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DEVELOPING A FRAMEWORK FOR EX-POST VALUE FOR MONEY ANALYSIS IN PUBLIC PRIVATE PARTNERSHIP PROJECTS

Final Report

by

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DISCLAIMER

TABLE OF CONTENTS

APPENDICES

EXCUTIVE SUMMARY

In recent years, Public Private Partnerships (PPPs) has emerged as a project delivery option for transportation projects in the US. This type of project delivery is generally a long term agreement between the public and private sectors for the purpose of delivering a project or service traditionally provided by the public sector. Some of the reasons for implementing PPPs are the ability to provide an overall lower life-cycle cost and to increase cost and schedule certainty. This is sometimes referred to as the ability to provide a better Value for Money, hence the use of Value for Money (VFM) analyses to compare overall financial impacts of PPP against those of a traditional delivery alternative. While the VFM analysis is considered as the best practice for selecting PPP approach, the primary challenge in conducting the analysis, however, is to validate the empirical results of these studies. Most of the previous studies have investigated ex-ante results and little has been done in regards to what can be considered ex-post studies. This study presents a framework for ex-post value for money analysis. Processes, data requirement, and algorithms are developed to ensure an ex-post assessment can be performed at various stages of PPP project development including commercial close, substantial completion, during operation and maintenance phase, and final acceptance. A hypothetical project based on various real world PPPs will be used as a case study to illustrate the method and procedure of ex-post VFM analysis framework.

1.0 INTRODUCTION AND OVERVIEW

1.1 OVERVIEW

Transportation agencies have increasingly considered the use of public private partnerships (PPPs) as an alternative project delivery method for public projects. This trend has been largely driven by a shortage of public funds, greater cost certainty and the perceived ability of PPPs to lower life-cycle costs–the ability to offer better value for money.

The Value for Money (VFM) analysis is typically used to compare aggregate benefits and costs of the PPP approach against those for the traditional public delivery alternative, which is typically Design-Bid-Build (DBB).

However, the effectiveness of PPP is not known; this is because, to date, only ex-ante VFM analysis has been performed, without validation from ex-post evaluation. The studies that have been completed in other countries show mixed and controversial performance of PPP practices. For instance, positive results were found for PPPs in terms of cost and time efficiency when Grimsey and Lewis (2005) examined major infrastructure projects in the United Kingdom and similar positive results for PPPs were reported from the comparison of 21 PPP projects in Australia by Raisbeck et al. (2010). However, other studies, such as Murphy (2008), Kakabadse et al. (2007), and de Neufville et al. (2010) illustrated numerous examples of PPPs failing to deliver value for money.

These early works reported on multiple projects and ignored the unique contextual aspects of each project. Because projects are greatly influenced by project specific characteristics that go beyond procurement options, including, but not limited to location, organizational structure, technical complexity, and societal dimensions, it is important to consider these characteristics.

This document aims to give an overview of how ex-post value for money analysis can play an integral role in future decision making process for PPP projects and will outline several of the most important aspects of ex-post value for money framework. The main purpose is to provide a resource for public agencies on VFM analysis in PPPs by exploring the state of the practice...

1.2 IMPORTANCE OF TOPIC

The majority of research and studies on VFM of PPPs have focused on the ex-ante VFM analysis. Ex-ante VFM analysis analyzes the project before the public-sector receives the bids i.e., commercial close to define whether a PPP alternative could be an option for the project. Because of this, it does not assess the value for money after commercial close which is really critical to track.

Therefore, there is a need to develop a new framework for VFM analysis to evaluate the PPP project during project lifecycle. Ex-post VFM analysis can be the answer to this need and should be conducted by public and private sector to monitor the initial VFM analysis to see whether project still brings value for money.

1.3 RESEARCH METHODOLOGY

In this study, the research methodology consists of three sections. First, the current and previous studies concerning value for money analysis will be reviewed to understand the concept of the value for money in PPP projects. Then, based on the concept of ex-ante, a new structure will be developed for value for money as an ex-post VFM analysis considering time, costs, risks, unforeseen elements, and financial parameters as principals which should be adjusted or updated at each milestone every time. Finally, a case study will be applied to investigate and study the concept of ex-post VFM analysis and compare the results of ex-post VFM analysis at different stages.

