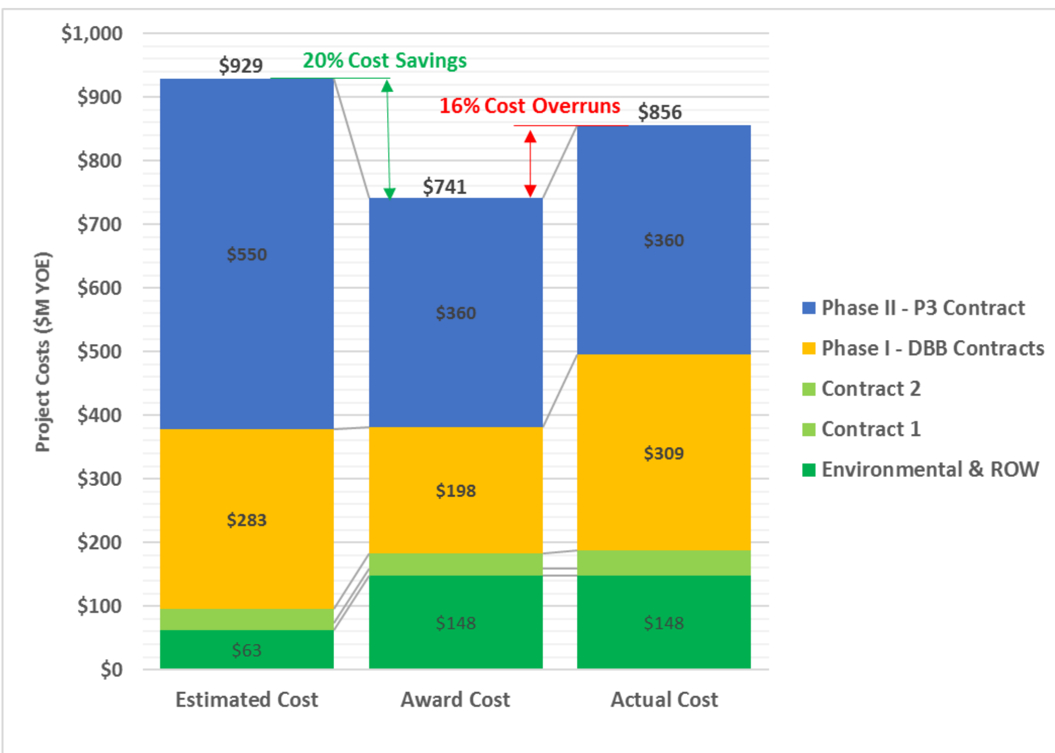


Figure 2-30: Presidio Parkway Project, Design And Construction Cost Performance

The project is expected to perform within the budget that was originally established in the IFP estimate of $929M for the estimated costs of the project for design and construction. Given the economic downturn at the time Phase I and Phase II were procured, the project realized an approximate 20% in cost savings when the project contracts were awarded (see Figure 2-30). The final expected cost of $856M, however, indicates that a contract cost overrun of approximately 16% was experienced, which will offset some of the initial cost savings.

Table 2-16: Presidio Parkway Total Costs Overview ($M YOE)

Project Costs	Estimated Cost	Award Cost	Actual Cost	Contract Cost Overrun
Environmental & ROW	$63	$148	$148	$0
Contract 1	$11	$11	$11	$1
Contract 2	$22	$24	$28	$4
Phase I - DBB Contracts	$283	$198	$309	$111
Phase II - P3 Contract	$550	$360	$360	$0
Total Project Cost	**$929**	**$741**	**$856**	**$115**

As shown in Table 2-16, the cost overruns experienced in Phase I DBB Contracts 3 and 4 account for approximately 15% of the contract cost overruns, whereas those cost overruns experienced in Phase II account for 0% with the current CCO's approved for Phase II. The pending claims noted, are not taken into account. Although the environmental costs, as well as the right-of way costs have actually exceeded the initial cost estimates, most of those costs were contained once construction for the project began.

Schedule Performance

*"They don't play the game of trying to halt or slow down construction [here]… a lot of the contractors in the traditional method will play this change order game, 'if you don't pay me then I am not going to build anything, what do I care? I want to make sure I get my money first.' But in this case, **they don't get the milestone payment until they have finished the project and the lenders will not let them sit on their hands, so in that regard they have a big motivator to finish on time even if there are delays along the way, regardless of whose fault it is**." – Project Sponsor Consultant*

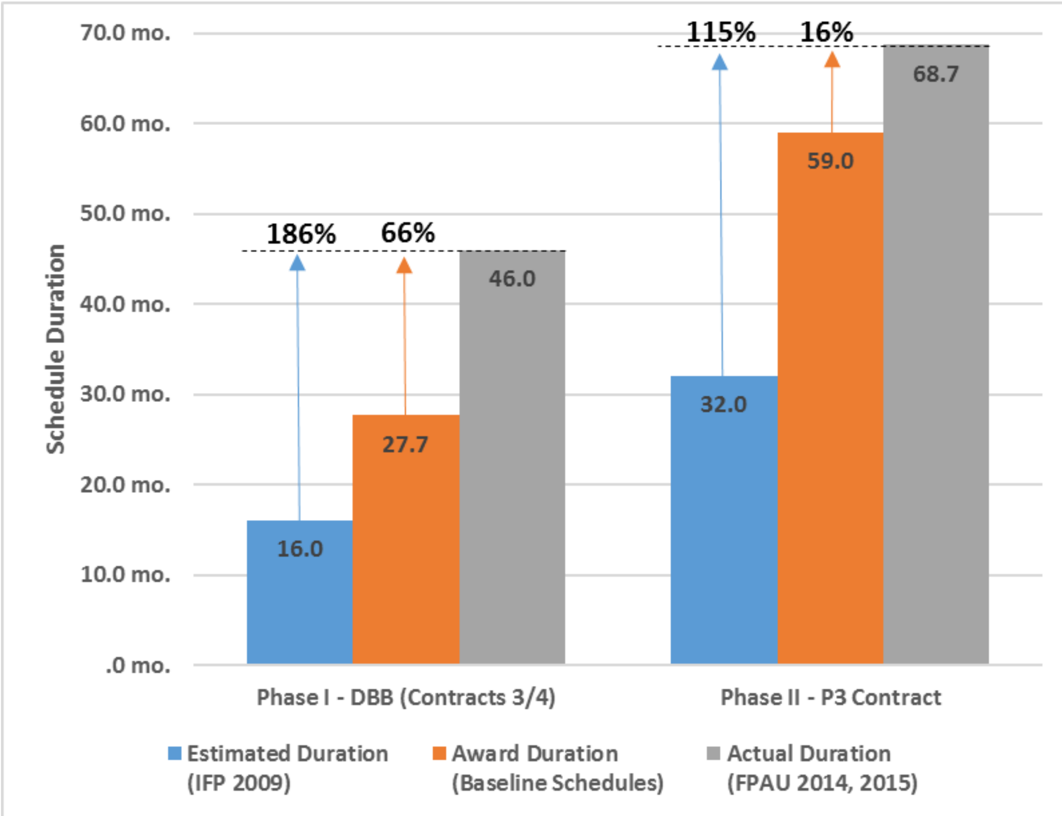


Figure 2-31: Schedule Performance Comparison - Phase I vs Phase II

The Presidio Parkway project experienced significant schedule overruns for both Phase I and Phase II. The total schedule growth for Phase I was 186%, whereas the total schedule growth for Phase II was 115%. Phase I had a total schedule growth of approximately 30 months, from 16 to 46 months (see Figure 2-31). Phase II had a total schedule growth of approximately 37 months, from 32 months to the expected 69 months to completion. Phase I experienced a 66% contract schedule growth, which compares the baseline contract duration established for Contracts 3 and 4 to their actual contract durations at completion and acceptance. Phase II experienced a 16% contract schedule growth, which was inclusive of a litigation delay and other delays that added approximately 14 months (discussed further). For Phase II, the contract award of the P3 contract is measured from commercial close of the contract, to the expected final completion and acceptance of design and construction. Further details are provided in the following sections.

Table 2-17: Schedule Performance for Phase I vs. Phase II Summary

Presidio Parkway Contracts	Estimated Duration	Award Duration	Actual Duration	Contract Growth %	Total Growth %	Award Growth %
Phase I - DBB Contracts 3 & 4	**16.0 mo.**	**27.7 mo.**	**46.0 mo.**	**66%**	**186%**	**73%**
Phase II - P3 Award to Construction Finish	**32.0 mo.**	**59.0 mo.**	**68.7 mo.**	**16%**	**115%**	**84%**

In comparing Phase I to Phase II schedule performance, in Table 2-17, each respective project duration is provided showing the schedule growth experienced in both phases. Both phases experienced delays that were not anticipated. Phase I experienced major delays due to weather conditions in the winter of 2010-2011, and 2011-2012, and it also experienced schedule impacts due to numerous change orders that resulted because of scope shifts between Phase I and Phase II, which included special requirements for the southbound high-viaduct steel fins, and tunnel design challenges with groundwater flow (SFCTA and Caltrans 2014). For Phase II, the project experienced significant delays due to litigation for the lawsuit filed by the Professional Engineers in California Government (PECG) in an effort to prohibit Caltrans from pursuing the Presidio Parkway as a P3. This lawsuit delayed the project by approximately 12 months from the original contract schedule submitted by the developer. The financial close process had to be suspended until litigation was completed and the project was given the green light to pursue Phase II as a P3. In addition to this, Phase II also experienced a department-caused delay of 2 months because the department failed to issue the developer its notice to proceed for construction when it was scheduled, once financial close was reached.

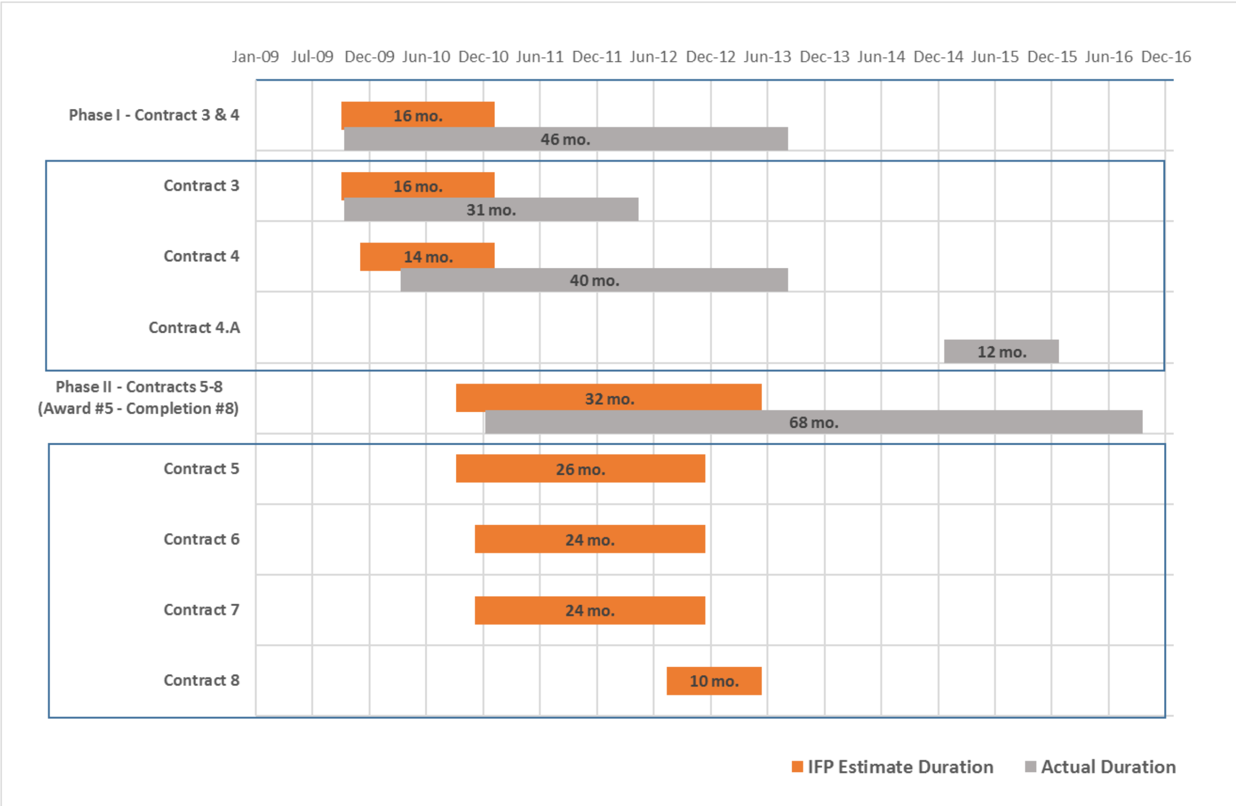


Figure 2-32: Project Schedule Performance Comparison, Contract Award to Contract Completion

The original schedule that was developed for the IFP estimate in May 2009 is considered to be a relatively accelerated and aggressive, hence the significant *total* schedule growth experienced when comparing time growth using this baseline. Figure 2-32 compares the DBB contracts for Phase I and the P3 Contract for Phase II to the schedule provided in the initial financial plan. Note that these timelines show the schedule from project award to construction completion, and do not reflect the procurement or pre-construction activities.

Phase I – DBB Schedule Performance

Assessing the schedule performance for the Presidio Parkway as a whole, and for each respective project phase, is a complicated process given the inherent interwoven relationship between phases - particularly the dependence of Phase II on Phase I's schedule performance. The schedule set on the IFP assumes a total project duration of 48 months with the first two Project-Wide Contracts 1 and 2 beginning in June 2009, and the completion of the last Contract 8 in June 2013. The IFP assumes the breakdown of eight separate contracts, including contracts 5-8 that were bundled as the P3 scope of work for Phase II. Contracts 1 and 2 are project-wide activities, Contracts 3 and 4 are the DBB contracts undertaken in Phase

I, and Contracts 5-8 were originally programmed as separate DBB contracts. Contracts 1 and 2 are assumed to be carried out throughout the length of the project through construction.

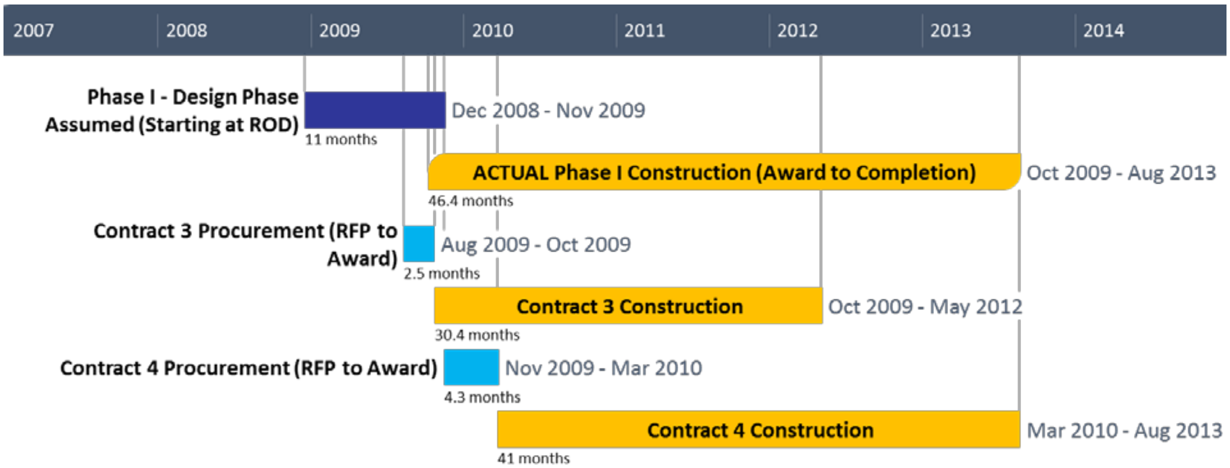


Figure 2-33: Overview of Phase I's Actual Schedule Timeline (see Appendix F for detailed data)

In order to make a comparison of the Phase I schedule performance to the Phase II schedule performance, the schedule measurements must be comparable. The DBB schedule performance measurement considers the start of construction soon after the contract is awarded, and it measures the duration of the project through the final completion date of construction for Contract 4. This measurement of Phase I assumes that Plans, Specifications and Estimate (PS&E) are complete prior the award of the contract for construction, including a 100% design complete, as is typical for DBB projects. Contract time growth provides a representation of the project's ability to contain the schedule established at contract award, and the additional growth from this schedule. Phase I in the Presidio Parkway established a baseline duration of approximately 27.7 months from the time Contract 3 was awarded to the final completion of Contract 4. However, Phase I had an actual duration of approximately 46 months (see Figure 2-33), which is close to 18 months more than the established duration, or a 66% contract cost growth. When Phase I's schedule performance is compared to past performance in DBBs, it falls in the higher range (please refer to Appendix D: Previous Project Performance Comparative Studies. The total schedule growth for this project was extremely high, which, as discussed, compares schedule growth to the aggressive schedule established in the initial financial plan. Phase I experienced a contract schedule growth of 66% percent, and 39% and 82% for contract 3 and 4 independently. Previous studies have found an average contract schedule growth for DBB highway projects to be anywhere from 2.3% to 71.1%.

Phase II – P3 Schedule Performance

> *"The P3 contract comes with specific time frames in which substantial completion must be achieved and the financing was based on those time frames.* ***There are actually very significant financial incentives for the design-builders to stay on schedule or to minimize delays that they incur regardless of whether they believe, or that we believe that another party is responsible for those delays.*** *And so in terms of keeping the project moving towards a specific target completion date,* ***that has been an advantage of the P3 structure.****" – Developer's Executive*

The P3 schedule performance is measured as the project duration from the time the P3 contract reached commercial close through the expected final completion date for construction. From the time the P3 was awarded, the project was delayed due to litigation in dealing with PECG's lawsuit, and then a department-caused delay in issuing its 'NTP 3' to begin construction. Furthermore, this includes the financial close process, which can be lengthier process in addition to the initial procurement period. Construction did not commence until November 2012, when Caltrans issued notice to proceed for construction[41]. This is the date that is used to measure schedule performance for construction of Phase II. Figure 2-34 shows an overview of Phase II's schedule timeline. Design for the Presidio Parkway began shortly after the project's Record of Decision was reached in December 2008. At that point, as the project's delivery began to be planned throughout 2009. At the end of June 2009, the design (PS&E) for Phase II (Contracts 5, 6, 7, and 8) was stopped while the assessment of potentially delivering Phase II as a P3 was initiated. The procurement for Phase II as a P3 began in February 2010 when an RFQ was released for which three teams were short-listed to provide a proposal for the project. In January 2011, the project reached commercial close, upon which a P3 agreement was signed. This date marks the completion of the procurement phase for Phase II. In total, the procurement phase was approximately 11 months in comparison to an average of 3 months for Contracts 3 and 4 in Phase I.

---

[41] (Golden Link Concessionaires 2015 p. 10)

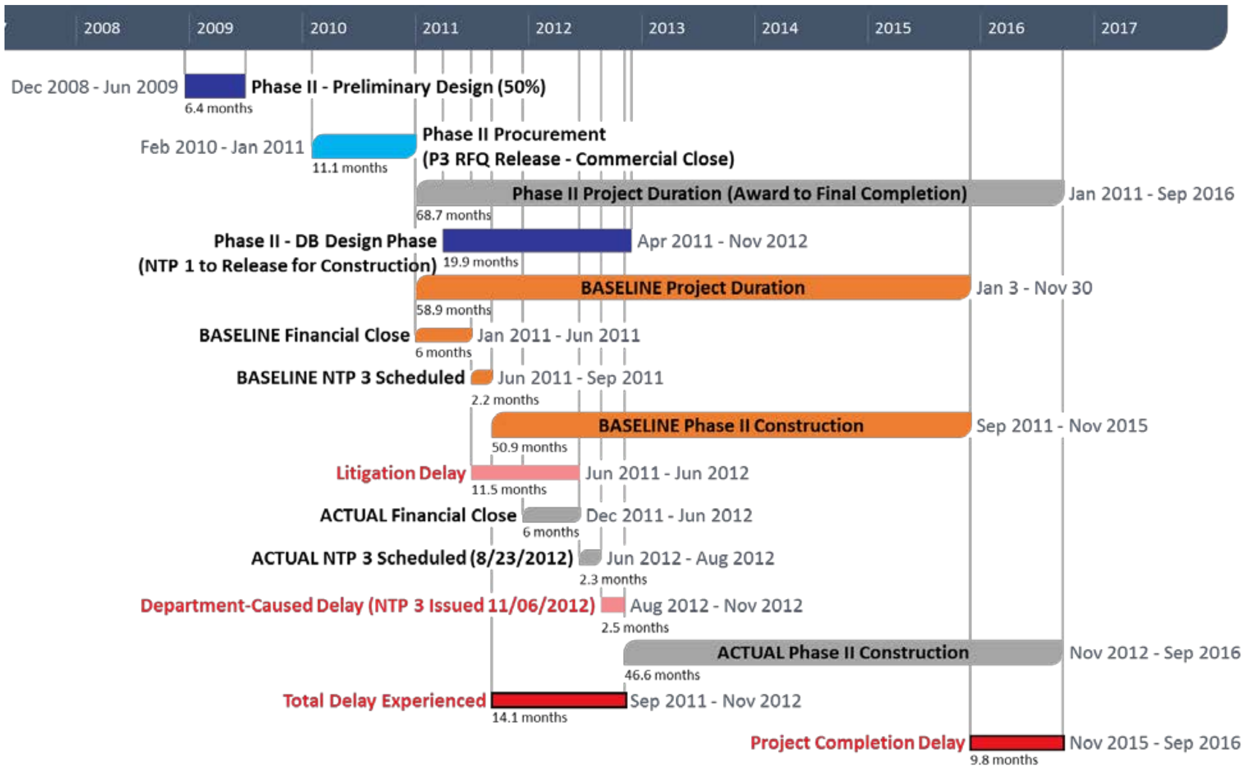


Figure 2-34: Overview of Phase II's Relative Timeline

Phase II had been scheduled to begin the Initial Project Debt Competition (IPDC) process (the Financial Close process), shortly after commercial close of the project in January 2011[42]. PECG filed litigation in November 2010, shortly after Caltrans announced a preferred bidder for the project. Given this, the scheduled financial close process was suspended until the end of litigation. In November 2011, the California Supreme Court denied PECG's request to review the case again, allowing the financial close process to begin once again. At this point, there was *a 12-month delay due to litigation*. The delay due to litigation in the project is measured by calculating the difference from when Financial Close was reached (in June 14, 2012), and the baseline financial close date scheduled prior to suspension of the process (June 30, 2011). Construction for Phase II was scheduled to begin by the date upon which Caltrans issued its NTP for the construction of Phase II, which was not given until November 2012. As shown, the concessionaire had a baseline schedule to begin construction following a 60-day period after reaching financial close. A 60-day period was also adjusted for construction (NTP 3) to begin approximately 60 days after July 14, 2012[43]. Caltrans issued a "partial" NTP 3 on November 8, 2012 for which an additional 3-

[42] Revised Phase II Schedule dated December 29, 2010, provided by GLC (P3 Agreement, Appendix 2A)
[43] (Golden Link Concessionaires 2015 p. 10)

month delay from the expected date was experienced. As noted in the first amendment to the P3 agreement, this is considered to be a "Department-Caused Delay"[44].

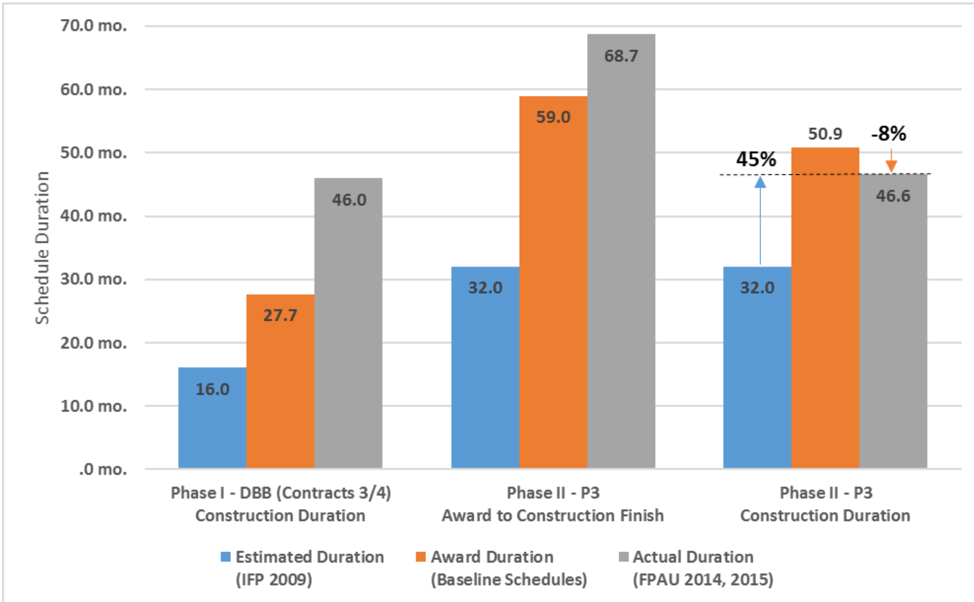


Figure 2-35: Schedule Performance Comparison for Phase I vs Phase II, with Construction Duration

The duration of Phase II construction is adjusted to begin at the start of NTP 3 through the expected final completion date in September 2016, for an approximate duration time of 47 months. Figure 2-35 shows that the total schedule growth for construction in Phase II is 45%, whereas the contract schedule growth is actually a reduction of 8%, which saves approximately 4 months. **Considering the delays encountered, which were approximately 14 months, the project is expected to reduce its construction time from the contract schedule established by 4 months, from 51 months to 47 months.**

Table 2-18: Schedule Performance for Phase I vs. Phase II Construction Summary

Presidio Parkway Contracts	Estimated Duration	Award Duration	Actual Duration	Contract Growth %	Total Growth %	Award Growth %
Phase I - DBB (Contracts 3/4) Construction Duration	16.0 mo.	27.7 mo.	46.0 mo.	66%	186%	73%
Phase II - P3 Construction Duration	32.0 mo.	50.9 mo.	46.6 mo.	-8%	45%	59%

From a total schedule growth perspective, Phase II experienced a 45% schedule growth, a quarter of Phase I's 186% schedule growth. The IFP estimate showed construction for Phase II to be twice as long

[44] Attachment A (pg. 24) of the First Amendment to the Public-Private Partnership Agreement for the Presidio Parkway Project, dated November 6, 2011.

as Phase I, yet the actual construction duration for both phases' construction period is expected to be almost identical (46 months vs. 46.6 months for Phase II). There is a dearth of literature that performs a comparison of the total schedule growth for P3 projects, meaning the growth from the budgeted estimated schedule duration to the actual schedule duration. However, similar to Phase I, Phase II also experienced higher schedule growth given the aggressive schedule initially established in the IFP for all contracts. Figure 2-35 shows both the total schedule performance (being inclusive of design, financial close, and litigation delays) as well as the construction phase-only schedule performance for Phase II. For the contract schedule growth, from contract award to actual schedule performance, past studies for both P3-delivered highway projects and design-build projects, range from -35.7% to 30.6%. Phase II experienced a 16% contract schedule growth, which is approximately 10 months. Per the analysis discussed above, an approximate total delay of 14 months increased the design and construction duration for the P3 contract from the baseline contract schedule, yet the project is expected to be reduced by 4 additional months (approximately) by the time final construction and acceptance of Phase II is complete (expected in September 2016).

Presidio Parkway Project Schedule Performance

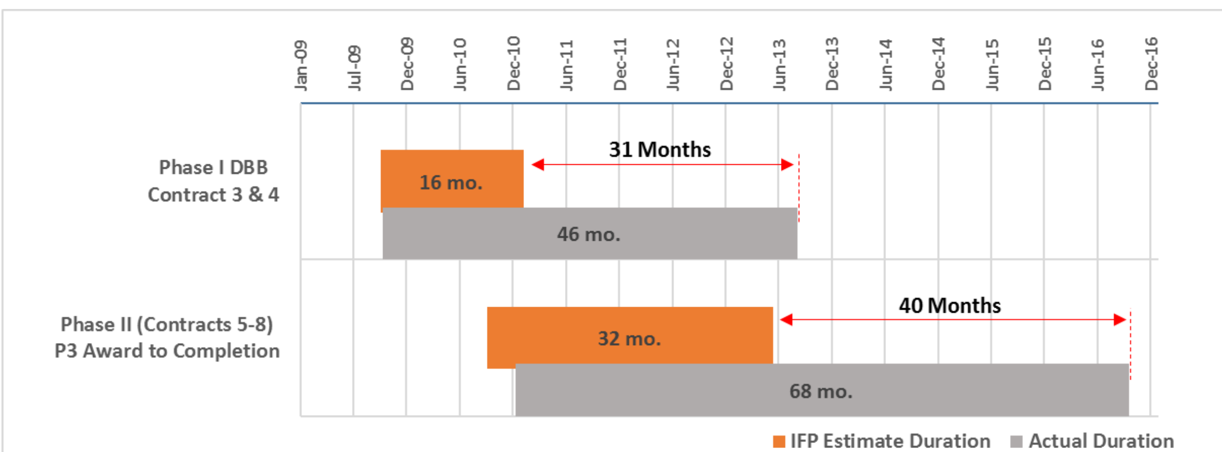


Figure 2-36: Presidio Parkway Project, Schedule Performance (see Appendix F for detailed data)

Assuming the project completes in September of 2016, the project will be delivered approximately 40 months after the first initial estimate (IFP 2009), which established an initial project completion in June 2013. For Phase I, the project was completed in August 2013, which is 31 months after the project Phase I was envisioned to be completed (February 2011), as shown in Figure 2-36. The advantage of schedule certainty for Phase II, given the P3 delivery, applies only to the construction phase of the project, where not only was the schedule contained to the duration established, but is expected to achieve an overall reduction of 4 months from the duration established at contract award. However, from the contract award to completion, when all delays and pre-construction activities are taken into account, this created a significant schedule duration growth, which is approximately 37 months.

Project Governance

Project governance issues in P3s are considered to be quite complex given the long 'shaping phase' inherent in such complex projects (Lessard and Miller 2013). P3s are "one-off, long-lived, highly asset-specific, multiphase transactions, surrounded by a multitude of internal and external stakeholders in changing contexts," (Levitt et al. 2014 p. 6) such that it is considered to be a case of *'extreme relational contracting'*. The internal governance of a P3 project, like the Presidio Parkway, is considered to be extreme because of the long-lived transaction inherent in a P3 agreement with multiple formal (contracts) and informal (relationships) forms of governance. This complexity results in misunderstandings and uncertain scenarios where decision-making among the project participants results in inefficient and often frustrating situations.

The additional layer of complexity in the Presidio Parkway, given the institutional context of the project with the project's location within a National Park, has been a unique aspect of this project. "The issue of the government relations among the various parties, particularly the concessionaire, Caltrans and the Presidio Trust, seems to be continuing," commented one of the sponsor's former project managers, "where the underlying causes of problems really haven't been dealt with and maybe there is no way to do that in the midst of the contract, and so everything is handled in sort of an ad-hoc basis, and I don't think to anyone's satisfaction." A right-of-entry (ROE) agreement between the Presidio Trust and the project sponsors (see Section 0), was signed in July of 2009, prior to the beginning of construction for Phase I activities. In this ROE agreement, the project was structured to be delivered using a DBB delivery approach for the whole project, prior to the decision of implementing a P3 for Phase II of the project. In the P3 agreement between Caltrans and the concessionaire, it is noted that the developer "shall be responsible for compliance with the terms and provisions of the Presidio Trust Right of Entry Agreement… including all consents and approvals for access by any Developer-Related Entry to the project right of way to perform any work required under this agreement[45]." Throughout the interviews, it was argued that this 'additional layer' in the project had caused the developer to coordinate with the Presidio Trust in a

[45] Public Private Partnership Agreement for the Presidio Parkway Project between Caltrans and GLC dated January 3, 2011 – Volume I, Article 2.

greater level than anticipated, and that the Presidio Trust's cooperation efforts were not as collaborative as expected.

"So the contract was structured in anticipation that the concessionaire would assume responsibility for engaging with any 3rd party after from when permits were acquired, which included the Presidio Trust, but more explicitly were expected to interact with both the Presidio Trust and the National Park Service on design review. I think that was fairly clear within the contract, although maybe, I think in hindsight, it is probably some language in there that is a little bit overstated," commented one of the sponsor's staff. Perhaps the way in which those relationships were specified, who was responsible to coordinate and communicate with whom among Caltrans, the developer, and the Trust, has caused the confusion as to exactly what role the developer was expected to have in coordinating with those relationships, particularly with the Trust.

Organizational Inertia

Organizational inertia refers to the tendency of a mature organization to continue on its current trajectory, and this can apply to both public and private organizations in their approach to managing P3s. In the presidio parkway, this inertia was particularly present regarding the *design review process* provided by the sponsors during construction. In the discussion of the quality management processes (see Section 0), this similar issue of the resistance from the project sponsors to implement an oversight quality management approach, instead of a more deterministic approach, was discussed.

In reference to the design reviewing process, in several instances, it was commented how the sponsors continued to behave as if the project was a DBB when asking for their review and approval of design drawings. "Even though this was a P3 project, their design staff which reviews all of the Phase II designs, they sort of behave as if in the same way that they would on a design-bid-build project, they are still very prescriptive about how something should look and how it should be designed" commented one of the developer's staff. Similarly, the sponsor's designers commented "we had already established the parameters, and we had already established the design for half the project. So you really then limit the flexibility you have and the design of the remainder of the project. You don't have the flexibility you would if you get the whole project using a PPP then the design-build entity would have more flexibility as to what it is they could build, by having half the project already built, designed and being built, you are restricted to some extent, the flexibility you have in the remainder of the design."

To some extent, the rigidity of the sponsors for the design itself is partially due to the phasing of the project, with Phase I having been built, and with the design parameters having been established. In another way though, even though the sponsors are supposed to have more of an oversight role, perhaps adjusting to that role will not be occur overnight with the first P3 and will require cultural changes over time. Caltrans' management plan for the Presidio Parkway (Caltrans 2012 p. 7) notes that "in order for a P3 project to be successful, it is critical for the public authority to train and structure its oversight team to understand that their roles are different than those that they typically have under design-bid-build (DBB) procurements. In fact, many of the public authority's former roles are performed by the Developer in P3 procurement."

Implementation Phase: Operation and Maintenance Stage

All phases of a P3 project's life cycle leading up to its O&M phase have been discussed in the previous sections. The O&M phase of a P3 is the longest phase of a P3's life cycle, which begins after the project's substantial completion of construction is completed initially, and then final completion and acceptance of the project, its 'turnkey', is achieved. During the O&M phase of the project, the project sponsors provide a similar oversight role, as with the design and construction stage of the project. Assistance is provided to the developer, and IQA processes are implemented to ensure that proper QA/QC procedures during O&M are used and that the technical requirements are met. The P3 developer must meet the O&M obligations and an O&M contract is executed with an 'O&M contractor,' in the case of the Presidio Parkway, that performs all the necessary routine O&M tasks, and renewal and upgrade work.

In Section 0 the O&M risk transfer achieved in the project is discussed. An overview of how the project sponsors have structured the payment mechanisms to ensure that sufficient funding is available throughout the concession period and how the concessionaire's responsibility for performance of the facility tied the availability payments is provided in that section. The transfer of O&M responsibilities to a private developer in a P3 agreement is one of the most important elements that differentiate P3s from traditional delivery approaches.

The advantages and disadvantages of transferring the O&M responsibility to the private developer in the Presidio Parkway are discussed in Table 19:

Table 2-19. P3 Advantages and Disadvantages - Implementation Phase: Operations and Maintenance

ADVANTAGES
Improved Life-Cycle Design: *Given the earlier involvement of the O&M parties responsible for the on-going O&M responsibilities, design and construction practices may be tailored to improve specific long-term life cycle considerations that would otherwise not be considered. However, the advanced state of the design development in this project limited the ability to perform significant design changes by the developer.*
Dedicated and Committed O&M Budget: *The project sponsors have established a dedicated O&M budget for the course of the concession period, which will be used to make availability payments to the P3 developer for their performance-based service of the facility.*
Improved Asset Condition: *The facilities' conditions are strategically ensured to be provided regular maintenance and major rehabilitation or replacement tasks are also scheduled throughout the concession period.*

Improved Level of Service: *The facilities' operational conditions are ensured through contractual requirements such as required response times for incidents and emergencies, as well as required regular maintenance to ensure an acceptable asset condition.*
Hand Back Renewal Process: *The contractual requirements for minimum asset condition at the end of the concession period and transition and education plans ensure a smooth handover to the Agency and acceptable asset condition at the end of contract term***.**
DISADVANTAGES
Cost of Maintenance: *Economies of scale can be lost in the implementation of a P3 operations and maintenance program.*

Improved Life-Cycle Design

Perhaps one of the most common advantages attributed to the inclusion of the O&M responsibility in P3s is the ability to enable the private sector to make design decisions that are tailored to benefit the long term O&M performance of a project. As discussed throughout the report, P3s incentivize the private partner to use life cycle design strategies because of the bundling of design, construction and O&M into a single contract. As so, if the private sector has the ability to improve the project's design while considering how such design decisions will affect them downstream in the O&M phase of the project, life cycle design improvements are expected in P3s.

In the Presidio Parkway project, improved life cycle design examples that were a result of the P3 being implemented were limited. As an example, the lighting system for the four cut-and-cover tunnels in the project were a design improvement that the O&M contractor for the project had an influence on. One of the design changes considered, but not implemented, was the use of LED lighting for the tunnels. The design-build project managers mentioned that they "did get to have a lengthy discussion with the operator about the lights in the tunnel, and maybe switch to [LED] lights because there was a future 20 or 30 year power savings, and then somehow we didn't get there". There was, however, a different life cycle design for the lighting system, which was the implementation of a lighting control system for the tunnels. The system implemented is known as the Tunnel Lighting Addressable Control System (TLACS) and it dynamically controls the luminance at the tunnel portal according to lighting levels outside, as well as the luminaire degradation inside. It controls and monitors more than 1,900 luminaires, helping the operator make critical savings on energy and operational costs (Nyx Hemera News Release 2015). The O&M operator noted how this system gives them additional control from what the design for Phase I of the project had. “And then there are also many more efficiencies with systems like that where you can view how many hours some of these lights have been on for, and so you know that you are getting towards [the end of] a cycle when lights are going to start burning out and you may go out and just group re-lamp all these before things start turning off” he added.

Another example that was found was the optimization of the ventilation system for the tunnels. In this case, the P3 team took over an existing design, as well as the technical requirements established for Phase I of the project. The developer indicated in their proposal that they “performed manual calculations to determine the preliminary jet fan selections. For each of the tunnels, we calculated the critical velocity using the specific geometry of the tunnel and the design fire. We then calculated the total thrust required to maintain the critical velocity by overcoming the losses in the specific tunnel" (Golden Link Concessionaires 2011). This particular example is shown as one of the life cycle design innovations that were identified despite noting explicitly that there were “limited opportunities for design innovations and enhancements” in this same proposal. They were, however, able to optimize the jet fan selection to meet the existing technical requirements and design by calculating the most efficient geometry and size of jet fans to be placed in the four tunnels.

These examples are some of the limited design improvements tailored to improve the life cycle performance of the project, which are considered to be relatively small or incremental. The late implementation of the P3, in regards to the advanced state of the design for this project, limited the ability of the developer to try and introduce rather large or radical life cycle design changes.

Dedicated and Committed O&M Budget

As discussed in previous sections of the report, one advantage of a P3 in terms of operations and maintenance is the dedicated and committed budget. Unlike projects procured conventionally by Caltrans, in the Presidio Parkway Project case the State has appropriated funds for the availability payments made to the concessionaire throughout the 30 year operation and maintenance period. This ensures that there will be sufficient funding for operations and maintenance throughout the concession as the availability payments are part of each year’s annual budget. In addition, as mentioned in previous sections, the availability payment mechanism is linked to performance requirements and subject to deductions if these requirements are not fully met. As such this payment mechanism helps to ensure both a base level of performance and guaranteed funding. Figure 2-20 provides an example of the types of performance requirements present in the P3 agreement.

Estimates for O&M costs per the P3 agreement total approximately $88M for operations expenditures, $24M for routine maintenance expenditures, and $80M for renewal and rehabilitation expenditures. A breakdown of these estimates can be found in Appendix C. Though these are estimates, they provide a level of budget certainty for the operations and maintenance period. Conversely, operations and maintenance budgets for Caltrans are determined on a yearly basis and can vary greatly. According to interviews with District 4 Operations and Maintenance officials, for each district the level of funding is determined yearly by Headquarters based on each district's needs; these needs are determined from pavement condition and level of service surveys. Funding availability is known before the start of each fiscal year, and projects must be developed and awarded within that year. Each district has a prioritized list of projects prior to this point and the level of funding determines which are able to be completed. Department-wide, degree and type of maintenance for each highway, as well as level of service goals, are determined based largely on available funds[46]. This level of uncertainty contrasts greatly from the regular, yearly budget with associated performance requirements present in the Presidio Parkway case.

The level of budget certainty present in the Presidio Parkway case allows for the development of a process for program renewal and long term maintenance. As outlined in the P3 agreement, the maintenance plan for the Presidio Parkway will be adjusted over time based on actual performance in accordance with the figure below. This helps to ensure that resources are being used in the most efficient way and that all handback requirements are met. Several individuals who were interviewed with Transfield highlighted this renewal plan as one of the main advantages of a P3, stating that this yearly process helps to inform required system upgrades throughout the course of the concession period.

[46] (Caltrans, 2016)

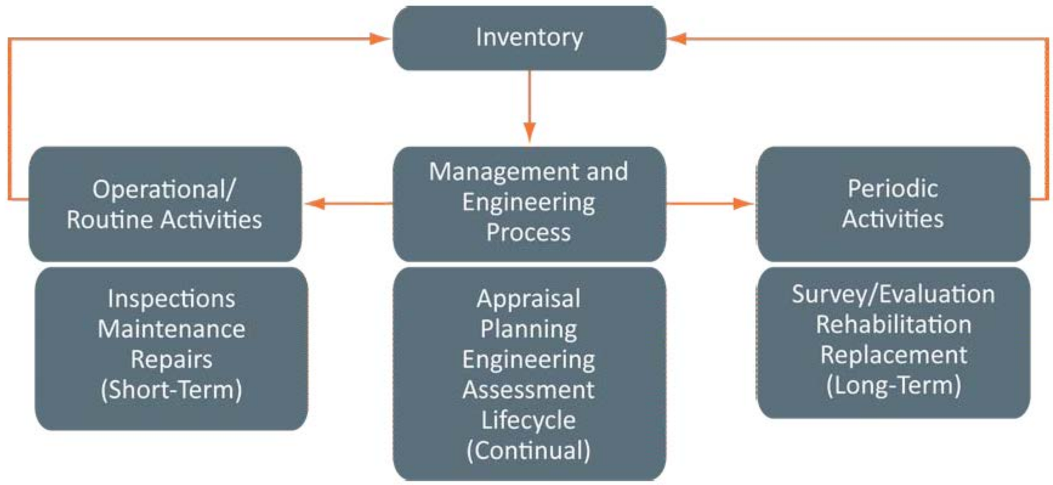


Figure 2-37: Integrated Renewal Process[47]

Improved Asset Condition

The incentive structure present in the availability payments discussed previously, yearly payments are tied to performance criteria, strategically ensures that regular maintenance, rehabilitation and replacement activities are scheduled and performed throughout the entirety of the concession period. It is theorized that this regular and continued maintenance will help to create a superior asset condition in comparison to facilities operated and maintained in a conventional way. Although evidence to support this phenomenon in P3s in the United States is sparse as most P3s facilities in the U.S. have not completed the O&M phase, there is supporting evidence in other contracting types in which the private sector is responsible for operations and maintenance. One study in Indiana showed that for contracts in which the private sector was responsible for maintenance that lasted more than 5 years, pavement condition was found to be superior to those similar projects that were procured conventionally. These pavements were found to have significantly lower IRI values and relatively low average rut depth as well. Not only did these projects have superior pavement quality, but over the long term they were more cost effective than conventional projects[48]. While these contracts were not P3s, in both schemes the Agency has no maintenance responsibility over a specified period of time and there exist financial incentives to provide a superior project. For these reasons, the above referenced study provides evidence for P3s delivering improved asset condition.

[47] (Golden Link Partners, 2011)
[48] (Singh, Labi, Bob, & Sinha, 2005)

Similarly, another case study comparing operations and maintenance of P3s in the U.S. to conventional delivery found positive results related to efficiency in operations and maintenance contracts. This study defined efficiency as “minimization of resources required to deliver agreed outputs at appropriate quality levels” and found that the P3 case was more cost efficient in total operations expenditures per mile and lane mile than a similar system of publicly maintained roads. It was also found that certain coordination issues exist at the state level that are not present in the case of the concessionaire and that the prioritization of projects due to funding insufficiencies found in the public case creates a generally suboptimal approach to operations and maintenance[49]. These findings provide further evidence for improved asset condition in the P3 case.