2.0 LITERATURE REVIEW

2.1 OVERVIEW

Transportation agencies have increasingly considered the use of public private partnerships (PPPs) as an alternative project delivery method for public projects. This trend has been largely driven by a shortage of public funds, greater cost certainty and the perceived ability of PPPs to lower life-cycle costs—the ability to offer better value for money. The Value for Money (VFM) analysis is typically used to compare aggregate benefits and costs of the PPP approach against those for the traditional public delivery alternative, which is typically Design-Bid-Build (DBB). However, the effectiveness of PPP is not known. This is because, to date, only ex-ante VFM analysis has been performed, without validation from ex-post evaluation.

2.2 DIFFERENT TYPES OF PROJECT DELIVERY

Cost, quality and time are three main parameters of each project in both the public and private sectors. Owner of the projects, which are mostly public-sector in infrastructure projects such as transportation, have been trying to enhance the quality, decrease the project cost, and compress the delivery period for their projects. As a result, different types of project delivery methods have been developed and applied in various projects, especially in transportation projects.
In fact, project delivery method is a term which is used to refer to all the contractual relations, roles, and responsibilities of the entities involved in a project. The Associated General Contractors of America (AGC) defines the project delivery method as “the comprehensive process of assigning the contractual responsibilities for designing and constructing a project" and it identifies the primary parties taking contractual responsibility for the performance of the work as the owner and contractor of the project (Ohrn & Rogers, 2004). In other study, Gransberg and Shane define the project delivery as the way contracts between the owner, the designer, and the builder are formed and the technical relationships that evolve between each party within those contracts (Gransberg & Shane, 2010). The term delivery method also refers to the approach used to organize the project team to manage the entire designing and building process. In other words, the owner decides which designers and contractors to use, when to hire them, and under what type of contract (Gloud, 2005). This shows that agencies or owners apply different project delivery methods to organize and finance different stages of projects including design, construction, and O&M at different type of projects from small building to mega projects like highway, airport and wastewater treatment plant.

Currently available project delivery methods have been created based on the traditional design-bid-build (DBB) method. Shortage in public funds is one of the reasons that the public-sector is interested in using the private sector in design, construction and even O&M via alternative project delivery methods such as construction management, design-build, and different types of

public-private partnership (Brownstein et al., n.d.). Each of these project delivery methods will be elaborated in the following sections. Different delivery methods include:

- Design Bid Build (DBB);
- CM at Risk (CMR);
- Design Build (DB) and
- Different Types of Public-Private Partnership (PPP or P3)

For each of these delivery methods, the standardized definitions and a brief explanation are included below (Gransberg & Shane, 2010).

2.2.1 Design Bid Build

A conventional or traditional project delivery method is one in which an owner either completes the design using in-house design professionals or asks an outside designer to furnish complete design services. The owner then advertises and awards a separate construction contract based on the completed construction design documents. In other words, owners will assign two different contractors to the project. One is a designer contract, and the other is a builder contract in which designer and builder do not have any contractual responsibility to each other; each only has a contract with the owner. In either case, the owner is responsible for the details of design and warrants the quality of the construction documents to the construction contractor.

In DBB, the owner "owns" the details of design during construction and as a result is financially liable for the cost of any errors or omissions encountered in construction (Touran, et al., 2009). In public DBB projects, the projects will generally be awarded on a low-bid basis. There is no contractual incentive for the builder to minimize the cost growth in this delivery system. Indeed, there can be an opposite effect: a builder who has submitted a low bid may need to review post-award changes as a means to make a profit on the project after bidding the lowest possible margin to win the project (Cushman, 1992) (Touran, et al., 2009)(Gransberg & Shane, 2010). One of the disadvantages of this method is that the contractor has no input until the bid award phase (Gloud, 2005).

2.2.2 Construction Manager at Risk (CMR)

CMR is a type of project delivery system in which an owner or client contracts with a construction manager, based on qualifications, experience, fees for management services, and target construction price, to manage and construct a project and transfer risks to CM (Caltrans, 2008; CDOT, 2008).

CMR is an integrated team approach to the planning, design, and construction of a project. It serves to help control the schedule and budget, and to ensure quality for the project owner. The team consists of the owner, the designer, and the at-risk construction manager. A CMR contract includes preconstruction and construction services. The construction manager is usually selected earlier in the design process and collaborates with the owner and designer during all phases of the project, including but not limited to planning, design, third-party coordination, constructability reviews, cost engineering reviews, value engineering, material selection, and contract package development. The construction manager and the designer commit to a high degree of collaboration. This is especially important when the agency is using CMR to

implement new construction technologies. A guaranteed maximum price (GMP) is established when the design of a specific feature of work is nearly complete (progressive GMP) or when the entire design is at a point where the CMR can reduce the magnitude of necessary contingencies. The construction manager warrants to the owner that the project will be built at a price not to exceed the GMP.

After the design is complete, the construction manager acts as the general contractor during the project construction phase. Strang describes the relationship change as follows: "The construction manager is an agent of the Owner in managing the design process, but takes the role of a vendor when a total cost guarantee is given." (Gransberg & Shane, 2010; Strang, 2002).

2.2.3 Design-Build (DB)

Another project delivery method that has been used in many projects is Design-Build (DB). DB is a project delivery system in which a single entity performs the design and construction of a project.

DB is a project delivery method in which the owner procures both design and construction services in the same contract. The method typically uses request for qualifications (RFQ)/request for proposals (RFP) procedures rather than the DBB invitation for bids procedures. There are a number of variations on the DB process, but all involve three major components. First, the owner develops an RFQ/RFP that describes essential project requirements in performance terms. Next, proposals are evaluated. Finally, with evaluation complete, the owner engages in a process that leads to contracts being awarded for both design and construction services. The DB entity is liable for all design and construction costs and normally provides a firm, fixed price in its proposal (Ibbs, Kwak, Ng, & Odabasi, 2003). This procurement model introduces the general concept of another project delivery, i.e., public private partnership, which will be discussed in detail.

Moreover, DB has its own advantages and disadvantages (CDOT, 2008). Among these advantages are: better risk allocation, clear project goals, reduced delivery time, better project feedback, single source of responsibility, enhanced innovation, partnering, early knowledge of project costs, integration of design and construction. Among the disadvantages are: potential culture change, cost estimation difficulties, contractors paying estimates during construction (lump sum), and overly fast (hasty) review of plans. Arguably the largest advantage is that by moving from DBB to DB the percentage of risk that the private-sector assumes increases. This means that the private-sector, or the contractor, has more responsibilities in handling the project.

2.3 PUBLIC-PRIVATE-PARTNERSHIPS (PPP)

PPP projects are thought to have developed in the 1980s in the United Kingdom as a form of agreement between the public and private sector. Since 1980, such a model has been extensively used, first in countries such as UK, Canada, Australia, Spain or Portugal, and more recently, throughout South America, Asia, Africa, and the United States (Cruz, 2013).

Each agency and country has its own conception of the fine points of PPP and there is no standard, internationally-accepted definition. The term is used to describe a wide range of agreements between public and private sector entities (World Bank, 2014). However, the general concept is similar to the design-build delivery method which defines a partnership between public and private in different phases of the project. Unlike typical conventional procurement (DBB), PPPs are highly complex and involve high capital costs and long contract periods that create long term obligations and a greater sharing of responsibilities and risks between the private and public sectors (Ministry of Finance Singapore, 2012).

Public-Private Partnership (PPP) arrangements have emerged all around the world in response to infrastructure deficits and the need to renovate existing old infrastructure. For example, America's aging infrastructure, including roads, bridges, and tunnels, is in need of upgrading and expansion, but federal and state governments do not have enough funds to cover the cost of many of these upgrades. However, partnerships with the private sector in which governments use private companies' technical, managerial and financial resources can partially fill the gap (Levy, 2011). The public and private sectors engage in a contractual, or institutional, relationship to ensure that certain infrastructure and/or services are available to citizens.