Operations and maintenance of the Presidio Parkway have been conducted by the concessionaire for only a short period of time, but there is some data available on the current asset conditions that can be compared to similar facilities operated and maintained by the Agency. Caltrans primarily utilizes IRI values and a qualitative pavement condition states measure to report pavement asset conditions. This data was obtained for all of District 4 for a period 2013-2015, the most recent pavement condition survey. For the Presidio Parkway, the available data was collected during phase two, but prior to the traffic shift to the new facility. Because of this, many of the data points were from the temporary bypass, not the completed Phase 1 or Phase 2 facility. However, even including the temporary bypass data for the Presidio Parkway, this facility still had the highest percentage of points with a pavement condition of “good/excellent” in comparison to similar projects, all of San Francisco County and all of District 4. Good/excellent condition is defined by Caltrans as a “condition with no or few potholes or cracks” and is stated to solely require preventative maintenance[50].

[49] (Martinez & Walton, 2014)
[50] (Caltrans, December 2015)

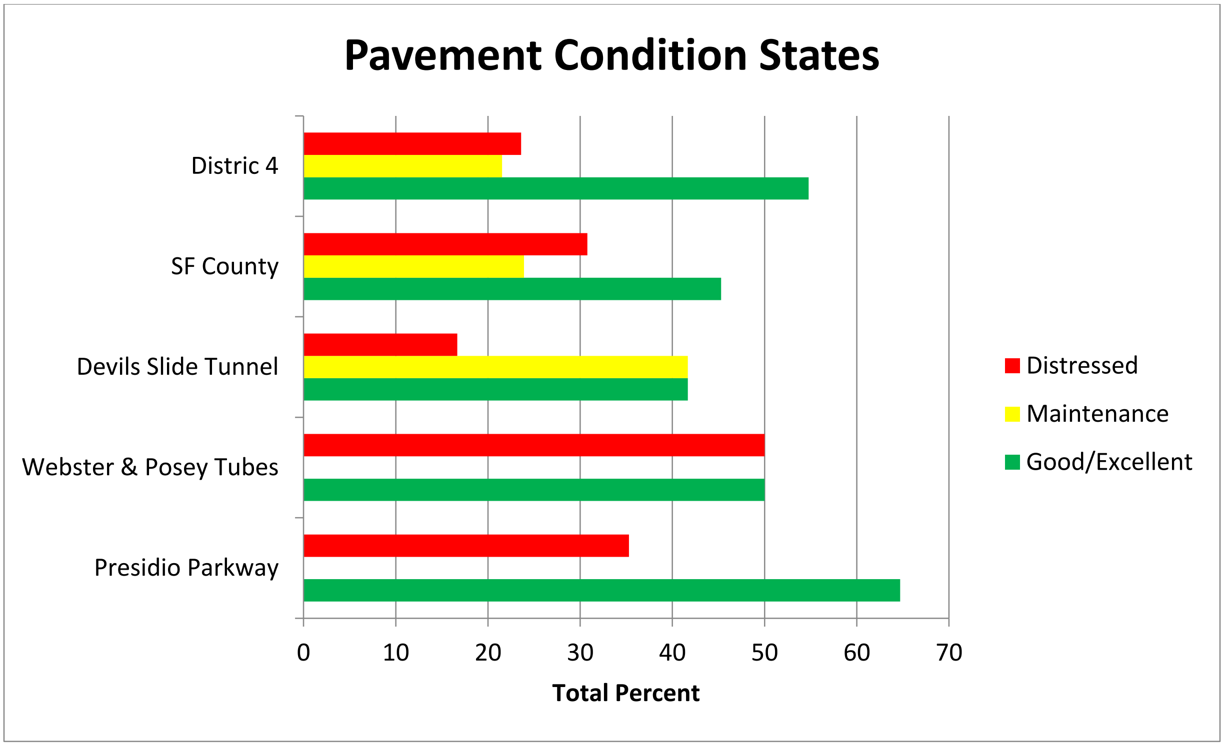


Figure 2-38: Pavement condition states for District 4 projects

A statistical analysis of these findings shows that there are significant differences between the pavement conditions in the above groups, shown by the p-value (Asymp. Sig.) of 0.002. Additionally, the mean ranks shown below indicate that the Presidio Parkway has the greatest average pavement condition.

Table 2-20: Mean Ranks for Pavement Condition

Ranks

	Project	N	Mean Rank
Pavement Condition	Presidio Parkway	17	6878.88
	Webster & Posey Tubes	12	8140.50
	Devils Slide Tunnel	12	7519.79
	Other SF County Projects	390	7772.07
	Other District 4 Projects	13681	7034.97
	Total	14112	

Test Statistics[a,b]

	Pavement Condition
Chi-Square	16.527
df	4
Asymp. Sig.	.002

a. Kruskal Wallis Test
b. Grouping Variable: Project

The results were more mixed when looking at IRI values for similar projects in comparison to the Presidio Parkway. The Devil's Slide Tunnel, which is of similar age, but has lower traffic volumes, had a lower average IRI value than that found on the Presidio Parkway. However, the Presidio Parkway had a lower average IRI value than the Webster & Posey Tubes, which has average daily traffic volumes that are still lower, but closer in scale to those of the Presidio Parkway. This comparison could suggest that the pavement condition of the Presidio Parkway performs better when compared to facilities with similar traffic even when including data from the temporary bypass. The p-value (sig. value) in the below table of 0.003 shows that the differences between the means in the similar project groups are statistically significant.

Table 2-21: IRI Value for Presidio Parkway & Similar Projects

Descriptives

IRI Value (in/mi)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Webster & Posey Tubes	8	202.750	55.0941	19.4787	156.690	248.810	120.0	278.0
Devils Slide Tunnel	8	125.750	16.3073	5.7655	112.117	139.383	104.0	153.0
Presidio Parkway	12	192.833	48.3789	13.9658	162.095	223.572	143.0	276.0
Total	28	176.500	53.8080	10.1687	155.635	197.365	104.0	278.0

ANOVA

IRI Value (in/mi)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	29318.333	2	14659.167	7.501	.003
Within Groups	48854.667	25	1954.187		
Total	78173.000	27			

To illustrate the large difference in traffic volumes, an additional figure below shows the average annual daily traffic of all facilities shown in the pavement condition figure above and IRI table, District 4, San Francisco County, similar projects and the Presidio Parkway, for comparison and scale.

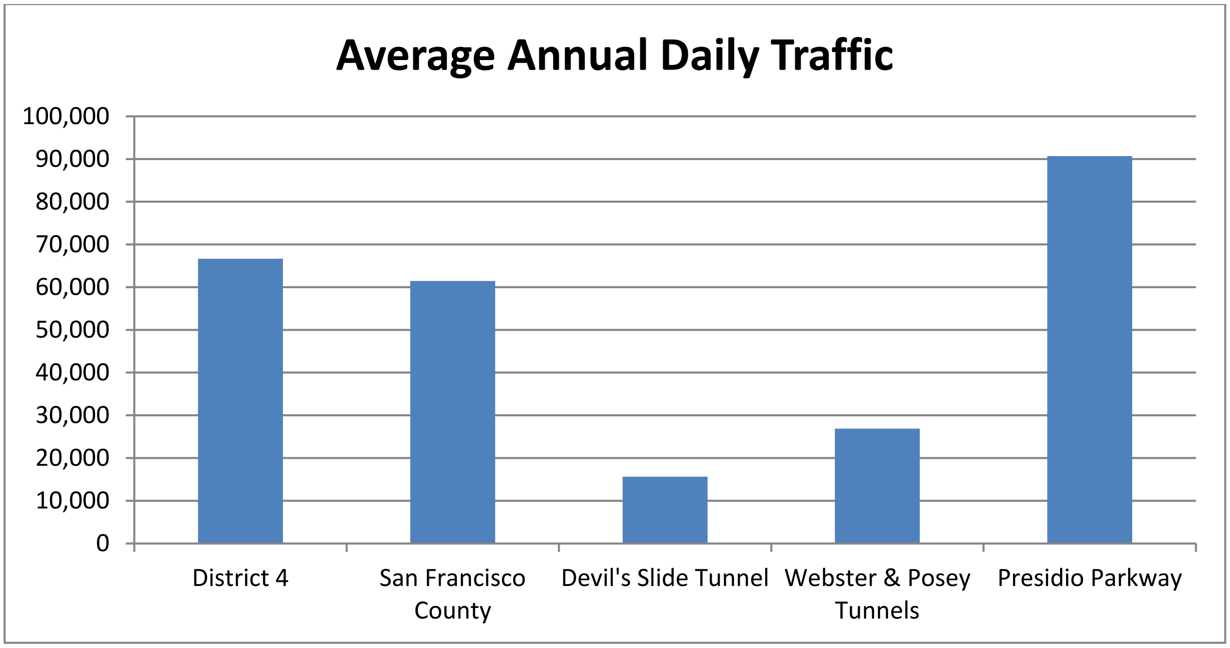


Figure 2-39: Annual Average Daily Traffic – District 4 Facilities

For both the Presidio Parkway and other Caltrans projects, bridge condition is measured through the use of a sufficiency index, which is required by the Federal Highway Administration, and a health index. Caltrans defines the health index as a "numerical rating that utilizes element inspection data to determine the remaining asset value of a bridge."[51] Similarly the sufficiency rating is comprised of structural adequacy and safety, serviceability and functional obsolescence, and essentiality for public use; it shows the sufficiency to remain in service of a particular asset[52]. When looking at these metrics for the Presidio Parkway, though the results are not statistically significant, analysis of the sufficiency rating and health index against projects with similar age and traffic shows the Presidio Parkway as performing better in both. These observations are weak as only two structures have been inspected to date, the Southbound Battery Tunnel and Battery Substation, and significant results could be expected with additional data points. Additionally, the structures analyzed on the Presidio Parkway have a lower standard deviation in both sufficiency rating and health index than similar projects. This could be evidence of proactive maintenance through more even treatment of roadways.

[51] (Caltrans, 2015)
[52] (Federal Highway Administration, 1995)

Table 2-22: Sufficiency Rating & Health Index for Presidio Parkway & Similar Projects

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
Sufficiency Rating	Similar Projects	10	89.810	5.6290	1.7800	85.783	93.837	79.0	97.0
	Presidio Parkway	2	92.500	1.1314	.8000	82.335	102.665	91.7	93.3
	Total	12	90.258	5.2093	1.5038	86.948	93.568	79.0	97.0
Health Index	Similar Projects	10	99.135	1.6285	.5150	97.970	100.300	95.5	100.0
	Presidio Parkway	2	100.000	.0000	.0000	100.000	100.000	100.0	100.0
	Total	12	99.279	1.5110	.4362	98.319	100.239	95.5	100.0

As noted previously, this superior asset condition is due in part to performance standards required by the P3 contract. Chapter 3 of the concessionaire's technical proposal details many of these requirements, including that all IRI values over 95 must be addressed within 90 days. The below table is an example many of these performance requirements which contribute to the improved asset condition on the Presidio Parkway. Additionally, interviews with several Transfield personnel highlighted the importance of these performance standards in the way operations and maintenance activities are performed. Many highlighted the proactive approach that has been adopted due in part to these standards; it was mentioned several times that required inspections and performance metrics allow the concessionaire to address issues even before the requirement is triggered.

Table 2-23: Example of Rigid Pavement Performance Requirements[53]

Performance Requirements	Timeline
Repair all cracks greater than or equal to 0.25 in. wide	90 days
Repair all settlement/depression greater than 1.5 in. deep over any 50 foot length	30 days
Repair all wheel ruts greater than 1.0 in. deep	90 days
Repair drip-track ruts over 0.5 in. deep	90 days
Repair alligator cracking in excess of 30 percent	90 days
Repair all potholes and slippage areas greater than 0.5 SQFT in area and/or 1.5 in. deep	24 hours

[53] Public Private Partnership Agreement for the Presidio Parkway Project between Caltrans and GLC dated January 3, 2011

A comparison of maintenance activities between the Presidio Parkway and similar projects was difficult as the method for recording these activities were dissimilar. Data from Caltrans IMMS system was provided for a similar project, the Webster and Posey Tubes, which showed that total number of man hours for operations and maintenance between October 2014 and October 2015. The data available for a similar period for the Presidio Parkway however is provided in monthly O&M reports by number of planned and unplanned maintenance activities. This difference in reporting mechanism could signal a difference in O&M tracking from cost in the case of Caltrans to performance in the case of the concessionaire. This difference ties into the issue of budget availability discussed in previous sections.

The type and frequency of maintenance activities for Caltrans is largely determined by budget availability. The maintenance manual for Caltrans makes this clear, stating that both degree of maintenance and type of maintenance should be determined by relevant authorities according to available funding, among other factors. Furthermore, the manual is careful to state that any maintenance procedures outlined in Caltrans documents should not be seen as a "legal standard of care" and should be taken as purely guidelines.[54] This is not true in the P3 case where the concessionaire is held to strict commitments, leading to a superior asset condition.

Improved Level of Service

Similar to the case of asset performance, the ability to maintain a superior level of service is limited by budgetary constraints in the agency case. As with performance requirements, the Caltrans maintenance manual stipulates that level of service goals should be set according to the resources available by the Chief of Division of Maintenance. The ability to meet these goals and objections is then determined through once yearly evaluations and reports. While the maintenance manual stipulates that Caltrans has a duty to protect the public from traffic interruptions, it is made clear that those recommendations outlined in the maintenance manual are not a legal standard of care and thus non-binding.[55]

Conversely, maximum response times for incidents and emergencies, among other requirements are contractual obligations in the P3 case. The concessionaire still follows all recommendations and procedures outlined in the applicable Caltrans maintenance manuals, and utilizes the level of service evaluation system "LOS 2000"utilized by all Caltrans districts. However, the contractual nature of the requirements in the P3 case helps to ensure that a minimum level of service is maintained throughout the entirety of the concession period. Monthly operations and maintenance reports indicate that thus far the

[54] (Caltrans, 2016)
[55] See note 54.

concessionaire has met all requirements related to response time, particularly for roadway incidents that affect lane availability.

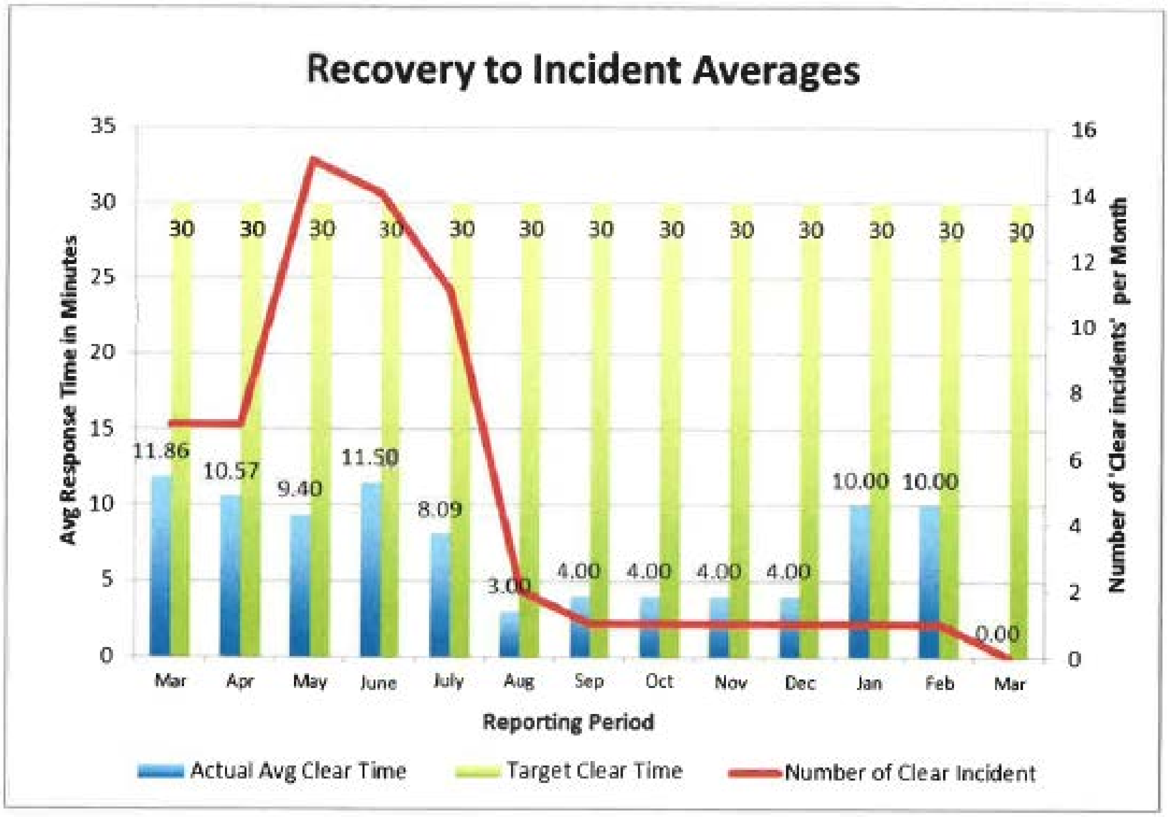


Figure 2-40: March 2016 Monthly Report – Incident Recovery Averages[56]

For major incident response, Caltrans complies with the goals of the Federal Highway Administration which specifies target average clearance of 90 minutes. However, research begun by Caltrans in 2010 showed that on average statewide this requirement is not met. Research notes from this same study in 2014 show that the statewide average is still over 3 hours for major incidents[57]. In the case of the Presidio Parkway Project clearance time frames depend on incident severity and the above graph includes mostly minor accidents where one lane is blocked[58]. However, the comparison of the two scenarios does show an ability to meet and exceed incident response requirements in the P3 case that is not met in the Agency case.

[56] (Broadspectrum, 2016)
[57] (Caltrans, June 2014)
[58] See note 56

Handback Renewal Process

One unique aspect of the P3 process is handback renewal which occurs at the end of the contractual term of operations and maintenance for the concessionaire. In the case of the Presidio Parkway Project, the P3 agreement stipulates that the handback renewal project should begin a minimum of 48 months prior to the end of the contract term with the submittal of a handback work plan by the concessionaire. The P3 agreement states that this work plan should include an inventory of asset condition to date for the facility, a plan for achieving end of term contract requirements and an O&M transition plan for Caltrans personnel[59]. This process helps to ensure that required steps are made far enough in advance to achieve the contractually required asset conditions and achieve a smooth transition for Caltrans operations and maintenance staff.

The minimum handback requirements vary based on asset type, but generally correspond to 80% of new condition. The P3 agreement stipulates both required criteria for acceptable asset condition and required remaining life at handback. Below is an example of these criteria for a specific asset category.

Table 2-24: P3 Agreement Minimum Handback Requirements[60]

TABLE 5.1 – HANDBACK REQUIREMENTS				
Asset Description	**Asset Sub System Description**	**Handback Evaluation Tasks**	**Handback Evaluation Criteria**	**Life Remaining at Handback (Years)**
Flexible Pavement	Pavement section within the O&M Limits	Flexible Pavement Condition Survey shall be conducted in accordance with Maintenance Manual Volume II, Section 4 for the A Family within 180 calendar days before the end of the Term; and Complete all tests in the Handback Renewal Work Plan to demonstrate the achievement of the required life remaining at the end of the Term.	No cracks greater than or equal to 0.25 inches in width; No settlement/depression greater than 0.5 inches in depth over any 50 ft. length; No wheel ruts greater than 1 inch deep; No drip-track ruts over 0.5 inches deep; No alligator cracking, pot holes or slippage areas; and Achievement of standards in the Handback Renewal Work Plan to demonstrate the achievement of the required life remaining at the end of the Term.	10 Years

[59] Public Private Partnership Agreement for the Presidio Parkway Project between Caltrans and GLC dated January 3, 2011.
[60] See note 59.

These minimum requirements help to ensure that when Caltrans takes over operations and maintenance responsibilities, the facility is of an acceptable quality that major maintenance won't be immediately necessary. As such this contractual requirement is essential to the long-term performance of the facility.

Cost of Maintenance

Many feel that certain economies of scale exist at Agency levels that are not present in a specific project case. Because P3 projects have dedicated crews for a particular facility, the cost of each individual maintenance activity is inherently higher in the P3 case. This feeling was highlighted by Caltrans maintenance staff members that were interviewed regarding operations and maintenance for the Presidio Parkway; all maintenance for the balance of Caltrans facilities are completed in house. Many expressed the feeling that could have performed the operations and maintenance of the Presidio Parkway and provided the same level of service for less money, highlighting as evidence duplicated efforts and facilities among other factors. Whereas the Presidio Parkway has dedicated maintenance crews for 11.2 lane miles, Caltrans is able to utilize only 1-2 crews for the entirety of San Francisco County, which has approximately 6,200 lane miles. This makes it so that facilities that are roughly comparable in type and age, such as the Devil's Slide Tunnel, have a yearly maintenance budget of approximately 10-15% of the Presidio Parkway maintenance budget; this facility does however experience lower average annual daily traffic than the Presidio Parkway.

It is important to note however that Caltrans itself has acknowledged in its 2007 State of the Pavement Report that $1 in preventative maintenance today could avoid $20 of reconstruction work in as little as 10 years. Additionally, the analysis of delivery options completed by Arup/PB found that to provide a similar level of service, the DBFOM scenario would be less expensive in the long run. This is primarily because of delaying major maintenance and replacement expenditures in the Agency case[61]. In the case of public-private partnerships there is little data to prove that the cost of overall maintenance will indeed be lower, but the ability to invest in preventative maintenance is encouraging.

[61] (Arup/PB Joint Venture, 2010)

Final Observations

The Presidio Parkway P3 project encountered and overcame several obstacles throughout its P3 life-cycle. If we look at other highway P3 projects across the country, the obstacles are not unique to this project. Most projects of this size and complexity, whether a P3 or not, face political and local opposition during the planning and transaction phase. Projects of this size take many years to come together, they have a long 'shaping phase' and have a large impact on its surrounding economy, given the direct benefits the project brings to the local and regional areas, and the indirect impact as well. Once the transaction phase reaches financial close, these projects often face internal organizational and institutional issues that are unavoidable. P3s are relatively new and novel in the US, although some states, such as Florida, Texas, and Virginia for example, have had more experience and exposure in implementing this type of project delivery in recent years. The Presidio Parkway is the first P3 undertaken under the newly established P3 enabling legislation in California, and with the new procedures and processes established concurrently with its implementation, many of the issues encountered were prone to happen with a lack of maturity in implementing the appropriate P3 processes.

The success of the Presidio Parkway, however, should not be measured by the obstacles that the project has encountered, and it should also consider the positive benefits that the project has brought to local bay area residents. These benefits relate to the cost savings captured, as measured from the initial budget established for the project, along with its continued containment of costs during construction. The schedule certainty, which takes into account the delays experienced in Phase II and compared to Phase I, ensures that the project sponsors and local residents do not experience further delays. This is a considerable benefit – users benefit sooner with a faster and timely delivery of the facility. Furthermore, an on-going high level of service for operations and maintenance of the facility, after its initial delivery, is practically guaranteed for 30 years. The project's hand-back requirements also guarantee the facility to be handed back to the state, with individual elements of the facility (i.e. at-grade road segments, tunnels, and bridges) in conditions with prescribed remaining design lives – for example, a 45-year remaining design life for all bridges at hand-back is required.

Through this in-depth case study, we have been able to explore and understand the underlying reasoning for many of these advantages and disadvantages that characterize P3s through the front-end planning phase, transaction phase, and implementation phase of the Presidio Parkway project. As discussed throughout the report, the way in which many of these issues evolved in the project are project-specific. However, many of the issues that have been analyzed are also applicable to future P3s, and provide valuable knowledge that should be taken into account in the future by public sector decision-makers. The following two sections provide our concluding remarks on the project, by focusing on its *internal generalization*, and subsequently we discuss how the lessons learned from this project can be applied to future P3s, by reflecting on the Presidio Parkway's outcomes.

Internal Generalization: Project-Specific Observations

> "Maybe if you wanted to have a really successful P3 project, it would be nice to have that where you didn't have the 3rd parties involved, meaning you aren't delving into somebody else's backyard, so if it was in the middle of a desert and you had lots of freedom to do almost anything you wanted to, I think that would be more successful. But in this location you are dealing with the national park, you deal with the presidio trust, you are dealing with all kinds of agencies that have jurisdiction over the project." – Developer's Design-Builder

Was the P3 project delivery method the right approach to deliver Phase II of the Presidio Parkway project? To answer this, we refer to the facts presented in this study. The biggest issue with the Presidio Parkway is that it was a project that had already started construction under a traditional design-bid-build process, and a P3 was implemented for the second half of the project. In addition to this, the project had already secured sources of funding for the project, both Phase I and Phase II, based on the initial estimates expected to be spent on the project. The project's location, within a National Park, in the Trust's jurisdiction along with the NPS, added another layer of complexity with the multiple stakeholders involved and complicated land ownership relation. "If I had a sample of 100 projects, would I have picked this one to start the P3 program in California? Probably not, because it is a very complicated project, half of it already done a different way and all these other things, but it didn't invalidate the choice of delivery method, and the only way to test that is by looking at how the market responds, vis-à-vis the ceiling [maximum availability payment] that we were given, and the market responded well under it," commented one of the sponsor's former executives. This opinion reflects the other side of the equation for determining whether or not the P3 delivery approach was the right decision. Considering that the budget established initially benefited from Phase II, and that the project performance for cost and schedule of construction was an on-time and on-budget, comparing it to Phase I's project performance, the P3 approach seems to be a valid decision.

We have observed that the project development and procurement steps that were performed by the project sponsors during the transaction phase, were comprehensive and robust. Although the project's drawbacks noted were known, the sponsor's thorough evaluation (through a detailed and comprehensive value for money study) took into account the risks that would still be retained by the public sector. The quantitative evaluation indicated that significant savings would be captured for the project upfront, as well as throughout the life of the project with a P3 approach, including the risks identified. Following the long and delayed procurement of Phase II, the project was able to capture an even better than expected 'value for money' in terms of cost at financial close. The life cycle cost savings locked in at financial close have proven to be quite significant considering the historic performance of large and complex mega-projects in the bay area, such as the bay bridge replacement project, and Phase I's project performance in the same project.

The performance of Phase II, however, goes without saying that other issues encountered at the expense of the value captured can be ignored. The institutional and organizational issues perhaps were not unexpected, but rather, the level of difficulty in dealing with them during the design and construction stage was not anticipated. Dealing with the Presidio Trust, as the landowners of where the project sits, shows us that the difficulty of the project is an issue that would be encountered regardless of the project delivery approach used for the project. "I would say that one of the huge differences in our working relationship is this breakdown of the collaborative design process, which has been, I think, much more difficult, and I think it has meant that we have had to use other mechanisms to enforce our interest in the process," commented one of the Trust's executives, "but again, Caltrans really worked in a much more collaborative way with us as one public agency to another, and my sense was that we resolved our conflicts with the contractor much more quickly and much more efficiently in Phase I than in Phase II." This comment shows that a more collaborative process between public to public agencies can be the reason why Phase II encountered a much more complex working relationship with the landowners.

In addition to this, the organizational inertia encountered in the project, both from the public and private parties, is an issue that can only be dealt with if the organizations get exposed to a project in the first place. This does not imply that neither of the two sectors were not prepared, for in fact the project sponsors had the assistance of some of the most experienced advisors in legal, technical, and financial issues in dealing with P3s in the US and internationally, and the developers' parent companies have many other P3s across the world. However, when the project is being implemented, at the design and construction interface, and the O&M interface, that is where the implementation processes begin to be adjusted and the uniqueness of every project begins to shape the implementation phase. There is no such thing as a ‘one-size-fits-all’ P3 agreement format that can be expected to function across the board. The learning curve, and perhaps the acceptance of P3 processes among the same project sponsors, encountered a steep curve being the first ‘pilot’ P3 project executed under this new legislation. “Part of the motivation [to use a P3], I think was also the idea that P3s as a concept could give the State of California a tool for doing much more efficient project delivery in the future, and that was important, that we do one and do it well, and do it successfully to prove the point, to demonstrate that P3s could be an effective project delivery tool,” commented one of the sponsor’s former executives. “It kept hope alive, it became a project that has some reality to it, it was something the people were in favor of, having P3 as a toolbox to rally behind, and that had it not happened [here] I think there is a good chance that the state would be even less inclined to do future P3s than they are now”.

Phase II of the Presidio Parkway has proven to be effective in managing some of the risks that have been transferred under the P3 agreement, and has shown notable project performance that demonstrates its effectiveness. Phase II overcame obstacles in implementing the P3 delivery approach under the project’s unique conditions. Of those conditions, the advanced development of the project given the phasing of the project and the complex project governance found in the project are the two conditions that appear to have been the most significant. The P3 approach for the delivery of Phase II in the Presidio Parkway has been effective in accomplishing most of the objectives and goals envisioned by the public officials. Of those objectives, the ability to secure private financing to complete the project and the delivery of the project on-time and within-budget during construction have been identified to as two significant benefits that the state has been able to quantify. Furthermore, despite the project being the first project to be implemented under the state’s new enabling legislation, proper procurement and management processes have been established that will help to path the way forward for future P3 projects in California.

External Generalization: Future P3 Considerations

The in-depth analysis of the typical advantages and disadvantages associated with P3s, as experienced by the Presidio Parkway project, can serve as a reference to public officials and transportation agencies that are considering the use of P3s in the future. Throughout the main P3 life-cycle phases discussed in this report, we have identified four major recurring themes that we believe are important for future transportation officials to consider when preparing, evaluating and implementing P3s. The themes are not meant to be all-inclusive, but are meant to provide valuable wisdom that may serve future P3 decision-makers to be able to successfully execute P3s in the future.

1. **The timing of implementation of a P3 should not be underestimated**

   The implementation of a P3 delivery approach can be made at any point along a project's development process, meaning whether evaluation for a P3 delivery approach begins as early as during the planning and environmental phase of a project, or as late as after preliminary design has been completed and even after construction of a phase of the project has begun. The latter, as the Presidio Parkway has proven, is possible and may still capture many of the benefits that are expected from a P3. However, the late consideration of implementing a P3 might expose the project to conflicting situations that would otherwise be either removed or mitigated more appropriately if the project was developed with P3 approach in mind from the beginning or earlier.

   For example, some of the friction that may be encountered is related to the public and political support for implementing the P3 in the first place. In the case of the Presidio Parkway, the development and procurement phase of the project encountered significant resistance from the sponsoring agency's own personnel even. Aside from Caltrans being a strong centralized organization, the fact that the project had already started construction for the first half of the project, and with an advanced development of the design for the project already underway, the validity in implementing a P3 this late in the process was questioned and resisted by many. Even if significant value-for-money was being predicted, from a practical standpoint it was a hard message to communicate and justify. Because of such conflicting issues, the level and amount of effort in 'pushing' the project as a P3 can be significantly reduced, and other pieces of the P3 process can be better defined.

2. **A rigorous P3 Development and Procurement process sets a strong foundation**

Although the Presidio Parkway encountered resistance in implementing a P3 for Phase II, the project was nonetheless successful because of the robust and rigorous project development and procurement steps that were performed by the project sponsors during the transaction phase. Perhaps the risk transfer was not optimal in comparison to a P3 with a more preliminary design and one being implemented from the beginning of a project; however, proper risk evaluation that took into account the risks that would still be retained by the public sector, and structuring the project to reflect the risk transferred to the private sector has proven to create a very strong incentive for the P3 team to deliver the project more efficiently. A proper approach to manage risk was evaluated, and therefore shows that the public sector has conducted its proper due diligence. In addition to this, the robust and comprehensive evaluation processes, being vetted through other state agencies and panels, has shown a transaction process that captures the best value by establishing a competitive procurement process.

3. **Project specifications need to be clear (expected vs. specified level of flexibility needs to be carefully evaluated)**

During the implementation of the P3 agreement, misalignment in what is expected of, and what is communicated to the private partner can result in conflicting and contradictory management processes. For example, the perceived quality and implementation of the quality management plans in a P3 can be considered to be inadequate to the project sponsors. However, the quality requirements established and communicated in the contract do not reflect those expectations and therefore conflict can arise as whether that level of effort is perceived to be inadequate by the public sponsors only, and it is something that is no longer under the control of the project sponsors in the first place. Processes that are demanded to be performed in a certain manner, or that cause conflict between parties can be traced back to project contract and requirements and how they were specified. Proper definition and detail can mitigate this common problem that arises in P3s, particularly given that interplay between prescriptive and performance-based specifications where P3s are considered and expected to have a more flexible environment given the risk transferred.

4. **The cultural change and adaptation to a P3 should be prioritized by public owners**

   The other part of the equation, related to proper specifications of contract documents, is the manner in which both the public and private partners in a P3 behave. In a sense, this can be thought of as the soft issues of the process, where culturally embedded processes and long-established organizational approaches will be in conflict with the new and needed approach under which a P3 functions. In the case of the Presidio Parkway for example, there is a long history of the project sponsors managing projects in a DBB basis, and the implementation of the P3 approach for the project changes the roles and responsibility of the public sector significantly. Because of this, with the expected learning curve, the implications for the implementation of a P3 are the public sector's fear of change or loss of control in certain processes, and the new areas of expertise that are expected of the public sector in providing an oversight and monitoring role. Proper training should be given to the project sponsor's staff, and should be tailored at proper levels of management.

These four themes are cross-cutting, and can be important to keep in mind across the P3 life-cycle phases of the project. Regardless of the uniqueness and complexity of each individual P3 that is being considered, maintaining those themes in mind when preparing, developing, and implementing a P3 could be extremely helpful to a project's successful execution. In a young 'P3-market', these observations can serve as a reference to other transportation agencies who are considering the use of P3s and could greatly benefit from the lessons learned from the Presidio Parkway project.

References

AECOM Consult Team. (2007). User Guidebook on Implementing Public- Private Partnerships for Transportation Infrastructure Projects in the United States, Final Report, Work Order 05-002. Washington, D.C.

Arup/PB Joint Venture. (2010). Analysis of Delivery Options for the Presidio Parkway Project (February 2010). San Francisco, CA.

Bain, R. (2010). “Construction risk – what risk?” Project Finance, (February), 46–50.

Bazeley, P., and Jackson, K. (2013). Qualitative Data Analysis with NVivo. SAGE Publications, Inc, London, UK.

Caltrans. (2010). Project Proposal Report (PPR) for the Presidio Parkway P3 Project (May 4, 2010).

Caltrans. (2012). “Management and Staffing Plan for the Presidio Parkway Project (Confidential).”

Caltrans. (2015). “Project Delivery Report, 2014-15 Q1 - Quarterly Report to the the California Transportation Commission.” <http://dot.ca.gov/hq/projmgmt/documents/ctc/CTCReport_2014-2015_Q1.pdf>.

Carollo, G., Garvin, M. J., Levitt, R. E., Monk, A. H. B., and South, A. (2012). Public-Private Partnerships for Infrastructure Delivery. SSRN Electronic Journal.

Chasey, A. D., Maddex, W. E., and Bansal, A. (2012). “A Comparison of Public-Private Partnerships and Traditional Procurement Methods in North American Highway Construction.” TRB Annual Meeting 2012, Transportation Research Board, Washington, D.C.

CTC. (2009). “Presidio Parkway Public Private Partnership Project Proposal Assessment (May 11, 2010).” California Transportation Commission.

CTC. (2015). “Financial Allocation for SHOPP Projects - Presidio Parkway Project Reslution FP-14-48 - Memorandum to California Transportation Comission Chair and Commissioners (May 28, 2015).” <http://www.catc.ca.gov/meetings/agenda/2015Agenda/2015_05/064_2.5b3.pdf>.

Deloitte Research. (2007). Closing America’s Infrastructure Gap: The Role of Public-Private Partnerships - A Deloitte Research Study.

Flyvbjerg, B., Holm, M. S., and Buhl, S. (2003). “How common and how large are cost overruns in transport infrastructure projects?” Transport Reviews, 23(1), 71–88.

Flyvbjerg, B., Skamris, M., and Buhl, S. (2002). “Underestimating Costs in Public Works Projects: Error or Lie?” Journal of the American Planning Association, 68(3), 279–295.

Golden Link Concessionaires. (2011). “Golden Link Concessionaire’s Technical Proposal: Preliminary Master Design Submittal (dated January 2011) - Comprehensive P3 Agreement, Volume 2, Section 2.”

Golden Link Concessionaires. (2015). “2015 Annual Financial Plan Update (FPAU), as of December 31, 2014 - Prepared Feb. 27, 2015.” FHWA.

Gransberg, D. D., Badillo-kwiatkowski, G. M., and Molenaar, K. R. (2003). “Project Delivery Comparison Using Performance Metrics.” 2003 AACE International Transactions, Association for the Advancement of Cost Engineering International, 1–5.

Gransberg, D. D., Runde, D. F., and Stergios, J. (2000). “The effect of innovative highway construction contract methods.” AACE International Transactions.

LAO. (2010). “Letter to Senator Alan Lowenthal, regarding the P3 Agreement between Caltrans and Golden Link Concessionaire LLC - December 9, 2010.” Legislative Analyst’s Office.

LAO. (2012). “Maximizing State Benefits From Public-Private Partnerships (November 8, 2012).” Legislative Analyst’s Office, Sacramento, CA.

Lessard, D. R., and Miller, R. (2013). “The shaping of large engineering projects.” International Handbook on Mega-projects, 34–56.

Levitt, R. E., Garvin, M. J., Scott, W. R., Dewulf, G., Monk, A., and South, A. (2014). “Toward an Integrated Lifecycle Governance Framework for Delivering Civil Infrastructure Projects through Public-Private Partnerships (P3s).” Engineering Project Organizations Conference 2014, Devil’s Thumb Ranch, Colorado.

MacDonald, M. (2002). Review of Large Public Procurement in the UK. London, UK.

Molenaar, K. R., Gransberg, D. D., and Sillars, D. N. (2015). NCHRP Report 808: Guidebook on Alternative Quality Management Systems for Highway Construction. Washington, D.C.

NCSL. (2010). Public-Private Partnerships for Transportation: A Toolkit for Legislators. Denver, CO.

Nyx Hemera News Release. (2015). “Intelligent Lighting to Reduce Costs (June 10, 2015).” TunnelTalk.com, <http://tunneltalk.com/USA-22May2015-San-Francisco-Presidio-Parkway-final-preparations.php>.

Parsons Brinckerhoff, Nossaman LLP, and HS Public Affairs. (2015). The Effect of Public-Private Partnerships and Non-Traditional Procurement Processes on Highway Planning, Environmental Review, and Collaborative Decision Making (SHRP 2 Report S2-C12-RW-1). Washington, D.C.

PIAC. (2010). Comments on the Presidio Parkway Public-Private Partnership Agreement (December 23, 2010). Sacramento, CA.

Raisbeck, P., Duffield, C., and Xu, M. (2010). “Comparative performance of PPPs and traditional procurement in Australia.” Construction Management and Economics, Routledge, 28(4), 345–359.

Ramsey, D. W., and Mounir, E. A. (2015). “Cost and Schedule Performance Benchmarks of U.S. Transportation PPP Projects.” TRB Annual Meeting 2015, Transportation Research Board, Washington, D.C.

Reinhardt, W. (2011). “The Role of Private Investment in Meeting U.S. Transportation Infrastructure Needs (May 2011).” American Road & Transportation Builders Association.

Sabol, P., and Puentes, R. (2014). Private Capital, Public Good - Drivers of Sucessful Public-Private Partnerships (December 2014).

SAIC, AECOM, and University of Colorado at Boulder. (2006). Design-Build Effectiveness Study - As Required by TEA-21 Section 1307 (f).

SFCTA. (2015). “Major Capital Projects Update – Presidio Parkway, April 22, 2015.” San Francisco, CA.

SFCTA, and Caltrans. (2009). “FHWA Initial Financial Plan (IFP) - May 12, 2009.” FHWA.

SFCTA, and Caltrans. (2014). “2014 Financial Plan Annual Update (FPAU), as of December 31, 2013.” FHWA.

Shrestha, P. P., O’Connor, J. T., and Gibson, G. E. (2011). “Performance comparison of large design-build and design-bid-build highway projects.” Journal of Construction Engineering and Management, ASCE, 138(1), 1–13.

Tom Warne and Associates LLC. (2005). Design-Build Contracting for Highway Projects - A Performance Assessment.

Whittington, J. (2012). “When to Partner for Public Infrastructure?” Journal of the American Planning Association, 78(3), 269–285.

Appendices

Appendix A: Case Study Protocol, March 2014

This may be requested from SFCTA. It has been withheld from this version of the report to reduce the length of this document.

Appendix B: Phase II P3 Procurement Schedule

Table 2-25: Phase II P3 Procurement Schedule (Source: Caltrans PMP dated July 20, 2012)

Activity	Due Date and Time
Issue Request for Qualifications (RFQ)	February 2, 2010
Statement of Qualifications Due Date	March 11, 2010
Short-listing Announcement	April 8, 2010
Issue Draft Request for Proposals (RFP)	May 25, 2010
Issue Final RFP	July 9, 2010
Issue Addendum No. 1 to Final RFP	August 13, 2010
Issue Addendum No. 2 to Final RFP	August 30, 2010
Issue Addendum No. 3 to Final RFP	September 7, 2010
Issue Addendum No. 4 to Final RFP	September 17, 2010
Issue Addendum No. 5 to Final RFP	September 24, 2010
Technical Proposal Due Date	September 13, 2010, 2:00 p.m. PDT
Financial Proposal Due Date	October 6, 2010, 2:00 p.m. PDT
Notice of Intent to Award	October 15, 2010
P3 Agreement Final Form	October 19, 2010
Public Hearing	October 21, 2010, 4:30 p.m. - 8:00 p.m. PDT
Submission of P3 Agreement to PIAC and Legislature for 60-day review period	October 26, 2010
Notice of Award	January 3, 2011
Commercial Close	January 3, 2011
P3 Agreement Executed	January 7, 2011
First Amendment to P3 Agreement Executed	October 7, 2011
Second Amendment to P3 Agreement Executed	June 14, 2012
Financial Close	June 14, 2012

Appendix C: Estimated O&M Costs and Payments

Table 2-26: Schedule of Availability Payments (lumped per fiscal year total)[62]

FY#	Payment Period Ending:	Actual MAP	Cumulative MAP
1	30-Sep-16	$ 13,551,104	$ 13,551,104
2	30-Sep-17	$ 25,573,808	$ 39,124,912
3	30-Sep-18	$ 22,315,057	$ 61,439,969
4	30-Sep-19	$ 22,415,650	$ 83,855,619
5	30-Sep-20	$ 22,549,472	$ 106,405,091
6	30-Sep-21	$ 22,592,362	$ 128,997,453
7	30-Sep-22	$ 22,730,899	$ 151,728,352
8	30-Sep-23	$ 22,840,641	$ 174,568,993
9	30-Sep-24	$ 22,984,408	$ 197,553,401
10	30-Sep-25	$ 23,035,644	$ 220,589,045
11	30-Sep-26	$ 23,184,561	$ 243,773,606
12	30-Sep-27	$ 23,304,281	$ 267,077,887
13	30-Sep-28	$ 23,458,902	$ 290,536,789
14	30-Sep-29	$ 23,519,243	$ 314,056,032
15	30-Sep-30	$ 23,679,479	$ 337,735,511
16	30-Sep-31	$ 23,810,089	$ 361,545,600
17	30-Sep-32	$ 23,976,550	$ 385,522,150
18	30-Sep-33	$ 24,046,824	$ 409,568,974
19	30-Sep-34	$ 24,219,411	$ 433,788,385
20	30-Sep-35	$ 24,361,897	$ 458,150,282
21	30-Sep-36	$ 24,541,276	$ 482,691,558
22	30-Sep-37	$ 24,622,386	$ 507,313,944
23	30-Sep-38	$ 24,808,447	$ 532,122,391
24	30-Sep-39	$ 24,963,893	$ 557,086,284
25	30-Sep-40	$ 25,157,362	$ 582,243,646
26	30-Sep-41	$ 25,250,295	$ 607,493,941
27	30-Sep-42	$ 25,451,053	$ 632,944,994
28	30-Sep-43	$ 25,620,638	$ 658,565,632
29	30-Sep-44	$ 25,829,478	$ 684,395,110
30	30-Sep-45	$ 25,935,307	$ 710,330,417
31	30-Sep-46	$ 6,161,866	$ 716,492,283

[62] (SFCTA and Caltrans 2014, Attachment A)

Table 2-27: OpEx Cost Estimate of Operations and Maintenance ($ 000's)

Operations and Maintenance Expenditures Estimate (OpEx)	Avg. Annual	30 Year Total	% OpEx
Operating Costs			
Agreement required construction insurance	$ 75	$ 2,254	2.0%
Inspection and reporting	$ 54	$ 1,628	1.4%
Integrated Maintenance Management System	$ 27	$ 801	0.7%
Other direct costs	$ 678	$ 20,349	18.1%
Reporting	$ 25	$ 751	0.7%
Security monitoring	$ 615	$ 18,459	16.4%
Staffing	$ 1,458	$ 43,752	38.9%
Utilities	$ 20	$ 601	0.5%
Operating Subtotal	**$ 2,953**	**$ 88,595**	**78.8%**
Routine Maitenance Costs			
Electrical	$ 42	$ 1,252	1.1%
ITS and Communications	$ 3	$ 83	0.1%
Litter and Debris	$ 67	$ 1,995	1.8%
Slopes, Drainage and Vegetation	$ 4	$ 125	0.1%
Structures	$ 12	$ 351	0.3%
Traffic Guidance	$ 57	$ 1,723	1.5%
Variable Costs	$ 8	$ 245	0.2%
Drains and drainage	$ 3	$ 75	0.1%
Incident Response	$ 83	$ 2,504	2.2%
Landscaping	$ 17	$ 498	0.4%
Storm Maintenance/Major Damage	$ 12	$ 351	0.3%
Tunnel Systems	$ 489	$ 14,659	13.0%
Maintenance Subtotal	**$ 795**	**$ 23,861**	**21.2%**
Total OpEx[1] ($ 000's)	**$ 3,749**	**$ 112,456**	**100.0%**

Note:

1. Public Private Partnership Agreement for the Presidio Parkway Project between Caltrans and GLC, Appendix 2-G(3): GLC Bid Breakdown of O&M Costs, dated January 3, 2011.