The public-private partnership delivery method has been defined in various ways and encompasses a wide range of partnerships between public and private sector. PPPs encompass a variety of project delivery options, with varying levels of private sector participation, based on risk transferred (Buxbaum & Ortiz, 2009), (Cruz, 2013). A PPP model is not a one size fits all structure; it is a delivery approach that includes a range of potential structures. The right structure selected for a PPP depends on many factors, such as complexity, public policy goals, private sector interest, and value for money. The desire and ability to transfer various risks to the private sector from the public sector is key in determining the most appropriate structure. P3 structures include the following options (arranged from least risk transfer to most risk transfer) (AECOM, 2012):

- Design-Build-Finance (DBF)
- Design-Build-Operate-Maintain (DBOM)
- Design-Build-Finance-Maintain (DBFM)
- Design-Build-Finance-Operate-Maintain (DBFOM)
- Build-Own-Operate (BOO)

2.3.1 PPP Delivery Method Structure

A typical PPP project is formed by different stakeholders from public-sector to private-sector which has its own sub-sections.

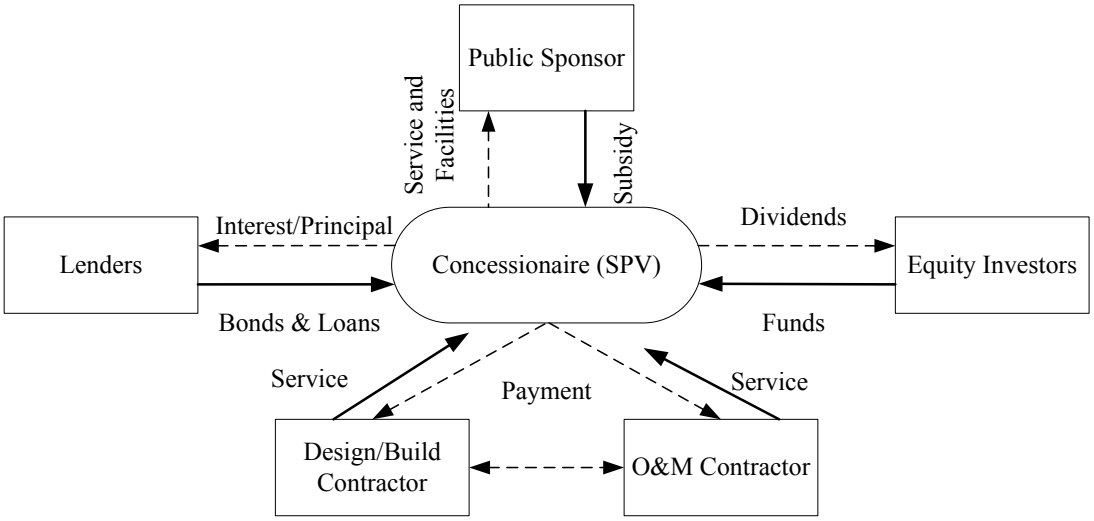

Figure 1: PPP Structure (FHWA, 2012; PWC, 2012)

A Special Purpose Vehicle or SPV is formed by private sector promoters and equity investors (Boussabaine, 2014) who will work under the Special Purpose Vehicle (SPV) management to bid for the PPP project. These companies play the critical role of proposing innovative solutions to meet Government's objectives for the PPP project. In a typical PPP project, the SPV will manage its design, construction and operational and maintenance responsibilities, by subcontracting the construction, operations and equipment supply to suitable providers. These subcontractors may be the parent companies of the SPV. In addition, the SPV will also raise the financing it needs to build any asset required to deliver the services. It will need to explore the financing arrangements with potential equity and debt providers such as the amount of the debt and equity, the rates of returns required, and the tenure of the loan. When the SPV starts to deliver the services, it will use the service payment streams it receives from the procuring agency, or any third party revenue generated, to repay its debt and equity providers, as well as its suppliers and subcontractors (Ministry of Finance Singapore, 2012).

There are two mechanisms for the payment in PPP projects. One is based on toll revenue; in this model the toll collecting mechanism is applied to repay the expenditure of the project. In this case, public or private will collect the tolls. The second mechanism is availability payment in which the private sector or concessionaire will be paid based on the availability of the services or infrastructure to the public.

2.3.2 Advantages and Disadvantages of PPP Procurement Method

The partnerships between public and private sectors bring advantages and disadvantages to the table. PPP advantages include, but are not limited to faster implementation, reduction of whole life costs and better risk allocation (European Comission, 2003). In another study, Morallos and Amekuzi investigated several benefits and advantages of PPP. They elaborated that there are several driving factors which have motivated public agencies to pursue this type of procurement. First, PPPs enable public agencies to transfer a substantial amount of costs to the private sector. Second, the involvement of the private sector in these procurements helps to accelerate the implementation of projects while encouraging the development of innovations in the delivery of

service and technology. Because of the performance-based structure of typical PPP agreements, a private agency will be unable to receive its payments until the service or facility is produced to the standards set by the public agency. Such agreements provide the private firm with an incentive to have shorter construction or delivery time frames. In addition, the presence of such incentives motivates improvements in the private consortium's overall quality of service and level of innovation it incorporates into these projects. Third, public agencies are attracted to the concept of PPPs for their ability to transfer a significant amount of project risk to the private sector. PPPs optimize risk allocation by transferring the risks to the party best able to manage them. The competency of the private sector in determining and handling these risks also leads to significant improvement in risk management strategies over traditional procurement methods (Morallos, Amekudzi, Ross, & Meyer, 2009). On the other side, higher financing costs, higher capital costs and having a complex structure are some of the disadvantages of PPP project delivery method. Consequently, it can be said that PPP is one of the solutions for public agencies to closing a widening gap between transportation infrastructure costs and available funding (Buxbaum & Ortiz, 2009).

2.4 VALUE FOR MONEY ANALYSIS (VFM)

There are several ways to complete the feasibility study of infrastructure projects which consist of Value for Money (VFM) analysis or simple discounted cash flow (DCF), decision analysis and real option analysis. In PPP projects, the most common methodology which has been used to evaluate the project is VFM analysis.

2.4.1 Definition and History of VFM Analysis

One of the most important considerations related to PPP project proposal is how we can evaluate the project in terms of costs and benefits that PPP may bring for the public-sector. Although VFM may not necessarily be the conventional term used to describe this type of analysis, most public agencies conduct some sort of financial benefit–cost analysis when determining which procurement route to take. Therefore, VFM is the most common analysis used to evaluate PPP projects.

This concept refers to the extent to which the proposed PPP approach offers greater value to the public agencies than the traditional approach. This analytical tool is often used to determine the project cost savings of a PPP approach paid for with availability payments or shadow tolls by the sponsoring agency (AECOM, 2007). VFM is a tool that can assist governments in selecting between most conventional public delivery methods i.e., DBB and private delivery (PPP) options such as DBFOM for infrastructure projects. A systematic analysis for PPP projects such as a VFM analysis can help not only pubic-sector in the process of decision making but also it can help private investors, banks, and other stakeholders seeking to invest and deliver PPP projects. As mentioned the definition of VFM assessment may differ between agencies, typically the analysis involves some financial comparison of the net present cost of PPP delivery method with conventional procurements. Morallos also mentioned in his research that the concept behind the VFM analysis is the calculation of the monetary of PPP benefits or savings (Morallos et al., 2009).

However, not all agencies pursuing PPPs have established a specific set of guidelines or procedures for performing a VFM or similar type of analysis. The United Kingdom was one of the first to establish a set of procedure for calculating the VFM that can be achieved in pursuing projects as PPPs. Several agencies, including some in Australia, Canada, and throughout Europe, have published their own sets of guidelines that parallel the United Kingdom's VFM analysis. Moreover, some U.S. states like Virginia, Texas, Florida and California are pioneers in having PPP projects.

2.4.2 Different Types of VFM Analysis

Based on when the VFM assessment will be conducted, there are two types of VFM analysis i.e. ex-ante and ex-post VFM analysis. As the names show ex-ante is the Latin for "from before" and it refers to the analysis before commercial close and before bids are received. It is related to the public evaluation of PPP projects. Typically, the ex-ante VFM assessment is conducted during the initial feasibility phase, when the economic viability of a project is reviewed before being open for bid.

On the other hand, ex-post is Latin for "from after" and this VFM analysis considers project financial comparison after receiving the bids and commercial close. Therefore, VFM assessment may also reappear in the procurement phase or after that but typically only to ensure that the costs submitted by bidders fall below what it would cost in a traditional procurement strategy.