Table 2-28: CapEx Cost Estimate of Operations and Maintenance ($ 000's)

Major Renewal and Rehabilitation Expenditures Estimate (CapEx)	Avg. Annual	30 Year Total	% CapEx
Bridges and Tunnels			
Bridge columns and superstructure (amounts include Tunnel structure costs)	$ 1,167	$ 35,006	43.9%
Bridge & Tunnels Subtotal	**$ 1,167**	**$ 35,006**	**43.9%**
Roadway			
Landscaping, planting, Irrigation and Hardscape	$ 3	$ 90	0.1%
Lighting	$ 293	$ 8,788	11.0%
Minor items (including barriers and fencing)	$ 39	$ 1,176	1.5%
Pavement Cross Streets	$ 1	$ 38	0.0%
Pavement Mainline Asphaltic Concrete pavement (including base)	$ 183	$ 5,483	6.9%
Pavement Mainline Portland Cement Concrete pavement	$ 122	$ 3,672	4.6%
Signs, Markings and Signalization	$ 23	$ 688	0.9%
Traffic Management Systems and ITS	$ 241	$ 7,226	9.1%
Roadway Subtotals	**$ 905**	**$ 27,161**	**34.1%**
Tunnel Systems			
Drainage	$ 5	$ 149	0.2%
Fire Detection and Alarm	$ -	$ -	0.0%
Fire Suppression Systems	$ 61	$ 1,826	2.3%
Illumination	$ 304	$ 9,130	11.5%
SCADA System (Included in Traffic Management Systems and ITS)	$ -	$ -	0.0%
Tunnel Ventilation Systems	$ 138	$ 4,139	5.2%
Tunnel Systems Subtotal	**$ 508**	**$ 15,244**	**19.1%**
Variable Costs			
Design/Professional Costs	$ 75	$ 2,239	2.8%
Variable Subtotal	**$ 75**	**$ 2,239**	**2.8%**
Total CapEx[1] ($ 000's)	**$ 2,655**	**$ 79,650**	**100.0%**

Note:

1. Public Private Partnership Agreement for the Presidio Parkway Project between Caltrans and GLC, Appendix 2-G(3): GLC Bid Breakdown of O&M Costs, dated January 3, 2011.

Appendix D: Previous Project Performance Comparative Studies

A literature review has been conducted to obtain all of the most salient and recent comparative studies that have focused on highway projects in the US, or transportation-related projects. Vertical, or building projects for which studies have similarly performed comparative analyses on different delivery methods have been omitted. Table 2-29 below shows these recent related studies along with the dataset used for each delivery method noted. Note that average project size or range has been noted if available from each respective study and only Total Growth and Contract Growth metrics per the definitions provided in this report have been extracted (if available). For further detailed information, refer to each respective study shown in the references.

Table 2-29: Average Project Performance from Previous Comparative Highway Studies in the US

		Total Growth		Contract Growth		
Research Study	**Delivery Method**	**Cost Growth (%)**	**Time Growth (%)**	**Cost Growth (%)**	**Time Growth (%)**	**Notes:**
Presidio Parkway (this study)	DBB (Phase I)	**9.2**	**186.0**	**55.8**	**66.0**	Shown for comparison
	P3 (Phase II)	**-34.6**	**115.0**	**0.0**	**16.0**	
	P3 (Phase II) Construction		**45.0**		**-8.0**	Construction Only
Ramsey and Mounir (2015)[1]	P3 (N=25)			**3.2**	**1.2**	Project Size: $18M-$2.1B
Chasey et al. (2012)	P3 (N=12)			**0.8**	**-0.3**	Project Size: $90M-$1.1B
Bain (2010)[2]	DBB			**25.0**		Meta-Analysis of 14 studies.
	P3			**13.0**		
Raisbeck et al. (2010)[3]	DBB	**24.1**	**11.5**	**13.8**	**2.3**	N=24, N=15, N=23, N=23
	P3	**0.4**	**11.8**	**2.4**	**2.5**	N=16, N=6, N=14, N=14
MacDonald (2002)[4]	DBB (N=13)			**66.0**	**15.0**	Project Size > $40M
	P3 (N=4)			**0.0**		Project Size > $40M
Whittington (2012)	DBB (N=1)	**56.0**		**53.0**		Contract Growth Calculated (not shown in study), Project Size = $27M Each
	DB (N=1)	**55.0**		**19.0**		
Shrestha et al. (2011)	DBB (N=16)			**6.3**	**20.5**	Project Size > $50M
	DB (N=6)			**7.8**	**5.1**	Project Size > $50M
Shresta et al. (2007)	DBB (N=11)			**4.1**	**12.9**	Project Size > $50M

		Total Growth		Contract Growth		
Research Study	**Delivery Method**	**Cost Growth (%)**	**Time Growth (%)**	**Cost Growth (%)**	**Time Growth (%)**	**Notes:**
	DB (N=4)			**-5.5**	**7.6**	Project Size > $100M
SAIC et al. (2006)	DBB (Cost:N=9, Time:N=11)	**3.6**	**4.8**	**4.3**	**71.1**	Project Size Uncertain
	DB (N=11)	**7.4**	**-4.2**	**6.0**	**30.6**	Project Size Uncertain
Tom Warne and Associates LLC (2005)	DB (Cost:N=21, Time:N=17)			**4.0**	**9.5**	Project Size: $83M-$1.3B Avg. = $368M
(Flyvbjerg et al. 2002, 2003)[5]	DBB, Fixed-link (N=18)	**25.7**				Fixed-link Projects, North America Sample
	DBB, Road (N=24)	**8.4**				Road Projects, North America Sample
(Gransberg et al. 2000)	DBB (N=21)			**10.6**	**33.5**	FDOT Projects, Project Size Avg = $9M
	DB (N=11)			**-2.0**	**-35.7**	FDOT Projects, Project Size Avg = $3M

Notes:
1. The Ramsey and Mounir (2015) study considers DB and DBF project delivery methods as P3s, and thus those 25 sample projects used are a combination of DB, DBF and DBFOM type of projects in the US.
2. The Bain study is a meta-analysis of 14 of the most prominent studies that have studied project performance for infrastructure-related construction, primarily from the road sector. The consolidated results of those 14 studies are shown here, as discussed in the article. This is not based on actual project samples.
3. The Raisbeck et al. (2010) study shows data from different sample sizes noted for some of the growth metrics shown, if not all sample sizes had all the data needed to conduct each respective performance metric.
4. Out of a total of 50 projects studied (39 Traditional, and 11 P3s) in this study, there were 13 'non-standard civil engineering' DBB projects for which the average growths are shown. These are considered to be innovative and complex 'non-standard' projects. For P3 projects, there were only four (4) P3 'standard civil engineering' projects for which the average growths are shown. There were no 'non-standard civil engineering' P3 projects in this dataset.
5. The Flyvbjerg database consists of a project size of 258 project across Europe (N=181), North America (N=61), and other geographical areas (N=16). It is also organized by project type into Rail (N=58), Fixed-link (N=33), and Road projects (N=167). Furthermore, performance is subdivided by project type per region, from which the performance averages for the North American dataset are shown in this table.

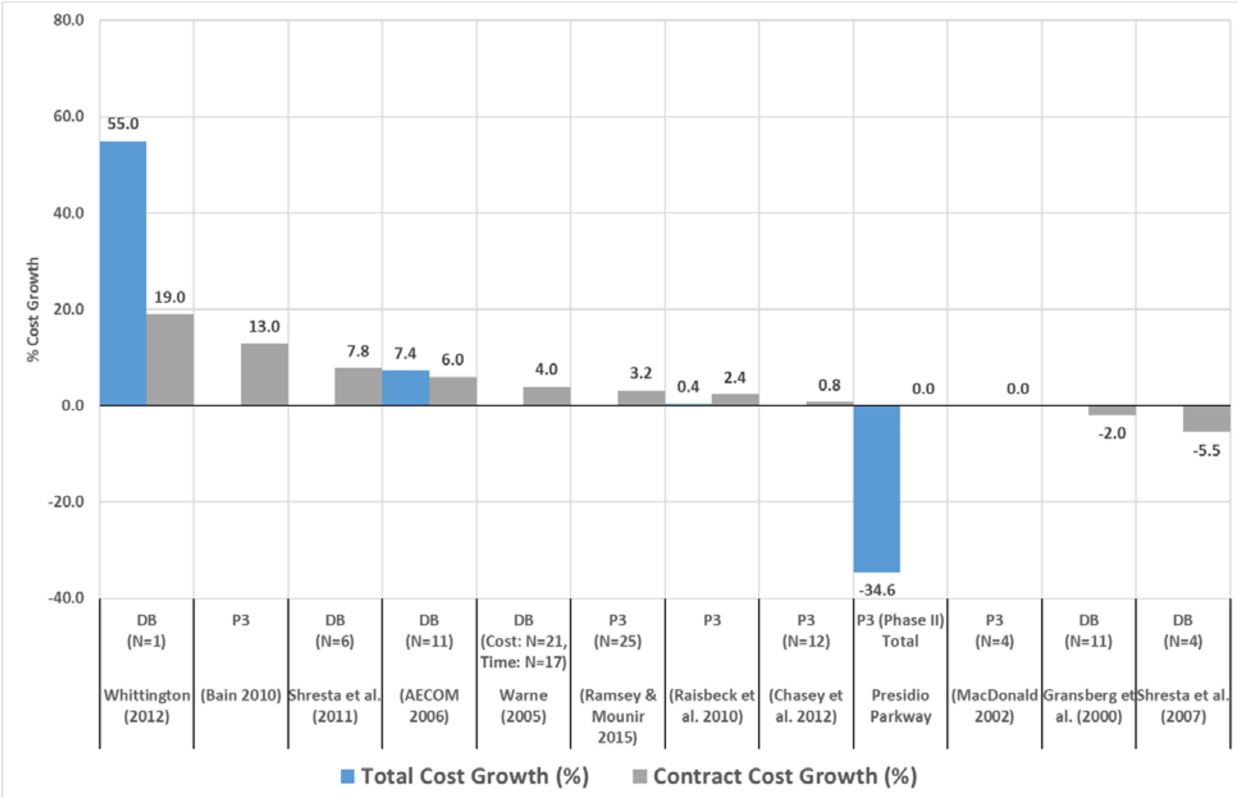


Figure 2-41: Phase II P3 Design and Construction Cost Performance Results, in Comparison to Previous P3 and Design-Build Average Highway Findings

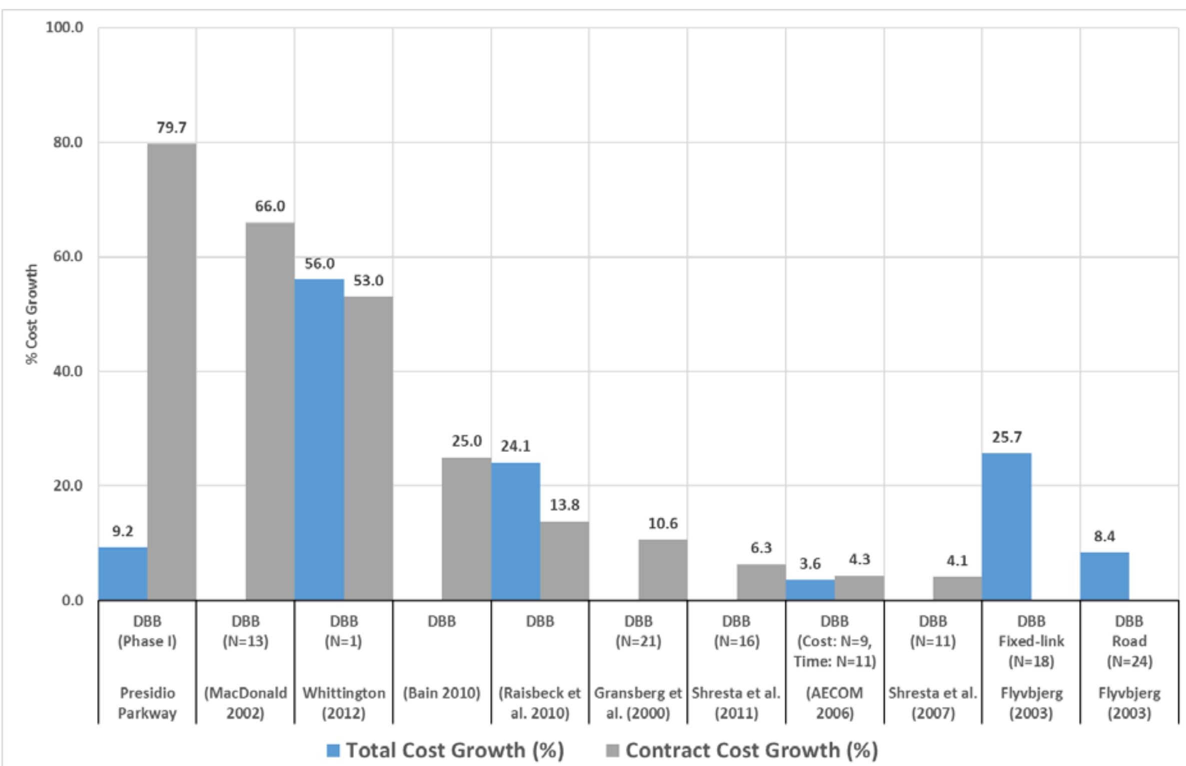


Figure 2-42: Phase I DBB Design and Construction Cost Performance Results, in Comparison to Previous DBB Average Highway Findings

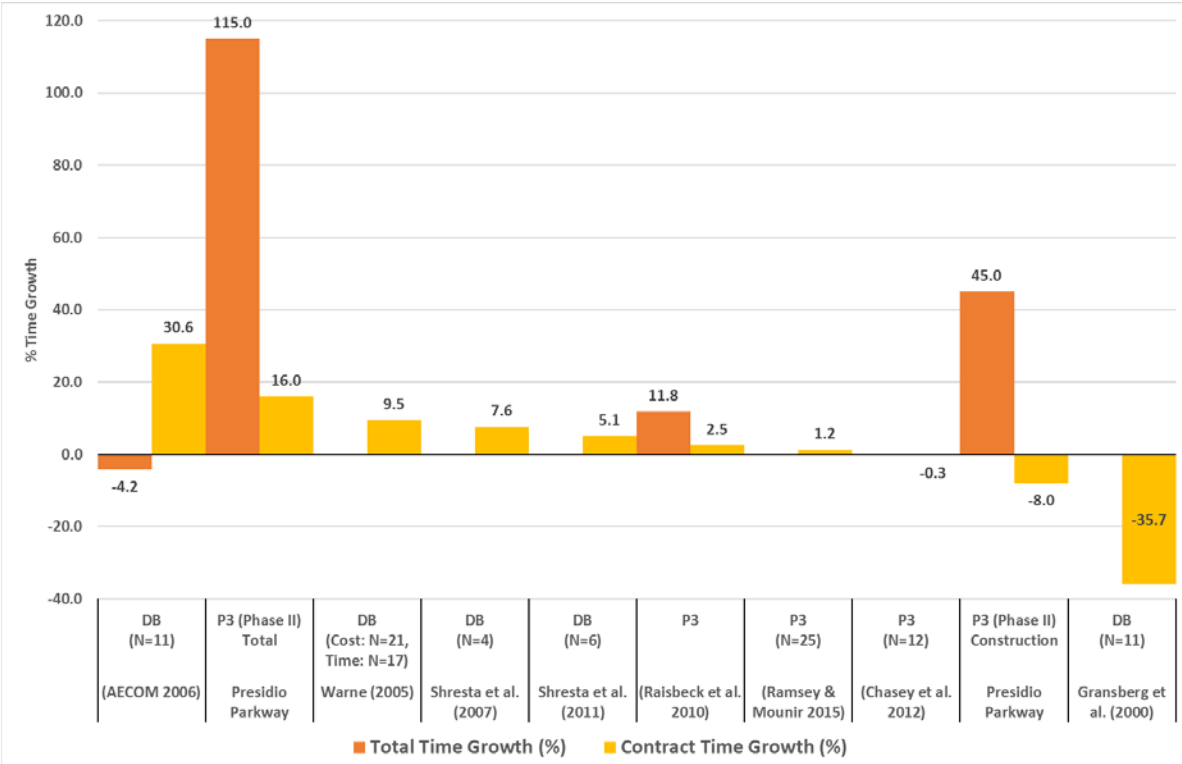


Figure 2-43: Phase II P3 Schedule Performance Results, in Comparison to Previous P3 and Design-Build Average Highway Findings

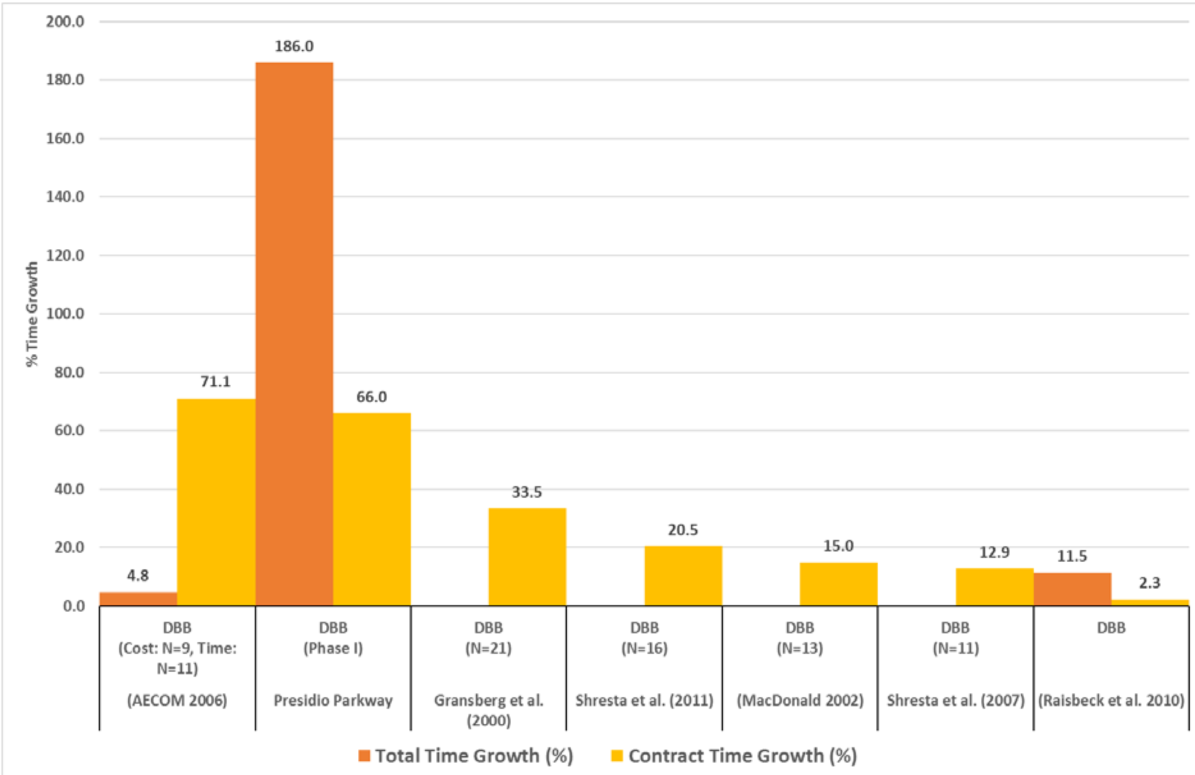


Figure 2-44: Phase I DBB Schedule Performance Results, in Comparison to Previous DBB Average Highway Findings

Appendix F: Detailed Schedule Performance Data

Table 2-30: Comparison of Phase I vs Phase II Schedule Performance

	Estimated Duration (IFP 2009)			Award Duration (Baseline Schedules)				Actual Duration (FPAU 2014, 2015)				
Presidio Parkway Contracts	**Start Date**	**End Date**	**Duration**	**Start Date**	**End Date**	**Duration**	**Award Growth %**	**Start Date**	**End Date**	**Duration**	**Total Growth %**	**Contract Growth %**
Phase I - DBB Contracts 3 & 4	10/1/2009	2/1/2011	16.0 mo.	10/23/2009	2/12/2012	27.7 mo.	**73%**	10/23/2009	8/21/2013	46.0 mo.	**186%**	**66%**
Contract 3	10/1/2009	2/1/2011	16.0 mo.	10/23/2009	8/19/2011	21.9 mo.	**36%**	10/23/2009	5/4/2012	30.4 mo.	**89%**	**39%**
Contract 4	12/1/2009	2/1/2011	14.0 mo.	4/8/2010	2/12/2012	22.2 mo.	**58%**	4/8/2010	8/21/2013	40.5 mo.	**188%**	**82%**
Phase II - P3 Project Duration	10/1/2010	6/1/2013	32.0 mo.	1/1/2011	11/30/2015	59.0 mo.	**84%**	1/3/2011	9/23/2016	68.7 mo.	**115%**	**16%**
Phase II - P3 Construction Duration	10/1/2010	6/1/2013	32.0 mo.	9/5/2011	11/30/2015	50.9 mo.	**59%**	11/6/2012	9/23/2016	46.6 mo.	**45%**	**-8%**

Notes:

1. Award Duration for Contract 3 from Baseline Schedule dated May 26, 2010, provided by C.C. Meyers, Inc (Contract 3 Contractor); Actual Duration dates from FPAU 2014.

2. Award Duration for Contract 4 from Baseline Schedule dated July 9, 2010, provided by R&L Brosamer (Contract 4 Contractor); Actual Duration dates from FPAU 2014.

3. P3 Project Duration dates from Revised Schedule dated December 29, 2010, provided by GLC (P3 Contractor) (P3 Agreement, Appendix 2A); Actual Schedule dates from FPAU 2015.

4. P3 Construction dates from Revised Schedule dated December 29, 2010, provided by GLC (P3 Contractor) (P3 Agreement, Appendix 2A), with NTP 3 "Partial" noting the start date for construction; Actual Schedule dates from FPAU 2015, adjusted for NTP 3 actual start date.

Table 2-31: Project Schedule Milestone Dates

Date	Description
12/01/1999	SFCTA/Caltrans MOU
02/23/2000	EIS Process Started (NOP Distributed)
12/01/2002	DEIS - 1st Version
04/01/2003	Presidio Parkway Alternative Introduced
12/01/2005	DEIS - 2nd Version
09/01/2006	Preferred Alternative Selected
10/14/2008	FEIS Signed
12/18/2008	ROD Signed
08/10/2009	RFP Phase I Contract 3 Released
10/23/2009	Phase I Contract 3 Awarded
11/16/2009	RFP Phase I Contract 4 Released
02/02/2010	P3 - Issue RFQ
03/23/2010	Phase I Contract 4 Awarded
04/08/2010	P3 Shortlist Announcement

Date	Description
07/09/2010	P3 Issue RFP
10/16/2010	P3 Preferred Proposer Selected
11/01/2010	PECG Litigation Filed
01/03/2011	P3 Agreement Signed
04/01/2011	P3 NTP 1 Signed (to commence Design)
11/01/2011	CA Supreme Court Denies PECG's Lawsuit
04/30/2012	Phase I Traffic Switch (Seismic Safety Milestone Reached)
05/04/2012	Contract 3 Completed & Accepted (Source: FPAU 2012)
06/14/2012	P3 Financial Close Reached
03/08/2013	P3 NTP 2&3 - Start of Phase II Construction & O&M
08/21/2013	Contract 4 Completed & Accepted (Source: FPAU 2013)
05/31/2015	Phase II Traffic Switch Scheduled
11/12/2015	P3 Substantial Completion (source: FPAU 2015)

CHAPTER 3: Fulfilling the Promise of Life Cycle Innovation on Public-Private Partnerships - A Comparative Case Study of Highway Projects

Abstract

Public-private partnerships (P3s) are becoming a prevalent solution to address the growing infrastructure needs across the US. Proponents of P3s believe that P3s enable the private sector to implement more life cycle design innovations, or design changes that benefit long-term project performance. While studies have explored innovation in highway P3s; to date, none have explored the effect of contract timing on the ability to realize life cycle design innovations. This study addresses this gap by analyzing three design-build-finance-operate-maintain (DBFOM) P3s to explore the influence of contract timing on the private sector's ability to realize life cycle design innovations. Using innovation theory as a framework to measure the magnitude of life cycle design changes, the research explored contract timing of private involvement and analyzed whether this timing enabled or inhibited the ability of the project team to realize the promise of life cycle innovations. Furthermore, through the identified examples, a conceptual model illustrates how the private sector's ability to perform more 'radical' life cycle design innovations increases the earlier the partner is brought into a project.

Introduction

State highway agencies are considering public-private partnerships (P3s) to address the growing infrastructure crisis and lack of continuing maintenance funds. Public-private partnerships can potentially speed construction and provide a continuing stream of maintenance funding. The P3 delivery method can encourage of innovation, increase asset utilization, and integrate whole-of-life management (Fitzgerald 2004). One of the most common arguments for the use of P3s is the ability to enable a more 'innovative' environment for the private sector to ultimately provide better long-term performance (Garvin 2003). Of interest in this study is the promise of P3s' ability to implement life cycle cost-saving innovations during the design and construction phase. These innovations should result in better life cycle performance during the operations and maintenance (O&M) phase. Blanc-Brude et al. (2009) state that P3s incentivize the private partner to use life cycle design strategies because of the bundling of design, construction and O&M into a single contract. Tawiah and Russell (2008) cite the incentive of higher maintenance profits for life cycle efficiency from the private sector. While many factors can contribute to life cycle performance improvements, this study specifically explores how the contract timing influences the opportunity for life cycle innovation in P3s.

The scope of this study addresses design-build-finance-operate-maintain (DBFOM) highway projects. P3s are defined as "a long-term contractual arrangement between the public and private sectors where mutual benefits are sought and where ultimately (a) the private sector provides management and operating services and (b) puts private finance at risk" (Garvin and Bosso 2008). While P3s are increasing, only 22 DBFOM P3 projects have been delivered or reached financial close since the early 1990s (FHWA 2015a; PW Financing 2015). The relatively small number of on-going P3 projects in design or construction dictates a case-based approach to study P3 decision timing and life cycle innovation. We chose three DBFOM cases to maximize the validity, replication and generalizability of our results: the Presidio Parkway, US-36 Managed Lanes, and Elizabeth River Tunnel projects, which together account for approximately $2.6 billion in capital investment. This study provides an in-depth exploration of agency P3 decision timing on the private sector's ability to implement life cycle design innovations. Project examples, viewed through the lens of innovation theory, illustrate how the P3 contract timing decision provides for, or inhibits, the ability to realize the promise of life cycle innovations.

Background

Highway Project Development Process

The highway project development process involves numerous activities, disciplines and stakeholder interactions (Anderson and Blaschke 2004). While the project development process and terminology vary slightly by agency, this study will use four phases to describe the highway planning and environmental review process through construction: planning; programming; preliminary design; and final design (see Figure 1).

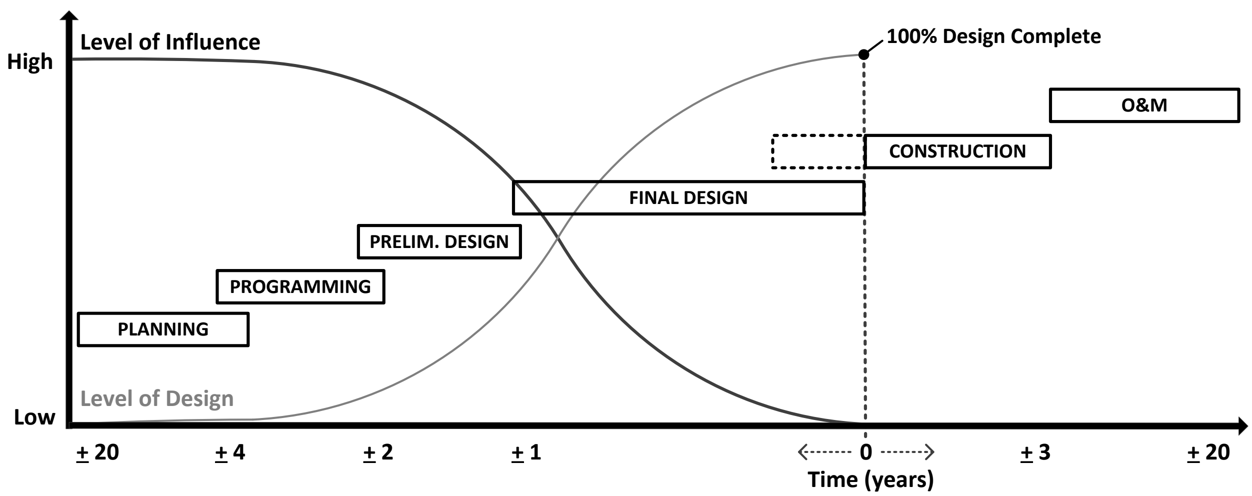


Figure 3-1: Level of Influence throughout the Project Development Process of a Highway Project

The *planning* phase begins up to 20 years or more before construction. At a macro level, the planning phase explores the purpose and need for projects, develops improvement/requirement studies, and explores early environmental considerations. The *programing* phase activities vary depending upon project size and scope, but generally involves major environmental and interagency review milestones, including those from the National Environmental Policy Act (NEPA). The magnitude of most P3 projects requires an extensive environmental review process (Parsons Brinckerhoff et al. 2015), and the P3 process generally includes an Environmental Impact Statement. The preparation of an Environmental Impact Statement, for example, takes 5-1/2 years on average (FHWA 2015b). The environmental process requires an evaluation of all “reasonable alternatives,” but typically results in no more than 5 to 10% of design.

Highway agencies associate the *preliminary* design phase with the beginning of the formal design processes. Specific design activities include preliminary plans for geometric alignments, bridge or structure (i.e. tunnels) layouts, and surveys, utility locations, and drainage design. A ‘30% level of design’ is typically in preliminary design. The end of *preliminary* and beginning *final* design is not always clear.

However, the end of final design will always produce construction plans, specifications and estimates for the construction process (FHWA 2013b).

The level of design and level of influence curves in Figure 1 are adapted from Paulson's seminal cost-influence curves (Paulson 1976). These curves show how decisions made in the earlier phases of a project have a greater influence on project outcomes. Paulson states that earlier decisions are made at a fraction of the cost of decisions made later in the project. Extending Paulson's concept to the highway project development phases and life cycle innovations, project stakeholders have the greatest ability to influence the long-term life cycle performance and outcomes in the planning, programming and preliminary design phases. At the completion of final design or during construction, any life cycle innovations are likely to have minimal impact.

Contract Timing of P3s

In this study, we define P3 contract timing as the point in which the private P3 concessionaire becomes contractually involved in the project. For example, if a concessionaire becomes involved through a pre-development agreement, prior to the execution of a formal P3 agreement, this is considered to be the time upon which the P3 concessionaire becomes contractually involved in the project. From a state agency's perspective, the decision to use a P3 approach begins earlier than the financial close (Parsons Brinckerhoff et al. 2015). Based on the US experience with P3s and Federal law (Title 23 CFR Part 636.119), this P3 decision may occur at any point, meaning as early as the planning phase, or as late as during the final design phase. Prior to financial close, a state agency can request technical support of the private sector through a pre-development agreement. The pre-development agreement will help to define the P3 project prior to the environmental clearance. While some agencies employ a pre-development agreement process to solicit life cycle input from the private sector, the formal P3 agreement is not executed until the pre-development agreement is complete, and upon the achievement of commercial close for the project.

Academic literature and government reports consider private sector innovation as one of the key P3 benefits (AECOM Consult Team 2007; FHWA 2007a; Grimsey and Lewis 2007). Private sector innovation can provide early considerations of constructability and O&M issues, for example. However, the inherent uncertainty of project scope early in the project (e.g., during the environmental review process) is an obvious challenge for private sector involvement. State agencies, by definition, are in a better position to deal with the environmental process due to compliance issues and the length of time that it takes. There is also concern that P3 involvement in the environmental process will limit competition and might not take all stakeholders needs into account (Parsons Brinckerhoff et al. 2015). Any discussion of the benefits from early private sector involvement with the goal of promoting innovation must take these concerns into account.

Life Cycle Design and Innovation

A highway project's life cycle begins with planning, goes through design, construction, operations, maintenance and the eventual end-of-life decommissioning/disposal (Ma et al. 2009; Sarja 2002). The major life cycle decisions are made during the initial delivery of a facility through the completion of the construction phase. While P3 projects define facility handback requirements (i.e., asset condition at the end of the concession), decommissioning is out of the scope of this study due to the lifespan of a transportation corridor. In fact, traditional design, construction and maintenance practices rarely consider decommissioning because transportation corridors are relatively permanent. In this study, we define life cycle design as an approach to optimize long-term project performance beyond initial delivery of a facility that strategically benefits facility operations.

Innovation describes the implementation of something new or novel. One of the most-cited definitions describes innovation as "the actual use of nontrivial change and improvement in a product, process, or system that is novel to the institution developing the change" (Freeman 1997). This research focuses on technological product and process innovations, to distinguish from 'non-technological' innovations, such as organizational or financial-oriented innovations (OECD 2005). Because this study focuses on life cycle design decision-making, we focus on design changes that aim to improve the long-term performance of the project. Drawing from these distinctive characteristics of innovation, in this study we describe the term *life cycle design innovation* as the implementation of a new or significantly improved technological change, in product or process design, that strategically benefits or improves the long-term life cycle performance of a project.

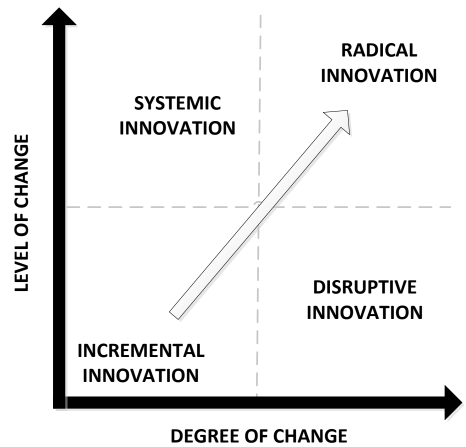


Figure 3-2: Innovation Classification Matrix adapted for this study

Using this definition, we can then explore the degree and level of technological change resulting from the implementation of a life cycle design innovation. The seminal work by Henderson and Clark (1990) introduces a classification system for innovations. Henderson and Clark build on the basis of *effect size*, where a small effect size is *incremental*, and a large effect size is *radical.* They introduce a two-dimensional classification of innovations, where one dimension captures the effect of an innovation on the integration or 'linkage' between components, and the other captures the effect on the design 'concept' of the components. Drawing from studies that classify innovations in the construction industry (Gambatese and Hallowell 2011; Sheffer and Levitt 2010; Slaughter 1998, 2000; Taylor and Levitt 2004), Figure 2 shows an innovation classification matrix to explore life cycle design innovation in this study.

Table 3-1: Life Cycle Design Innovation Classifications

Classification	Definition
Incremental	An incremental life cycle design innovation introduces a relatively small, non-trivial, change to an existing design, resulting in a *low degree of change*. The design is reinforced and extended, and the changes remain within an individual project component. It does not alter other project components or the integration among them, hence remaining at the *individual component level of change*.
Disruptive	A disruptive life cycle design innovation primarily introduces major changes in the design concept or technological approach, resulting in a *high degree of change*. It remains, however, at the *individual component level of change* and does not alter other project components or processes.
Systemic	A systemic life cycle design innovation introduces single or multiple innovations working together that result in incremental, a *low degree of change*, in the design concept or technological approach. However, it

	causes major changes to other project components or the integration among them, causing a *systemic level of change*.
Radical	A radical life cycle design innovation introduces single or multiple innovations working together considered to be both disruptive, having a *high degree of change* in the design concept or technological approach, and systemic, causing major changes to other project components or the integration among them, a *systemic level of change*.

Life cycle design innovation is used in this study to determine the degree and level of technological change, in product or process design. We classify life cycle design innovations as incremental, disruptive, systemic, or radical. Table 1 provides study-specific definitions of the classifications. This study-specific classification system more appropriately addresses (1) the project-level analysis; (2) the highway-sector context; and (3) the strategic focus on life cycle performance during the design stage. The degree of change measures the novelty of the design changes implemented or considered, and the level of change measures how life cycle design innovations impact the integration among project components. The term 'disruptive' indicates, from a degree of change perspective, that the life cycle design innovation is new or significantly improved, as opposed to a small 'non-trivial' reinforcement of an existing design. The term 'systemic' indicates, from a level of change perspective, that the changes alter other project components or the integration among them. The term radical in the context of construction innovations has been typically reserved to be used for rather 'rare, unpredictable "shooting star" events' that cause major changes in the industry as whole (Slaughter 1998). We have adopted the term to a project-level of analysis in this discussion, to distinguish the few instances where major life cycle design innovations, both disruptive and systemic, were introduced.

P3s and Innovation – A Point of Departure

While P3s are theorized and perceived to be 'more innovative' in meeting each respective project's needs and goals, there are a dearth of studies that focus on innovations in P3s, nor yet, the life cycle design decision-making process in P3s. Two prior case studies (Russell et al. 2006; Tawiah and Russell 2008) explored innovations based upon procurement mode. Russell et al. (2006) hypothesized that "innovation in an infrastructure project is a function of the procurement mode adopted and innovation that is realized in P3s is greater." However, in both case studies the innovations were incremental and the relationship between innovation potential and the procurement method adopted was 'tenuous'. Neither of these case studies, however, indicated how the contractual timing in these projects was managed and whether that affected the level of innovation that the projects accomplished.

Leiringer (2006) conducted a cross-case comparative study on four projects to explore technological product and process innovations during the design and construction phases of P3 projects. This study, which was also driven by "the purported added potential for realizing innovations," analyzed four potential drivers for innovation in P3s: design freedom, collaborative working, risk transfer and long-term commitment. Leiringer found mixed evidence that these four drivers were effective in encouraging innovation in P3s. The type of innovations explored in these previous studies focus on innovations that benefit the design and construction phase of the projects, and primarily address the impact of these innovations on initial project performance, as opposed to long-term project performance. There is a lack of studies that have analyzed innovations that extend past initial delivery to benefit or improve the long-term performance of the projects.

In a quantitative study, Rangel and Galende (2010) conducted an assessment on 68 Spanish highway concessions to determine whether several proposed factors fostered more innovation in P3 projects. Their analysis concludes that the transfer of design responsibility does not (statistically) determine the application of innovation in P3s. This is a contradictory statement to what many proponents of P3s, such as Grimsey and Lewis (2005), would argue in that the design responsibility in P3s encourages private contractors to "choose designs that will work, and explore innovations that can improve quality and reduce maintenance and operating costs." In other case studies, the realization of innovation in Private Finance Initiative (PFI) P3 projects in the UK has been found to be largely unrealized. Through an assessment of potential stimulants and impediments to creativity and innovation in P3s, Eaton et al. (2006) evaluated four case studies of different sectors and found that at the project-level, 'segmentation of project disciplines' was one of the main impediments present in all four projects. Similarly, in Barlow and Köberle-Gaiser (2008), a study of four PFI hospital projects concluded that the main structural problem to achieving innovation was "a separation of the project supply side, through the private sector consortium, and operational services." This is also contrary to the expected collaboration to be achieved among the bundled and integrated project team members in P3s, from which substantial design changes tailored to benefit a project's long-term O&M performance can emerge. Previous studies like these, however, have not strategically evaluated the level of those life cycle design innovations accomplished in P3s.

To address the above gaps, this study explores how contract timing affects the level of life cycle design innovation the private sector can accomplish in P3s. More specifically, this study focuses on the contractual timing of the involvement of the private sector and on how this timing influenced the life cycle design innovations that were proposed or implemented in the three selected case study P3 projects. The research question in this study is: How does contract timing influence the ability to realize life cycle design innovations in P3 highway projects?

Research Methods

The number of DBFOM highway P3 projects that have been implemented in the US is very limited. There is an even smaller sample size of P3 projects that were going through the design and construction stage during the two-year data collection period of our study. A case study research approach was selected for multiple reasons, including a limited sample size, the research question's focus on explaining and exploring 'how' contract timing influences life cycle design innovations in P3s, and because the phenomenon must be explored within its real-life context in an on-going P3 project (Yin 2009). Given the conditions that characterize the construction engineering and management domain (i.e. uniqueness of projects, duration, complexity), case studies allow construction engineering and management researchers to answer questions of how and why, and to contextualize a phenomenon and then define how it plays out under different contexts (Taylor et al. 2011).

This research employed a multiple-case study design (Eisenhardt 1989; Yin 2003, 2009) and selected three on-going highway P3 projects for analysis. Studying multiple cases, as opposed to a single-case study, allows the researchers to observe if emergent findings are idiosyncratic to one case or replicated by the others, something commonly referred to as replication logic (Eisenhardt and Graebner 2007; Eisenhardt 1989). Generalizability thus increases with replication logic. We use an embedded case study design, where the life cycle design innovations are embedded units of analysis within each respective project, or case.

The case studies were selected to represent a varied sample of representative highway P3 projects in the US. Given the existing DBFOM population of 22 completed or ongoing projects in the US, these three projects capture 14% of those potential population. Each P3 project is unique. The way in which the projects evolve to become 'P3s' introduces contextual differences. We selected P3 case studies based upon four factors: (1) projects differed in contract timing; (2) projects had ongoing design and construction during our data collection periods; (3) projects varied in size, scope complexity and location, and (4) projects varied in P3 contractual structures, such as payment mechanisms and internal subcontracting (i.e. O&M subcontracting versus self-performing). Table 2 shows the three case study projects selected with their respective project characteristics.

Table 3-2: Case Study Projects' Characteristics

Project Name	Location	Size ($M)	Design & Construction	P3 Type	Concession
Presidio Parkway (Phase II)	San Francisco, CA	$365 (ph.2) $496 (ph.1)*	2013 - 2015	DBFOM w/APs	30 Years
US-36 Managed Lanes (Phase II)	Denver-Boulder, CO	$181 (ph. 2) $319 (ph. 1)*	2014 - 2016	DBFOM w/tolls	50 years
Elizabeth River Tunnel	Norfolk-Portsmouth, VA	$2,088	2012 - 2018	DBFOM w/tolls	58 Years

***Note: Phase I (non-P3 scope) data provided for reference.**

One of the projects chosen—Elizabeth River Tunnel—had the private sector involvement during an early phase of the design development process, another was in the preliminary design phase—US-36 , and the third—Presidio Parkway—was in a design stage beyond preliminary design. This selection of these cases allowed us to analyze a range of timing of P3 implementation during the design development process of the projects, and hence the ability to study the implementation of life cycle design innovations within each individual case.

Data Collection

The main sources of data were semi-structured interviews with project participants and project documentation. We conducted semi-structured, in-depth interviews with key decision-makers in each respective project to explore our research question. The interviewees were selected based upon their organizational role, current role in the projects, or former roles during the design development process of the projects. A total of 32 interviews were conducted, including single person (N=26) and two-person interviews (N=6), for a total of 38 interviewees. Table 3 lists the respective stakeholder organizations for each of the three projects that were interviewed, along with the number of interviewees from each respective role.

Table 3-3: Case Study Interviews Conducted

Interviewee Perspectives	Presidio Parkway	US-36 Managed Lanes	Elizabeth River Tunnel	Total
Private Stakeholders				
P3 Concessionaire	1	2	2	5
P3 Design-Build Constructor	1	1	1	3
P3 Design-Build Designer	2	1	1	4
P3 O&M Operator	1	1	1*	2

Public Stakeholders				
Project Sponsors	11	5	4	20
State Agency P3 Unit	1	1	2	4
Total Interviewees	17	11	10	38

*Note: The P3 Concessionaire for the Elizabeth River Tunnel project self-performs O&M.

We interviewed public and private sector stakeholders. Private stakeholders included representatives from the concessionaire, the design-build constructor, the design-build designer, and the O&M operator. Public stakeholders included the project sponsors and their consultants working on the project, and their respective state agency's 'P3 Unit' office. The semi-structured interview format helped to explore ideas and generate propositions rather than gather facts or statistics. As a result, quality was preferred over quantity. As Oppenheim (1992, p. 67) explains, "the job of the depth interviewer is thus not that of data collection but ideas collection." Using this approach, a standard interview protocol was developed to explore each project's respective contract timing and life cycle design innovations. Interviewees were asked about the design decision-making process on each of the three projects from their respective roles and perspectives, as well as issues that may have enhanced or constrained life cycle considerations in the design. The interviews conducted were audio-recorded and later transcribed into text. Once we reached theoretical saturation, when new information was no longer mentioned, per each respective case across respondents, we determined that interviews were complete (Yin 2009) .

The interview data was combined with project documents that were either publicly available or provided by interviewees. The documents included procurement documents, responsive proposals, and contract agreements including all appendices and amendments. This information helped to triangulate the evidence from the interviews with official legal, technical or financial documents. The other main type of documents were secondary sources of information, such as studies that were previously conducted on each respective project, and article 'clippings' related to the project for example, some of which are noted and included in the references throughout the discussion of the findings.