Ex-post VFM reviews whether a particular PPP project has achieved value for money in practice. In ex-ante value for money analysis the likely outcomes of the project have been predicted and estimated before it is undertaken, to assist decision making on whether to undertake PPP option or not (N. Walzer, 1998).

This kind of analysis will give the public and private sectors better understanding regarding initial VFM analysis in order to use in future PPP decision making. As discussed further in subsequent sections, in practice few governments carry out ex-post VFM assessments of PPP projects which in turn creates challenges in data availability to inform ex-ante VFM analysis. Therefore, developing a solid framework for ex-post VFM analysis by using the current practice for ex-ante is critical and beneficial for both public and private sectors as a tool to oversee the efficiency of their first evaluation. Ex-ante value for money is the difference between risk adjusted PSC and shadow bid SB while the ex-post VFM is the differences between PSC and PPP bids or Updated PPP Bid or APB at different stages.

2.4.3 VFM Analysis Framework

The VFM analysis typically involves a combination of qualitative and quantitative analysis (The World Bank, 2013). The quantitative component includes all the factors that can be valued. It features a methodology that compares the PPP project costs with a similar project scenario often called the "public sector comparator" (PSC). The PSC is a hypothetical scenario used in a VFM assessment to determine what it would cost the procuring agency to pursue this same PPP project as a traditional procurement. The qualitative assessment of the VFM analysis takes into consideration the aspects of the project that cannot be quantified. The qualitative assessment also

looks at factors such as the characteristic of the market and the competitiveness present within the bidding environment. This assessment portion also evaluates the resources and capabilities of the private and the public sector as well as any other additional benefits and costs that were not assigned a value in the quantitative assessment. Each of the VFM analyses, i.e. ex-ante and ex-post frameworks, will be discussed in following sections.

2.4.4 Ex-ante VFM Analysis Framework

In ex-ante value for money analysis, the focus is on evaluating the project before commercial close. As mentioned previously, the basic structure of ex-ante value for money analysis contains two main parts: quantitative analysis and qualitative analysis. The quantitative section is formed by Public Sector Comparator (PSC) which is a benchmark for the costs of procuring the project through traditional delivery method such as DBB. On the other hand, the Shadow Bid (SB) includes the costs of the same project when the private-sector is responsible for delivering the project. Then, PSC and SB will be compared with each other (G. Dewulf, 2012).

2.4.4.1 Quantitative Analysis: Public Sector Comparator

One of the major components of the quantitative assessment of a VFM analysis is the PSC. As previously mentioned, the PSC is a hypothetical scenario that estimates the net present value (NPV) of the expected life cycle costs to the public agency if it were to pursue the PPP project through a traditional procurement (Morallos et al., 2009; Victorian Department of Treasury, 2001). Indeed, the Public Sector Comparator is the quantitative benchmark against which the value for money delivered by private bids is compared. In other words, the PSC is an estimate of the net present cost to the government if it were to deliver the project under a more traditional procurement method. The PSC contains forecast lifetime cash flows for a government delivered reference project based on the infrastructure and service specifications provided to bidders, i.e. on a like-for-like basis to the PPP.

The PSC typically consist of four components, the raw PSC, retained risk, transferrable risk and competitive neutrality. Together these components make up the expected cost. While the PSC is a useful tool for contributing to the ex-ante calculation, it has its inherent limitations. For instance, much caution is required in choosing the appropriate discount rate to calculate the NPV of the project were it to be carried out by the government (OECD, 2008).

Raw PSC

The raw PSC accounts for the base costs of delivering the project under the public procurement; these base costs are the capital and operating costs of producing the reference project; the PPP minus the private sector involvement. For these two projects to be compared, the calculations should assume that the reference project will be subjected to the same level of standards and specifications that would be required in the PPP scenario.

The raw PSC calculates the costs associated with building, owning, operating, maintaining, and delivering the service during the same period specified in the PPP proposal (Victorian Department of Treasury, 2001). It will include the cash flows of costs from the services but the cost of the risks in the project as there are two separate components of the PSC that determine the costs of transferable and retained risks will not be incorporated in raw PSC calculations (G.

Dewulf, 2012)(Morallos et al., 2009). The simple formula (1) shows the relationship between raw PSC and its elements.