Data Analysis

QSR Nvivo software (Bazeley and Jackson 2013) was used to organize and analyze the documentation and transcribed interviews. Over 31 hours of recorded audio for the interviews resulted in over 400 pages of transcribed text that was imported, together with documents, and systematically coded. The coding process was conducted in two 'cycles.' The first cycle of coding was an organizational, or structural approach to sort appropriate data into macro-categories for further analysis, including categories such as life cycle design examples, contract timing, and design perspectives, among others. Following this process, each code was then further analyzed for a more substantive interpretation of the data in line with the research objectives. For example, one of the interviewees, when discussing the life cycle design considerations for the Presidio Parkway project, commented: “I think this project has not had as much leeway for innovation as to what I think is a typical P3, or a typical design-build project might, because we have been more confined by what was done in phase one of the project with respect to the design. So in some ways I sort of feel like there has been a little bit less innovation on this project than I would have expected.” This section of the interview was then coded to the themes of ‘innovation’, ‘design flexibility’, and ‘contract timing’ because in this response, the individual topic of innovation in general is being discussed and how the timing of the P3 given its phasing limited design flexibility in the project. Due to the amount of project documentation, only the project documents referenced by the interviewees, or project documents noted as relevant to the study’s objective or specific examples identified were analyzed for this study, some of which are referenced here.

Findings

To analyze how life cycle design innovations were implemented, and how contract timing influenced these innovations, we first provide the context and describe the contract timing for each of the three case study projects. Second, we discuss life cycle design innovations, starting from the most radical to the most incremental life cycle design innovations. We then provide a more in-depth discussion on how contract timing influenced these examples.

Contextual Setting

Here we present the context of each project. We focus on how the project development process evolved in each of the projects. Drawing from the literature on the highway project development process, we establish a comparative P3 contract timing point for each project. We then use this point to discuss timing in relation to life cycle design innovations.

The design development stage for the Presidio Parkway was considered to be a relatively ‘mature’ or ‘constrained’ design stage for a P3 project – part of the scope in Phase II was parallel, a ‘mirror’ image, to the scope of work completed in Phase I, and its transition from a traditional Design-Bid-Build approach in Phase I to a P3 in Phase II contributed to this. A report on the project (LAO 2012) noted that the amount of completed design in this project limited the ability to find cost-savings using innovative design and construction means. In many cases, the concessionaire had to follow plans and specifications that it did not fully design. Similarly, an assessment by the California Transportation Commission (CTC 2009) indicated that the project was notable because of “its advanced state of design, prescriptive specifications for Phase II in the context of U.S. and California law, as well as allocation of lifecycle cost responsibility for segments not built by the Developer. Therefore, the potential for innovation may be reduced.”

For the US-36 Managed Lanes project, a Pre-Financial Close Technical Due Diligence Report (BYT Group 2014) noted that the design was “preliminary in nature and indicates design intent by means of preliminary drawings and narrative to address the required scope of the project.” Furthermore, in this report they indicated that the design of the critical elements had reached approximately 30-40% development at the time of bidding. The same design-build joint venture that was part of Phase I is part of the P3 team for Phase II of the project.

The timing of the P3 involvement in the third project, the Elizabeth River Tunnel, was at a very early design stage, particularly regarding the new Midtown tunnel design. A pre-development agreement, was awarded during the environmental process for the project, prior to completion of the NEPA process. A solicitation for conceptual proposals to develop and operate the project was offered in 2008 and a sole bidder was awarded a pre-development agreement that began the year after. At this point, the sponsoring agency and the concessionaire began to work as “close collaborators in environmental review, final design, and engineering. They formed working groups to tackle environmental issues, utilities and right of way, communications, and others” (Parsons Brinckerhoff 2013). One of the interviewees, the design manager, made a similar comment on how the P3 concessionaire and the design-build constructor funded a ‘preliminary engineering phase,’ where they essentially “brought the design up to approximately a 30% design stage to allow the detailed pricing to occur for the tunnels so they could negotiate a final price.” This response demonstrates the level of design that was completed when the P3 team began to work in the project, considered to be a very conceptual level of design.

Figure 3 shows the variation in contract timing in relation to the project development process timeline, and therefore the level of design maturity, for each of the three case study projects selected. The Elizabeth River Tunnel project was introduced before completion of the NEPA process with a preferred alternative design already selected. The other two projects were closer to the other extreme of this possible contract-timing continuum. The US-36 Managed Lanes project exhibited properties of having a design considered to be preliminary in nature, while the Presidio Parkway project exhibited a more advanced state of design relative to a preliminary design. The two phased projects are also shown in Figure 3 with a slight variation in their design maturity.

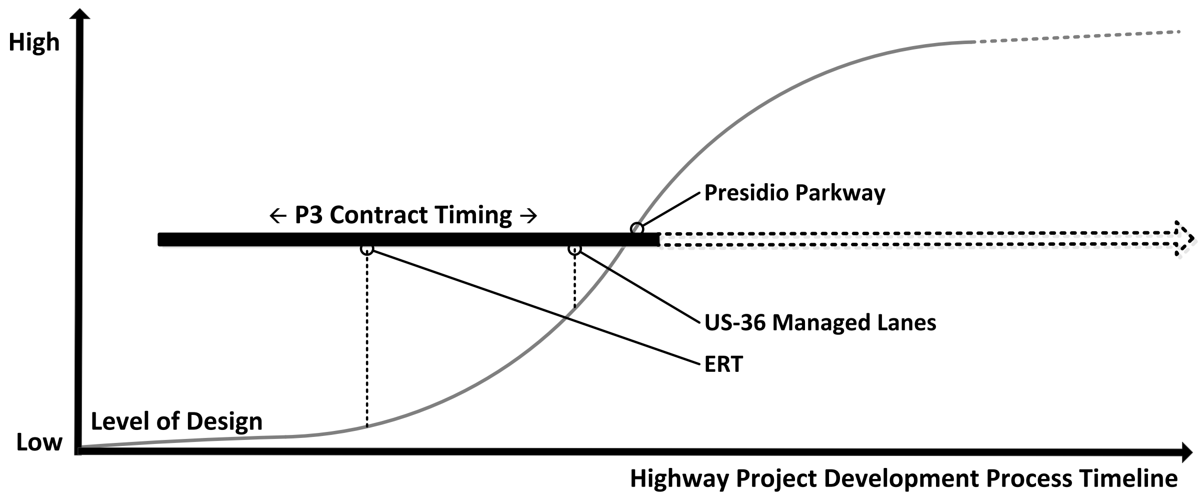


Figure 3-3: Relative Contract Timing for the Three Selected P3 Case Study Projects

Life Cycle Design Innovations

To understand how contract timing impacts life cycle design innovations, we identified and analyzed life cycle design innovations from the three case study projects. Table 4 shows the types of life cycle design innovations that were identified in each case. Of those identified, some were successfully implemented, while others were not, or were partially accepted life cycle design innovations. A description of each life cycle design innovation identified is provided in Table 5, which may be referenced back through this section as the four types of innovations identified are presented in this section.

Table 3-4: Type of Life Cycle Design Innovations identified in the Case Studies

Innovation	Presidio Parkway	US-36 Managed Lanes	Elizabeth River Tunnel
Radical	X	X	√
Systemic	X	√	√
Disruptive	√	√	√
Incremental	√	√	√

Note: √ = Identified; X = Not Identified

Table 3-5: Life Cycle Design Innovation Examples Identified, sorted by Project & Innovation Type

Example No.	**Project Scope**	**Life Cycle Design Innovation**	**Innovation Type**
Elizabeth River Tunnel Project			
1	New Midtown Tunnel Design	Decision to Proceed with an Immersed Concrete Tunnel Design vs. a Steel-shell Tunnel	Radical
2	New Midtown Tunnel Ventilation System	Selection of a Jet Fan Based Longitudinal Ventilation System	Systemic

3	New Midtown Tunnel Structural Design	Partial Removal of Corrosion Protection System for Immersed Concrete Tunnel	Disruptive
4	New Midtown Tunnel Structural Design	Concrete Mix Design for Immersed Concrete Tunnel Elements	Incremental
5	MLK Extension Bridge Decks	Replacement of Stainless Steel Rebar with Black Steel for Bridge Work in MLK Extension	Incremental
US-36 Managed Lanes Project			
6	Pedestrian Underpass & Utility Bridge	Consolidation of a Bikeway/Pedestrian underpass and a Utility bridge, both crossing the highway	Systemic
7	I-25 Bridge Deck Superstructure Rehabilitation	The Use of Polyester Polymer Concrete (PPC) Overlay for the rehabilitation of the I-25 Bridge Deck Superstructure	Disruptive
8	US-36, Concrete Pavement	Optimization of Concrete (PCCP) Pavement Thickness	Incremental
Presidio Parkway Project			
9	Tunnel Lighting	Consideration of LED Lighting use instead of HID Lighting for cut-and-cover tunnels	Disruptive
10	Tunnel Lighting	Implementation of a Lighting Control System for the tunnels	Disruptive
11	Tunnel Ventilation System	Optimization of Jet Fan Based Longitudinal Ventilation System	Incremental

We applied the innovation classification matrix (see Figure 2) to each example. First, all life cycle design examples were laid out across each individual project. We then proceeded to evaluate the 'level' or 'magnitude' the life-cycle improvement had on the project or its components. The innovation classification 'lens' allowed us to distinguish between these levels and the degree of change accomplished in each of the identified examples.

Radical Innovations

Radical life cycle design innovations are considered to be those that are both disruptive and systemic. The Elizabeth River Tunnel project was the only case where an example of a radical life cycle design innovation was found. The P3 team proposed the use of an immersed concrete tunnel (Example #1, see Table 5). As indicated in the P3 team's proposal (Elizabeth River Crossings LLC 2008), "while round, steel tunnel construction has been the norm in the US, a rectangular, concrete tunnel is proposed due to the efficiency and cost advantages of reinforced concrete." A preferred alternative design had already been selected, which was the construction of 'a limited access highway facility and tunnel to provide for east-west travel to improve traffic movement between the cities of Portsmouth and Norfolk at the Midtown Tunnel crossing' (FHWA 2007b). There were no technical requirements that had specified a preferred method of construction at that point. The design can be considered to be open at this point, as the design manager for the P3 team commented, "the state didn't have any design work done, there was literally a line on a map, 'I want a two lane tunnel, put it here'" he commented.

Historically, all immersed tunnels in the US have been traditional steel-shell immersed segments, and this project is only the second one to use concrete immersed segments in the US. The P3 concessionaire set this preferred approach to build the tunnel and therefore many of the subsequent decisions, such as the tunnel systems, configuration, and materials to be used to construct the project were affected by it. In order to meet a 120-year design life performance requirement, the team had to develop a concrete mix design in an extremely corrosive environment without the use of corrosion inhibitors. The project sponsor's construction manager commented on the concrete mix design developed for this project, an identified innovation, that "it is something like you have probably never seen before, there were a lot of water reducing agents, all sorts of things in there to make it behave properly, and it was a challenge." The concrete mix design (Example #4) is a result of the major radical design decision to design and construct an immersed concrete tunnel. The concrete mix example, however, is an incremental life cycle design innovation, as it is a modified product design that does not disrupt the other project components.

Systemic Innovations

Systemic life cycle design innovations are those that are considered to have a high level of change, meaning that other components in the project are affected, or readjusted, hence having a 'systemic' change. Systemic life cycle design innovations were identified in both the Elizabeth River Tunnel and US-36 Managed Lanes projects.

In the Elizabeth River Tunnel project, the selection of a jet fan-based longitudinal ventilation system (Example #2) is considered to be a systemic life cycle design innovation. This design decision changed many of the surrounding project components in the tunnel as it affected the cross-sectional dimensions of the tunnel. As indicated in the P3 team's proposal, "while jet fans have not been the standard solution in US tunnel applications in the past, they are able to efficiently vent exhaust gases and provide fire/smoke control in modern tunnels. They can save space and reduce the cost of the tunnel structure by eliminating plenums." In addition, this was also a decision driven by the life cycle considerations of the project, as the operation and maintenance costs for this system are expected to be lower. The three most common ventilation systems, transverse, semi-transverse, and longitudinal ventilation systems, were all evaluated by the P3 team and it was then determined, as indicated in their proposal, that "a longitudinal ventilation system based on jet fans will result in the smallest cross-section while having the lowest future maintenance costs" (Elizabeth River Crossings LLC 2008). To reinforce as to why this is considered to be a systemic life cycle design change, the degree of change is the reinforcement of existing design technologies, as indicated in their proposal, and not a disruptive, 'newer' technology.

In the US-36 Managed Lanes project, project interviewees made reference to their ability to adjust the design to make the O&M phase of the project more efficient, and, therefore improve the long-term performance of the project. The O&M manager for the project expressed how, through their input during the preliminary design phase of the project, they were able to "create some efficiencies, or some synergies" by reconfiguring specific project elements. With the O&M operator's input during design, the project team modified the existing design and consolidated an existing pedestrian and bikeway underpass with a utility bridge (Example #6). One project team member commented: "From our perspective it made it a no brainer, you move away from having two pieces of infrastructure to pipes that are attached to a pedestrian bridge." This design change is the adjustment of an existing design, yet by simply having two elements combined, other project components had to be reconfigured to accommodate the new consolidated pedestrian bridge, and for the removal of the existing underpass crossing the highway.

While the Elizabeth River Tunnel and US-36 Managed Lanes projects implemented systemic life cycle design innovations, the Presidio Parkway project did not. None of the interviewees were able to indicate systemic examples related to life cycle-oriented design changes that were accomplished in the project.

Disruptive Innovations

Disruptive life cycle design innovations are new or significantly improved design changes that, unlike systemic or radical innovations, do not require adjustments to adjacent project components. We found examples of disruptive life cycle design innovations in all three cases.

In the Elizabeth River Tunnel project, the team partially removed the corrosion protection system for the new midtown tunnel to account for life cycle performance of the project. This change was implemented during pre-development agreement phase of the project as the Technical Requirements were being developed. The modification was accepted with the requirement to make the tunnel 'compatible' for future installation of the corrosion protection system if needed. One project team member stated that their original provisional requirements required a cathodic protection system. They went on to say that the protection system “got to be very expensive very quickly” commented one of the interviewees, “as part of the negotiation process after the end of preliminary design, it was put on a list of things that they were able to then go back and remove. And then we offered to at least make the tunnel compatible with a future cathodic system, so if they wanted to come in later and plug one in (VDOT Technical Requirements 2011), at least all the rebar will be tied so you could get to it and hook the system up.” Such design decisions offset the upfront costs to install a component that is not needed in the first cycles of a project, yet they are able to install at a later point in the life of the project, given that they are responsible for the performance of the project and it will need to meet the standards specified in the hand-back requirements of the project.

A second example of a disruptive life cycle design innovation is the use of a Polyester Polymer Concrete (PPC) overlay (Example #7) for a bridge deck that was to be rehabilitated by the P3 team in the US-36 Managed Lanes project. In this case, the P3 team decided to use a PPC overlay, instead of a prescribed asphalt overlay for the rehabilitation of a large, and vital to the network, bridge deck that is to be maintained by the concessionaire. This alternative overlay has a higher upfront cost than the prescribed asphalt overlay, however, it provides a better preservation of the bridge deck and an improvement for the long-term life cycle performance of the bridge deck. “So is it going to cost us more to mill this stuff off versus asphalt, then we will have to buy that material again which is going to be more expensive in the future. So we are trying to figure out, are we gaining anything from our service standpoint by doing this?”

commented the concessionaire's project manager for the project, "and I think the result is that we are going to see some long term savings, but more importantly, we are going to preserve that structure more so because if that structure goes down then we have got really big problems." The importance of maintaining this bridge deck for the next 50 years, while considering what replacement, as opposed to maintenance, would mean from a life cycle cost perspective, played a pivotal role in design decisions like this one. The O&M manager stated: "That was strictly a lifecycle decision…we are well into the slope of that initial deterioration curve, ready to get to the end point where it just falls off and you need to replace the structure, and in order to hold it at this level, we really needed to go with this PPC overlay."

In the Presidio Parkway there were disruptive life cycle design innovations related to the lighting system for the four cut-and-cover tunnels in the project. One of the design changes considered, but not implemented, was the use of LED lighting for the tunnels (Example #9). The design-build project managers mentioned that they "did get to have a lengthy discussion with the operator about the lights in the tunnel, and maybe switch to [LED] lights because there was a future 20 or 30 year power savings, and then somehow we didn't get there". There was, however, a different disruptive life cycle design innovation for the lighting system, which was the implementation of a lighting control system for the tunnels (Example #10). The system implemented is known as the Tunnel Lighting Addressable Control System (TLACS) and it dynamically controls the luminance at the tunnel portal according to lighting levels outside, as well as the luminaire degradation inside. It controls and monitors more than 1,900 luminaires, helping the operator make critical savings on energy and operational costs (Nyx Hemera News Release 2015). The O&M operator noted how this system gives them additional control from what the design for Phase I of the project had. "And then there are also many more efficiencies with systems like that where you can view how many hours some of these lights have been on for, and so you know that you are getting towards [the end of] a cycle when lights are going to start burning out and you may go out and just group re-lamp all these before things start turning off" he added.

As shown with these examples of disruptive life cycle design innovations, which were found in all three projects, the ability to implement new or improved technological design changes, disruptive life cycle design innovations, is possible regardless of the contract timing or the maturity of the design when a P3 team gets involved. In comparison to the systemic examples shown, these do not require the re-adjustment of adjacent project components, even if the technological approach or design is a much newer or significantly improved design change.

Incremental Innovations

Incremental life cycle design innovations are considered to be non-trivial, small reinforcements or refinements of an existing design that do not alter other adjacent project components within the design being changed. Incremental life cycle design innovations were identified in all of the projects.

In the Elizabeth River Tunnel project, Example #4 (concrete mix design) was classified as an incremental life cycle design innovation because it was a refinement of the concrete mix design to meet the performance specifications established for the tunnel. Within the Elizabeth River Tunnel project, the design decision to use black steel rebar (Example #5) to replace stainless steel rebar for the bridge work scope of work was also an incremental innovation. While this decision reduced quality, as it is a less corrosive material than stainless steel, the design team considered the long-term life cycle performance of the project when making the decision, given that the P3 team is responsible for its upkeep for 58 years. "We had discussions about different types of rebar, whether it was going to be black rebar, or partially coated, or stainless, or MMFX," indicated the design manager during the interview, "and in the end a decision was made to allow the use of black rebar which is certainly a lower first cost choice but not necessarily the lowest lifecycle choice."

Within the US-36 Managed Lanes project, project stakeholders also considered both upfront and lifecycle costs of the decision made in Example #8, which optimized the concrete pavement thickness in the second phase of the project. The P3 team submitted this change as an Alternative Technical Concept with their proposal (Plenary Roads Denver 2014), in which they proposed using a different design approach to meet the 30-year design life requirement of the concrete pavement. The project sponsors partially accepted the design approach, however, they required the same thickness to ensure consistency with the Phase I scope of work. This was an interesting example that was echoed by the interviewees, as the concessionaire's project manager commented, "it could save on not only your concrete cost for construction but the sub grade thicknesses could all change, so you may not be cutting as much or you might not be filling as much, it just depends on where you are. It has a very significant impact across five miles for Phase II, but ultimately [the project sponsors] said 'no, keep it to 10 inches, we want to be consistent with Phase I'." However, the project sponsors did comment that if the project had not been a phased project, meaning if it had been a P3 from the beginning, "I think we wouldn't have been as restrictive on the pavement, since the concessionaire has to maintain those facilities for the next forty to fifty years." This example shows a partial optimization limited by the design standards established in Phase I of the project.

In the Presidio Parkway project, an example of an incremental life cycle design innovation was the optimization of the ventilation system for the tunnels (Example #11). In this case, the P3 team took over an existing design, as well as the technical requirements established for Phase I of the project. The P3 team indicated in their proposal that they "performed manual calculations to determine the preliminary jet fan selections. For each of the tunnels, we calculated the critical velocity using the specific geometry of the tunnel and the design fire. We then calculated the total thrust required to maintain the critical velocity by overcoming the losses in the specific tunnel" (Golden Link Concessionaires 2011). This particular example is shown as one of the life cycle design innovations that were identified despite the P3 team noting explicitly that there were "limited opportunities for design innovations and enhancements" in this same proposal. They were, however, able to optimize the jet fan selection to meet the existing technical requirements and design by calculating the most efficient geometry and size of jet fans to be placed in the four tunnels.

These examples of incremental life cycle design innovations show design changes that reinforce the existing designs for the projects. Many of these examples are characterized as "optimizations" of certain project components. Being the least disruptive type of life cycle design innovations, the optimization of major project components, such as the concrete pavement in the US-36 Managed Lanes project or the rebar for a scope of the Elizabeth River Tunnel project, are design changes that take into account the long-term life cycle performance of the project and the P3 teams still has the ability to introduce them despite the level of the design in the projects.

Table 5 shows the type of life cycle design innovations that were identified in the three case study projects selected. Noting the relative contract timing presented for each of the projects, and the level of innovations accomplished in each respective project, the relation between contract timing and level of life cycle design innovations accomplished is strengthen. The following section discusses this relationship further.

Discussion of the Findings

The life cycle design innovation examples in the three selected projects show the distinct range of design changes that improve the long-term performance of the project. The examples are not quantified in terms of 'how much' they are expected to improve the long-term performance of projects, but rather explored, through an innovation framework in terms of the magnitude of the design changes accomplished. Interestingly, the only radical example identified was found in the Elizabeth River Tunnel project, where the timing of the P3 involvement in this project was at a very early design stage. Systemic examples were identified for the Elizabeth River Tunnel project and US-36 Managed Lanes project, but not in the Presidio Parkway project. Both disruptive and incremental examples were identified in all of the three projects.

These findings demonstrate literal replication through the different contract timing points in the levels of life cycle design innovations identified across the three projects. The cases were carefully selected to predict similar results given the broad range of contract timing. As discussed in Taylor et al. (2011), in analytic studies conducted in construction projects, like this one, researchers "need to collect data on multiple analytically similar cases that have depth. Replication can be used to strengthen evidence by repetition and create generalizable theory." All of the life cycle design innovations identified can be compared across a relative timeline per project, as shown in Figure 4.

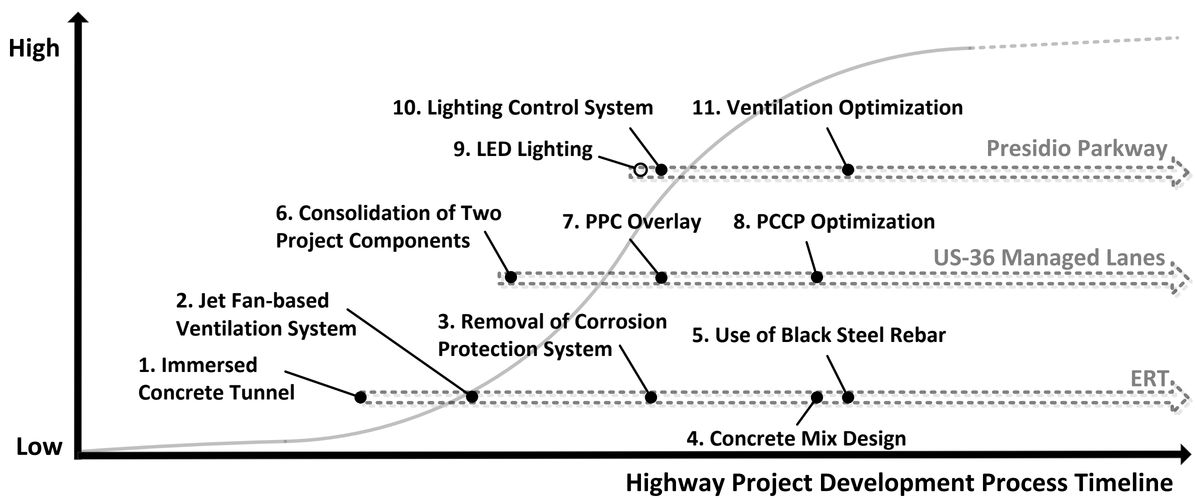


Figure 3-4: Life Cycle Design Innovations identified in each Project across a Relative Timeline

Drawing from the contract timing and identified examples, we observe that the ability of the P3 team to implement radical life cycle design innovations is amplified for projects with planning or early programming level designs. As one of the state agency's P3 Unit executives indicated: "if we go much more than 10% or 15%, we are taking away the potential for innovation that the private sector has, and, to me, it is a waste of resources too because [they] are going to come in with their unique ideas and they are going to change a lot of stuff around. So you will be wasting resources if you went, on a project like this, more than 10% or 15%." This response speaks to that relationship between the ability of the P3 concessionaire to be able to propose and implemented radical life cycle design innovations and the timing upon which it is implemented—earlier in a project's development process timeline, as opposed to a much further developed or mature design. In contrast, looking at the US-36 Managed Lanes project and the Presidio Parkway project, whose design was constrained by decisions implemented in the earlier phases of construction (i.e., the non-P3 phases), the flexibility to try and propose radical life cycle design innovations, and even systemic in some cases, is taken away. “I think there is a lot less of an opportunity to look at the long lifecycle cost when you do it in a two phased approach, because the first phase kind of sets the bar of what the project is going to look like without the concessionaire’s input” commented the design-build project manager for one of the projects. Similar responses regarding the reasoning behind the ability of the P3 concessionaires to be able to implement a design change at all, show, conceptually, how the incremental ability of P3 concessionaires to be able to implement ‘radical’ life cycle design innovations increases the earlier they get involved.

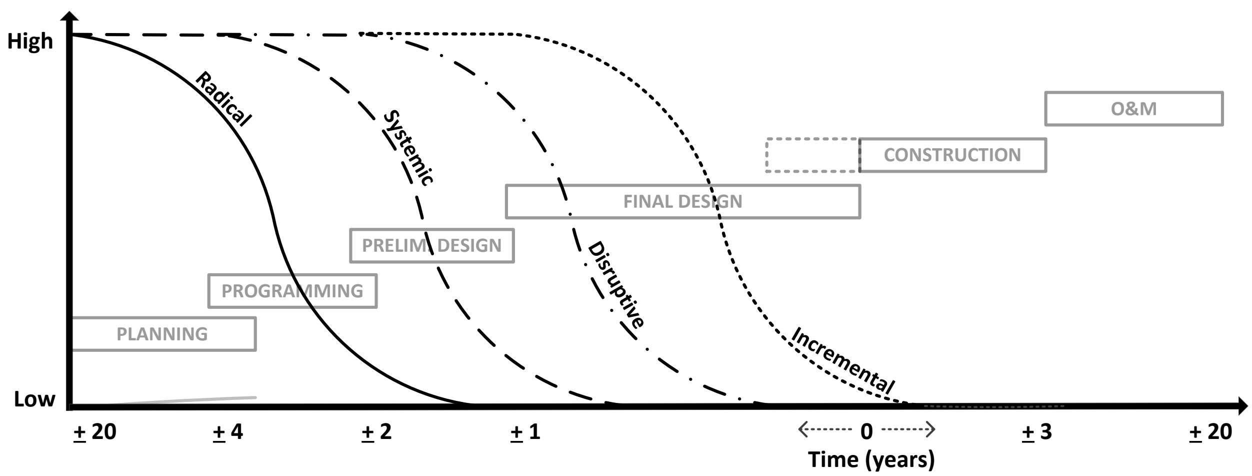


Figure 3-5: The Ability to Perform Life Cycle Design Innovations throughout the Project Development Process

Figure 5 depicts a conceptual model of the opportunity to incorporate life cycle design innovations throughout a project’s development process timeline. Based on this three-case comparative case study, we posit that a P3 concessionaire’s ability to perform systemic, or higher-level life cycle design innovations, has to happen prior to the conclusion of the preliminary design phase of a project. “We had already established the parameters, and we had already established the design for half the project. So you really then limit the flexibility you have and the design of the remainder of the project” commented one of the project sponsor’s for the Presidio Parkway, “you don’t have the flexibility you would if you get the whole project using a P3, then the design-build entity would have more flexibility as to what it is they could build” he added. Again, this response reinforces how contract timing enhances or inhibits the ability to perform life cycle design innovations of different magnitudes, depending on the design stage upon which the project is transferred to the private sector.

As shown through the identified examples, the level of design constrains the ability to realize certain levels of innovation regardless of the inherent project type and complexity. If the level of design, or predetermined parameters, are more defined for certain project components, the flexibility to make or propose design changes is then limited. All levels of innovation are possible across a tunnel or highway project, however, the ability to realize different levels of innovation is constrained by the level of design definition provided by the agency at the time the P3 concessionaire becomes contractually involved.

Conclusion

A comparative case study approach of three on-going DBFOM-type of highway P3s was conducted to explore how contract timing influences the ability of P3 concessionaires to propose and implement life cycle design innovations in P3 projects. Through an in-depth analysis of interviews and project documents, this research identified and classified life cycle design innovations and then showed when and how the P3 concessionaires were able to perform life cycle design innovations based upon contract timing.

The contributions from this study are two-fold. From a *theoretical perspective*, this study contributes to the body of knowledge that addresses innovation and how P3s enhance the long-term life cycle performance of projects. There have been a limited number of studies that address technologically-oriented innovations and that analyze if P3s enhance innovative behavior in such projects. In addition to this, this study focused on innovations that strategically sought benefits or improvements for the long-term life cycle performance of projects (i.e., life cycle design innovations), something that had not previously been studied. The life cycle design innovations were then classified through an 'innovative lens' as radical, systemic, disruptive, or incremental life cycle design innovations. In Figure 5, we provide a conceptual model that illustrates how the perceived private sector's ability to perform more 'radical' life cycle design innovations increases the earlier the partner is brought into a project. More specifically, the ability to perform different levels of life cycle design innovations across a highway project's development process is depicted.

From a *practical standpoint*, this concept can be extended to future P3 projects. State agencies can consider the amount of innovation that a potential project can deliver given its stage along the project development process. The level of design completed when a P3 concessionaire is brought into the project, the contract timing, is defined to some extent whether it is intentional or not. Furthermore, individual project components require to be more defined than others (i.e. a road component vs. a tunnel component). However, given the purported potential for innovation typically attributed to *all* P3s, it is worth noting how this potential can be limited, or improved, when innovation is a chief project objective for pursuing a project as a P3 in the first place. This potential is affected when its contract timing is conceptualized as early as in the planning phase, or as late as in the final design phase along the project development process.

This study provides an extension to the existing literature and lays a more solid foundation for future studies addressing innovation in highway P3s. The eminent growth of P3s in the US will offer more opportunities to identify if the realization of private sector innovation, being a chief claimed P3 benefit, continues to be largely unrealized and why. Possible future research could develop and formalize processes that improve the alignment between public sector expectations and the level of innovation allowed within P3s. Other key factors that can influence the level of innovation achieved, such as competition, could also be studied in depth. For example, in the project that exhibited the most radical design innovations in this study, the Elizabeth River Tunnel project, there was no competition in the procurement process.

As with any research, this study has limitations. First, as noted earlier, there are a limited number of P3 cases in the design stage, particularly DBFOM projects. Thus, the range of contract timing was limited to the contract timing within the selected cases. We recommend that additional case studies be completed to analyze life cycle design innovations at early stages of a project. For instance, an unsolicited proposal, with no preferred alternative design already selected during the environmental review process, would allow a fourth case study to validate whether radical life cycle design innovations were developed in early design phases to a greater extent. However, the contract timing and classification of life cycle design innovations found in each project agrees with broader concepts in the literature. We would not expect new findings with a fourth case study, but it would provide additional validation.

Acknowledgements

The authors would like to acknowledge and thank all project interviewees, across the three projects studied, who have made themselves available for this study. Their undisrupted attention and willingness to talk with the research team during the data collection period for this project has allowed for such an in depth case study to be possible.

References

AECOM Consult Team. (2007). User Guidebook on Implementing Public- Private Partnerships for Transportation Infrastructure Projects in the United States, Final Report, Work Order 05-002. Washington, D.C.

Anderson, S., and Blaschke, B. (2004). NCHRP Synthesis 331: Statewide Highway Letting Program Management - A Syntheis of Highway Practice. Washington, D.C.

Barlow, J., and Köberle-Gaiser, M. (2008). "The private finance initiative, project form and design innovation." Research Policy, 37(8), 1392–1402.

Bazeley, P., and Jackson, K. (2013). Qualitative Data Analysis with NVivo. SAGE Publications, Inc, London, UK.

Blanc-Brude, F., Goldsmith, H., and Välilä, T. (2009). "A Comparison of Construction Contract Prices for Traditionally Procured Roads and Public–Private Partnerships." Review of Industrial Organization, 35(1-2), 19–40.

BYT Group. (2014). "US 36 Managed Lanes Toll Concession Project - Pre-FC Technical Due Diligence Report (February 18, 2014)." <http://emma.msrb.org>.

CTC. (2009). "Presidio Parkway Public Private Partnership Project Proposal Assessment (May 11, 2010)." California Transportation Commission.

Eaton, D., Akbiyikli, R., and Dickinson, M. (2006). "An evaluation of the stimulants and impediments to innovation within PFI/PPP projects." Construction Innovation: Information, Process, Management, 6(2), 63–67.

Eisenhardt, K. M., and Graebner, M. E. (2007). "Theory Building From Cases: Opportunities and Challenges." Academy of Management Journal, 50(1), 25–32.

Eisenhardt, M. (1989). "Building Theories from Case Study Research." The Academy of Management Review, 14(4), 532–550.

Elizabeth River Crossings LLC. (2008). ERC Conceptual Proposal for the DT/MT/MLK Extensions Project - Sept. 2008.

FHWA. (2007a). "Case Studies of Transportation Public-Private Partnerships around the World," Final Report Work Order 05-002. Washington, D.C.

FHWA. (2007b). "Revised Record of Decision for Route 58/Midtown Tunnel (July 10, 2007)." Federal Highway Administration - Virginia Division.

FHWA. (2013). "Clarifying the Scope of Preliminary Design." Every Day Counts (EDC), <http://www.fhwa.dot.gov/everydaycounts/projects/toolkit/design.cfm> (Jan. 1, 2015).

FHWA. (2015a). “P3 Concessions in the US.” <http://www.fhwa.dot.gov/ipd/p3/resources/p3_concessions_map_newbuild.aspx> (Dec. 10, 2015).

FHWA. (2015b). “Estimated Time Required to Complete the NEPA Process.” <https://www.environment.fhwa.dot.gov/strmlng/nepatime.asp#graph> (Oct. 15, 2015).

Fitzgerald, P. (2004). “Review of Partnerships Victoria Provided Infrastructure.” Growth Solutions Group, Melbourne, Australia.

Freeman, C., and Soete, L. (1997). The Economics of Industrial Innovation. MIT Press.

Gambatese, J. a., and Hallowell, M. (2011). “Enabling and measuring innovation in the construction industry.” Construction Management and Economics, 29(6), 553–567.

Garvin, M. J. (2003). “Role of project delivery systems in infrastructure improvement.” Construction Research Congress 2003, 1–8.

Garvin, M. J., and Bosso, D. (2008). “Assessing the Effectiveness of Infrastructure Public-Private Partnership Programs and Projects.” Public Works Management & Policy, 13(2), 162–178.

Golden Link Concessionaires. (2011). “Golden Link Concessionaire’s Technical Proposal: Preliminary Master Design Submittal (dated January 2011) - Comprehensive P3 Agreement, Volume 2, Section 2.”

Grimsey, D., and Lewis, M. (2007). Public private partnerships: The worldwide revolution in infrastructure provision and project finance. Edward Elgar Publishing Limited.

Grimsey, D., and Lewis, M. K. (2005). “Are Public Private Partnerships value for money? Evaluating alternative approaches and comparing academic and practitioner views.” Accounting Forum, 29(2005), 345–378.

Henderson, R. M., and Clark, K. B. (1990). “Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms.” Administrative Science Quarterly, 35(1), 9–30.

LAO. (2012). “Maximizing State Benefits From Public-Private Partnerships (November 8, 2012).” Legislative Analyst’s Office, Sacramento, CA.

Leiringer, R. (2006). “Technological innovation in the context of PPPs: incentives, opportunities and actions.” Construction Management and Economics, 24(March 2006), 301–308.

Ma, J., Chen, A., and He, J. (2009). “General framework for bridge life cycle design.” Frontiers of Architecture and Civil Engineering in China, 3(1), 50–56.

Nyx Hemera News Release. (2015). “Intelligent Lighting to Reduce Costs (June 10, 2015).” TunnelTalk.com, <http://tunneltalk.com/USA-22May2015-San-Francisco-Presidio-Parkway-final-preparations.php>.

OECD. (2005). Oslo manual: Guidelines for collecting and interpreting innovation data. Oslo Manual, Organisation for Economic Co-operation and Development.

Parsons Brinckerhoff. (2013). Federal Environmental Compliance for Projects Utilizing Alternative Funding Models and Transportation Officials - NCHRP Project 25-25, Task 81 (October 2013).

Parsons Brinckerhoff, Nossaman LLP, and HS Public Affairs. (2015). The Effect of Public-Private Partnerships and Non-Traditional Procurement Processes on Highway Planning, Environmental Review, and Collaborative Decision Making (SHRP 2 Report S2-C12-RW-1). Washington, D.C.

Paulson, B. (1976). "Designing to reduce construction costs." Journal of the Construction Division, ASCE, 102(4), 587–592.

Plenary Roads Denver. (2014). "Plenary Roads Denver Work Proposal for the US 36 Managed Lanes Project (Dated February 25, 2014) - US-36 Managed Lanes Concession Agreement, Schedule 7."

PW Financing. (2015). "Public Works Financing - Volume 306, July-August 2015." Public Works Financing, 306.

Rangel, T., and Galende, J. (2010). "Innovation in public–private partnerships (PPPs): the Spanish case of highway concessions." Public Money & Management, 30(1), 49–54.

Russell, A. D., Tawiah, P. A., and De Zoysa, S. (2006). "Project innovation - a function of procurement mode?" Canadian Journal of Civil Engineering, 33(12), 1519–1537.

Sarja, A. (2002). Integrated Life Cycle Design of Structures. Spon Press - Taylor & Francis Group, London, UK.

Sheffer, D. A., and Levitt, R. E. (2010). "How Industry Structure Retards Diffusion of Innovations in Construction : Challenges and Opportunities." Engineering Project Organizations Conference 2010, South Lake Tahoe, CA.

Slaughter, E. S. (1998). "Models of Construction Innovation." Journal of Construction Engineering and Management, ASCE, 124(3), 226–231.

Slaughter, E. S. (2000). "Implementation of construction innovations." Building Research & Information, 28(1), 2–17.

Tawiah, P. a., and Russell, A. D. (2008). "Assessing Infrastructure Project Innovation Potential as a Function of Procurement Mode." Journal of Management in Engineering, 24(3), 173–186.

Taylor, J., Dossick, C., and Garvin, M. J. (2011). "Meeting the burden of proof with case-study research." Journal of Construction Engineering and Management, ASCE, 137(4), 303–311.

Taylor, J. E., and Levitt, R. E. (2004). "Understanding and managing systemic innovation in project-based industries." Innovations: Project Management Research, D. I. Cleland, D. P. Slevin, and J. K. Pinto, eds., Project Management Institute, Newton Square, PA, 83–99.

VDOT Technical Requirements. (2011). Final Design Criteria for the New Midtown Tunnel - Prepared by PB Americas, Inc (October 21, 2011).

Yin, R. K. (2003). Applications of Case Study Research. Sage Publications, Inc, Thousand Oaks, California.

Yin, R. K. (2009). Case study research: Design and methods. Sage Publications, Inc, Thousand Oaks, California.

CHAPTER 4: The Influence of P3 Organizational Structures on Life Cycle Design Decision-Making: A Comparative Case Study of Highway Projects in the US

Abstract

Organizational structures in Public Private Partnerships (P3s) have the potential to decrease fragmentation and increase collaboration between the key project team stakeholders across a project's life cycle phases. This, in turn, can also enhance the realization of improved life cycle design. In this study, the organizational structure of three recent P3s implemented in the US during their design-build stage is explored by focusing on how the established organizational structures may influence the life cycle design decision-making process of each respective project, and comparing across the projects. Interviews with key project team members, along with project documentation, were analyzed to explore the life cycle design decision-making process in each of these projects. The empirical findings demonstrate how increased integration can result in an improved life cycle design decision-making process. However, each project's unique context and constraints may cause actual project integration to be less than what is intended. As a consequence, this diminishes the opportunities for integration that are perceived to be of extreme importance to the life cycle design process, particularly in being able to incorporate a more 'iterative' and 'over-the-shoulder' design process. This design process is facilitated by the organizational structure established in P3s. Effective implementation of key mechanisms of coordination, such as a single point of contact and downstream team member over-the-shoulder design reviews, enable improvement of life cycle design processes.

Introduction

Over the last two decades, the use of public-private partnerships (P3s) to deliver transportation facilities across the US has increased substantially. As of June 2015, half of the 22 existing transportation design-build-finance-operate-maintain (DBFOM) transactions were awarded between 2011 and 2015 alone (FHWA 2015a; PW Financing 2015). P3s allow greater private sector participation in the delivery and financing of transportation projects (FHWA 2013a). Garvin and Bosso (2008) define P3s as projects where mutual benefits are sought between the public and private sector, and where ultimately the private sector provides management and operating services and puts private finance at risk. In the US, the P3 contractual structures most commonly implemented are DBFOM contracts.

The ability to use private financing and to accelerate the completion of large and complex projects, on time and on budget, are often the most cited benefits of P3s (Deloitte Research 2007). Given the increasing infrastructure funding crisis in the US, P3s are a potential solution to close the increasing gap between transportation infrastructure costs and funding (Buxbaum and Ortiz 2009). P3s, however, are also commonly attributed to improve service and provide a better 'value for money' through appropriate risk transfer, encouraging innovation, greater asset utilization and integrated whole-of-life management (Fitzgerald 2004). One of the reasons that improved value is expected in P3s, in comparison to traditional delivery options, is because of the ability of the private partner to implement cost-saving investments during design and construction, for example, to lower long-term life-cycle costs during the operations and maintenance (O&M) phase of a facility. Life cycle design, therefore, is defined as an approach to optimize long-term project performance beyond initial delivery of a facility that strategically benefits facility operations (see Chapter 3).

By accepting the combined risk for delivery and on-going operations, the private partner is expected to provide integrated solutions, and thus the project as a whole benefits from this increased project integration (Roehrich and Caldwell 2012). At the same time, the private partner's integrated project team is expected to establish contractual and relational governance structures that allow it to function in an integrated manner (Zheng et al. 2008). However, despite the intended organizational approaches, actual practice tends to result in opposing and often contradictory approaches. For example, private project teams may in fact 'disintegrate' project risks when the P3 project is executed, thereby diminishing those opportunities for integration that are perceived to be of extreme importance.

In this study, we explored the organizational structure of three recent P3s implemented in the US during their design-build stage (the Presidio Parkway, US-36 Managed Lanes, and Elizabeth River Tunnel projects). We interviewed the principal project team members involved in the project, including the P3 concessionaire, the design-builder, the designer, and the O&M contractor, along with the public sponsor's key personnel. We collected and analyzed project documentation that supports each project's intended organizational approach to increase integration, and actual implementation, and have analyzed it to show how organizational structures influence the life cycle design decision-making process in P3s. Through a comparative case study, the private partners' organizational structure in P3s illustrates how project team integration and the allocation of risk have been handled in each project. The empirical findings from this study demonstrate how project teams may disintegrate project risks when executing a P3 project. As a consequence, this diminishes the opportunities for integration that are perceived to be of importance to the P3 process, thereby affecting the life cycle design decision-making process.

Background

Public Private Partnerships Delivery Strategy

A project delivery method can be defined as "a process by which a project is comprehensively designed and constructed for an owner and includes project scope definition (concept and feasibility); *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" (Touran et al. 2009 p. 4). In the transportation sector, projects in the US have been dominated by the 'traditional' engineering and construction delivery method, the design-bid-build (DBB) approach. Over the past two decades, the US has experienced a shift to the implementation of more 'integrated' and 'flexible' delivery approaches, such as design-build (DB) and P3 arrangements.

Changing project delivery approaches affects how a project's organizational structure functions in a project. Risks typically allocated to the public sector are reallocated to the private sector in P3s and this changes the dynamics of how, and when, project team members become more engaged and collaborate with each other. A project's life cycle risk is one of the major risks that is reallocated in P3s. The manner in which the major project risks are structured in contracts determines the project delivery strategy that the public owner will implement (Miller and Gerber 2012; Miller et al. 2000). These strategies may be categorized by the 'bundling' of a) the procurement of the services needed to design and build a facility initially, and b) the service provision of the facility. These two phases, the initial delivery and the O&M phase, make up the relative life cycle risk responsibility shifted to a private partner in P3s. As Grout (1997) and Hart (2003) argue, under a P3 approach the private sector is encouraged to introduce cost-reducing changes (design decisions) when the responsibility for the quality of well-specified service provision remains with the private partner.

When design, construction, O&M, and financing are combined, the project delivery strategy has transferred the full life cycle responsibility of a project to a private party by contract. When the private sector is responsible for the on-going long-term operations of a facility, and its performance affects a private party directly, this incentivizes the private sector to think strategically in how design decisions may affect the long-term life cycle performance of a project (Blanc-Brude et al. 2009). It is expected that the private partner in P3s focuses on a more thorough and strategic life cycle design decision-making process than may be typically carried out in segmented, 'unbundled' project delivery strategies.

Integrated delivery approaches like DBFOM differ substantially from the traditional delivery approach. The traditional approach solidified the degree of fragmentation, and thus separation, among project team members (Sheffer and Levitt 2012). Horizontal fragmentation, the fragmentation between disciplines, occurs through the trade-by-trade competitive bidding environment of traditional delivery, which tends to result in decision-making that is beneficial for individual aspects of a project but may not be from a life cycle perspective (Hall et al. 2014). Vertical fragmentation, the fragmentation between a project's life cycle phases (e.g. fragmentation of design and construction), causes "broken agency" across the value chain in the production of infrastructure facilities. Different decision-makers incur the risks and benefits associated with individual phases in a facility's life cycle, which results in little consideration for life cycle decisions, and "the individual or firm that bears capital costs does not usually bear the full lifecycle operating costs" (Sheffer and Levitt 2010). Public-Private Partnerships create a motivating operational environment, and thus have the potential to decrease fragmentation and increase integration between the main project stakeholders and project phases, which can improve output quality and operational efficiency in projects (Lehtinen 2012).

Organizational Structures

A project's organizational structure includes internal and external stakeholders. Internal stakeholders are described as those entities with a legal contract to the project, whereas external stakeholders are entities with a non-contractual interest in the project (Siering and Svensson 2012). In P3s, internal stakeholders include both the public sponsors and the private concessionaire. However, the role and influence of the public sector is reduced in a P3 (Savas 2006) and the private stakeholders have much closer proximity to, and activity in a project (Siering and Svensson 2012). To simplify and establish the terminology used in this paper, we differentiate between the main internal project stakeholders as public and private stakeholders. Figure 4-1 shows an overview of the typical organizational structure established in a P3.

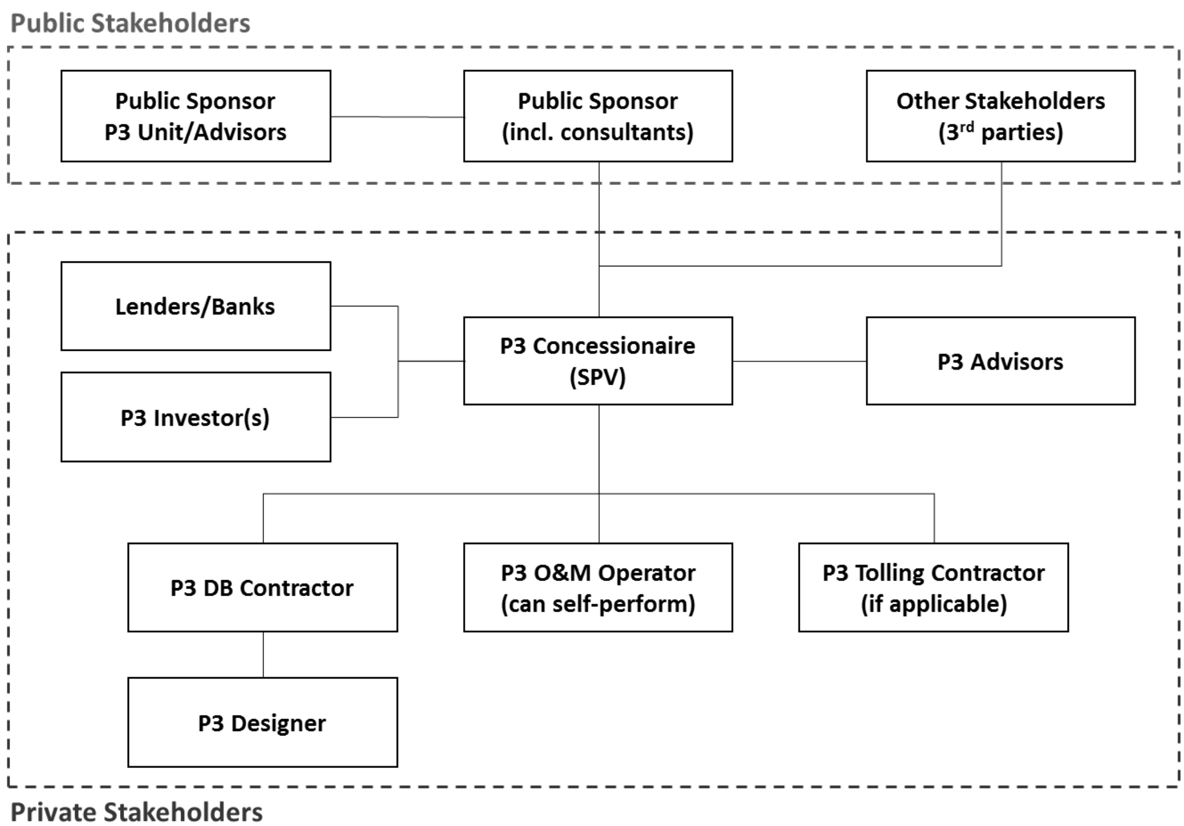


Figure 4-1: Typical P3 Organizational Structure

Public stakeholders are composed of the public sponsors (the client), which may include a specialized 'P3 unit' established to provide support in the management and oversight of P3s, and other third party stakeholders who have a direct stake on the project, such as land owners. Private stakeholders are those individual entities, or companies, that join together to form a team, which we refer to as the 'project team' collectively in this study. The project team is composed of the special purpose vehicle (SPV), typically referred to as the P3 concessionaire, that is established by the P3 investors to facilitate project financing and to act as the central 'hub' in a project team's organizational structure. The SPV is the only entity in the project team that has a contractual relationship with the public stakeholders and with all private stakeholders. Moreover, the SPV is at the center of all contractual and financial matters in a P3 and has, ideally, control over many of the decision-making processes of the project (Yescombe 2007).

When a P3 SPV is formed, this formalizes its organizational structure. The roles and responsibilities of all project team members are defined, dividing the labor and allocating project risks. The hierarchy of the project team, indicating the expected lines of communication within the project team, and the boundaries of the organization are also established. In addition, coordination mechanisms, or formal rules and procedures, with which the project team members are enabled to execute a project and expected to collaborate are also defined (Yescombe 2007).

Life Cycle Design

Project stakeholders have the greatest ability to influence the long-term life cycle performance of a project during the design phase of a project. The concept of how design decision-making influences the long-term cost performance of a project and how the level of control over those costs decreases as the project evolves has been long understood by many industries. The well-known cost influence curve (Paulson 1976), shows how the level of influence that decisions made in the earlier phases of a project's life cycle have a much greater influence on project outcomes, at a minimal fraction of the project's complete life cycle cost. By the time construction is completed, the influence that any decision might have on the remaining life cycle of the project is minimal. Thus, design decisions and changes made earlier in the design process can be optimized to benefit a project's life cycle outcomes, while later design decision-making is limited in what can be changed and to what extent it can be adjusted.

The design process in a DBB, given the fragmented process across the life cycle of a project, is often described as a linear 'waterfall' design process. A linear process limits the input from all key stakeholders during the design decision-making process that could otherwise benefit from all parties involved through the life cycle of a project, as shown in Figure 3. Each phase in a project's life cycle is optimized for the benefit of the enterprise responsible for its (the phase's) activities in a DBB (Thomassen 2011). The process tends to be inflexible, where inflexibility is characterized by frozen outcomes and sequential processes (Royce 1970; Weisert 2003). Ideas and feedback for design decisions flow to downstream activities only, but are not typically fed upstream, as shown in Figure 4-2.

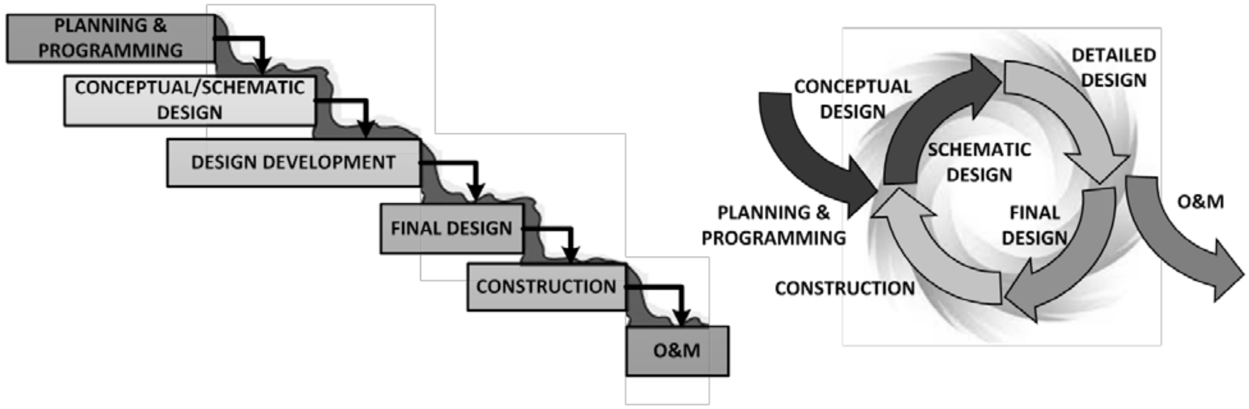


Figure 4-2: A Sequential 'Waterfall' (left) vs. an Iterative 'Whirlpool' Design Process (right)

In alternative project delivery strategies, such as DB, where design and construction are combined, and even more so in fully combined project delivery strategies, such as P3s, control of the design is reallocated from only the engineer to the entire team. Contrary to the linear DBB design process, a P3 design process works in an iterative 'whirlpool' manner, with significant 'over-the-shoulder' design reviews by the P3 concessionaire, the design-build contractor, the O&M operator, financier, and, to some extent, the owner (Hatem and Gary 2013). The ability to have input into the design by project stakeholders typically involved in later phases of the project life cycle, provides the opportunity to better optimize the functionality of the project to improve a project's overall life cycle performance.

For a project team to function in an iterative manner, as described, the proper means of coordination that enable project integration must be in place. Furthermore, the project team must follow-through and implement the intended means of coordination. The flow of information and knowledge, accomplished by organizational and technological means of coordination (Fergusson and Teicholz 1993), is also expected to occur in P3 projects. 'Organizational means of coordination' are a consequence, in part, of a P3's organizational structure established by formal project documents and informal practices that establish these coordination mechanisms. The flow of design information and knowledge is analyzed to determine how this affects a project's life cycle design decision-making process in P3s. The increased integration achieved through a P3 project delivery strategy is expected to improve the life cycle design decision-making process. This is accomplished in a project by enabling project team members that are involved in different phases to collaborate and coordinate. Consistent with Fergusson and Teicholz (1993) and Sheffer and Levitt (2012), project team's must integrate horizontally and vertically; consequently, we define project team integration as the degree to which project team members from separate parent organizations within a project team engage in coordination and collaboration efforts to support the project's goals.

Point of Departure

The combined project delivery strategy of P3s is expected to significantly alter project organizational structures, which, in turn, should increase integration of project team members and thus, improve the life cycle design decision-making processes. There are limited DBFOM highway projects in the US, and thus we conducted an exploratory study of P3 organizational structures in three projects. Previous studies in this area have addressed how P3 organizational structures impact project processes. For instance, in van Marrewijk et al. (2008) the contractual arrangements of two mega-projects that implemented a variation of a P3 contract were explored to determine how such structures supported successful cooperation between key project participants. The researchers found very different levels of integration in these two projects, showing the importance of power relations and project cultures, within each delivery strategy, for project stakeholders' cooperation and integration. For this reason, they recommend that further studies take an "emic or internally-focused, contextually-grounded view of actual practice" to examine how organizational structures function in P3s.

In other studies, researchers have explored how organizational structures have been adopted in the highway and building sector in the UK, and what arrangements increase integration and how they do so (Davies and Salter 2006; Roehrich and Caldwell 2012). These studies indicate that 'vertical disintegration' of project activities and phases still occurs in P3s, with teams proceeding to unbundle and distribute risks internally once the project team takes over. The organizational structure and commensurate project risks and responsibilities therefore do not necessarily create higher levels of integration.

In Chapter 3 we explored the influence of contract timing on the private sector's ability to realize life cycle design innovations. The same three projects were explored. A thorough analysis showed when radical life cycle design innovations can be accomplished in P3s. The study demonstrated how 'radical' life cycle design examples were identified in the Elizabeth River Tunnel project, and 'systemic' examples were identified for both the Elizabeth River Tunnel project and US-36 Managed Lanes project. However, no radical or systemic examples were identified in the Presidio Parkway project, due in part to the timing of the P3 team's involvement. Lower 'incremental' levels of life cycle design innovation examples were identified in all three projects. Through these examples, this study illustrates how the private sector's ability to perform more 'radical' life cycle design innovations increases the earlier the partner is brought into a P3 project, focusing solely on contract timing.

This study builds from prior work and explores how P3 organizational structures affect the life cycle design decision-making process of highway projects, which is hypothesized to allow the private sector to realize an improved life cycle design processes. This study seeks to explore how the organizational structures established in each of the three P3 projects influenced the ability of the project teams to improve life cycle design processes. Therefore, the research question established for this study is: *How do P3 organizational structures influence the life cycle design decision-making process of highway projects?*

Research Approach and Setting

This study has chosen a case study approach as the main research method to gain an in-depth understanding from the perspective of each of the main project stakeholders, represented by key project participants interviewed from each respective stakeholder firm. A case study approach is appropriate for the research question because it requires the exploration of a phenomenon within its real-life context and a contextually-grounded view of actual processes (Yin 2009). Case studies allow CEM researchers to answer questions of how and why, to observe and document causal factors, "and to capture the participant's own observations about how the case in question is similar or different from other projects" (Taylor et al. 2011).

We employed a multiple-case study design (Eisenhardt and Graebner 2007; Eisenhardt 1989; Yin 2009) to analyze three well-known highway P3 projects on-going in the US. We conduct a cross-sectional analysis and conduct an observational snapshot from the design-build stage of each project, supporting our observations and interviews with project documentation. By studying multiple cases, as opposed to a single-case study, the findings and comparative analysis result in a more generalizable discussion that may be extended to other P3 projects, and which may strengthen the reliability of the findings.

Case-Study Setting

The three case study projects studied are the Presidio Parkway project, located in San Francisco, CA, the US-36 Managed Lanes project, located in Denver, CO, and the Elizabeth River Tunnel project located in Norfolk, VA. These three projects were candidates because of they were in the design-build stage at the time of the study. Additionally, the variations in their organizational structures allowed us to explore the research questions. Data was collected on all three projects during the construction stage of the design-build phase, with the design being recently completed or close to being completed. Table 4-1 shows an overview of each project's key characteristics.

Table 4-1: Case Study Projects' Characteristics

Project Name	Presidio Parkway (Phase II)	US-36 Managed Lanes (Phase II)	Elizabeth River Tunnel
Location	San Francisco, CA	Denver-Boulder, CO	Norfolk-Portsmouth, VA
Design-Build Phase	2013 - 2015	2014 - 2016	2012 - 2018
Concession Period	30 Years	50 years	58 Years
Contract Type	DBFOM w/APs	DBFOM w/tolls	DBFOM w/tolls
Contract Value ($M)	$365 (ph.2)	$181 (ph.2)	$2,088
O&M Contractor	Subcontracted	Subcontracted	Self-performed
Project Development Idiosyncrasies	The P3 is a sequential phase of the project (phase II) that continues the work completed under a Design-Bid-Build contract (phase I). The O&M contractor was contracted after the project was awarded. Per the Concessionaire's proposal, the organizational structure noted O&M to be self-performed.	The P3 is a sequential phase of the project (phase II) that continues the work completed under a Design-Build (phase I). The Design-Build contractor is the same team that participated in phase I, and transitioned into Phase II as part of the winning consortium for the P3 phase.	This project received only one proposal during the conceptual phase of the project. The sole-proposer carried out a Pre-Development Agreement phase prior to the development of the formal P3 Contract Agreement. The P3 concessionaire established its own O&M staff to self-perform.

Data Collection

This case study employed two main sources of information. To gather a more in-depth understanding of actual managerial approaches and perspectives, key project participants were strategically targeted from all of the main project organizations involved during the design-build phase of each of the three projects. In addition to interviews, we collected primary and secondary project documentation.

Interviews

We conducted semi-structured interviews with key decision-makers in each respective project. These participants were selected based upon their organizational role within each of their respective organizations, which included the P3 concessionaire, the design-builder, the designer, and the O&M contractor, and the public sponsor's key personnel. In addition to this, the participants selected demonstrated an intimate knowledge of the project's organizational structure, management structure, technical aspects, and life cycle design decision-making. We ensured that similar interviewee perspectives were obtained on all three projects, as shown in Table 4-2, to complete a comparative analysis across projects.

Table 4-2: Case Study Interview Perspectives Covered

Interviewee	Presidio Parkway	US-36 Managed Lanes	Elizabeth River Tunnel
Private Stakeholders			
P3 Concessionaire	√	√	√
P3 DB Contractor	√	√	√
P3 Designer	√	√	√
P3 O&M Operator	√	√	√[1]
Public Stakeholders[2]			
Project Sponsor Project Manager	√	√	√
Project Sponsor Construction Manager	√	√	√
Project Sponsor Design Manager	√	√	√
Project Sponsor P3 Unit/Advisor	√	√	√
3rd Party Stakeholder	√[3]	X	X

Notes: √ = Covered; X = Not Covered
1. The P3 Concessionaire for the Elizabeth River Tunnel project self-performs O&M.
2. Public Stakeholders includes consultants acting as or representing the roles shown.
3. The Presidio Trust for the Presidio Parkway Project was the only 3rd party stakeholder interviewed.

A total of 34 interviews were conducted, including single person (N=28) and two-person interviews (N=6), for a total of 40 interviewee perspectives. Each interview lasted, on average, 45 minutes to one-hour long. In the Presidio Parkway project, a significant amount of time was spent on-site, which allowed us to interview 14 public stakeholders, and 5 private stakeholders. For the US-36 project, we interviewed 6 public stakeholders, and 5 private stakeholders, and for the Elizabeth River Tunnel project, we were able to interview 6 public stakeholders, and 4 private stakeholders. A standard interview protocol was developed, with which the interviewees were asked open-ended questions, in a semi-structured manner, allowing for the interviewees to provide as much depth on specific topics as possible, while staying within the topics of interest (Oppenheim 1992; Spradley 1979).

Project Documentation

This study draws heavily from project documentation to be able to interpret the differences or similarities between the managerial approaches and organizational structures, discussed through the interviews and the intended approaches established in the project documents. There are primary documents that provide direct or firsthand evidence about each respective project, such as the project procurement documentation, original proposals, contract agreements, project requirements, and public and private project management plans. Secondary documents were also collected, which typically discuss, interpret, or comment upon the project, such as articles in newspapers and websites, or articles found in scholarly journals that discuss or evaluate the projects. For each of the three projects, the primary documentation was collected to the greatest extent possible either being on-site or from online sources. Table 4-3 summarizes the primary types of project documentation that was collected for each of the projects.

Table 4-3. Primary Project Documentation Collected

Document Type	Presidio Parkway	US-36 Managed Lanes	Elizabeth River Tunnel
Procurement Documents			
Request for Proposal	√	√	√[1]
P3 Concessionaire's Proposals			
Financial Proposal[2]	√	√	√[3]
Technical Proposal[2]	√	√	√[3]
- Subsection: Design & Construction	√	√	√
- Subsection: O&M / Service	√	√	√
- Subsection: Mgmt. / Organization	√	√	√
Pre-development Agreement (PDA)			
Interim Agreement	X (n/a)	X (n/a)	√[4]
Project Agreements			
P3 Concessionaire Agreement (CA)	√	√	√
P3 Design-Build Contract	√	√	√
P3 O&M Agreement	√	√	X (n/a)
P3 Tolling Services Agreement	X (n/a)	√	√
Interface Agreements	√	√	√
Project Technical Requirements			
Project Management Requirements	√	√	√
Design and Construction Requirements	√	√	√
O&M / Handback Requirements	√	√	√
Tolling Requirements	X (n/a)	√	√
Project Management Plan (PMP)			
FHWA-required Project Sponsor PMP for Major Projects[5]	√	√	√
Environmental Documentation and Others			
NEPA-related Documentation	√	√	√
Value For Money Studies	√	√	X (n/a)[6]

Notes: √ = Obtained; X = Not Obtained

1. VDOT released a Solicitation for Conceptual Proposal.
2. Original proposal sections indicated for the Presidio Parkway and US-36 projects are available in each respective project agreement's appendices/schedules.
3. For the ERT project, there is a single and comprehensive proposal with each respective section noted.
4. An 'Interim Agreement' phase was part of the ERT project prior to the development of the formal P3 Contract Agreement.
5. These PMPs reflect each respective state DOT's project management approach – this is different than the P3 Concessionaire's internal PMP.
6. No value for money or related project delivery evaluation was conducted for the ERT project (Regimbal 2012).

For the secondary project documentation, the sources that are referenced in the discussion are provided in the references of this paper, from which further information may be obtained. The number of project documents for each of the projects was substantial, and helps to provide different perspectives on some of the findings, that either complement or contradict what was identified.

Data Analysis

A qualitative analysis software, QSR Nvivo (Bazeley and Jackson 2013), was implemented to organize and analyze all the data collected. The 34 interviews were audio recorded and transcribed, with over 31 hours in recorded audio, resulting in approximately 400 pages of transcribed text. The transcribed interviews, along with the project documentation selected for analysis, was then systematically coded. The coding process that was implemented in this study was guided by the recommended approaches in Miles et al. (2013) and Saldaña (2009). As part of the multiple-case study design, a within-case analysis was first performed on the three projects to gather and provide an internal understanding of each project's unique setting and longitudinal development. Second, a cross-case analysis was performed to develop and provide an explanation of the identified themes across the three projects. This deepened the understanding and explanation of the findings.

Empirical Findings

The emperical findings illustrate how a P3 organizational structure influences the life cycle design decision-making process in each project. We provide a discussion of each project's formation, a snapshot of the longitudinal development upon which specific roles and the level organizational involvement within each project team begins to occur. Next, we develop a cross-case comparison of the three projects. We discuss integration, or mechanisms of coordination within each P3 project, during the delivery of each project, including how those mechanisms were *intended to be implemented* and whether or not they were realized and enforced. We use responses from the interviews, as well as project documentation, to identify realized project integration. We then provide an overview of how each project's intended life cycle design decision-making process was *actually implemented*, and whether this influenced how a holistic life cycle risk perspective was captured. Finally, we provide an in-depth discussion of how P3 organizational structures influence life-cycle design decision-making based on these findings.

Organizational Structures Formation

The three projects had similar organizational structures, with small variations in the number of project team members and stakeholders. All project teams had at least seven main organizations. Table 4-4 shows a breakdown of the three project teams, illustrating the different organizations.

Table 4-4: P3 Project Team Organizational Structures' Breakdown

Private Partner Role	Presidio Parkway	US-36 Managed Lanes	Elizabeth River Tunnel
P3 Concessionaire (SPV)	P3 Concessionaire	P3 Concessionaire	P3 Concessionaire / O&M Operator
P3 Investor(s)	P3 Investor 1 (50% share) P3 Investor 2 (50% share)	P3 Investor	P3 Investor 1 (50% share) P3 Investor 2 (50% share)
P3 Design-Build Contractor(s)	P3 DB Contractor 1 (50%) P3 DB Contractor 2 (50%)	P3 DB Contractor 1 (50%) P3 DB Contractor 2 (50%)	P3 DB Contractor 1 (45%) P3 DB Contractor 2 (40%) P3 DB Contractor 3 (15%)
P3 Lead Designer	P3 Designer	P3 Designer	P3 Designer
P3 O&M Operator	P3 O&M Operator	P3 O&M Operator	N/A[1]
P3 Tolling Contractor	N/A[2]	Tolling Contractor (Public Agency)	Tolling Contractor (Private Agency)

Notes:
1. The P3 Concessionaire self-performs O&M for ERT project.
2. The Presidio Parkway project does not require tolling as it is an availability payment P3.

In the project proposals submitted for procurement, all the project teams indicate that the P3 investors' level of activity and involvement would be extensive from the 'front-end' through commercial and financial close. The US-36 project team's proposal, for example, indicated that they will actively manage the project delivery, from design and construction through the entire O&M phase. In the Presidio Parkway project, it is also indicated that the P3 investors lead the developer's management team. Subsequently, it is noted that once the preferred proposer is selected, the P3 investors *ensure* successful commercial and financial close. For these two projects, this shows the considerable level of P3 investor involvement up to the beginning of the delivery, when design and construction begins. "The people that are charged with winning the project are concerned with 'present dollars' and *really don't have a big concern for life cycle cost* because it is going to be a different group that has to maintain it," commented one interviewee when discussing the typical role of P3 investors in P3 projects. Key decision-makers, the P3 investors, who develop and propose defining life cycle design decisions upfront during the development and bidding stage of a project become less involved during the design-build stage. In the Elizabeth River Tunnel project, a representative of the P3 investors commented how "several of us from the *development* team stuck around for a little bit to build this company," noting that several participants who were involved in the development stage *transitioned* to the delivery of the project to maintain an active and seamless project execution.

The three projects show a similar longitudinal development of the project team organizational structure. In particular, it is noted that the P3 concessionaire actively manages the project delivery, from design and construction through the entire O&M stage. The P3 investors, however, have a specific role during the ‘development’ stage of the project. Their involvement decreases after reaching commercial and financial close. Table 4-5 in the next section shows these intended *P3 Organizational Involvement* processes noted in each proposal.

These observations illustrate the ‘iterative’ over-the-shoulder design process that is *expected* to begin to occur, particularly during the ‘delivery’, or design-build stage of a P3 project. The Elizabeth River Tunnel project, for example, has maintained continuity during formation of their organizational structure, as discussed by one of the interviewees. When early life cycle design decisions are made, prior to a project’s design-build stage, key project team participant can make or commit to substantial life cycle design decisions, such as the design decision to build an immersed concrete tunnel as opposed to a steel tunnel, for the Elizabeth River Tunnel project. If those decision-makers are not continuously involved throughout the delivery, and more importantly, when the design begins to evolve, the design process becomes a sequential process in this transition, despite the aforementioned ‘iterative’ approach expected in P3s.

Table 4-5: Intended P3 Organizational Approaches – Project Documentation Evidence

Project	P3 Organizational Involvement	P3 Integration Approach	P3 Project Contractual Language
Presidio Parkway Project	*"[The P3 investor] will coordinate the financing for the project using a number of advisors, lenders and equity investors, …[the P3 concessionaire] will actively manage the project delivery, from design and construction through the entire operations period."* **(Concessionaire's Proposal, Presidio Parkway Project)**	*"[The concessionaire] will establish task forces during the design process. These task forces will include Department staff; [concessionaire] team members, including designers, field constructors, and O&M personnel; and third party stakeholders as needed... An important function of the task forces is to review assets with respect to lifecycle expectations to ensure optimization of Project components and integration during design development."* **(Concessionaire's Proposal, Presidio Parkway Project)**	*"Concessionaire and Constructor agree to cooperate and effectively administer the interaction between the DB Work and the O&M Work in a manner that minimizes conflicts and effectively facilitates in a coordinated manner the construction and operation of the Project."* **(Design-Build Executed Agreement dated 01-03-2011 for the Presidio Parkway Project, Section 5.9.1)**
US-36 Managed Lanes Project	*"[The P3 investors] will lead the developer's management team, they have overall responsibility for the management of the development process. Once the preferred proposer is selected, the P3 investors will maintain regular contact to ensure successful Commercial and Financial Close."* **(Concessionaire's Proposal, US-36 Managed Lanes Project)**	*"During the design-build period, the [concessionaire's] Project Manager, will have full authority over and responsibility for the Project. He will be the concessionaire's primary contact with [the public sponsors], will oversee all Project operations and make final decisions regarding all administrative, technical and contractual matters. His responsibilities include coordinating and integrating the work of the design-build team and the O&M team. Once construction is complete, the project manager role will transition to the [concessionaire's] O&M Project Manager. He will be [the department's] primary point of contact, and have authority to make decisions for the Concessionaire during the O&M period."* **(Concessionaire's Proposal, US-36 Managed Lanes Project)**	*"Task Force Meetings - At a minimum, the Concessionaire shall conduct task force meetings for the following disciplines to facilitate "over the shoulder" review of the design: 1. Drainage; 2. Roadway; 3. Structures; 4. Traffic/ITS/tolling; 5. Utilities; 6. Environmental; 7. Public involvement"* **(Concession Agreement between HPTE and Plenary Roads Denver LLC dated 02-25-2014, Schedule 5, Section 2.1.4.1)**
Elizabeth River Tunnel Project	*"Key principles of [the P3 investors]'s approach to project governance will be: […] flat organizational structures to enable the swift passage of information for timely decision-making;[…] clearly mapped processes and assignment of responsibilities against key business drivers; and effective transfer of knowledge and information between project stages in order to assure continuity."* **(Concessionaire's Proposal, Elizabeth River Tunnel Project)**	*"Joint methods of working include: formal Kick-Off meetings for each stage; a central Project vision and strategy; autonomous teams for each function where decisions are made by those who are closest to the action… transparency of information sharing ("open book") that builds trust and which is based on "fact not opinion";… direct lines of communication to provide timely decision- making and that work point-to-point, across functional boundaries; co-location at the project and operational site."* **(Concessionaire's Proposal, Elizabeth River Tunnel Project)**	*"Coordination with Concessionaire Contractors. The DB Contractor shall permit Concessionaire Contractors to introduce and store materials on the Project Right of Way and perform their services. The DB Contractor shall cooperate with the Concessionaire and Concessionaire Contractors (including the Tolling Contractor in accordance with the Interface Agreement) to coordinate the DB Work with the work of Concessionaire Contractors."* **(Design-Build Contract dated 12-05-2011 for the Elizabeth River Tunnel Project, Section 8.12 (b))**

Intended Life Cycle Design Decision-Making Processes

In this section, we make observations centered around the intended line of communication and coordination in each project, and discuss how such mechanisms were enforced. The three projects implemented strategic mechanisms to increase this integration during the delivery stage. In this study we have identified coordination mechanisms that were noted to be the most important for the projects studied, and that were described in the project teams' proposals. These coordination mechanisms were noted when integration or collaboration was discussed during the interviews. We focus on how integration was intended to be achieved and whether it was present during the project.

In the three case studies, the P3 concessionaires specify the expected level and amount of effort for team member collaboration. For example, in the Presidio Parkway's concessionaire's proposal, the concessionaire specifies that the approach to review the life cycle 'expectations' of the project is through the implementation of *task forces*. The project sponsors and the concessionaire team members, which includes "designers, field constructors, and O&M personnel", along with third party stakeholders are expected to participate in these task forces (see intended *P3 Integration Approach* in Table 4-5).

When questioned regarding this approach, the Presidio Parkway concessionaire's representative indicated that they were having a greater degree of collaboration, given that coordination mechanisms like the specific task forces noted enabled the project team to make sure they include O&M feedback. The dedicated O&M operator participated in the design review process, so the entity contractually responsible for O&M performance was involved. This involvement is different from what is typically done in traditional DBB design processes. At the same time, one of the project sponsor's representative shared their view on this (see Table 4-6) indicating that it did not appear that the concessionaire was managing the project in an integrated manner, but rather appeared to be a 'pass-through' of the risks to each respective subcontractor (the design-builder and O&M operator).

The US-36 P3 concessionaire also made a similar comment, indicating how rare it was to include the O&M perspective in the design review processes in DBB delivery. One of the US-36 project sponsor's project managers commented that the P3 concessionaire had been more 'hands off' than what was expected from them, commenting on the single point or contact expected from the concessionaire. The concessionaire for this same project emphasized that one of the key elements to ensure an effective management and communication process was having a *single point of contact* established, as shown in their proposal (see Table 4-6). The US-36 concessionaire commented that "in this circumstance, it is like a design-build project *layered* in with additional management that the P3 provides. So we follow all that functionality of the design-build process and fundamentally, the difference is that in a traditional design-build, [the design-build contractor] would send their approval directly to [the project sponsors]. Here, it runs through [the concessionaire] and we pull in [the O&M operator] and make sure that we are all on board before it goes to [the project sponsors].” This comment demonstrates that additional level of coordination and line of communication that a P3 adds. However, as noted by the design-builder, in reality it was more practical for the design-builder to communicate directly with the project sponsor and request the P3 concessionaire’s input when needed.In the Elizabeth River Tunnel, one of the project sponsor’s construction managers commented that the project was a ‘team effort’ that had brought together the main players involved in this project during the early design development process (see Table 4-6). This interviewee also noted how the technical requirements were a product of collaboration with the concessionaire, who is also self-performing O&M, along with other project team members. When asked about the level of integration that was achieved, the concessionaire’s representative commented that the primary design team was *co-located*, and noted that co-location was an important mechanism to increase integration (see Table 4-6). In this project’s proposal, several methods to achieve collaboration among the project team members were indicated to be implemented, including transparency, and direct lines of communication, among others, to increase integration in the delivery of the project. The Presidio Parkway and US-36 also had all their key project team members co-located throughout the delivery of the project.

The project teams specify their intended approaches in their project proposals submitted, and this is typically amended to the contracts drafted for the projects. Table 4-5 shows the contractual language for each of the three projects, indicating means to increase and ensure cooperation and coordination among the project team members. While some of the language was found directly in the Design-Build contract agreements for the Presidio Parkway and the Elizabeth River Tunnel for example, the US-36 project had more direct language in the main concession agreement between the project sponsor and the P3 concessionaire. The contracts for the concessionaire, the design-build contractor, and the O&M operator formalize the coordination mechanisms from the proposals. In addition, the original proposals are appended to the contracts reinforcing the intention of the parties regarding utilization of coordination mechanisms.

Table 4-6: Interviewee Responses on Actual Processes and Issues Encountered

Project	Project Sponsors' Responses	P3 Concessionaires' Responses	Design-Builders' Responses
Presidio Parkway Project	*"I don't see any evidence that the [concessionaire] has any interest in the actual construction or operations of the project. It appears that [the concessionaire] has essentially done 100% transparent pass-through of the construction and design features of the P3 agreement to the Design Build Joint Venture, and same thing with O&M"* ***- Project Sponsor PM***	*"Perhaps we are having a greater degree of coordination between our design builders and our O&M team than you might find in a typical Caltrans project for example. [State agencies] are operated 'in silo', [where] the construction and design folks don't interact all that much with the O&M people, [and] there may not always be a great sharing of information, and design and construction gearing their activities towards the need of [the] O&M people."* ***– P3 Concessionaire***	*"Even though this was a P3 project, their design staff which reviews all of the Phase II designs, they sort of behave as if in the same way that they would on a design-bid-build project, they are still very prescriptive about how something should look and how it should be designed." -* ***Design-Builder***
US-36 Managed Lanes	*"We thought they would be more involved in decision-making for [the project]… they attend the meetings and such but there is very little direction from the [concessionaire] now to the [design-build contractor]."* ***- Project Sponsor CM***	*"If this project was a traditional delivery with [with the project sponsors], very rarely do the maintenance guys have a place at the table during design."* ***- P3 Concessionaire***	*"From a contractual point of view, we should probably be communicating more with the concessionaire and letting them coordinate with the owner. But, in practice, it really went a lot like Phase I. There have been a few occasions where I have taken issues to the concessionaire and let [them] communicate those to the owner, but a lot of this has really gone, even though it isn't set up that way, directly between us and [the project sponsors], and [the concessionaire] has just stood on the sidelines."* ***- Design-Builder***
Elizabeth River Tunnel	*"It was a team effort between the design-build contractor, the current Engineer of Record, the concessionaire, and the project sponsors, so there was a large group of people that finalized the technical requirements."* ***- Project Sponsor CM***	*"That is where you can really get into the 'over-the-shoulder' [design], you can go talk to the designer or the designer could ask you to come see them if they were having a problem, a constructability problem. So I think it is very important that [the design-build contractor] set it up right, they had their designer leads and a few other backups co-located with them."* ***- P3 Concessionaire***	*"In the discussions, the O&M guys were in the room, so [the concessionaire] was in the room when we were talking to [the project sponsors], and [the designer] and [the design-build contractor], to discuss what the implications were to where they could weigh in… so those discussions were then written into the specifications based on the feelings of [the concessionaire] and [the project sponsors] for longevity concerns."* ***- Design-Builder***

Actual Life Cycle Design Decision-Making Processes

Given the how risk allocation was handled in each project, and more specifically, how life cycle risk responsibility was handled during the delivery of each project, actual life cycle design decision-making processes are found to have performed differently than what was expected. Each project experienced a design decision-making process that may not reflect the ideal 'over-the-shoulder' design review process. This demonstrates how the implementation of key mechanisms identified in the previous section enhance project integration, if implemented properly. Table 4-6 shows sample responses highlighting some key issues that have affected actual life cycle design decision making-processes.

In the Presidio Parkway project, a complex institutional environment was encountered given the ownership of the adjacent national park within the project area. This added a layer of complexity to the project affected how the project team's organizational structure functioned. The main land owners included a third party stakeholder who influenced many project decisions, and disrupted the expected processes. Throughout the interviews, it was stated that this 'additional layer' in the project, meaning the influential third party stakeholder, had caused the concessionaire and the design-build contractor to coordinate at a greater level than what was anticipated.

Although the organizational structure places the concessionaire as the single point of contact to coordinate holistic life cycle risk management during the delivery phase, the interaction with this third party stakeholder caused coordination among the project team members to function differently (see Table 4-6). The allocation of life cycle risk and responsibilities in this project were rather disintegrated, treated in an 'unbundled' manner almost, causing the the predetermined coordination mechanisms to be readjusted. In the case of the Presidio Parkway, the design-build contractor was left to manage the design and construction risks without much input from the concessionaire. Furthermore, in managing the design decision-making process, along with the input and coordination with this influential third party stakeholder, may have inhibited the project's team ability to realize an improved life cycle design process.

The US-36 case also illustrates how actual coordination and lifecycle risk allocation can differ from intended. In this case, the development of the project was phased and the first phase of the project was delivered using a segmented delivery strategy that did not initially include a life cycle risk responsibility. The second phase of the project, in which a P3 organizational structure was established, the design-build contractor from the first phase transitioned into the second phase, as part of the same P3 project team established. As a result, the P3 concessionaire was an 'additional layer' of management introduced for Phase II of the project. Within this P3's organizational structure, it was consequently more beneficial and efficient to let the design-build contractor continue as the principal coordinator with the public project sponsor, while receiving feedback from the new stakeholders, the P3 concessionaire and the O&M operator.

When the design-build contractor was asked to comment on their life cycle input given their role in the project now as a P3 project team, the design-build contractor commented how their perspective is no different than a design-build job. For example, they are only responsible for the delivery and not the life cycle responsibility of the project (see Table 4-6). Similar to the Presidio Parkway project, this shows the same disintegrated approach in the actual delivery of the project, where the design-build contractor is left to deal primarily with the design and construction of the project with minimal input from the P3 concessionaire. It is more effective to have the design-build contractor deal directly with the project sponsors in design decision-making with minimal input from the concessionaire, and the O&M operator. In these two projects, the Presidio Parkway and US-36 projects, the single point of contact responsibility was shifted to the design-build contractor. In the Presidio Parkway project, given the unexpected amount of additional coordination needed with a third party stakeholder to the contract, the intended task forces became obsolete, and the design review process altered any potential for introducing 'over-the-shoulder' design reviews that could modify or propose life cycle design changes in an already constrained design process.

In the Elizabeth River Tunnel, the interviewees described a much more collaborative and integrated project team approach. Individuals from the development phase remained for project delivery. The allocation of the life cycle risk in this project was handled effectively by maintaining the P3 concessionaire as the primary point of contact. In addition, the concessionaire decided to self-perform the O&M responsibility rather than subcontracting for this service. "That is another decision we made pretty earlier on, [to self-perform O&M], and we decided to build up the O&M from the ground up" commented a representative from the concessionaire on this project. The difference in this organizational structure for this project is that inherent responsibility for the long-term O&M performance of the project that the concessionaire takes on. This does not imply that in the other two projects, the ultimate party responsible for O&M performance is not the P3 concessionaire, regardless of self-performing or not. However, the participants described a more centralized and involved concessionaire that was not 'removed' from the design decision-making process, as with the other two projects.

One of the design-builder's representative for the Elizabeth River Tunnel commented (see Table 4-6) that with the concessionaire being the O&M operator in this project, the concessionaire had a significant amount of influence in determining the design approach during the design review process of the project. Furthermore, the concessionaire contributed to the development of the performance specifications of this project also. In this project, that strategic line of communication was present throughout the development of the design, which also included the co-location of all the project team members. Given this, the project was able to capture life cycle design oriented decisions that were 'pushed' by the project team, and the P3 investors who also remained involved during the design process.

Both the Presidio Parkway and US-36 project have shown that the single point of contact was shifted to the design-build contractor, and therefore it has affected their ability to benefit from an integrated approach to enhance the life cycle design decision-making process, as this minimized the holistic and life cycle perspective found in the Elizabeth River Tunnel. Ideally, the P3 concessionaire would have acted as the direct point of contact between the project sponsors and the design-builders, and would have enforced integration to include the O&M operator during the life cycle design optimization. However, in practice, the projects have proceeded to function, in a way, as a traditional design-build project would, where the design-builder coordinates directly with the project sponsors and the P3 concessionaire stayed on the 'sidelines' in this case. The project risks are approached in an unbundled manner within these project teams. In the Elizabeth River Tunnel project, the P3 concessionaire has implemented that strategic line communication and single point of contact effectively, showing an increased integration among the project team members and ensuring that those mechanisms of coordination are enforced.

Discussion of Empirical Findings

The empirical findings show how P3 organizational structures influence the life cycle design decision-making process in P3s. Interestingly, as exhibited in the Elizabeth River Tunnel project, a greater level of integration was accomplished through key mechanisms of coordination being effectively employed. This project has been shown to have accomplished an improved and more integrated life cycle design decision-making process that has allowed key project team members to collaborate and coordinate better, ultimately facilitating a more 'iterative' design process. The P3 concessionaire, who also self-performs the O&M for the project, has been noted to have had an active and continuous role throughout the development and delivery of the project. In comparison, both the Presidio Parkway and US-36 projects have shown a point of discontinuity within their project teams as the projects transitioned from development to delivery. More specifically, key decision-makers involved in that early stage of the project do not continue to participate in the delivery of the project, and this alters the ability to achieve that iterative design process expected in P3s from the beginning. Table 4-7 presents an overview of the main findings discussed.

Table 4-7: Intended vs. Actual Coordination

Main Findings	Presidio Parkway Project	US-36 Managed Lanes Project	Elizabeth River Tunnel Project
Organizational Structure Formation	Early project team members do not maintain a continuous involvement, and iterative design processes do not occur immediately.	Early project team members do not maintain a continuous involvement, and iterative design processes do not occur immediately.	A continuous involvement of key project team members throughout early defining project interfaces, ensuring early iterative design processes.
Intended Life Cycle Design Decision-Making Processes	The implementation of task forces that bring designer, constructor, concessionaire and O&M party together are indicated in their proposal.	A single point of contact is indicated as an important mechanism of coordination in their proposal to enhance integration.	Co-location and a single point of contact, among other mechanisms of coordination are indicated in their proposal to enhance integration.
Actual Life Cycle Design Decision-Making Processes	Third party coordination issues affect actual intended processes. Single point of contact is shifted to the Design-Builder from the P3 concessionaire. Co-location was implemented.	Established coordination and communication channels were more practical. Single point of contact is shifted to the Design-Builder from the P3 concessionaire. Co-location was implemented.	The P3 concessionaire actively participated and implemented that single point of contact. Task forces were found to be extremely collaborative, resulting in project requirements being modified with integrated input. Co-location was implemented.

The second interesting finding that has been discussed is the identification of intended mechanisms of coordination communicated through the proposals submitted. The interviews, along with triangulation to project documentation, also identified these notable mechanisms of coordination expected to be implemented to increase integration in each project. These mechanisms are: establishing a single point of contact with the P3 concessionaire being that key point; the use of task forces for the design review process to enable an over-the-shoulder design process; and co-location of key design leads and project team stakeholders to facilitate communication within the project teams. We show how these intended mechanisms were communicated and enforced through formal project contract documents, and discuss how the actual realization of those mechanisms was viewed through different project team members' perspectives.

Maintaining a single point of contact for the Presidio Parkway and US-36 project has been shown to have functioned differently given each projects' unique context. More specifically, these two projects have indicated to have shifted this responsibility to some extent, in which the design-builder coordinated directly with the project sponsors, while the P3 concessionaires' involvement was reduced. The Elizabeth River Tunnel project exhibited a greater level of integration through the former implementation of these key mechanisms of coordination. All three projects have shown these mechanisms identified in their proposals. However, their effective implementation, as seen through the interviews, is project-specific and can be affected by each project's unique context that can make their implementation impractical, thereby affecting how the life cycle design decision-making process actually performs.

"So you have four, potentially five players now that need to sit around the table and make a decision and look at the calculus of that decision… they all have to understand enough about each other's business and decision-making process that you are making the right decisions for the team, not for your own sake, and that gets pretty challenging when you've got four or five companies with drastically different backgrounds and understanding, and risk profiles," commented a representative from the concessionaire that was interviewed for the US-36 project. The complexity in bringing those "four or five players," to sit around the table to make decisions that support a project's goals, was a common theme that was echoed throughout the interviews. Achieving this intrinsic motivation for all project team members in these projects, who traditionally might operate in a more fragmented and individualistic manner, is a rather complex process that is facilitated through key mechanisms of coordination. Through the increased project team integration that the established organizational structures enforce, the design decision-making process evolves in a more iterative manner, allowing for the opportunity to improve the life cycle design decision-making process.

Conclusion

A comparative case study approach was implemented to study how the typical organizational structure established in P3s influences the life cycle design decision-making process of highway projects. This study identified and demonstrated how increased project team integration that is accomplished through coordination mechanisms can enhance the life cycle design decision-making process in P3s. In the contrary, a reduced, or inefficient project team integration in P3s can result in reduced opportunities for the realization of improved life cycle design decision-making processes.

In the Elizabeth River Tunnel project, the discussions show how the intended mechanisms were enforced and successfully implemented. The Presidio Parkway and US-36 projects were less successful in enforcing and maintaining the intended mechanisms of coordination throughout the project delivery. We make an assertion that, higher levels of life cycle design cannot be solely attributed to the level of integration exhibited in each of these projects.

The theoretical contribution that this study establishes, is through the extension of the growing body of knowledge that is currently focusing on providing a deeper understanding of P3 organizational structures. Although similar in-depth case studies have focused on the exploration of how P3 organizational structures function, none have previously taken an in-depth approach to focus how the life cycle design decision-making process may be influenced. The empirical findings show agreement with Davies and Salter (2006), and Roehrich and Caldwell (2012), in how the private project teams may in fact 'disintegrate' project risks when a P3 project is executed, and how this has diminished the opportunities for integration that are perceived to be of extreme importance to the P3 process.

Furthermore, through the actual experiences of these three cases, there is a practical lesson for both the public sector and private sector to consider how integration is actually a key component in achieving improved life cycle design processes – a notable benefit of P3s in general. The public sector and private sector can benefit from the experiences of these three projects by thinking more strategically through how mechanisms of coordination should be enforced. For example, how other project constraints not anticipated in these projects, such as the third party stakeholder influence and the on-going pre-established lines of communication in a phased project, can limit how effective coordination efforts are, and hence reduce the expected level of integration expected.

The limitations of this multiple case study are noted next. First and foremost, the limited number of P3 cases, particularly DBFOM projects, that were available at the time that this study was conducted greatly limits the number of 'ideal' sample projects that could potentially provide more extreme cases of integration. Second, the ability to participate in observational data collection efforts for the projects would have increased the richness of the discussion provided, complementing many of the findings also. However, we were unable to participate in some of those meetings or exercises where those mechanisms of coordination were expected to be implemented. All projects indicated that it was not appropriate for an outsider to observe and be present in many of these meetings. We recommend that future studies focus on exploring the identified coordination mechanisms, along with others that are not present in this case study, in future P3s. Longitudinal, or longer studies in which the life cycle outcomes can be measured and traced to the level of collaboration and integration in the delivery phase of a project would show some interesting findings to further explore how P3s influence life cycle design processes *and* outcomes.

References

Bazeley, P., and Jackson, K. (2013). Qualitative Data Analysis with NVivo. SAGE Publications, Inc, London, UK.

Blanc-Brude, F., Goldsmith, H., and Välilä, T. (2009). "A Comparison of Construction Contract Prices for Traditionally Procured Roads and Public–Private Partnerships." Review of Industrial Organization, 35(1-2), 19–40.

Buxbaum, J. N., and Ortiz, I. N. (2009). Public-Sector Decision Making for Public-Private Partnerships: A Synthesis of Highway Practice, NCHRP Synthesis 391. Washington, D.C.

Davies, A., and Salter, A. (2006). "The Great Experiment: Public-Private Partnerships and Innovation in Design, Production, and Operation of Capital Goods in the UK." Flexibility and Stability in the Innovating Economy, M. McKelvey and M. Holmén, eds., Oxford University Press, New York, 73–95.

Deloitte Research. (2007). Closing America's Infrastructure Gap: The Role of Public-Private Partnerships - A Deloitte Research Study.

Eisenhardt, K. M., and Graebner, M. E. (2007). "Theory Building From Cases: Opportunities and Challenges." Academy of Management Journal, 50(1), 25–32.

Eisenhardt, M. (1989). "Building Theories from Case Study Research." The Academy of Management Review, 14(4), 532–550.

Fergusson, K. J., and Teicholz, P. M. (1993). "Impact of Integration on Industrial Facility Quality." Stanford University.

FHWA. (2013). "FHWA Office of Innovative Program Delivery: P3 Defined." <http://www.fhwa.dot.gov/ipd/p3/defined/index.htm>.

FHWA. (2015). "P3 Concessions in the US." <http://www.fhwa.dot.gov/ipd/p3/resources/p3_concessions_map_newbuild.aspx> (Dec. 10, 2015).

Fitzgerald, P. (2004). "Review of Partnerships Victoria Provided Infrastructure." Growth Solutions Group, Melbourne, Australia.

Garvin, M. J., and Bosso, D. (2008). "Assessing the Effectiveness of Infrastructure Public-Private Partnership Programs and Projects." Public Works Management & Policy, 13(2), 162–178.

Grout, P. (1997). "The economics of the private finance initiative." Oxford Review of Economic Policy, 13(4), 53–66.

Hall, D., Algiers, A., Lehtinen, T., Levitt, R. E., Li, C., and Padachuri, P. (2014). "The Role of Integrated Project Delivery Elements in Adoption of Intergral Innovations." Engineering Project Organizations Conference 2014, 1–20.

Hart, O. (2003). "Incomplete contracts and public ownership: remarks, and an applicaiton to public private partnerships." The Economic Journal, 113(March), 69–76.

Hatem, D. J., and Gary, P. B. (2013). Public-Private Partnerships: Opportunities and Risks for Consulting Engineers. American Council of Engineering Companies.

Lehtinen, T. (2012). "Increasing integration in construction projects: A case study on a PPP project adopting BIM." Proceedings of the European Conference on Product and Process Modelling (ECPPM) 2012, CRC Press, Reykjavik, Iceland, 439–446.

van Marrewijk, A., Clegg, S. R., Pitsis, T. S., and Veenswijk, M. (2008). "Managing public–private megaprojects: Paradoxes, complexity, and project design." International Journal of Project Management, 26(6), 591–600.

Miles, M. B., Huberman, A. M., and Saldaña, J. (2014). Qualitative Data Analysis - A Methods Sourcebook. SAGE Publications, Inc, Thousand Oaks, California.

Miller, J. B., Garvin, M. J., Ibbs, C. W., and Mahoney, S. E. (2000). "Toward a New Paradigm: Simultaneous Use of Multiple Project Delivery Methods." Journal of Management in Engineering, ASCE, American Society of Civil Engineers, 16(3), 58–67.

Miller, J. B., and Gerber, J. K. (2012). "Advanced Project Delivery: Improving the Odds of Success - How Roles Differ for Owners and Lenders with Changes in Delivery Method." 2012 Annual Meeting of the ABA Forum on the Construction Industry, Las Vegas, NV.

Oppenheim, A. (1992). Questionnaire design, interviewing and attitude measurement. Continuum, New York, NY.

Paulson, B. (1976). "Designing to reduce construction costs." Journal of the Construction Division, ASCE, 102(4), 587–592.

PW Financing. (2015). "Public Works Financing - Volume 306, July-August 2015." Public Works Financing, 306.

Regimbal, J. J. J. (2012). An Examination of the Virginia Public-Private Transportation Act of 1995 (November 2012).

Roehrich, J. K., and Caldwell, N. D. (2012). "Delivering integrated solutions in the public sector: The unbundling paradox." Industrial Marketing Management, Elsevier Inc., 41(6), 995–1007.

Royce, W. W. (1970). "Managing the development of large software systems." Proceedings IEEE, WESCON, 1–9.

Saldaña, J. (2009). The Coding Manual for Qualitative Researchers. SAGE Publications, Inc, Thousand Oaks, California.

Sheffer, D. A., and Levitt, R. E. (2010). "How Industry Structure Retards Diffusion of Innovations in Construction : Challenges and Opportunities." Engineering Project Organizations Conference 2010, South Lake Tahoe, CA.

Sheffer, D. A., and Levitt, R. E. (2012). CRGP Working paper #0069: Fragmentation inhibits innovation : Overcoming professional and trade lock-in.

Siering, J., and Svensson, A. (2012). Managing External Stakeholder Relationships in PPP Projects - A Multidimensional Approach (Technical Report No. 2012:163). Gothenburg, Sweden.

Spradley, J. P. (1979). The Ethnographic Interview. New York: Harcourt Brace Jovanovich College.

Taylor, J., Dossick, C., and Garvin, M. J. (2011). "Meeting the burden of proof with case-study research." Journal of Construction Engineering and Management, ASCE, 137(4), 303–311.

Thomassen, M. (2011). "BIM & Collaboration in the AEC Industry." Aalborg University.

Touran, A., Gransberg, D. D., Molenaar, K. R., Ghavamifar, K., Mason, D. J., and Fithian, L. A. (2009). TCRP Report 131: A Guidebook for the Evaluation of Project Delivery Methods. Transportation Research Board, National Academies, Washington, D.C.

Weisert, C. (2003). "There's no such thing as the Waterfall Approach! (and there never was)." Information Disciplines, Inc, <http://www.idinews.com/waterfall.html>.

Yescombe, E. (2007). Public-private partnerships: principles of policy and finance. Elsevier Ltd.

Yin, R. K. (2009). Case study research: Design and methods. Sage Publications, Inc, Thousand Oaks, California.

Zheng, J., Roehrich, J. K., and Lewis, M. A. (2008). "The dynamics of contractual and relational governance: Evidence from long-term public–private procurement arrangements." Journal of Purchasing and Supply Management, 14(1), 43–54.

CHAPTER 5: Conclusions

The three papers presented in this dissertation (Chapters 2, 3, and 4) have explored the following overarching research question: *How do Public-Private Partnerships influence the Life Cycle Design Decision-making Process of Highway Projects in the US?* Optimizing and improving the life cycle design decision-making process may be one of the most important benefits that the implementation of P3s provides to the public. The inherent characteristics of P3s incentivize the private sector to think more strategically about long-term life cycle performance, and hence to strategically implement a life cycle-oriented design. Moreover, the increasing interest in the implementation of P3s, as well as the need to deliver large and complex projects that are vital to local and regional economies, calls for a better understanding of P3s. This dissertation contributes to a better understanding of how the implementation of P3s for highway projects influences the inherent life cycle design decision-making process. Figure 5-1 provides a conceptual overview of the results and contributions of this dissertation, reiterating each research gap and research question for reference.

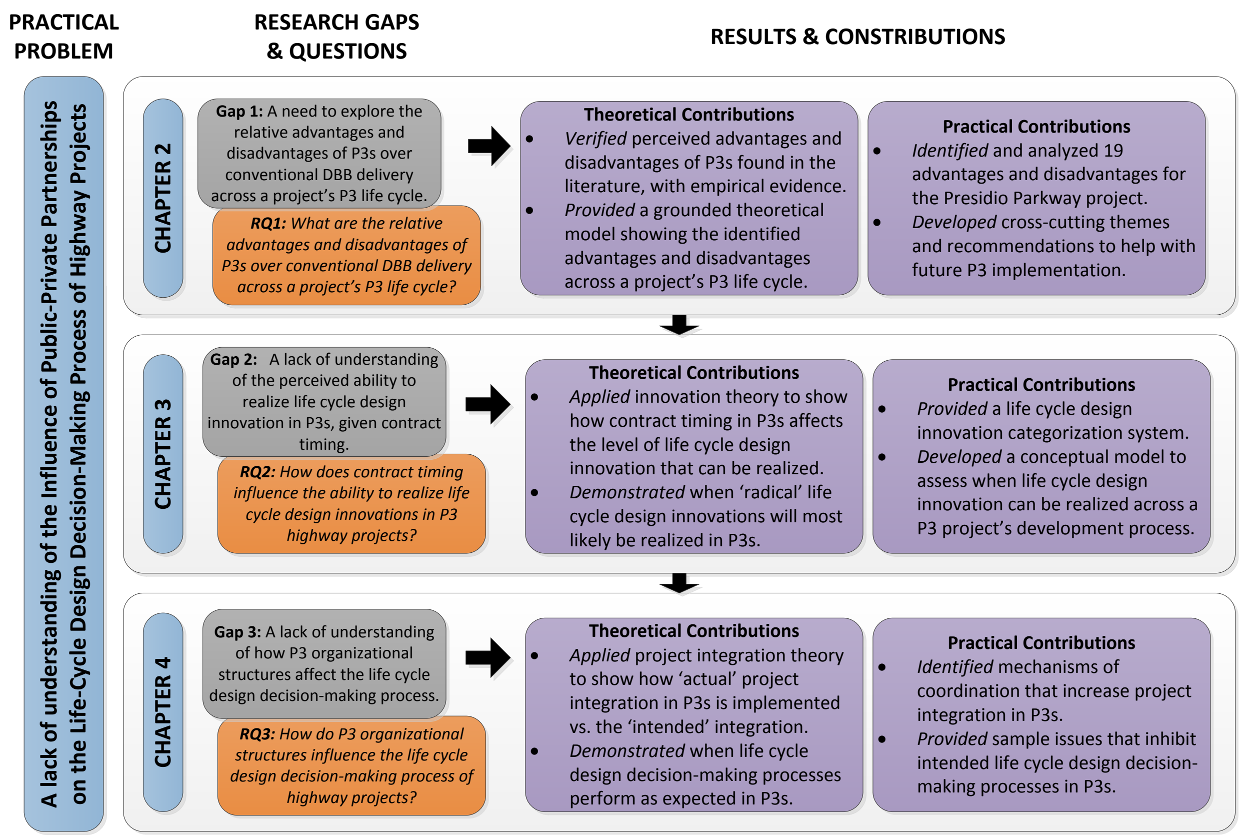


Figure 5-1: Summary of Dissertation Contributions

Chapter 2 identified the relative advantages and disadvantages between P3 and DBB projects across the P3 life cycle. Issues that influence the life cycle design decision-making process were also identified, helping extend the overarching research question in the subsequent chapters. Chapter 3 followed by analyzing how contract timing can enhance, or inhibit, the ability of the private sector to realize life cycle design innovation in highway projects. Chapter 4 explored how the P3 organizational structures influence integration between the key project team stakeholders during the delivery of the project, which in turn, can enhance the opportunity to improve the life cycle design decision-making process.

Contributions to Theory

Chapter 2 presents a single case study of the Presidio Parkway project, a project that implemented both a P3 and DBB delivery. Through an in-depth case study of this project, the relative advantages and disadvantages from implementing a P3 were explored and compared to the traditional DBB process, addressing the first gap identified in the literature. Previous studies have analyzed specific advantages or disadvantages and have typically focused within a specific P3 life cycle phase (AECOM Consult Team 2007; Bain 2010; Blanc-Brude et al. 2009; Chasey et al. 2012; Deloitte Research 2007; Grimsey and Lewis 2002; MacDonald 2002; Morallos and Amekudzi 2008; NCSL 2010; OECD 2008; Raisbeck et al. 2010; Ramsey and Mounir 2015). However, none of these previous studies have provided a holistic comparison of those advantages and disadvantages across a project's P3 life cycle. And, while the advantages and disadvantages were previously identified in this past work, this project validated these findings by grounding them in empirical evidence collected and analyzed on one project.

The advantages and disadvantages that were validated are organized in the conceptual 'P3 life cycle' framework shown in Table 5-1. Although all P3 life cycle advantages and disadvantages were initially explored, not all advantages and disadvantages were validated through this single case study. Other factors that were not validated are also shown in Table 5-1.

Table 5-1: Relative Advantages and Disadvantages Identified in Chapter 2.

P3 Life Cycle	Policy & Planning Phase	Transaction Phase	Implementation Phase
Advantages Validated	✓ *Private Financing* ✓ *Accelerated Delivery* ✓ *Reduced Debt Constraints and Optimal Use of Public Funds*	✓ *Competitive Procurement Process* ✓ *Optimal Risk Allocation* • *Design* • *Construction* • *Financing* • *O&M* ✓ *Life Cycle Cost Evaluation*	✓ *Improved Quality* ✓ *Cost and Schedule Certainty* ✓ *Improved Life Cycle Design* ✓ *Dedicated & Committed O&M Budget* ✓ *Improved Asset Condition* ✓ *Improved Level of Service* ✓ *Hand Back Process*
Disadvantages Validated	✓ *Regulatory Constraints and Opposition* ✓ *Lack of P3 Maturity*	✓ *Complex Procurement Process*	✓ *Project Governance* ✓ *Organizational Inertia* ✓ *Cost of Maintenance*
Other factors not validated in case study:	o Loss of Government Control o Sustainability	o Financing Costs o Competitiveness Level [a comparative review with other bidders' proposals]	o Contract Management o Project Description and Specification o Project Management & Oversight o Residual Value [at hand back]

Chapter 3, which builds upon the initial findings from Chapter 2, provides a multiple case study of three P3s to address the need to understand how contract timing influences the ability to realize life cycle design innovations in P3s. I applied Innovation theory (Gambatese and Hallowell 2011; Henderson and Clark 1990; Sheffer and Levitt 2012; Slaughter 1998; Taylor and Levitt 2004) to show how contract timing affects the 'level' of life cycle design innovation that can be realized in P3s. I showed that contract timing, defined as the point in which the private P3 concessionaire becomes contractually involved in the project influences life cycle design innovations. These findings reinforce the original work of Paulson (1976) by demonstrating, through case-based evidence, how decisions made in the earlier phases of a project's life cycle have a much greater influence on project outcomes – in this case innovation. Furthermore, life cycle design innovations are classified through this 'innovative lens' as radical, systemic, disruptive, or incremental life cycle design innovations. Previous studies that have addressed innovations in P3s (Barlow and Köberle-Gaiser 2008; Eaton et al. 2006; Leiringer 2006; Russell et al. 2006; Tawiah and Russell 2008) have not focused on life cycle design innovation, nor how contract timing influences the ability to realize life cycle design innovations. Chapter 3 also provides a conceptual model that illustrates when more 'radical' life cycle design innovations can be realized, and shows how contract timing can influence the ability to realize life cycle design innovation in P3s.

Chapter 4 provides a multiple case study of three P3s to address how P3 organizational structures function, focused on the life cycle design decision-making process of P3s. Project team integration literature (Fergusson and Teicholz 1993; Sheffer and Levitt 2012) and organizational structure literature (Yescombe 2007) are applied to develop an approach to explore how P3 organizational structures affect the life cycle design decision-making process. Previous studies, such as Davies and Salter (2006) and Roehrich and Caldwell (2012), have explored how P3 organizational structures increase integration, but have not yet focused on understanding how organizational structures affected the life cycle design decision-making process. This paper thoroughly evaluates how organizational mechanisms of coordination increase project integration in P3s. It evaluates if the intended approaches were actually implemented, and how these mechanisms affected the life cycle design decision-making processes. The empirical findings show agreement with previous studies in how the private project teams may in fact 'disintegrate' project risks when a P3 project is executed, and how this has diminished the opportunities for integration.

Contributions to Practice

The findings from this dissertation will be beneficial to the industry, and more specifically, to both public and private P3 practitioners who are currently implementing P3s or are evaluating the possibility of future P3 implementation. Although the context of this dissertation has focused on the transportation sector, many of the concepts and findings are also applicable to other sectors given the conceptual nature of the topics explored, and the similarities in the processes.

In Chapter 2, the 19 advantages and disadvantages identified across the Presidio Parkway project's P3 life cycle can become a valuable point of reference to P3 practitioners. The in-depth discussions provided for each factor and the more generalizable discussion of how to enhance or mitigate the identified advantages and disadvantages, can be used when *preparing*, *evaluating*, and *executing* P3s in the future. In addition to this, four cross-cutting themes, along with recommendations have been *developed* to help with future P3 implementation. These are crafted particularly for the public sector when considering the implementation of P3 as a delivery method. The four themes focus on the consideration of *timing of implementation*, the *P3 development and procurement process*, *project specifications*, and *organization cultural issues*. Moreover, the P3 life cycle framework upon which the relative advantages and disadvantages have been discussed (the *policy and planning phase*, the *transaction phase*, and the *implementation phase*), could become a valuable tool for how sponsoring agencies organize their screening or evaluation processes in the future. The recommendations and suggested considerations that the four themes highlighted are important for the implementation of future P3s. The in-depth and thorough case study presented of the Presidio Parkway project in Chapter 2 identified these defining issues while considering how the traditional DBB process functions in comparison. Given that traditional DBB processes are the benchmark by which P3 processes are evaluated, the successful execution of a P3 project hinges on these issues that were noted across the advantages and disadvantages validated.

The findings and discussions in Chapter 3 can be beneficial to both the public and private sector when implementing P3s. These findings focus on the evaluation of the amount of flexibility inherent in a particular project, given contract timing, and the level of life cycle design innovation that may possible at that time. This concept of the amount of innovation that a potential P3 project can deliver given its stage in the project development process, is something that is needed to enhance the intended benefits of P3s. Innovation, in general, is typically attributed to *all* P3s as a given attribute. However, as the findings from Chapter 3 have shown, this potential for innovation can be greatly limited or enhanced given contract timing. The life cycle design innovation examples presented in Chapter 3 show how design changes or modifications were not possible, even though improving or optimizing the life cycle performance of the project was an important objective of the project. Therefore, both the public and private sector could benefit from thinking more strategically about how life cycle design innovations are evaluated, and to what extent they may be possible in P3s, given contract timing.

In Chapter 4, the findings focus on the way in which P3 organizational structures function. Project team integration is explored to evaluate what key mechanisms of coordination are important for the life cycle design decision-making process. The private sector can achieve its intended level of integration in P3s through the strategic alignment of the mechanisms of coordination identified in Chapter 4. These identified mechanisms can be incorporated in future P3s to increase the opportunity for life cycle design realization. Similar circumstances or issues, such as influential third party stakeholders that may disrupt the intended integration shown through one of the cases, may inhibit how P3 organizational structures actually function, despite having the proper mechanisms of coordination in place.

Limitations and Suggestions for Future Research

A notable limitation of this dissertation is the number of P3 project that were available for study. With only 22 highway DBFOM projects implemented across the US in the last two decades, only a few handful projects were on-going during their design-build phase, which was needed for this research. The research was limited to the selected three projects. As a consequence, future studies could extend the generalizability of these findings by comparing additional cases in regards to contract timing and organizational structure. Nevertheless, as Flyvbjerg (2006) argues, case study methodology is also a great tool for identifying "black swans" because of the in-depth approach that a case study undertakes, noting what often appears to be 'white', and on closer examination turns out to be 'black'. In this dissertation, through the richly described project examples that have been identified, it is evident that some of the issues explored would have not been understood otherwise. The detailed observations provided in the empirical evidence would have not been possible otherwise.

The qualitative research methodology chosen for this dissertation, the case study methodology, introduces another set of limitations. Throughout the case study process, an active approach to address these limitations was developed in concurrence with the case study design. Threats to the validity and reliability of the findings from this dissertation determine the quality of the case study research. Using the procedures recommended by Yin (2009), a set of tactics were established to address these limitations to greatest extent possible. First, in dealing with 'construct validity,' the operational procedures established for the data collection process, triangulation has been a key strategy that was implemented. Triangulating the project interview data with project documentation, and literature has strengthened the construct validity of the research, shown throughout the three chapters. This could be improved through observations, which is something that was not possible in this case study, given the timing (i.e., design processes being completed), the sensitivity of the projects (i.e., inter-organizational issues that arise from design interpretations), and the private stakeholders not feeling comfortable having an outsider in such meetings. Second, 'internal validity' refers to the interpretation of the data analyzed and whether subjectivity and bias influences how the findings have been described in this dissertation. In Chapter 1, the data analysis process describes how both within-case and cross-case analyses were performed as part of the case study design. Through this approach, for a single-case study this provides an understanding of the project and data collected as related to the theoretical propositions or hypothesis found in the literature and presented upfront. For a cross-case analysis of the three projects, the findings are reiterated and compared to what is found in the literature, as evidence of the explanations or patterns found in the analysis. Furthermore, resources such as Oppenheim (1992) and Spradley (1979) helped to develop the questions and considerations when conducting the case study interviews, in order to reduce bias and to ensure that the semi-structured format of the interviews was adequate.

The third limitation from using case study methodology is the research's 'external validity.' External validity deals with justifying whether the case study's findings may be generalizable beyond the immediate cases selected. This threat has been recognized to be primarily one of the greatest challenges and criticisms in doing case studies. This threat to the validity of the findings in this dissertation has been addressed by using theory, as part of the within-case analyses, as discussed above. For the cross-case analyses presented, replication logic is a key tactic that was implemented and reiterated in Chapters 3 and 4. This helps to observe if emergent findings are idiosyncratic to one case or replicated by the others, thereby making the findings generalizable beyond the immediate three cases selected (Eisenhardt and Graebner 2007; Eisenhardt 1989). The fourth limitation is described as 'reliability,' meaning how well the operational procedures established and described in this case study could be repeated and conducted by another researcher and arrive at similar findings and conclusions. The development of a case study protocol discussed (see Appendix B), primarily for the data collection processes, serves to document the procedures that have been implemented in detail. In addition to this, using a qualitative software like Nvivo (Bazeley and Jackson 2013) helps in maintaining a well-organized case study database in which all documents, interview transcripts, and the analyses can be accessed by other researchers to judge the rigor and procedures of the project as a whole.

Although the limitations of case study research have been addressed to some extent, future research could address the remaining limitations by expanding upon the findings from this dissertation. A suggested area for future research that addresses the life cycle design outcomes in P3s could focus on performance evaluation. The history of P3 projects in the US is short, and therefore the longitudinal and actual meaningful life cycle cost performance data of projects is not something that may be easily accessible or available. A promising research topic on life cycle performance of P3s could focus on evaluating similar project components across multiple P3 projects. Through retroactive data, this can evaluate how P3 projects have been maintained, say for concrete pavement, vs. how public agencies with comparable roads currently provide maintenance, within similar regions.

The framework developed in Chapter 2, along with the advantages and disadvantages identified, could be extended to evaluate the current practices of state agencies in evaluating P3s. The development and establishment of P3 processes and tools is an on-going process across many states, and a synthesis of this type would be greatly beneficial to practitioners, as well as to evaluate current theoretical frameworks that have been developed. Furthermore, the remaining factors that were not validated could be explored further as the Presidio Pakrway project evolves, and the data to properly evaluate these factors becomes available.

In Chapter 3, opportunism and competitive advantages may affect project outcomes, given early contract timing. However, this has not been addressed and is a potential limitation. For example, the Elizabeth

River Tunnel project was a sole-source procurement that had no compeition during the procurement process. As a consequence, competitiveness in the procurement process could be a factor that influences the life cycle design decision-making process, which may play a larger role, in addition to contract timing.

Finally, all projects indicated that it was not appropriate for an outsider to observe and be present in many of the meetings in which life cycle design decisions were discussed. Having the opportunity to conduct this type of observation, could reveal a lot about the life cycle design processes inherent in P3s. Therefore, a suggestion for similar future studies is to focus on exploring the identified coordination mechanisms, along with others that are discussed in this dissertation, through observations of these processes. Such an in-depth perspective on the limited P3s that exist could show other components of the life cycle design decision-making process in P3s that have not yet been identified.

Big Thoughts – So what? What's next?

The relationship between the quality of infrastructure, the quality of highways, and the ability for developed countries to maintain a competitive economy is undeniably important. Every year the infrastructure crisis continues to grow, as the funding gap gets larger, and projects that are needed today continue to be postponed. Public agencies are embracing P3s to deliver major and complex highway projects that are resource intensive and can have a positive impact in the surrounding economies. The three cases studied in this dissertation are a prime example of that. They are considered to be of a large magnitude. They have taken many years to reach construction and operation. They are also significant improvements to their surrounding economies and benefit the local and regional households and businesses.

It is known that not every project can or should be delivered using a P3, and P3s are not the one-size-fits-all solution to fixing and maintaining the US infrastructure. In fact, as already indicated, based on the history of DBFOM projects implemented for US highway projects, most of these projects are driven by a lack of funding. Under the traditional pay-as-you-go financing approach, projects of this magnitude can be delayed significantly, lengthening the time until enough funding is available to begin construction. As consequence, projects become more expensive without being able to accelerate their delivery because of budgetary constraints.

Much has been said about P3s' ability to benefit from private sector innovation and optimized life cycle cost performance for the delivery of highway projects. A common P3 benefit is the offer of a solution to prevent the years of delayed maintenance from catching up in the future. While the upfront capital costs of projects are accelerated to begin construction sooner for these projects, the back-end of projects is also benefited, because of the life cycle-oriented strategy that a P3 environment encourages. At the same time, both the private and public sector are exposed to rather new and unusual delivery processes. Therefore, the optimal life cycle design decision-making process will continue to improve as barriers are broken down, and these new processes are embraced.

References

AECOM Consult Team. (2007). User Guidebook on Implementing Public- Private Partnerships for Transportation Infrastructure Projects in the United States, Final Report, Work Order 05-002. Washington, D.C.

Bain, R. (2010). "Construction risk – what risk?" Project Finance, (February), 46–50.

Barlow, J., and Köberle-Gaiser, M. (2008). "The private finance initiative, project form and design innovation." Research Policy, 37(8), 1392–1402.

Bazeley, P., and Jackson, K. (2013). Qualitative Data Analysis with NVivo. SAGE Publications, Inc, London, UK.

Blanc-Brude, F., Goldsmith, H., and Välilä, T. (2009). "A Comparison of Construction Contract Prices for Traditionally Procured Roads and Public–Private Partnerships." Review of Industrial Organization, 35(1-2), 19–40.

Chasey, A. D., Maddex, W. E., and Bansal, A. (2012). "A Comparison of Public-Private Partnerships and Traditional Procurement Methods in North American Highway Construction." TRB Annual Meeting 2012, Transportation Research Board, Washington, D.C.

Davies, A., and Salter, A. (2006). "The Great Experiment: Public-Private Partnerships and Innovation in Design, Production, and Operation of Capital Goods in the UK." Flexibility and Stability in the Innovating Economy, M. McKelvey and M. Holmén, eds., Oxford University Press, New York, 73–95.

Deloitte Research. (2007). Closing America's Infrastructure Gap: The Role of Public-Private Partnerships - A Deloitte Research Study.

Eaton, D., Akbiyikli, R., and Dickinson, M. (2006). "An evaluation of the stimulants and impediments to innovation within PFI/PPP projects." Construction Innovation: Information, Process, Management, 6(2), 63–67.

Eisenhardt, K. M., and Graebner, M. E. (2007). "Theory Building From Cases: Opportunities and Challenges." Academy of Management Journal, 50(1), 25–32.

Eisenhardt, M. (1989). "Building Theories from Case Study Research." The Academy of Management Review, 14(4), 532–550.

Fergusson, K. J., and Teicholz, P. M. (1993). "Impact of Integration on Industrial Facility Quality." Stanford University.

Gambatese, J. a., and Hallowell, M. (2011). "Enabling and measuring innovation in the construction industry." Construction Management and Economics, 29(6), 553–567.

Grimsey, D., and Lewis, M. K. (2002). "Evaluating the risks of public private partnerships for infrastructure projects." International Journal of Project Management, 20, 107–118.

Henderson, R. M., and Clark, K. B. (1990). "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms." Administrative Science Quarterly, 35(1), 9–30.

Leiringer, R. (2006). "Technological innovation in the context of PPPs: incentives, opportunities and actions." Construction Management and Economics, 24(March 2006), 301–308.

MacDonald, M. (2002). Review of Large Public Procurement in the UK. London, UK.

Morallos, D., and Amekudzi, A. (2008). “The state of the practice of value for money analysis in comparing public private partnerships to traditional procurements.” Public Works Management & Policy, 13(2), 114–125.

NCSL. (2010). Public-Private Partnerships for Transportation: A Toolkit for Legislators. Denver, CO.

OECD. (2008). “Public-private partnerships: In pursuit of risk sharing and value for money.” Organisation for Economic Co-operation and Development, Organisation for Economic Co-operation and Development.

Oppenheim, A. (1992). Questionnaire design, interviewing and attitude measurement. Continuum, New York, NY.

Raisbeck, P., Duffield, C., and Xu, M. (2010). “Comparative performance of PPPs and traditional procurement in Australia.” Construction Management and Economics, Routledge, 28(4), 345–359.

Ramsey, D. W., and Mounir, E. A. (2015). “Cost and Schedule Performance Benchmarks of U.S. Transportation PPP Projects.” TRB Annual Meeting 2015, Transportation Research Board, Washington, D.C.

Roehrich, J. K., and Caldwell, N. D. (2012). “Delivering integrated solutions in the public sector: The unbundling paradox.” Industrial Marketing Management, Elsevier Inc., 41(6), 995–1007.

Russell, A. D., Tawiah, P. A., and De Zoysa, S. (2006). “Project innovation - a function of procurement mode?” Canadian Journal of Civil Engineering, 33(12), 1519–1537.

Sheffer, D. A., and Levitt, R. E. (2012). CRGP Working paper #0069: Fragmentation inhibits innovation : Overcoming professional and trade lock-in.

Slaughter, E. S. (1998). “Models of Construction Innovation.” Journal of Construction Engineering and Management, ASCE, 124(3), 226–231.

Spradley, J. P. (1979). The Ethnographic Interview. New York: Harcourt Brace Jovanovich College.

Tawiah, P. a., and Russell, A. D. (2008). “Assessing Infrastructure Project Innovation Potential as a Function of Procurement Mode.” Journal of Management in Engineering, 24(3), 173–186.

Taylor, J. E., and Levitt, R. E. (2004). “Understanding and managing systemic innovation in project-based industries.” Innovations: Project Management Research, D. I. Cleland, D. P. Slevin, and J. K. Pinto, eds., Project Management Institute, Newton Square, PA, 83–99.

Yescombe, E. (2007). Public-private partnerships: principles of policy and finance. Elsevier Ltd.

Yin, R. K. (2009). Case study research: Design and methods. Sage Publications, Inc, Thousand Oaks, California.

INTEGRATED REFERENCES

AECOM Consult Team. (2007). *User Guidebook on Implementing Public- Private Partnerships for Transportation Infrastructure Projects in the United States, Final Report, Work Order 05-002*. Washington, D.C.

Anderson, S., and Blaschke, B. (2004). *NCHRP Synthesis 331: Statewide Highway Letting Program Management - A Syntheis of Highway Practice*. Washington, D.C.

Arup/PB Joint Venture. (2010). *Analysis of Delivery Options for the Presidio Parkway Project (February 2010)*. San Francisco, CA.

ASCE. (2011). *Failure to Act: The Economic Impact of Current Investment Trends in Surface Transportation Infrastructure*. Washington, D.C.

ASCE. (2013a). *Failure to Act: The Impact of Current Infrastructure Investment on America's Economic Future*. Washington, D.C.

ASCE. (2013b). *ASCE's 2013 Report Card on America's Infrastructure*. Washington, D.C.

Bain, R. (2010). "Construction risk – what risk?" *Project Finance*, (February), 46–50.

Barlow, J., and Köberle-Gaiser, M. (2008). "The private finance initiative, project form and design innovation." *Research Policy*, 37(8), 1392–1402.

Bazeley, P., and Jackson, K. (2013). *Qualitative Data Analysis with NVivo*. SAGE Publications, Inc, London, UK.

Blanc-Brude, F., Goldsmith, H., and Valila, T. (2006). *Ex ante construction costs in the European road sector: a comparison of public-private partnerships and traditional public procurement*. Economic and Financial Reports / European Investment Bank, No. 2006/01.

Blanc-Brude, F., Goldsmith, H., and Välilä, T. (2009). "A Comparison of Construction Contract Prices for Traditionally Procured Roads and Public–Private Partnerships." *Review of Industrial Organization*, 35(1-2), 19–40.

Buxbaum, J. N., and Ortiz, I. N. (2009). *Public-Sector Decision Making for Public-Private Partnerships: A Synthesis of Highway Practice, NCHRP Synthesis 391*. Washington, D.C.

BYT Group. (2014). "US 36 Managed Lanes Toll Concession Project - Pre-FC Technical Due Diligence Report (February 18, 2014)." <http://emma.msrb.org>.

Caltrans. (2010). *Project Proposal Report (PPR) for the Presidio Parkway P3 Project (May 4, 2010)*.

Caltrans. (2012). "Management and Staffing Plan for the Presidio Parkway Project (Confidential)."

Caltrans. (2015). "Project Delivery Report, 2014-15 Q1 - Quarterly Report to the the California Transportation Commission." <http://dot.ca.gov/hq/projmgmt/documents/ctc/CTCReport_2014-2015_Q1.pdf>.

Carollo, G., Garvin, M. J., Levitt, R. E., Monk, A. H. B., and South, A. (2012). *Public-Private Partnerships for Infrastructure Delivery*. *SSRN Electronic Journal*.

CBO. (2012). *Using Public-Private Partnerships to Carry Out Highway Projects*. Congressional Budget

Office.

CBO. (2015a). *Public Spending on Transportation and Water Infrastructure, 1956 to 2014 (March 2015)*. Washington, D.C.

CBO. (2015b). “Public Spending on Transportation and Water Infrastructure, 1956 to 2014 (March 2015) - Data and Supplemental Information.” <https://www.cbo.gov/publication/49910> (Aug. 31, 2015).

Chasey, A. D., and Agrawal, N. (2013). “A Case Study on the Social Aspect of Sustainability in Construction.” *ICSDEC 2012*, ASCE, ed., Proceedings of the 2012 International Conference on Sustainable Design, Engineering, and Construction, Forth Worth, TX, 543–551.

Chasey, A. D., Maddex, W. E., and Bansal, A. (2012). “A Comparison of Public-Private Partnerships and Traditional Procurement Methods in North American Highway Construction.” *TRB Annual Meeting 2012*, Transportation Research Board, Washington, D.C.

Creswell, J. W. (2007). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. Sage Publications, Inc, Thousand Oaks, California.

CTC. (2009). “Presidio Parkway Public Private Partnership Project Proposal Assessment (May 11, 2010).” California Transportation Commission.

CTC. (2015). “Financial Allocation for SHOPP Projects - Presidio Parkway Project Reslution FP-14-48 - Memorandum to California Transportation Comission Chair and Commissioners (May 28, 2015).” <http://www.catc.ca.gov/meetings/agenda/2015Agenda/2015_05/064_2.5b3.pdf>.

Davies, A., and Salter, A. (2006). “The Great Experiment: Public-Private Partnerships and Innovation in Design, Production, and Operation of Capital Goods in the UK.” *Flexibility and Stability in the Innovating Economy*, M. McKelvey and M. Holmén, eds., Oxford University Press, New York, 73–95.

Deloitte Research. (2007). *Closing America’s Infrastructure Gap: The Role of Public-Private Partnerships - A Deloitte Research Study*.

Eaton, D., Akbiyikli, R., and Dickinson, M. (2006). “An evaluation of the stimulants and impediments to innovation within PFI/PPP projects.” *Construction Innovation: Information, Process, Management*, 6(2), 63–67.

Eisenhardt, K. M., and Graebner, M. E. (2007). “Theory Building From Cases: Opportunities and Challenges.” *Academy of Management Journal*, 50(1), 25–32.

Eisenhardt, M. (1989). “Building Theories from Case Study Research.” *The Academy of Management Review*, 14(4), 532–550.

Elizabeth River Crossings LLC. (2008). *ERC Conceptual Proposal for the DT/MT/MLK Extensions Project - Sept. 2008*.

Fergusson, K. J., and Teicholz, P. M. (1993). “Impact of Integration on Industrial Facility Quality.” Stanford University.

FHWA. (2004). *Performance Specifications Strategic Roadmap: A Vision for the Future, Spring 2004 - updated: Nov. 26, 2013*. Federal Highway Administration.

FHWA. (2007a). *“Case Studies of Transportation Public-Private Partnerships around the World,” Final Report Work Order 05-002*. Washington, D.C.

FHWA. (2007b). “Revised Record of Decision for Route 58/Midtown Tunnel (July 10, 2007).” Federal Highway Administration - Virginia Division.

FHWA. (2013a). “FHWA Office of Innovative Program Delivery: P3 Defined.” <http://www.fhwa.dot.gov/ipd/p3/defined/index.htm>.

FHWA. (2013b). “Clarifying the Scope of Preliminary Design.” *Every Day Counts (EDC)*, <http://www.fhwa.dot.gov/everydaycounts/projects/toolkit/design.cfm> (Jan. 1, 2015).

FHWA. (2015a). “P3 Concessions in the US.” <http://www.fhwa.dot.gov/ipd/p3/resources/p3_concessions_map_newbuild.aspx> (Dec. 10, 2015).

FHWA. (2015b). “Estimated Time Required to Complete the NEPA Process.” <https://www.environment.fhwa.dot.gov/strmlng/nepatime.asp#graph> (Oct. 15, 2015).

Fitzgerald, P. (2004). “Review of Partnerships Victoria Provided Infrastructure.” Growth Solutions Group, Melbourne, Australia.

Flyvbjerg, B. (2006). “Five misunderstandings about case-study research.” *Qualitative Inquiry*, 219–245.

Flyvbjerg, B., Holm, M. S., and Buhl, S. (2003). “How common and how large are cost overruns in transport infrastructure projects?” *Transport Reviews*, 23(1), 71–88.

Flyvbjerg, B., Skamris, M., and Buhl, S. (2002). “Underestimating Costs in Public Works Projects: Error or Lie?” *Journal of the American Planning Association*, 68(3), 279–295.

Freeman, C., and Soete, L. (1997). *The Economics of Industrial Innovation*. MIT Press.

Gambatese, J. a., and Hallowell, M. (2011). “Enabling and measuring innovation in the construction industry.” *Construction Management and Economics*, 29(6), 553–567.

Garvin, M. J. (2003). “Role of project delivery systems in infrastructure improvement.” *Construction Research Congress 2003*, 1–8.

Garvin, M. J., and Bosso, D. (2008). “Assessing the Effectiveness of Infrastructure Public-Private Partnership Programs and Projects.” *Public Works Management & Policy*, 13(2), 162–178.

Golden Link Concessionaires. (2011). “Golden Link Concessionaire’s Technical Proposal: Preliminary Master Design Submittal (dated January 2011) - Comprehensive P3 Agreement, Volume 2, Section 2.”

Golden Link Concessionaires. (2015). “2015 Annual Financial Plan Update (FPAU), as of December 31, 2014 - Prepared Feb. 27, 2015.” FHWA.

Gransberg, D. D., Badillo-kwiatkowski, G. M., and Molenaar, K. R. (2003). “Project Delivery Comparison Using Performance Metrics.” *2003 AACE International Transactions*, Association for the Advancement of Cost Engineering International, 1–5.

Gransberg, D. D., Runde, D. F., and Stergios, J. (2000). “The effect of innovative highway construction contract methods.” *AACE International Transactions*.

Grimsey, D., and Lewis, M. (2007). *Public private partnerships: The worldwide revolution in infrastructure provision and project finance*. Edward Elgar Publishing Limited.

Grimsey, D., and Lewis, M. K. (2002). “Evaluating the risks of public private partnerships for infrastructure projects.” *International Journal of Project Management*, 20, 107–118.

Grimsey, D., and Lewis, M. K. (2005). “Are Public Private Partnerships value for money? Evaluating alternative approaches and comparing academic and practitioner views.” *Accounting Forum*, 29(2005), 345–378.

Grout, P. (1997). “The economics of the private finance initiative.” *Oxford Review of Economic Policy*, 13(4), 53–66.

Hall, D., Algiers, A., Lehtinen, T., Levitt, R. E., Li, C., and Padachuri, P. (2014). “The Role of Integrated Project Delivery Elements in Adoption of Intergral Innovations.” *Engineering Project Organizations Conference 2014*, 1–20.

Hart, O. (2003). “Incomplete contracts and public ownership: remarks, and an applicaiton to public private partnerships.” *The Economic Journal*, 113(March), 69–76.

Hatem, D. J., and Gary, P. B. (2013). *Public-Private Partnerships: Opportunities and Risks for Consulting Engineers*. American Council of Engineering Companies.

Henderson, R. M., and Clark, K. B. (1990). “Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms.” *Administrative Science Quarterly*, 35(1), 9–30.

HM Treasury. (2006). *Value for Money Assessment Guidance*. London.

Hodge, G. A., and Greve, C. (2007). “Public-Private Partnerships: An International Performance Review.” *Public Administration Review*, 67(3), 545–558.

Hodge, G. A., and Greve, C. (2009). “PPPs: The Passage of time permits a sober reflection.” *Economic Affairs*, 29(1), 33–39.

Istrate, E., and Puentes, R. (2011). *Moving Forward on Public Private Partnerships: U.S. and International Experience with PPP Units*. *ibtta.org*.

LAO. (2010). “Letter to Senator Alan Lowenthal, regarding the P3 Agreement between Caltrans and Golden Link Concessionaire LLC - December 9, 2010.” Legislative Analyst’s Office.

LAO. (2012). “Maximizing State Benefits From Public-Private Partnerships (November 8, 2012).” Legislative Analyst’s Office, Sacramento, CA.

Lehtinen, T. (2012). “Increasing integration in construction projects: A case study on a PPP project adopting BIM.” *Proceedings of the European Conference on Product and Process Modelling (ECPPM) 2012*, CRC Press, Reykjavik, Iceland, 439–446.

Leiringer, R. (2006). “Technological innovation in the context of PPPs: incentives, opportunities and actions.” *Construction Management and Economics*, 24(March 2006), 301–308.

Lessard, D. R., and Miller, R. (2013). “The shaping of large engineering projects.” *International Handbook on Mega-projects*, 34–56.

Levitt, R. E., Garvin, M. J., Scott, W. R., Dewulf, G., Monk, A., and South, A. (2014). “Toward an Integrated Lifecycle Governance Framework for Delivering Civil Infrastructure Projects through Public-Private Partnerships (P3s).” *Engineering Project Organizations Conference 2014*, Devil’s Thumb Ranch, Colorado.

Loulakis, M. (2013). “Legal Aspects for Performance-Based Specifications for Highway Construction and Maintenance Contracts.” *National Cooperative Highway Research Program (NCHRP)*.

Ma, J., Chen, A., and He, J. (2009). “General framework for bridge life cycle design.” *Frontiers of Architecture and Civil Engineering in China*, 3(1), 50–56.

MacDonald, M. (2002). *Review of Large Public Procurement in the UK*. London, UK.

van Marrewijk, A., Clegg, S. R., Pitsis, T. S., and Veenswijk, M. (2008). “Managing public–private megaprojects: Paradoxes, complexity, and project design.” *International Journal of Project Management*, 26(6), 591–600.

Miles, M. B., Huberman, A. M., and Saldaña, J. (2014). *Qualitative Data Analysis - A Methods Sourcebook*. SAGE Publications, Inc, Thousand Oaks, California.

Miller, J. B. (2000). *Principles of public and private infrastructure delivery*. Springer.

Miller, J. B., Garvin, M. J., Ibbs, C. W., and Mahoney, S. E. (2000). “Toward a New Paradigm: Simultaneous Use of Multiple Project Delivery Methods.” *Journal of Management in Engineering, ASCE*, American Society of Civil Engineers, 16(3), 58–67.

Miller, J. B., and Gerber, J. K. (2012). “Advanced Project Delivery: Improving the Odds of Success - How Roles Differ for Owners and Lenders with Changes in Delivery Method.” *2012 Annual Meeting of the ABA Forum on the Construction Industry*, Las Vegas, NV.

Molenaar, K. R., Gransberg, D. D., and Sillars, D. N. (2015). *NCHRP Report 808: Guidebook on Alternative Quality Management Systems for Highway Construction*. Washington, D.C.

Morallos, D., and Amekudzi, A. (2008). “The state of the practice of value for money analysis in comparing public private partnerships to traditional procurements.” *Public Works Management & Policy*, 13(2), 114–125.

Morallos, D., Amekudzi, A., Ross, C., and Meyer, M. (2009). “Value for Money Analysis in U.S. Transportation Public-Private Partnerships.” *Transportation Research Record: Journal of the Transportation Research Board*, 2115, 27–36.

NAO. (2003). *PFI: Construction Performance, Report by the Comptroller and Auditor General HC 371 Session 2002-2003*. *HC*, London, UK.

NCSL. (2010). *Public-Private Partnerships for Transportation: A Toolkit for Legislators*. Denver, CO.

Nyx Hemera News Release. (2015). “Intelligent Lighting to Reduce Costs (June 10, 2015).” *TunnelTalk.com*, <http://tunneltalk.com/USA-22May2015-San-Francisco-Presidio-Parkway-final-preparations.php>.

OECD. (2005). *Oslo manual: Guidelines for collecting and interpreting innovation data*. *Oslo Manual*, Organisation for Economic Co-operation and Development.

OECD. (2008). “Public-private partnerships: In pursuit of risk sharing and value for money.” Organisation for Economic Co-operation and Development, Organisation for Economic Co-operation and Development.

Oppenheim, A. (1992). *Questionnaire design, interviewing and attitude measurement*. Continuum, New York, NY.

Parsons Brinckerhoff. (2013). *Federal Environmental Compliance for Projects Utilizing Alternative Funding Models and Transportation Officials - NCHRP Project 25-25, Task 81 (October 2013)*.

Parsons Brinckerhoff, Nossaman LLP, and HS Public Affairs. (2013). *The Effect of Public-Private Partnerships and Non-Traditional Procurement Processes on Highway Planning, Environmental Review, and Collaborative Decision Making (Prepublication Draft dated April 26, 2012)*. Transportation Research Board, National Academies, Washington, D.C.

Parsons Brinckerhoff, Nossaman LLP, and HS Public Affairs. (2015). *The Effect of Public-Private Partnerships and Non-Traditional Procurement Processes on Highway Planning, Environmental Review, and Collaborative Decision Making (SHRP 2 Report S2-C12-RW-1)*. Washington, D.C.

Paulson, B. (1976). "Designing to reduce construction costs." *Journal of the Construction Division, ASCE*, 102(4), 587–592.

PIAC. (2010). *Comments on the Presidio Parkway Public-Private Partnership Agreement (December 23, 2010)*. Sacramento, CA.

Plenary Roads Denver. (2014). "Plenary Roads Denver Work Proposal for the US 36 Managed Lanes Project (Dated February 25, 2014) - US-36 Managed Lanes Concession Agreement, Schedule 7."

PW Financing. (2014). "Public Works Financing - Volume 296, September 2014." *Public Works Financing*, 296.

PW Financing. (2015). "Public Works Financing - Volume 306, July-August 2015." *Public Works Financing*, 306.

Raisbeck, P., Duffield, C., and Xu, M. (2010). "Comparative performance of PPPs and traditional procurement in Australia." *Construction Management and Economics*, Routledge, 28(4), 345–359.

Ramsey, D. W., and Mounir, E. A. (2015). "Cost and Schedule Performance Benchmarks of U.S. Transportation PPP Projects." *TRB Annual Meeting 2015*, Transportation Research Board, Washington, D.C.

Rangel, T., and Galende, J. (2010). "Innovation in public–private partnerships (PPPs): the Spanish case of highway concessions." *Public Money & Management*, 30(1), 49–54.

Regimbal, J. J. J. (2012). *An Examination of the Virginia Public-Private Transportation Act of 1995 (November 2012)*.

Reinhardt, W. (2011). "The Role of Private Investment in Meeting U.S. Transportation Infrastructure Needs (May 2011)." American Road & Transportation Builders Association.

Roehrich, J. K., and Caldwell, N. D. (2012). "Delivering integrated solutions in the public sector: The unbundling paradox." *Industrial Marketing Management*, Elsevier Inc., 41(6), 995–1007.

Royce, W. W. (1970). "Managing the development of large software systems." *Proceedings IEEE, WESCON*, 1–9.

Russell, A. D., Tawiah, P. A., and De Zoysa, S. (2006). "Project innovation - a function of procurement mode?" *Canadian Journal of Civil Engineering*, 33(12), 1519–1537.

Sabol, P., and Puentes, R. (2014). *Private Capital, Public Good - Drivers of Sucessful Public-Private Partnerships (December 2014)*.

SAIC, AECOM, and University of Colorado at Boulder. (2006). *Design-Build Effectiveness Study - As Required by TEA-21 Section 1307 (f)*.

Saldaña, J. (2009). *The Coding Manual for Qualitative Researchers*. SAGE Publications, Inc, Thousand Oaks, California.

Sarja, A. (2002). *Integrated Life Cycle Design of Structures*. Spon Press - Taylor & Francis Group, London, UK.

SFCTA. (2015). "Major Capital Projects Update – Presidio Parkway, April 22, 2015." San Francisco, CA.

SFCTA, and Caltrans. (2009). "FHWA Initial Financial Plan (IFP) - May 12, 2009." FHWA.

SFCTA, and Caltrans. (2014). "2014 Financial Plan Annual Update (FPAU), as of December 31, 2013." FHWA.

Sheffer, D. A., and Levitt, R. E. (2010). "How Industry Structure Retards Diffusion of Innovations in Construction : Challenges and Opportunities." *Engineering Project Organizations Conference 2010*, South Lake Tahoe, CA.

Sheffer, D. A., and Levitt, R. E. (2012). *CRGP Working paper #0069: Fragmentation inhibits innovation : Overcoming professional and trade lock-in*.

Shrestha, P. P., O'Connor, J. T., and Gibson, G. E. (2011). "Performance comparison of large design-build and design-bid-build highway projects." *Journal of Construction Engineering and Management, ASCE*, 138(1), 1–13.

Siering, J., and Svensson, A. (2012). *Managing External Stakeholder Relationships in PPP Projects - A Multidimensional Approach (Technical Report No. 2012:163)*. Gothenburg, Sweden.

Slaughter, E. S. (1998). "Models of Construction Innovation." *Journal of Construction Engineering and Management, ASCE*, 124(3), 226–231.

Slaughter, E. S. (2000). "Implementation of construction innovations." *Building Research & Information*, 28(1), 2–17.

Spradley, J. P. (1979). *The Ethnographic Interview*. New York: Harcourt Brace Jovanovich College.

Tawiah, P. a., and Russell, A. D. (2008). "Assessing Infrastructure Project Innovation Potential as a Function of Procurement Mode." *Journal of Management in Engineering*, 24(3), 173–186.

Taylor, J., Dossick, C., and Garvin, M. J. (2011). "Meeting the burden of proof with case-study research." *Journal of Construction Engineering and Management, ASCE*, 137(4), 303–311.

Taylor, J. E., and Levitt, R. E. (2004). "Understanding and managing systemic innovation in project-based industries." *Innovations: Project Management Research*, D. I. Cleland, D. P. Slevin, and J. K. Pinto, eds., Project Management Institute, Newton Square, PA, 83–99.

Thomassen, M. (2011). "BIM & Collaboration in the AEC Industry." Aalborg University.

Tom Warne and Associates LLC. (2005). *Design-Build Contracting for Highway Projects - A Performance Assessment*.

Touran, A., Gransberg, D. D., Molenaar, K. R., Ghavamifar, K., Mason, D. J., and Fithian, L. A. (2009). *TCRP Report 131: A Guidebook for the Evaluation of Project Delivery Methods*. Transportation Research

Board, National Academies, Washington, D.C.

VDOT Technical Requirements. (2011). *Final Design Criteria for the New Midtown Tunnel - Prepared by PB Americas, Inc (October 21, 2011)*.

Weisert, C. (2003). "There's no such thing as the Waterfall Approach! (and there never was)." *Information Disciplines, Inc*, <http://www.idinews.com/waterfall.html>.

Whittington, J. (2012). "When to Partner for Public Infrastructure?" *Journal of the American Planning Association*, 78(3), 269–285.

Yescombe, E. (2007). *Public-private partnerships: principles of policy and finance*. Elsevier Ltd.

Yin, R. K. (2003). *Applications of Case Study Research*. Sage Publications, Inc, Thousand Oaks, California.

Yin, R. K. (2009). *Case study research: Design and methods*. Sage Publications, Inc, Thousand Oaks, California.

Zheng, J., Roehrich, J. K., and Lewis, M. A. (2008). "The dynamics of contractual and relational governance: Evidence from long-term public–private procurement arrangements." *Journal of Purchasing and Supply Management*, 14(1), 43–54.

APPENDIX A: Additional Case Study Project Information

This appendix has been developed to provide additional information for the *US-36 Managed Lanes project* in Denver, CO, and the *Elizabeth River Tunnel project* in Norfolk-Portsmouth, VA. The Presidio Parkway project, given that an in-depth single case-study report was prepared, in-depth comparable information and discussions are provided in Chapter 2. For each of these two case studies, a brief overview is provided with more visual references to have better grasp of the project's setting, each organizational structure, and a breakdown of the scope of work in each project with approximate cost estimates provided at financial close. Although for the Presidio Parkway project, a thorough overview of the project was presented in Chapter 2, similar project information for the two other project could not be included in some of the chapters or in appendices due to space limitations.

US-36 Managed Lanes Project

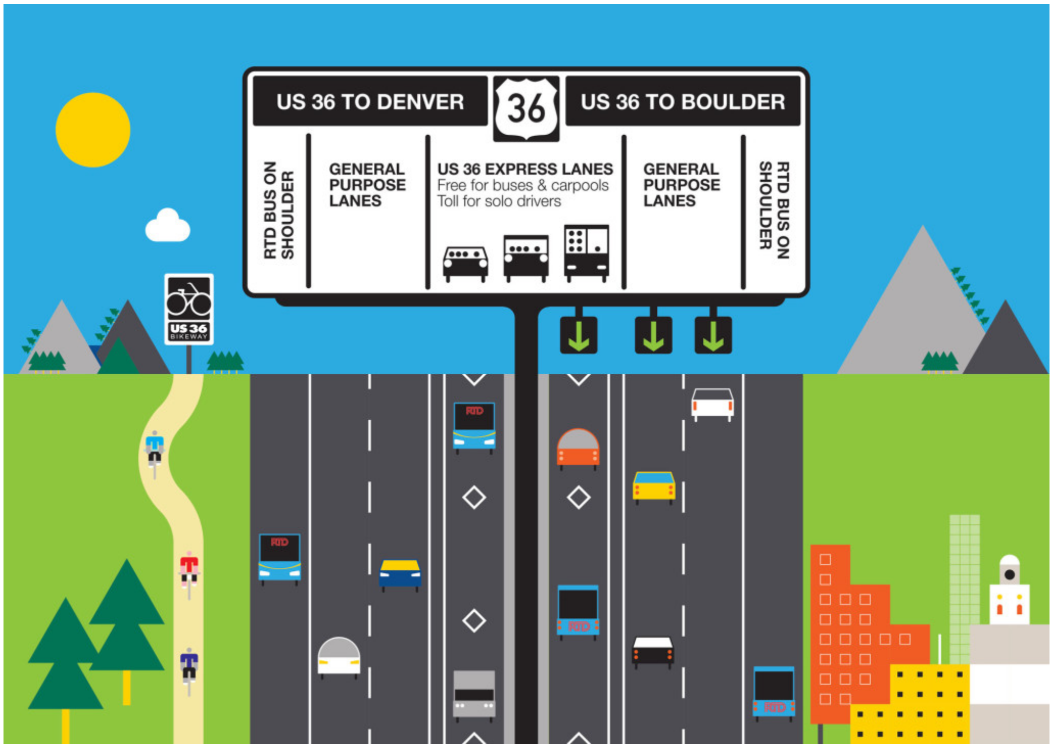


Figure A-1: US-36 Managed Lanes Project Lane Configuration (Source: 36commutingsolutions.com)

The US-36 Managed Lanes project is a multi-modal highway project that improves the existing four-lane state highway that connects the Denver and Boulder metropolitan areas in Colorado. The existing four-lane state highway was considered to be operating at a congested level, operating at nearly 90% capacity and carrying between 80,000 to 100,000 vehicle trips per day. The scope of work in this project is split into two sequential phases. Approximately 15 miles total are reconstructed, where the first phase of the project covers the first 10 miles delivered under a Design-Build delivery approach, while Phase II completes the remaining 5 miles with a DBFOM-approach with a "revenue risk" payment mechanism (see Figure A-2).

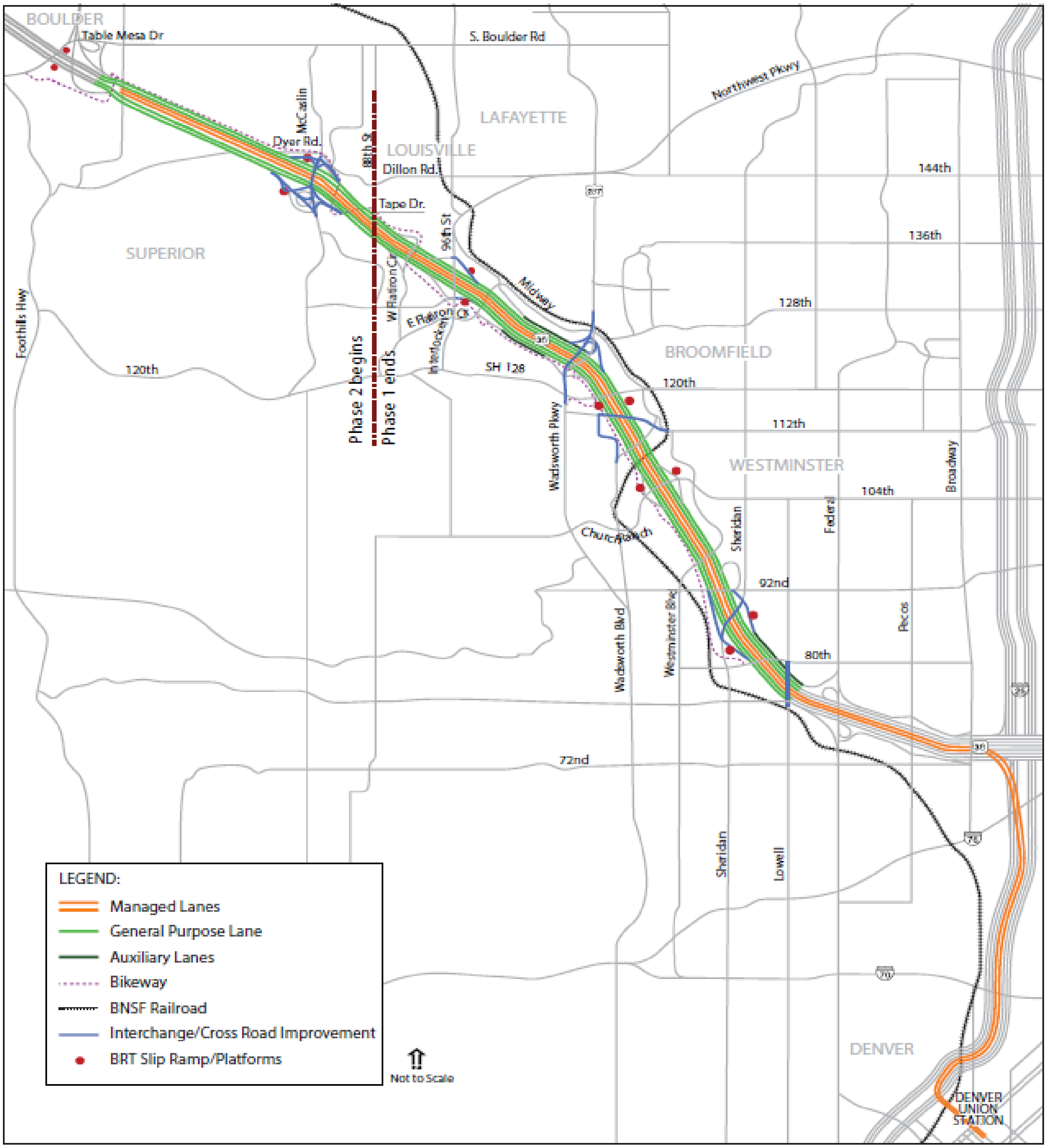


Figure A-2: US-36 Managed Lanes Project Overview (Source: www.codot.gov)

The $500 million project is a 50-year concession agreement in which the concessionaire assumes responsibility for Phase I and Phase II facilities. The managed lanes include High Occupancy Vehicles (carpooling), and a Bus Rapid Transit system that makes use of the improved managed lanes. The cost for the design and construction of Phase I of the project is estimated to be $320M, while Phase II is approximately $180M. A mix of local and state funds of approximately $60M were secured and committed for Phase II, prior to the procurement of Phase II as a P3. The P3 developer, under the P3 agreement established, assumes the TIFIA loan used in Phase I in addition to the loan for Phase II ($115M total), and the combination of private debt, equity, and private activity bonds (PABs) (see Table A-1).

Table A-1: US-36 Sources of Funding for Phase I and Phase II

US-36 Managed Lanes Sources of Funding	Phase I	Phase II	Total
Federal Public			
Federal Funds	$ 10.0		$ 10.0
TIFIA	$ 55.4	$ 60.0	$ 115.4
State/Local Public			
State/Local Funds	$ 253.9	$ 59.5	$ 313.4
Private			
Debt		$ 20.5	$ 20.5
Equity		$ 20.5	$ 20.5
PAB's		$ 20.0	$ 20.0
Grand Total	**$ 319.3**	**$ 180.5**	**$ 499.8**

The general organizational structure of the main project stakeholders can be seen in Figure A-3. In this project, the SPV established for this project has a contract with the High Performance Transportation Enterprise, which is an office established within CDOT to manage this type of contracts requiring private and/or alternative funding sources. In comparison to the other two projects, this P3 unit office acts on behalf of the state agency, whereas for other states, a P3 unit typically serves as the advisors to the owner.

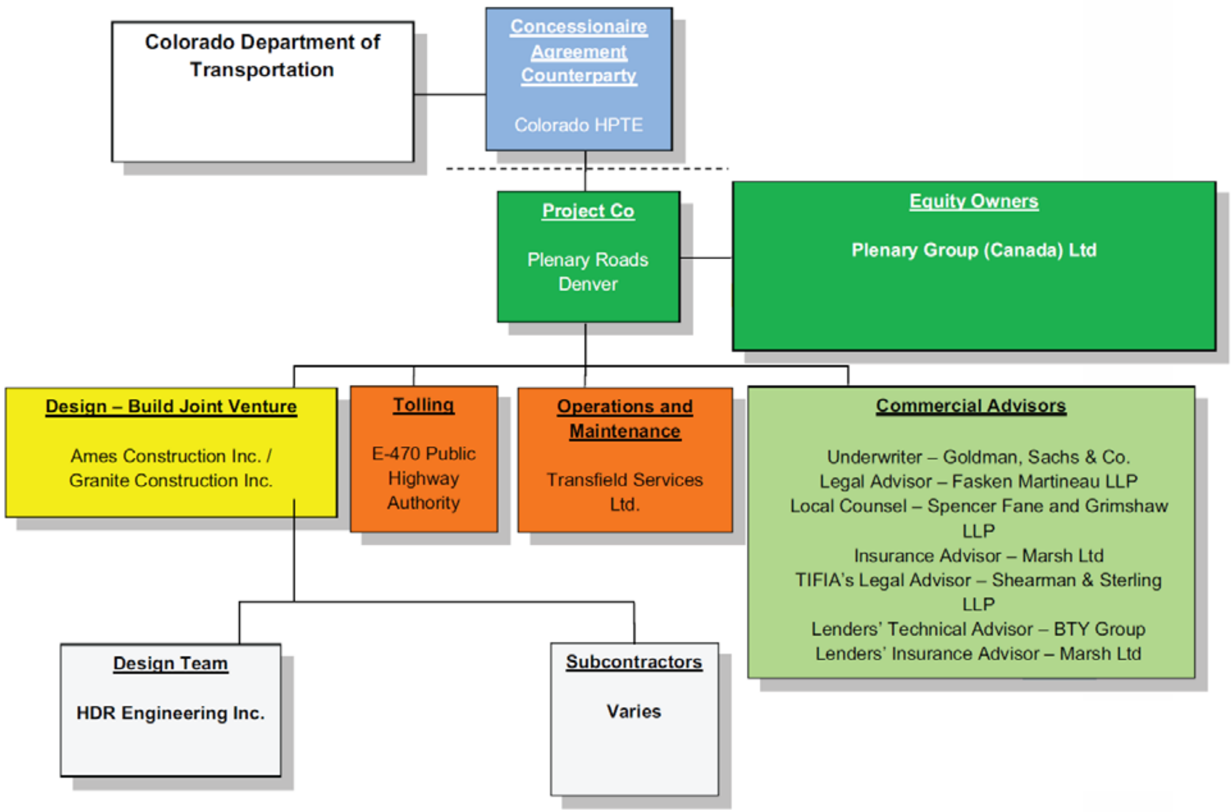


Figure A-3: US-36 Managed Lanes Project Organizational Structure (Source: BYT Group (2014))

The following three tables have been modified to provide an overview of the estimated life cycle project costs for the project at the time that financial close was reached for this project. The estimates provided are the Design-Build Contract costs (Table A-2), routine O&M project costs (Table A-3), and major renewal and rehabilitation project costs (Table A-4).

Table A-2: US-36 Design-Build Cost Estimate at Financial Close

Direct Costs	Amount ($ 000's)		% Sub	% Total
Concrete Paving	$	14,862	18.7%	12.2%
Bridges/CIP Ret Walls/CIP CBC's	$	13,508	17.0%	11.1%
Mass Earthwork, Select Fill & Road Base	$	9,847	12.4%	8.1%
Drainage	$	9,507	12.0%	7.8%
Electrical (Lighting, Signals & Pavement Markings)	$	7,142	9.0%	5.9%
Maintenance of traffics	$	7,013	8.8%	5.8%
Permanent Signs & Pavement Markings	$	2,705	3.4%	2.2%
Retaining Walls (MSE Precast Panels)	$	2,429	3.1%	2.0%
Concrete Slipform Barrier/Guardrail	$	1,768	2.2%	1.5%
Curb, Gutter, Bike Path & Flatwork	$	1,757	2.2%	1.4%
Asphalt Paving	$	1,712	2.2%	1.4%
Removals and Demolition	$	1,484	1.9%	1.2%
Surveying	$	1,282	1.6%	1.1%
Fence and Metal Guardrail	$	1,025	1.3%	0.8%
Sub Mobilization & RTD Bus Stop Amenities	$	936	1.2%	0.8%
Irrigation/Lanscaping/Seeding	$	914	1.2%	0.8%
Erosion Control	$	795	1.0%	0.7%
Utility Adjustments/Relocations	$	588	0.7%	0.5%
Environmental	$	121	0.2%	0.1%
Direct Subtotal	**$**	**79,394**	**100.0%**	**65.4%**
Indirect Costs				
Design/Bond/Insurance/QA-QC	$	17,919	42.6%	14.8%
Management & Others	$	10,165	24.2%	8.4%
Contingency	$	3,224	7.7%	2.7%
Profit & Home Office OH	$	10,748	25.6%	8.8%
Indirect Subtotal	**$**	**42,056**	**100.0%**	**34.6%**
Total Costs				
Total DB Cost Estimate (02-25-13)[1]	**$**	**121,450**		**100.0%**
Notes:				
1. *US-36 Managed Lanes Toll Concession Project Pre-FC Technical Due Diligence Report v2.6.* Prepared by BTY Group, dated Feb. 18, 2014 (pg. 148)				

Table A-3: US-36 Estimated O&M Operational Expenditures at Financial Close

Operations and Maintenance Expenditures Estimate (OpEx)	Avg. Annual	50 Year Total	% OpEx
Operating Costs			
Indirects	$ 314	$ 15,704	7.4%
Staff Labour	$ 640	$ 32,017	15.1%
Craft Labour	$ 21	$ 1,042	0.5%
US Equipment	$ 250	$ 12,500	5.9%
Operating Subtotal	**$ 1,225**	**$ 61,264**	**28.8%**
Maitenance Costs			
Pavement Maintenance	$ 163	$ 8,159	3.8%
Roadside Maintenance	$ 24	$ 1,224	0.6%
Drainage	$ 145	$ 7,245	3.4%
Vegetation and Aesthetics	$ 68	$ 3,387	1.6%
Traffic Services	$ 920	$ 45,991	21.7%
Snow and Ice Control	$ 1,223	$ 61,136	28.8%
Facility Maintenance	$ 5	$ 250	0.1%
Land Bridge Maintenance	$ 180	$ 9,018	4.2%
Project Asset Valuation	$ 262	$ 13,103	6.2%
Prime Bond	$ 33	$ 1,626	0.8%
Maintenance Subtotal	**$ 3,023**	**$ 151,140**	**71.2%**
Total OpEx[1] ($ 000's)	**$ 4,248**	**$ 212,403**	**100.0%**
Note:			
1. *US-36 Managed Lanes Toll Concession Project Pre-FC Technical Due Diligence Report v2.6.* Prepared by BTY Group, dated Feb. 18, 2014 (pg. 152)			

Table A-4: US-36 Estimated O&M Capital Expenditures at Financial Close

Major Renewal and Rehabilitation Expenditures Estimate (CapEx)	Avg. Annual	50 Year Total	% CapEx
US-36 (Phases 1 & 2)			
Paving	$ 421	$ 21,066	35.1%
Land Bridges	$ 94	$ 4,721	7.9%
Drainage	$ 11	$ 544	0.9%
Traffic and Safety	$ 128	$ 6,412	10.7%
Miscelaneous	$ 234	$ 11,706	19.5%
US-36 Subtotal	**$ 889**	**$ 44,448**	**74.1%**
I-25			
Paving	$ 153	$ 7,631	12.7%
Land Bridges	$ 84	$ 4,203	7.0%
Drainage	$ 4	$ 193	0.3%
Traffic and Safety	$ 4	$ 180	0.3%
Miscelaneous	$ 67	$ 3,352	5.6%
I-25 Subtotal	**$ 311**	**$ 15,559**	**25.9%**
Total CapEx[1] ($ 000's)	**$ 1,200**	**$ 60,007**	**100.0%**

Note:

1. *US-36 Managed Lanes Toll Concession Project Pre-FC Technical Due Diligence Report v2.6.* Prepared by BTY Group, dated Feb. 18, 2014 (pg. 154)

Elizabeth River Tunnel Project

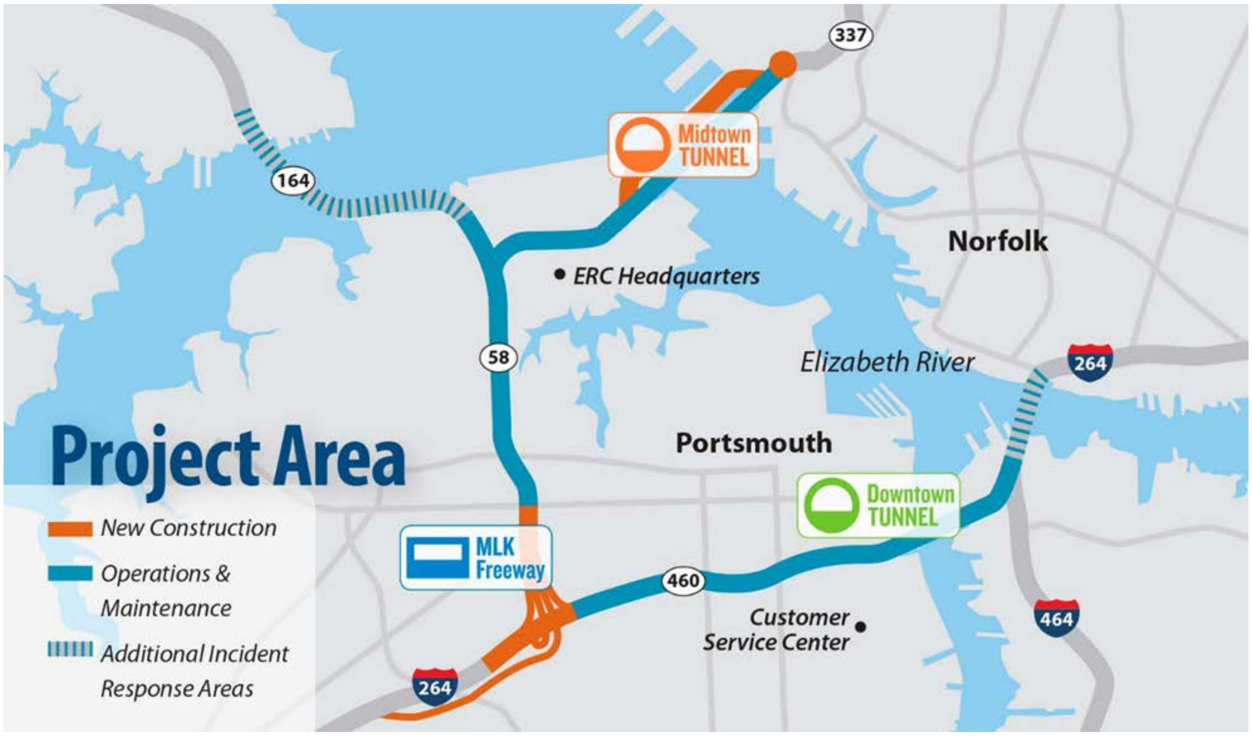


Figure A-4: Elizabeth River Tunnel Project Overview (Source: www.driveert.com)

The Elizabeth River Tunnel project is a $2.1 billion project that includes the construction of a new two-lane, mile-long tunnel that runs almost parallel to an existing tunnel—the Midtown tunnel—under the Elizabeth River, linking the cities of Norfolk and Portsmouth, Virginia. It also includes the extension of the Martin Luther King (MLK) highway, which is approximately a 0.8 mile extension of U.S. Route 58 that will connect two adjacent highways to improve circulation in the area's network. Furthermore, the project also includes the rehabilitation of the existing Midtown tunnel, as well as two other 'Downtown tunnels' crossing the southern branch of Elizabeth River (see Figure A-4). The new Midtown tunnel is only the second immersed concrete tunnel in the nation. The 58-year concession agreement was structured as a "revenue-risk" DBFOM in which the concessionaire assumes the O&M responsibility of all 4 tunnels once completed (the new and existing Midtown Tunnels, and the two Downtown Tunnels), along with approximately 5 miles of surrounding network roads connecting the tunnels and new MLK extension highway.

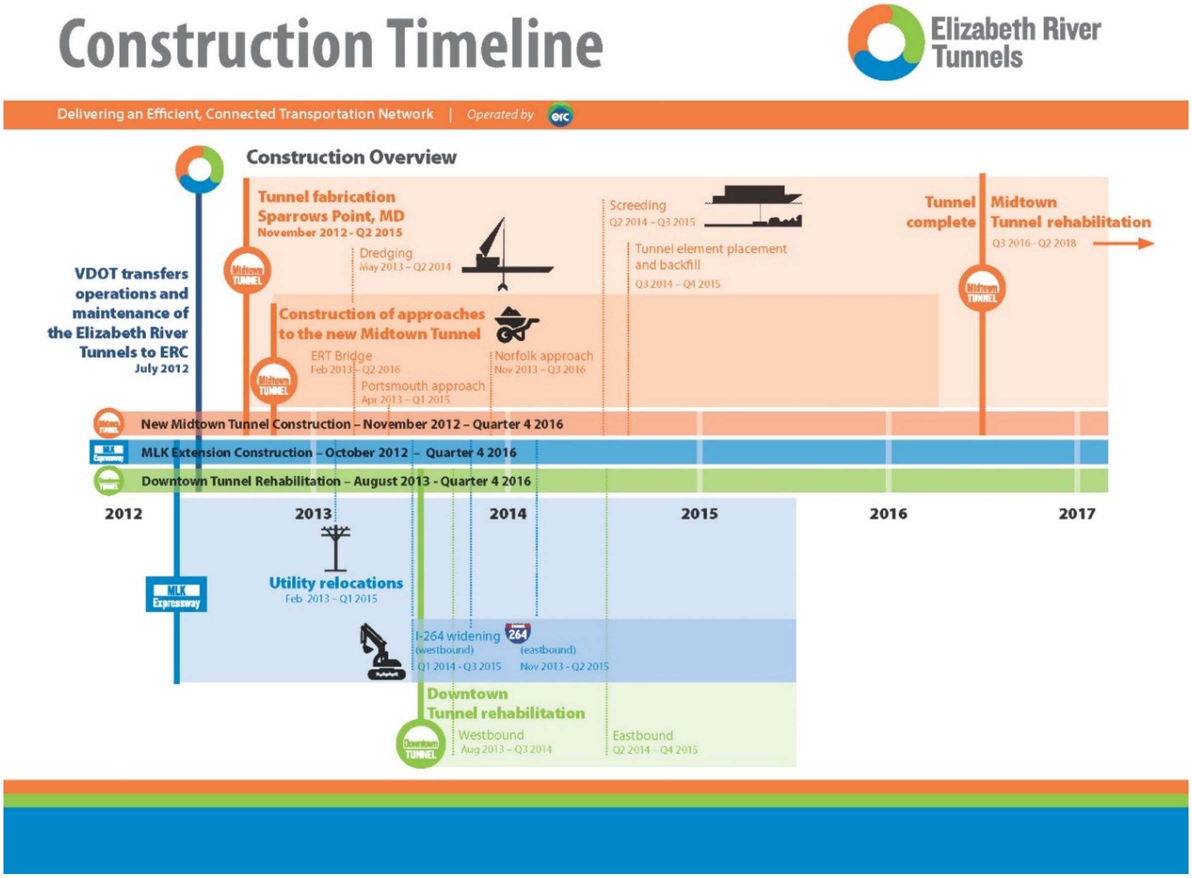


Figure A-5: Elizabeth River Tunnel Project Construction Timeline (source: www.driveert.com)

The timing of the P3 involvement in this project was at a very early design stage, particularly regarding the new Midtown tunnel design. A pre development agreement, referred to as an Interim Agreement in this project, was awarded during the environmental process for the project, prior to completion of the NEPA process. The state agency decided to 'bundle' the new Midtown tunnel, the MLK extension and rehabilitation projects as a single P3 project, and an EA that aggregated the three projects began. A solicitation for conceptual proposals to develop and operate the project was offered in 2008 and a sole bidder was awarded a pre development agreement that began the year after. At this point, the sponsoring agency and the developer began to work as "close collaborators in environmental review, final design, and engineering. They formed working groups to tackle environmental issues, utilities and right of way, communications, and others" (Parsons Brinckerhoff 2013). The sources of funding for the $2.1 Billion price tag of this project can be found in Table A-5 below.

Table A-5: ERT Sources of Funding (Source: www.driveert.com)

ERT Sources of Funding	P3
Federal Public	
ERT - TIFIA Loan	$ 422
ERT - TIFIA Loan Capitalized Interest	$ 43
State/Local Public	
ERT - Toll Revenues (During Construction)	$ 268
ERT - VDOT Subsidy	$ 408
Private	
ERT - Equity	$ 272
ERT - Senior PABs	$ 675
Grand Total	**$ 2,088**

The organizational structure for this project can be seen in Figure A-6 and Figure A-7. The difference with this project, in comparison to the other two case studies, if that the same SPV that was established (ERC), will be self-performing the O&M project activities throughout the 58-year concession, whereas both the Presidio Parkway and the US-36 project subcontracted the O&M responsibility.

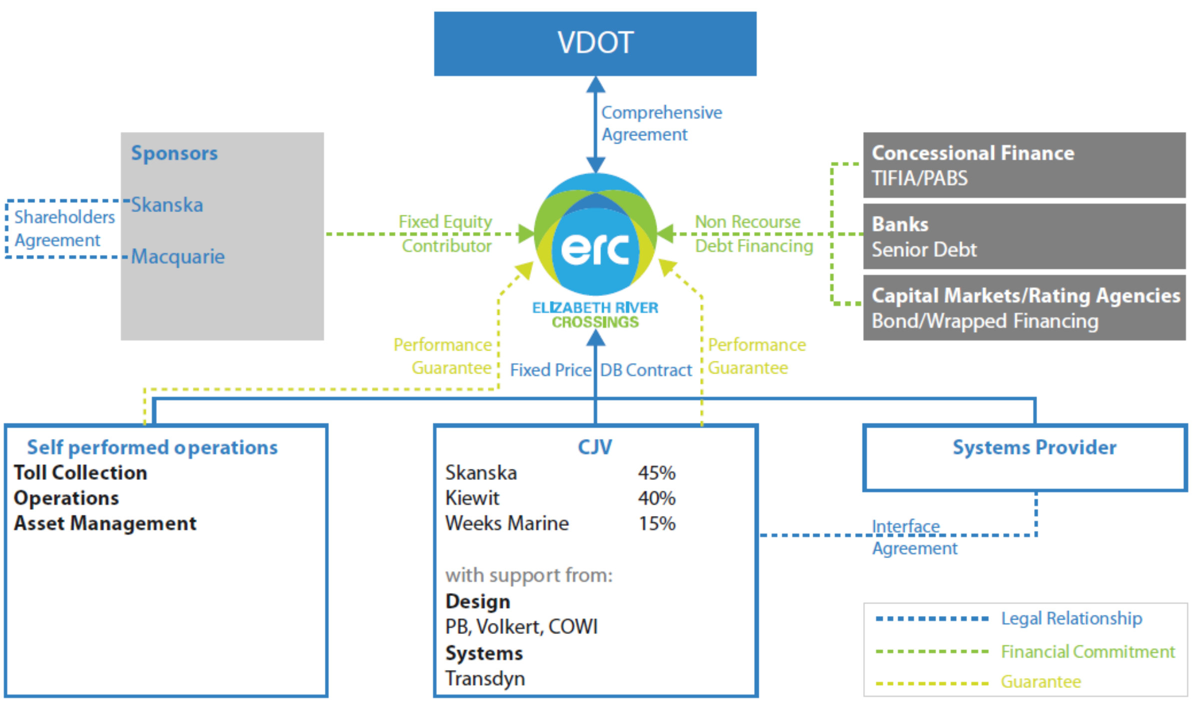


Figure A-6: Elizabeth River Tunnel Project Organizational Structure (Source: ERC (2008))

Figure A-7: Elizabeth River Tunnel Project Partnerships Overview (Source: www.driveert.com)

The following three tables have been modified to provide an overview of the estimated life cycle project costs for the project at the time that financial close was reached for this project. The estimates provided are the Design-Build Contract costs (Table A-6: ERT Design-Build Cost Estimate at Financial CloseTable A-6), routine O&M project costs (Table A-7Table A-3), and major renewal and rehabilitation project costs (Table A-8).

Table A-6: ERT Design-Build Cost Estimate at Financial Close

Direct Costs	Amount ($ 000's)	%Sub	%Total
New Midtown Tunnel	$ 435,728	59.2%	29.8%
New MT Tunnel Fabrication (Sparrows Point, MD)	$ 114,236	15.5%	7.8%
Existing Tunnels Rehabilitation	$ 56,600	7.7%	3.9%
MLK Freeway Extension	$ 129,501	17.6%	8.9%
Direct Subtotal	**$ 736,066**	**100.0%**	**50.4%**
Indirect Costs			
Bonds & Tax	$ 36,949	5.1%	2.5%
ROW	$ 12,715	1.8%	0.9%
Insurance	$ 33,896	4.7%	2.3%
Supervision/ Indirects	$ 109,722	15.2%	7.5%
Design & QA/QC	$ 144,619	20.0%	9.9%
Contingencies & Escalation	$ 244,908	33.8%	16.8%
Profit	$ 141,256	19.5%	9.7%
Indirect Subtotal	**$ 724,064**	**100.0%**	**49.6%**
Total Costs			
Total DB Cost Estimate @ Financial Close[1]	**$ 1,460,130**		100.0%

Notes:

1. *Independent Technical Advisor Report, DT/MT/MLK Extension Technical Due Diligence Findings* , Prepared by Arup, dated March 27, 2012 (pg. 45)

Table A-7: ERT Estimated O&M Operational Expenditures at Financial Close

Operations and Maintenance Expenditures Estimate (OpEx)	Avg. Annual	58 Year Total	% OpEx
Personel			
SPV Management	$ 1,625	$ 94,264	9.8%
Finance & Administration	$ 1,264	$ 73,295	7.6%
Information Technology	$ 955	$ 55,380	5.7%
Operation and Maintenance	$ 5,675	$ 329,178	34.1%
Construction Phase (Years 1 to 6)	$ 225	$ 13,037	1.3%
Personel Subtotal	**$ 9,744**	**$ 565,154**	**58.5%**
Consultants & Advisors			
Consultants & Advisors Subtotal	**$ 1,592.43**	**$ 92,361**	**9.6%**
Overhead			
G&A	$ 1,129	$ 65,502	6.8%
Utilities	$ 1,318	$ 76,429	7.9%
OH Subtotal	**$ 2,447**	**$ 141,931**	**14.7%**
Out-Sourced Services			
Services	$ 1,011	$ 58,624	6.1%
Tunnel Maintenance	$ 833	$ 48,325	5.0%
Bridges Maintenance	$ 68	$ 3,954	0.4%
Pavement Maintenance	$ 48	$ 2,810	0.3%
Roadside Maintenance	$ 74	$ 4,273	0.4%
Facilities Maintenance	$ 72	$ 4,147	0.4%
Vehicle & Equipment Maintenance	$ 192	$ 11,116	1.1%
ITS Maintenance	$ 495	$ 28,721	3.0%
Snow & Ice Maintenance	$ 90	$ 5,220	0.5%
Out-Sourced Services Subtotal	**$ 2,883**	**$ 167,189**	**17.3%**
Total OpEx[1] ($ 000's)	**$ 16,666**	**$ 966,635**	**100.0%**
Notes:			
1. *Independent Technical Advisor Report, DT/MT/MLK Extension Technical Due Diligence Findings* , Prepared by Arup, dated March 27, 2012 - Table 14 (pg. 107)			
All prices are in 2011 USD.			

Table A-8: ERT Estimated O&M Capital Expenditures at Financial Close

Major Renewal and Rehabilitation Expenditures Estimate (CapEx)	Avg. Annual	58 Year Total	% OpEx
CapEx			
Tunnels	$ 2,724	$ 157,974	35.2%
Bridges	$ 1,716	$ 99,553	22.2%
Pavement Interventions	$ 1,150	$ 66,686	14.9%
Roadside	$ 500	$ 28,997	6.5%
Facilities	$ 523	$ 30,349	6.8%
Vehicle & Equipment	$ 333	$ 19,337	4.3%
ITS	$ 794	$ 46,040	10.3%
Total CapEx[1] ($ 000's)	**$ 7,740**	**$ 448,936**	**100.0%**
Notes:			
1. *Independent Technical Advisor Report, DT/MT/MLK Extension Technical Due Diligence Findings* , Prepared by Arup, dated March 27, 2012 - Table 15 (pg. 108)			
All prices are in 2011 USD.			

APPENDIX B: Project Interview Protocols

EXTERNAL Interview Protocol:

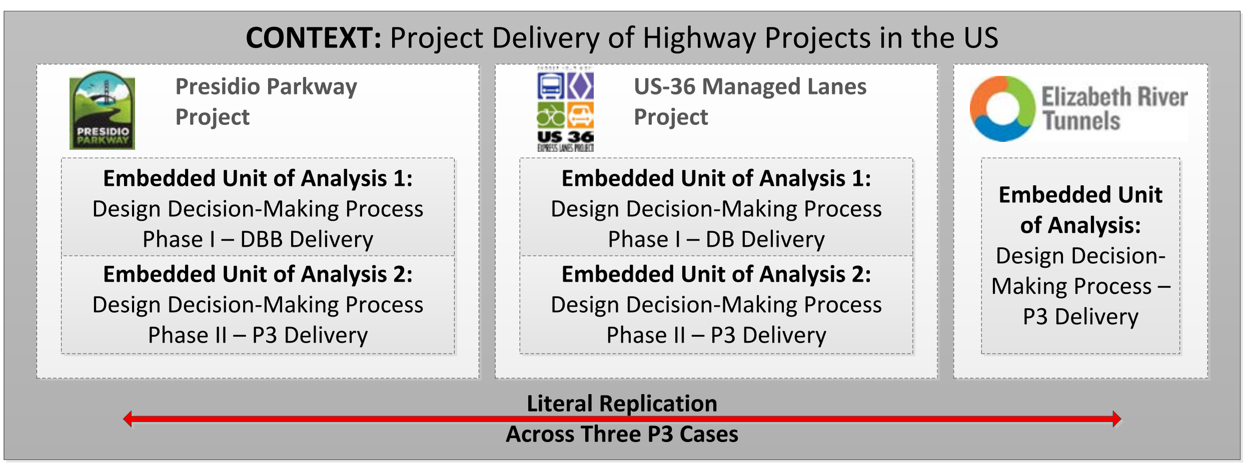
The Influence of P3s on the Life Cycle Design Decision-Making Process of Highway Projects in the US

Introduction and Purpose of Interviews:

Thank you for taking the time to participate in this research. By discussing your experience and knowledge on the project, your input is very valuable for us to better understand specific issues and characteristics of this particular project. Furthermore, drawing from your first-hand experience on *project life cycle decision-making processes* or on *general public-private-partnership (P3) processes*, we are able to understand this project better and to conduct a more *thorough*, *comprehensive* and *objective* data collection process.

Research Overview:

This research aims to explore and explain how P3s influence the life cycle design decision-making process of highway projects. This research proposes to do this through three case studies of P3 highway projects that allow for these type of decisions and considerations to be explored.



Studying these three P3 projects that have been strategically selected to represent a variation across similar delivery processes, will allow for similar observations to be inferred regarding the life cycle design decision-making process, and thus achieve what is referred to as literal replication.

Interview Process:

We anticipate the interview to take approximately 60 minutes. The interview has been organized to follow a semi-structured process based on the objectives of the study. Open-ended questions are used with some detailed issues that have evolved during the interviews that we would like to explore further. Do not feel restricted to elaborate and/or even add more details or topics we might be missing or should consider while discussing these questions, particularly if you feel they will strengthen our understanding of the processes being discussed.

Interview Topics:

The interview has been structured to discuss the following, interrelated, topics focused on the present case study:

- Part 1: Key P3 project characteristics that enable life-cycle design processes to evolve properly in this project
- Part 2: Specific life-cycle design considerations that have been implemented or considered in this project
- Part 3: Organizational aspects of the project that might influence the life-cycle design decision-making process in this project

Consent:

Note that your participation is voluntary and confidential, and you may withdraw yourself or your responses from the study at any time. Furthermore, with your consent, we would also like to audiotape the interview for later transcription and analysis. This will allow us to focus on the interview versus taking notes during the interview, and the transcripts allow us to go back and review the information from your responses thoroughly afterwards. We appreciate your participation and time, and look forward to meeting with you.

If you have any questions about this study either now or in the future you may contact Eric Antillon by email at eric.antillon@colorado.edu and by phone at 720-280-7894, Professor Amy Javernick-Will of the University of Colorado at Boulder by email at amy.javernick@colorado.edu and by phone at 303-492-6769, or Professor Keith Molenaar of the University of Colorado at Boulder by email at keith.molenaar@colorado.edu and by phone at 303-492-7317.

INTERNAL Interview Protocol (US-36 Sample):

Questions

The research topics have been structured into three, interrelated, topics to be explored.

- Part 1: Key **P3 project characteristics** that enable life-cycle design processes to evolve properly
- Part 2: Specific **life-cycle design considerations** experienced in this project
- Part 3: **Organizational aspects** of P3 projects that affect life-cycle design decision-making

Part 1: I would like to start by setting the context of the project to understand how the P3 procurement decision evolved in this project – whether an early or late P3 involvement was the case for this project. This also helps to position the design process within the project, was the design locked in? Was it phased? How was the design handled by the P3 developer? How mature or undeveloped was the design?

- P3 Project Characteristics
    - **Can you provide the setting or context for how the P3 procurement of this project was conducted?**
        - PROBES:
            - US-36 started as a design-build project, was the project always planned as a two phase project?
            - US-36 project participants for phase I and phase II design-build are the same: Ames/Granite and HDR. Has the P3 procurement changed the delivery of the second phase or is it a continuation/extension of the first phase (no difference)?
    - **Can you describe the project scope?**
        - Condition – a significant replacement of an existing highway (brownfield) with a significant amount of expansion
        - Complexity – amount of structural components, lane miles, operation of tolling systems, etc
    - **Can you describe the inter-relations with the DOT, particularly in thinking in regards to the design?**
        - PROBES:
            - Has the P3 process been an easy transition working with CDOT staff?
            - Has there been friction in implementing P3 processes? DBB-like behavior?
            - How experienced is your firm in working in P3 projects?
    - **Can you discuss the design development prior to the P3/DB involvement?**
        - PROBES:
            - CDOT's in-house design? CDOT's consultants?
            - Phasing of design? Degree of design?

EMERGENT TOPICS

- I-25 Express Lanes scope of work:
  - Bringing assets up to baseline performance
  - 20th St. Flyover Bridge
- E-470 Toll Collection
- O&M Transfield Contract for 20 years only
- Fluid transition from phase I to phase II with same DBJV
- ATC proposal process (during procurement ~120 ATC's proposed)

Part 2: This second part aims to address specific life-cycle design considerations that have been implemented in the project. Having set the context for the design process, how have life-cycle design considerations been implemented in this project? What specific examples are out there? What specific differences between one phase vs. the other in the case of a phased project?

- Life Cycle Design Considerations
  - **Can you discuss any specific design alterations that have been proposed by the P3 developer as a result of the P3 process implementation?**
    - PROBES:
      - Structural design alterations? Pavement?
      - System alterations? Traffic control systems?
  - **If so, can you discuss how that life-cycle consideration was implemented?**
    - PROBES:
      - Life-cycle phase being addressed?
      - Performance measurement
      - Level of detail?
  - **EMERGENT TOPICS**
    - Saw & Seal alternatives not implemented (MnDOT's approach to concrete pavement, no sealing)
    - I-25 flyover bridge with waterproof membrane
    - Roadway and Bike path geometric improvement discussions
    - Boulder Creek Bridge widening
    - Utilities/Path over US-36 near McCaslin
    - Striping options (result of new CDOT requirements)
    - ATC 19 – Pavement alternative to re-use existing pavement for phase II
  - Was the ATC/Best Value Process set up differently to incorporate Life Cycle Proposals than the DB/DBB process?
    - Evaluation Criteria
    - Technical Score

Part 3: For this aspect of the research, considering the integration achieved under a P3 delivery approach, we are interested in exploring the organizational aspects that influence the life cycle design decision-making process. As an exploratory format, there are two main concepts that are of particular interest:

- The organizational approach taken for the P3
    - The traditional construction and facilities management-led
    - The financer-led
- The financial leverage in the project
    - Project performance directly affects main project stakeholders
    - Risks are 'passed-down' directly to DBJV or O&M Contractor
- **What are your thoughts on the organizational benefits or efficiencies that the P3 structure allows for vs the DB phase in this project?**
- **What is the level of involvement of plenary in the project? Is there an active role in the DB process? O&M Process? Tolling operations process?**

    - **EMERGENT TOPICS**
        - Financial motivation/incentive with non-compliance points/penalties
        - Comparisons of CDOT's typical O&M approach vs. a P3's
        - Design process iteratively passed through Plenary/Transfield prior to CDOT (DBJV perspective)
        - Organizational efficiency/drawbacks (double check for DBJV)

APPENDIX C: IRB Approvals

University of Colorado Boulder

Institutional Review Board
563 UCB
Boulder, CO 80309
Phone: 303.735.3702
Fax: 303.735.5185
FWA: 00003492

22-Jan-2014

Exempt Certification

Antillon, Eric
Protocol #: 14-0001
Title: Presidio Parkway Case Study: A Case Study Comparing Conventional Project Delivery and Public-Private Partnership

Dear Eric Antillon,

The Institutional Review Board (IRB) has reviewed this protocol and determined it to be of exempt status in accordance with Federal Regulations 45 CFR 46.101(b). Principal Investigators are responsible for informing the IRB of any changes or unexpected events regarding the project that could impact the exemption status. Upon completion of the study, you must submit a Final Review via eRA. It is your responsibility to notify the IRB prior to implementing any changes.

Certification Date: 22-Jan-2014
Exempt Category: 2

Click here to find the IRB reviewed documents for this protocol: Study Documents

The IRB has reviewed this protocol in accordance with federal regulations, university policies and ethical standards for the protection of human subjects. In accordance with federal regulation at 45 CFR 46.112, research that has been approved by the IRB may be subject to further appropriate review and approval or disapproval by officials of the institution. The investigator is responsible for knowing and complying with all applicable research regulations and policies including, but not limited to, Environmental Health and Safety, Scientific Advisory and Review Committee, Clinical and Translational Research Center, and Wardenburg Health Center and Pharmacy policies.

Please contact the IRB office at 303-735-3702 if you have any questions about this letter or about IRB procedures.

Douglas Grafel
IRB Admin Review Coordinator
Institutional Review Board

University of Colorado Boulder

Institutional Review Board
563 UCB
Boulder, CO 80309
Phone: 303.735.3702
Fax: 303.735.5185
FWA: 00003492

APPROVAL

19-Feb-2015

Dear Eric Antillon,

On **19-Feb-2015** the IRB reviewed the following protocol:

Type of Submission:	Amendment
Review Category:	Exempt
Title:	Presidio Parkway Case Study: A Case Study Comparing Conventional Project Delivery and Public-Private Partnership
Investigator:	Antillon, Eric
Protocol #:	14-0001
Funding:	None
Documents Approved:	14-0001 Protocol (19Feb15);
Documents Reviewed:	HRP-213: FORM - Amendment;
Description:	- Study updated to include additional data collection cases/new subjects. No overall changes to procedures.

The IRB approved the protocol on **19-Feb-2015**.

Click the link to find the approved documents for this protocol: Approved Documents. Use copies of these documents to conduct your research.

In conducting this protocol you must follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,
Douglas Grafel
IRB Admin Review Coordinator
Institutional Review Board

APPENDIX D:ICSC '15 Conference Proceedings

5th International/11th Construction Specialty Conference
5e International/11e Conférence spécialisée sur la construction

Vancouver, British Columbia
June 8 to June 10, 2015 / *8 juin au 10 juin 2015*

THE INFLUENCE OF PUBLIC-PRIVATE PARTNERSHIPS ON DESIGN FLEXIBILITY AND DOWNSTREAM DESIGN FEEDBACK IN THE PRESIDIO PARKWAY

Eric I. Antillón[1], Amy Javernick-Will[2] and Keith R. Molenaar[3]
[1] Ph.D. Candidate, University of Colorado at Boulder, U.S.A.
[2] Assistant Professor, University of Colorado at Boulder, U.S.A.
[3] Professor, University of Colorado at Boulder, U.S.A.

Abstract: Public-Private Partnerships (P3s) offer the opportunity to improve integration among project stakeholders throughout a project's life cycle. Stakeholder integration, in turn, can enhance design decision-making process by focusing on the project's life cycle cost. The objective of this paper is to compare and contrast design decision-making in a P3 and design-bid-build (DBB) process to explore if life cycle considerations are better optimized under a P3 delivery method. To do this, we analyzed a project that included both P3 and DBB project delivery strategies—the Presidio Parkway. We collected data through 16 open-ended, semi-structured interviews with key project participants. We analyzed the data for design decision-making processes and found mixed evidence supporting the proposition that life cycle considerations can be better optimized under a P3 delivery method. Specifically, we found that the ability of the P3 contractor to influence project outcomes depends on the timing of the integration of the designer in a P3 and the degree of design criteria and flexibility allowed. In the case study analyzed, the P3 designer was able to influence downstream life cycle considerations, such as the operations and maintenance of the project; however, given the degree of definition of the design and the timing of integration of the P3 designer, it was not possible to influence the upstream design decisions. These findings allow researchers to better understand how P3s are being integrated from a design perspective and allow the public sector to realize how the timing and degree of definition of the design in P3s influences a concessionaire's ability to make life cycle design choices.

Introduction

The use of public-private partnerships (P3s) as an alternative project delivery method to deliver highway projects has become increasingly attractive over the past two decades. A P3 is defined as "a contractual agreement formed between a public agency and a private sector entity that allows for greater private sector participation in the delivery and financing of transportation projects" (FHWA 2013). P3s are a potential solution to close the increasing gap between transportation infrastructure costs and funding (Buxbaum and Ortiz 2009). Governments may use P3s to reduce pressure on government budgets, expedite financing, or facilitate innovation (AECOM Consult Team 2007), among others. Implementing P3s is commonly attributed to the improved services and better value for money achieved through appropriate risk transfer, encouraging innovation, greater asset utilization and integrated whole-of-life management (Fitzgerald 2004). Value for money is defined as the optimum combination of whole-of-life costs and quality (or fitness for purpose) of the good or service to meet the user's requirement (HM Treasury 2006). One of the reasons a better value for money is expected for P3 delivery is because of the ability of the private partner to implement cost-saving investments during the design and construction of a project that may lower the long-term life-cycle cost during the operations and maintenance (O&M) phase. The private partner is incentivized to use such strategies when the design and construction of a project is bundled with its O&M phase into a single contract (Blanc-Brude et al. 2009). Because stakeholders have the greatest ability to influence the long-term life cycle performance of a project during the design phase (Paulson 1976), 'life-cycle' decisions are expected to take place in the design phase. Of particular interest is how information from all project phases, including construction and O&M, is integrated and considered when making design decisions for the project. The flow of design information—specifically whether it flows as a sequential 'waterfall' from one phase to another, or whether the information is iterated back and forth in a 'whirlpool' fashion—is expected to greatly impact life cycle considerations.

While previous studies have focused on the comparison of P3 projects to traditionally procured projects by using initial cost and schedule performance metrics that do not extend beyond initial delivery or compare overall life cycle cost performance (Blanc-Brude et al. 2006, 2009; Chasey et al. 2012; NAO 2003; SAIC et al. 2006), this study will focus specifically on life cycle considerations in the design decision-making processes. Because most P3 projects are long-term arrangements that last between 30-99 years, the scarcity of projects available for analysis has made it difficult to draw life cycle conclusions (CBO 2012). However, by focusing on life cycle considerations in the design process, this paper can contribute to our understanding of the project characteristics or conditions that enable the enhancement of life cycle design decision-making processes. To do so, the research team analyzed the design decision-making processes in a single case study of a project that implemented both traditional DBB and P3 delivery.

Background

Project Delivery Methods

A project delivery method (PDM) refers to the contract methodology used to acquire and deliver the basic elements of any infrastructure project (Miller et al. 2000). It is "a process by which a project is comprehensively designed and constructed for an owner and includes project scope definition (concept and feasibility); 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" (Touran et al. 2009 p. 4). The manner in which these PDM functional elements are structured determines the PDM strategy that the owner of the facility will implement (Miller and Gerber 2012).

PDM strategies may be broadly categorized by the bundling of the procurement of the services needed to initially *deliver* the facility, and to provide its intended service, the *usage* of facility. These two phases, the delivery and usage, can be referred to as the relative life cycle phase responsibility (Chasey and Agrawal 2013). Increasing the private involvement through allocating different responsibilities increases the amount of risk assumed by the private sector during the delivery of a facility. Note that the finance element of a project is something that occurs throughout the life of a project, and the degree of responsibility for financing might vary depending on the contract terms of a project. By assigning such key functional responsibilities, a *segmented* versus *combined* ('bundled') PDM strategy is determined to deliver a project, meaning the bundling of these key functional elements. P3s are typically considered to be in between this range of the traditional 'segmented' delivery strategies, and fully privatized 'combined' strategies (Miller et al. 2000).

Public-Private Partnerships

A public-private partnership (P3) does not constitute a single PDM, and there are many delivery methods depending on how a P3 is interpreted. The literature on the definition and types of P3s is also vast (Hodge and Greve 2007, 2009). A P3 has been defined as an agreement between the government and one or more private partners in which the private partners deliver the service in such a manner that "*the service delivery* *objectives of the government are aligned with the profit objectives of the private partners* and where the effectiveness of the alignment depends on a sufficient transfer of risk to the private partners" (OECD 2008, p.8). More strictly, using the appropriate terminology of PDMs discussed above, P3s for this study are classified as those whose functional life cycle phases are combined, the delivery and usage of the facility, and for which finance is also part of the risk transferred, primarily the Design-Build-Finance-Operate-Maintain (DBFOM) type of PDM.

To put into perspective the P3 environment in the US, one of the most recent published summaries from a major projects database (PW Financing 2014) indicates that there have been only 30 transportation P3s in the US, dated from 1993 through September 2014. Out of these 30 projects, 17 are currently under operation, and the rest under construction. Also, only 21 of these projects have been carried out under this described DBFOM delivery strategy, whereas the rest are leases (i.e. Chicago Skyway) (n=5) and build-own-operate (BOO) projects (n=4), which are not considered to be P3s per the definition established for this study. Furthermore, 8 of these DBFOM transactions have been structured under an availability-based payment mechanism (DBFOM-avail.) over the past few years, and the rest have been structured as direct-toll payment structures or similar (DBFOM-toll). The number of projects that would allow for the intended research on P3 projects to be conducted in this study is very limited.

Life-Cycle Design

Project stakeholders have the greatest ability to influence the long-term life cycle performance of a project during the design phase. The concept of how design decision-making influences the long-term cost performance of a project and how the level of control over those costs decreases as the project evolves has been long understood by many industries. Paulson's well-known "cost influence curve" (Paulson 1976), shows how the level of influence that decisions made in the earlier phases of a project's life cycle phase have a much greater influence on project outcomes, at a minimal fraction of the cost of the project's complete life cycle cost. By the time construction is completed the influence that any decision might have on the remaining life cycle of the project is minimal, if any, and might be a considerably large capital expense at that point.

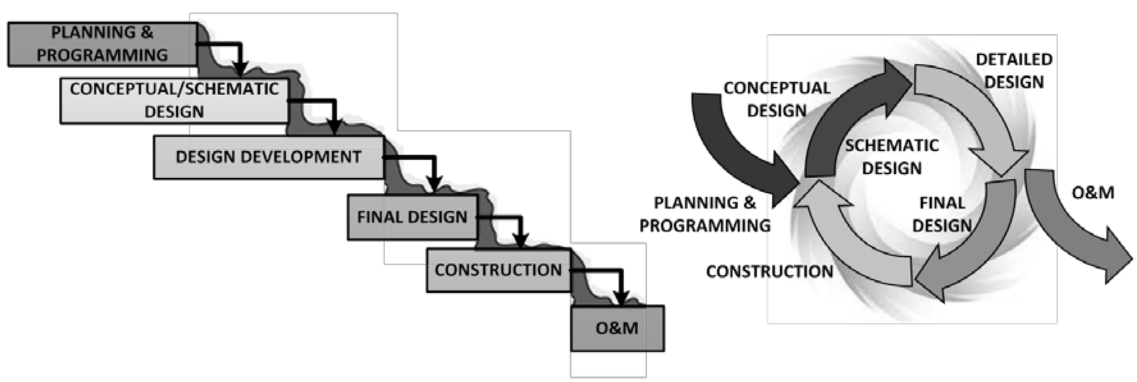


Figure 1: A Sequential 'Waterfall' (left) vs. an Iterative 'Whirlpool' Design Process (right)

The traditional DBB design process can be compared to a linear 'waterfall' approach in which, given the segmented approach of each functional element, each phase is optimized for personal benefit (Thomassen 2011). The concept of a waterfall design process has emerged from the discussion of software development processes (Royce 1970). The general idea of such processes is that it can be considered to be an extremely inflexible design process, where inflexibility is characterized by frozen outcomes and sequential processes (Weisert 2003). As shown in Figure 1, this suggests that ideas and feedback for design decisions only flow to downstream activities but may not be fed upstream; furthermore, the inability of starting later phases in which other project participants get involved and may provide valuable life cycle feedback to the design process, alters the design.

Alternative PDMs on the other hand, such as design-build, and even more so in what can be considered to be a fully ‘combined’ PDM strategy, such as P3s, control of the design is removed from the engineer and given to the entire team. As opposed to the waterfall model, working in a complete linear fashion, in a P3, the design process is considered to be iterative ‘whirlpool’ process, with significant “over-the-shoulder” design reviews by the contractor, financier, operator, and, to some extent, the owner (Hatem and Gary 2013). The ability of having input into the design by other project stakeholders involved in different phases of the project life-cycle, provides the opportunity to better optimize the functionality of the project to improve a project’s overall life cycle performance.

Research Methodology

The research methodology for this study was an *embedded single-case study design* methodology (Yin 2009), as shown in Figure 2. The case study methodology was selected because the case study selected, the Presidio Parkway project discussed further below, was a *revelatory* case (Flyvbjerg 2006), meaning that it was a P3 project with a unique contextual setting that allowed for the opportunity to study the design process under special circumstances. Specifically, the case allowed for a side-by-side comparison of two delivery strategies—design-bid-build and P3—implemented to construct the Presidio Parkway Project in the US. This research analyzed the design decision-making processes within each of the two phases of this project, delivered under each respective PDM.

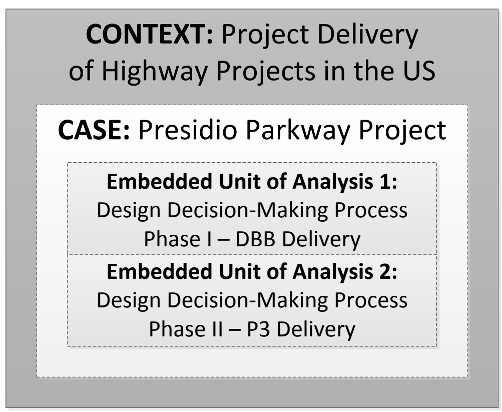


Figure 2: Embedded, Single-Case Study Design

Case Study Setting and Unit of Analysis

There have been limited transportation P3 projects in the US in the last 20 years, with only 21 existing projects delivered under a DBFOM-type of P3. To select the appropriate projects for this study, P3 projects whose design phase was on-going or recently finished were targeted. The Presidio Parkway Project, located in San Francisco, CA, was selected as the case for this study. This particular project was split into two phases delivered under different PDM strategies: Phase One was delivered as a traditional Design-Bid-Build (DBB), and Phase Two was continued as a P3 (DBFOM-type). The P3 developer for this project also assumes operations and maintenance for both phases after initial delivery of the project for a contract term of 30 years. This particular case became a project in which two design processes were considered under each respective delivery mode, and therefore the design processes were chosen for analysis to compare the influence of PDM strategy on design decision-making. Data was collected during the spring of 2014, when the design of the project was almost complete. *The design processes were treated as embedded units of analysis within a single case, given that they were part of the same project*.

The project's condition can be considered to be a 'hybrid' project, meaning that it is not a brownfield nor a complete greenfield project since it is adding a significant amount of structures as well as the replacement of most of the existing facility. The project is approximately a 1.5 mile long road with a significant amount of structures, with four cut-and-cover tunnels, six bridges, and three interchanges split between the two phases. Furthermore, the P3 delivery of the project was structured as an availability-based payment mechanism, as opposed to a toll-revenue P3 mechanism.

Data Sources

This research collected data from project participants by conducting semi-structured interviews. This research analyzes the data collected from the interviews, which were the most in-depth source of data. A total of 16 on-site interviews were conducted, with 20 different participants. The interviewees were targeted to represent a broad spectrum of all stakeholders involved in the project, particularly those that could have the knowledge to discuss design issues experienced in this project. Table 1 lists the organizational role and project role for each of the participants.

Table 1: Description of Case Study Project Interviewees

Pseudonym(s)	***Project Phase***	***Organization***	***Project Role***
Waller & Clayton	Phase I & II	Public	Project Sponsor CM
Octavia	Phase I & II	Private	Project Sponsor Consultant
McAllister	Phase II	Private	Project Sponsor Consultant
Shrader	Phase I & II	Public	Project Sponsor PM
Eddy	Phase II	Private	P3 O&M Provider
Valencia	N/A	Public	External Organization
Lombard	Phase I & II	Public	Project Sponsor PM
Polk	Phase I	Public	Project Sponsor Engineer
Larkin	Phase II	Private	P3 Developer Management
Ellis	Phase II	Private	P3 DBJV Manager
Green	Phase I & II	Private	Project Sponsor Consultant
Sutter & Geary	Phase I & II	Public	Project Sponsor Engineers
O'Farrell & Hayes	Phase I	Public	Project Sponsor Engineers
Hyde	N/A	Public	External Organization
Jackson & Scott	Phase II	Private	P3 Engineering-Designer
Vallejo	Phase I & II	Public	Project Sponsor PM

The research team conducted exploratory, semi-structured, in-depth interviews. The format employed was meant to develop ideas and research hypotheses rather than to gather facts or statistics. Determining the number of interviews to conduct was dependent on reaching theoretical saturation, when new information was no longer mentioned. As a result, quality was preferred over quantity (Oppenheim 1992). As Oppenheim (1992, p. 67), explains, "the job of the depth interviewer is thus *not* that of data collection but *ideas* collection." Using this approach, interviewees were asked about the design decision-making process on each phase of the project and conditions that may have enhanced or constrained life cycle considerations in the design. The semi-structured interviews began by asking directly how the choice of project delivery method had influenced the life cycle design decision-making process, particularly, characteristics of life cycle design were explored, including the integration of life cycle functional properties (Design, Construction, O&M, Reconstruction and/or End-of-Life properties).

Data Analysis

The research team used QSR Nvivo software to organize and analyze the data. The interviews were audio-recorded, transcribed into text, and imported into the software. Over 17 hours of recorded audio time for the interviews shown in Table 1 resulted in over 215 pages of text, after all audio files were transcribed word-by-word. The data was systematically coded to identify significant patterns following the coding process described by Miles et al. (2013). The coding process was primarily driven by two 'cycles' that allowed the researchers to draw conclusions from the interviews regarding the life cycle design decision-making process as experienced in this case. The first cycle of coding was an organizational, or structural approach to sort appropriate data into macro-categories for further analysis. Following this process, a more explicit identification of the content in the interviews allowed for more a 'substantive' and 'theoretical' description of the data to be analyzed more in line with the research objectives. For example, one of the interviewees, when discussing the life-cycle design considerations in phase two: *"I think this project has not had as much leeway for innovation as what I think of is a typical P3, or a typical design-build project might, because we have been more confined by what was done in phase one of the project with respect to the design. So in some ways I sort of feel like there has been a little bit less innovation on this project than I would have expected."* This section of the interview was coded to themes of 'innovation' and 'design flexibility'.

Following the initial coding, the data was then further analyzed. During this process, we focused on explanation building (Yin 2009). Specifically, we focused on how the theoretical proposition of this study was either supported or challenged from the data collected. The theoretical proposition was: *Design information in a segmented PDM strategy flows one-way, downstream in a sequential design process in which no downstream design feedback may be incorporated into upstream design activities. In a combined PDM strategy, an iterative overlapping design process allows for a two-way information exchange between upstream and downstream design activities, thereby allowing for life cycle design to be better optimized.* This paper describes and explains what has happened in this single case, regarding the stated proposition. This includes interpreting and mapping the results from the case study to this proposition in order to understand it from this single case (Eisenhardt 1989).

Findings

The Presidio Parkway had a significant amount of overlap between phase one (DBB) and phase two (P3). As a result, while the project provided an ideal laboratory setting for analyzing two different delivery methods under similar settings, the overlapping sequence of processes also created constraints for attributing differences and similarities solely to one PDM strategy employed. However, the researchers were able to identify project characteristics that influence life cycle design decisions under a P3. These characteristics are explained as the timing of implementing a P3 in a project during its development, and the design flexibility of the project. Furthermore, as part of using this case study to explain the life-cycle design decision-making process under a P3 delivery strategy, examples of downstream design feedback are also discussed. These examples are related to the design feedback that benefited constructability and the O&M phase of this project.

Timing of P3 Implementation

When the interviewees were asked about design decisions, all participants indicated that the unique phasing of the delivery methods limited the ability of the P3 designer to influence the design and consider life cycle aspects. In this case study, the P3 developer entered the project after many design decisions had been made. As Hayes shared, *"just because phase one was already built, a lot of ground work was done for the P3 group, the developer, and in the contract we have some language that phase two has to be similar to phase one. So pretty much it takes the innovation out of the developer."* Other interviewees indicated that, if a P3 project is to benefit from the private sector's innovations, the P3 developer has to have the ability to alter the design and be able to provide value engineering input. As a result, the definition of the design requirements and its implications for design flexibility must be given thoughtful consideration upfront by the public sponsors. A recent report (Parsons Brinckerhoff et al. 2013) indicated that the private sector may be able to best define and incorporate design alternatives based upon life cycle considerations in a highway project prior to the conclusion of the environmental clearance process. On the other hand, a 'post-environmental clearance' P3 procurement may reduce the ability of the P3 developer to propose alternative technical concepts (ATCs) that will influence life cycle design optimization decisions significantly.

Design Flexibility

Interviewees' also indicated that contract specifications limited the design flexibility of the project. These contract specifications are the contract documents in which the owner communicates a project's requirements and how conformance with those requirements will be measured, as thus, determine the amount of flexibility allowed in the design (Loulakis 2013). The degree of specifications varies from performance-based specifications (PBS) that describe the final product based upon operational characteristics, and thus offer the P3 contractor a greater degree of flexibility in how to achieve the final product; to 'prescriptive' specifications that explicitly describe the final product in terms of component materials, dimensions, tolerances, weights, and even required construction means and methods, thus giving the owner maximum control of the project (FHWA 2004). For this project, the P3 design process was considered to be relatively prescriptive. As McAllister indicated, *"I think it [this project] is rather prescriptive for a P3 project because it is supposed to mimic the look of the other side so there isn't really a lot of flexibility… innovation is probably coming from the means and methods, but in terms of appearance there isn't really a lot you can play with."*

Because the P3 delivery finished a project half-built under a DBB, the design specifications had to be prescriptive for this project: *"You don't want to be too prescriptive, in fact you don't want to be prescriptive at all; however, in this situation there has to be some prescription… using these contract documents is a challenge. You don't want to restrict things too much but then, at the same time, you want to make sure what they are going to build is a mirror image of what is already there."* From a life cycle design perspective, the ideal setting for a P3 is when 'degrees of freedom' are given to the P3 designer to meet a functional need without limiting the design parameters that the designer might propose. Overall, the timing of the P3 and the contractual specifications of the project greatly affected the P3 developer's design flexibility. One interviewee, Green, indicated that the limitations inherent in brownfield projects may always limit design flexibility and that the optimal conditions for considering lifecycle within the design are Greenfield projects: *"Maybe the most beneficial application of a P3 is where you have more of a Greenfield project where there is a lot of flexibility, so as what the franchise can do meeting a fundamental need, but flexibility to kind of start from scratch as to what it is they can do and innovate more"*.

Downstream Design Feedback

The timing of P3 implementation and the design requirements for this project limited the ability of the P3 developer to alter the early, upstream design. However, downstream from the design phase, particularly constructability issues and O&M processes benefitted from the life cycle considerations used by the P3 team.

Constructability

Within the P3 delivery strategy, the developer subcontracted the design and construction of the project. As previous studies have shown (SAIC et al. 2006), constructability reviews are typically incorporated into the design phase on P3 projects, thus enhancing the construction phase of projects. Within this project, we compared the approaches taken to construct the piles for the project's viaducts. In phase one, under the DBB approach, the project sponsors were 'conservative'—they did not want to take any risks in having the piles fail and therefore 'over designed' the piles. One of the project sponsors, Waller, explained their approach in phase one for this particular example: *"we designed it a full depth casing because [the department] didn't want to take a risk, if we had historic buildings next to our new bridge, we couldn't do any pile driving because we would collapse the building, so we said 'let's drill down a full depth casing…' we took an extremely conservative route plus we didn't want to have a 12 foot diameter hole collapse on us."* Under this phase the sponsors did not try to optimize or make the design and construction process more efficient, from an economical perspective. In comparison, under the P3 delivery, phase two, the contractors chose a different design to eliminate the need for casings, as Ellis indicated: *"we didn't have the permanent case because our designers didn't think that we needed that, we added rebar, and we did something to eliminate the need for permanent casings."*

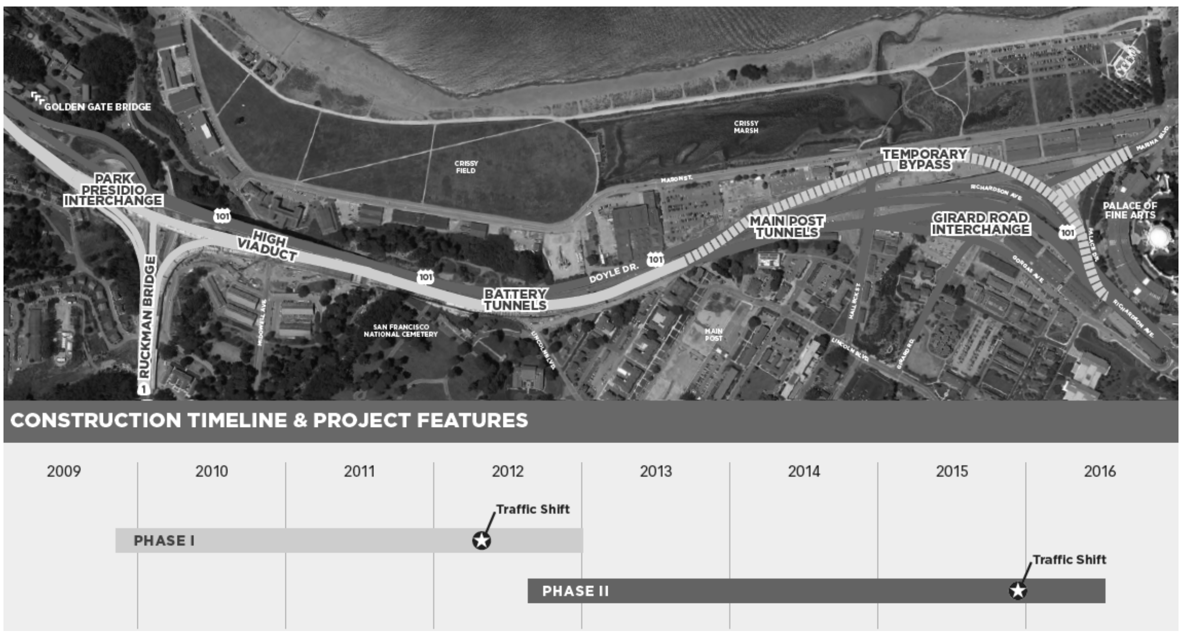


Figure 3: Presidio Parkway Construction Overview (Source: www.presidioparkway.org)

This specific example shows how a project component was approached differently under different PDM strategies. The following excerpt from one of the interviews with the public sponsors, Clayton, highlights how this difference is reflected by their 'motivations': *"We were under pressures, but different pressures, so it is kind of interesting because, okay, this is Doyle drive, this is kind of a high profile job in the Bay Area in the State of California so we were both under pressure but for different reasons. We want to get to seismic safety, we didn't want to delay the P3, it costs us money to delay plus we don't get the seismic safety traffic switch which is important for public safety. They had different reasons, they want to get done, they have a banker, their financier's saying 'hey when are you going to get done, pay us back?' So that is kind of interesting, we have pressures but for different reasons."* Looking at this comparison, the motivations that drive these particular design decisions can be appreciated. In one phase, 'safety' drove the decision to build the piles with a permanent casing. Phase one's more 'conservative' design approach can be argued to be driven by an underlying motivation to reduce all risk of potential failure which may delay the achievement of seismic safety, given the importance of this particular arterial road in the region for public safety. In phase two, the decision to eliminate permanent casings can be argued to be driven by an underlying motivation that resulted in a more economically efficient design, and that significantly reduced the time to construct the second high viaduct, given the financial pressure that the P3 team experienced.

Operations & Maintenance

During the construction of phase two, the O&M provider began operations for the scope of work delivered in phase one. As a result, there was in-depth integration of the O&M service provider with the P3 design-build team in phase two, allowing the O&M team to provide significant feedback to the designer as they began the operations of the complex facility. As discussed, the overlapping of the project phases (phase one and phase two) allowed for the O&M phase to begin during the construction of phase two. *"In most projects you don't normally get that and [the P3 designer] would tell us all day long, 'we never really get to talk to the end user and how they want it configured, how they want it to function, you know, do you want it to do this? or do you want it to do this?' And those are all the conversations that we have on a weekly basis"* commented one of the O&M contractors, Eddy.*"So those are the things that we are pushing for and we are getting on this project, but those things may not have been thought of in phase one, because hey guess what? In most cases, in most typical delivery, you never really talk to the end user, and say 'I like your design, but me getting out there to access or do what I need to do out there could be done in a little different way, it isn't going to cost more money, it's just a little different way to do it and you can take into account what my needs are at the end of the day.'"*

This particular response has been provided to show the type of conversations that the O&M provider is having with the P3 designers in order to benefit the O&M phase of the project for both phase one and phase two scopes of work. Phase one might have not considered the operability as in-depth, including the systems that were installed for traffic management in one of the tunnels, as much as phase two was able to incorporate. The 'systems' of this project, considering the fact that this project is more a 'tunnel' project than it is a road project, were a very important component. Having four tunnels that the O&M contractor is responsible for, which carry over 100,000 vehicles, average daily traffic, and this being the main artery connecting the North Bay to the San Francisco through the Golden Gate Bridge shows the importance of the systems in this project. This same interviewee, Eddy, commented: *"a lot of times I think phase one was built as a roadway project and not necessarily a tunnel project which has a lot of more intricacies in terms of how traffic is managed, how the systems in the tunnel are managed, everything from the lights system to the fire alarms to the CCTV cameras and how that all talks and communicates together… but I think the real benefits are in the systems and devices and how that is used and that is I think something that is kind of in the back, that a lot of people don't understand. That is where your bang is, your bang for your buck is there. In terms of the systems and how they operate, how they all intercommunicate together and how we get things off the roadway."*

This second example shows the O&M phase, being a downstream phase from a life-cycle perspective, being enhanced by the P3 strategy in this project. Having the O&M operator being closely aligned with the P3 designer, specific design input regarding the systems of the tunnels, for example, were design feedback that was incorporated to improve the operability of the project. This in turn, enhances the long-term performance of the project overall from an operations perspective.

Conclusions and Future Work

This study explored and presented initial findings from how life cycle design decision-making processes are influenced by project delivery methods in the embedded case study of the Presidio Parkway project. P3s are considered to be the most integrative and 'combined' project delivery strategies to deliver infrastructure projects. Through the analysis of interviews conducted with project participants we found that the timing of P3 implementation, the degree of design flexibility, and the degree of overlap between the O&M and design-build team influences the ability to consider life cycle perspectives and private sector innovations during the design.

These initial findings are limited to the single case study of this project. Ongoing work will extend these findings by analyzing life cycle considerations in the design phase on two additional P3 transportation projects in the US, and by conducting a cross case comparative analysis. To conduct this analysis, we will select projects to analyze based upon characteristics such as the technical complexity of the project (i.e. structure-heavy project vs. a road project), the DBFOM payment mechanism (i.e. direct tolls vs. availability payment), the project condition (i.e. greenfield vs. brownfield), and the organizational structure of the project (i.e. a fragmented vs. integrated structure, and financial leverage).

References

AECOM Consult Team. 2007. "User Guidebook on Implementing Public- Private Partnerships for Transportation Infrastructure Projects in the United States, Final Report, Work Order 05-002." Washington, D.C.

Blanc-Brude, F, H Goldsmith, and T Valila. 2006. "Ex Ante Construction Costs in the European Road Sector: A Comparison of Public-Private Partnerships and Traditional Public Procurement." *Economic and Financial Reports / European Investment Bank*, No. 2006/01

Blanc-Brude, Frédéric, Hugh Goldsmith, and Timo Välilä. 2009. "A Comparison of Construction Contract Prices for Traditionally Procured Roads and Public–Private Partnerships." *Review of Industrial Organization* 35 (1-2) (October 14): 19–40. doi:10.1007/s11151-009-9224-1.

Buxbaum, Jeffrey N., and Iris N. Ortiz. 2009. "Public-Sector Decision Making for Public-Private Partnerships: A Synthesis of Highway Practice, NCHRP Synthesis 391." Washington, D.C.

CBO. 2012. "Using Public-Private Partnerships to Carry Out Highway Projects." *Congressional Budget Office*.

Chasey, Allan D., and N. Agrawal. 2013. "A Case Study on the Social Aspect of Sustainability in Construction." In *ICSDEC 2012*, edited by ASCE, 543–551. Forth Worth, TX: Proceedings of the 2012 International Conference on Sustainable Design, Engineering, and Construction.

Chasey, Allan D., William E Maddex, and Ankit Bansal. 2012. "A Comparison of Public-Private Partnerships and Traditional Procurement Methods in North American Highway Construction." In *TRB Annual Meeting 2012*. Washington, D.C.: Transportation Research Board.

Eisenhardt, M. 1989. "Building Theories from Case Study Research." *The Academy of Management Review* 14 (4): 532–550.

FHWA. 2004. "Performance Specifications Strategic Roadmap: A Vision for the Future, Spring 2004 - Updated: Nov. 26, 2013." *Federal Highway Administration*.

Fitzgerald, Peter. 2004. "Review of Partnerships Victoria Provided Infrastructure Partnerships Victoria - Review." Melbourne, Australia.

Flyvbjerg, Bent. 2006. "Five Misunderstandings about Case-Study Research." Qualitative Inquiry: 219–245.

Hatem, David J., and Patricia B. Gary. 2013. *Public-Private Partnerships: Opportunities and Risks for Consulting Engineers*. American Council of Engineering Companies.

HM Treasury. 2006. "Value for Money Assessment Guidance." London.

Hodge, Graeme A., and Carsten Greve. 2007. "Public-Private Partnerships: An International Performance Review." *Public Administration Review* 67 (3) (May): 545–558. doi:10.1111/j.1540-6210.2007.00736.x.

———. 2009. "PPPs: The Passage of Time Permits a Sober Reflection." *Economic Affairs* 29 (1) (March): 33–39. doi:10.1111/j.1468-0270.2009.01864.x.

Loulakis, MC. 2013. "Legal Aspects for Performance-Based Specifications for Highway Construction and Maintenance Contracts." *National Cooperative Highway Research Program (NCHRP).*

Miles, Matthew B., A. Michael Huberman, and Johnny Saldaña. 2013. *Qualitative Data Analysis - A Methods Sourcebook*. 3rd Editio. SAGE Publications, Inc.

Miller, John B., Michael J. Garvin, C. William Ibbs, and Stephen E. Mahoney. 2000. "Toward a New Paradigm: Simultaneous Use of Multiple Project Delivery Methods." *Journal of Management in Engineering, ASCE* 16 (3) (May 1): 58–67. doi:10.1061/(ASCE)0742-597X(2000)16:3(58).

Miller, John B., and Joel K. Gerber. 2012. "Advanced Project Delivery: Improving the Odds of Success - How Roles Differ for Owners and Lenders with Changes in Delivery Method." In *2012 Annual Meeting of the ABA Forum on the Construction Industry*. Las Vegas, NV.

NAO. 2003. "PFI: Construction Performance, Report by the Comptroller and Auditor General HC 371 Session 2002-2003." HC. London, UK.

OECD. 2008. "Public-Private Partnerships: In Pursuit of Risk Sharing and Value for Money." *Organisation for Economic Co-operation and Development*.

Parsons Brinckerhoff, Nossaman LLP, and HS Public Affairs. 2013. “SHRP 2 C12: The Effect of Public-Private Partnerships and Non-Traditional Procurement Processes on Highway Planning, Environmental Review, and Collaborative Decision Making (Prepublication Draft Dated April 26, 2012).” *Transportation Research Board*, National Academies, Washington, D.C.

Paulson, BC. 1976. “Designing to Reduce Construction Costs.” *Journal of the Construction Division, ASCE* 102 (4): 587–592.

PW Financing. 2014. “Public Works Financing - September 2014.” *Public Works Financing* 296.

SAIC, AECOM, and University of Colorado at Boulder. 2006. “Design-Build Effectiveness Study - As Required by TEA-21 Section 1307 (f).”

Thomassen, Mats. 2011. “BIM & Collaboration in the AEC Industry.” Aalborg University.

Touran, Ali, Douglas D. Gransberg, Keith R. Molenaar, Kamran Ghavamifar, D.J. Mason, and Lee A. Fithian. 2009. “TCRP Report 131: A Guidebook for the Evaluation of Project Delivery Methods.” *Transportation Research Board*, National Academies, Washington, D.C.

Yin, Robert K. 2009. *Case Study Research: Design and Methods*. Fourth Edi. Thousand Oaks, California: Sage Publications, Inc.