Raw PSC=CAPEX+OPEX (1)

Capital costs should reflect the full resource costs of the project, including cost of public assets used in the project. Operating costs include whole life cost of operating and maintaining the asset to the same standard as required for private operator. These costs can also be divided into direct and indirect costs

Direct Capital Costs:
Direct capital costs include the cost of construction, raw materials, design allowance, planning, commissioning, and those transaction costs directly relevant to government delivery of the reference project. In ex-ante VFM analysis, these direct costs should be based on the best available data. Raw PSC should exclude risk and contingencies because risk and contingency will be accounted under different groups.

Direct Operating & Maintaining Costs:
Direct operating & maintaining costs include the cost of services to be delivered by the private partner as a part of the project. The raw PSC should be checked against the service specification to ensure that all costs of government delivering services to the prescribed standard are included. This may mean that the cost of delivery in the raw PSC may be different from government's current cost of delivering similar services. These costs consist of raw materials, direct management costs, utilities, employee costs.

Indirect Costs:
Those costs which are not directly related to the project are indirect costs such as overhead.

Competitive neutrality
One of the key adjustments included in PSC is competitive neutrality. This adjustment removes the inherent competitive advantages or disadvantages that would be available to a government agency pursuing the PSC but inaccessible to the private sector completing the PPP (Burger & Hawkesworth, 2011; Morallos et al., 2009; Victorian Department of Treasury, 2001).
In other words, the competitive neutrality value allows the PSC and private sector bids to be compared on an equivalent basis. If competitive neutrality is not taken into account, the NPV of PSC may be artificially lower or higher than that for the private sector bid. Typically the value for competitive neutrality takes account of factors such as differences in tax liabilities, regulatory costs and tort liability limitations (VDOT, 2011 (Cruz, 2013) (Levy, 2011)).

Risk Matrix
Risk in a PPP project relates to the uncertain outcomes which can directly affect the project in terms of finances and services. The risks can be categorized based on the phase and their types. A Risk matrix typically is used to define different risks in the project.

Risks are categorized based on the phase of the project into the five groups including political risks, construction risks, site related risks, completion risks, O&M risks, termination risks and financial risks (A. Akintoye, 2009).

Risk Allocation

One of the key differences between a PPP and traditional procurement is how risk is allocated. PPPs seek to transfer risk from the government to the private sector. While an inflow of private capital and a change in management responsibility alone can be beneficial, significant risk transfer is necessary to derive the full benefit from such changes. The impact of risk transfer on financing costs, and the pricing of risk to ensure efficient risk transfer, then have to be addressed (DFA, 2004). It is believed that risk transfer can improve risk management and makes PPPs more cost-efficient that traditional public procurement.

Risk transfer is at the heart of structuring VFM analysis, either ex-ante or ex-post VFM analysis. There are only a limited number of ways in which risks can be handled. Some of the risks can be retained by public-sector. The Second group belongs to those risks that transfer to the private sector, i.e. transferable risks. It is quite difficult to ensure or even define an optimal risk allocation scenario.

Risk Pricing

Estimating risk costs is an essential part of the VFM analysis in the PPP procurement process. The public and private sector's point of view in risk estimations are different regarding estimating the cost of risks allocated in PPP project. Therefore, the risk costs that the public-sector considers in the PSC and SB may not be the same as what the private sector considers, or SPV considerations and calculations in the PPP proposal bid.

The general formula (2) to quantify the risk is as shown below:

$$\textbf{Risk Value=Probability of Occurrence} \times \textbf{Risk Cost (2)}$$

Risk costs will capture all possible costs that are not considered in the direct and indirect costs discussed in previous sections. After all types of costs were calculated, the public-sector and private-sector are required to develop a cash flow model for each of them. Once risks have been quantified and allocated to the best party, their values need to be incorporated into the VFM analysis in order to compare procurement models on a risk-adjusted basis.

2.4.4.2 Quantitative Analysis: Shadow Bid

A Shadow Bid is defined as the estimated cost to the public sector if the same project considered in the PSC case were delivered by the private sector as a PPP (FHWA, 2012). In other words, Shadow Bid or SB is the financial model of the expected PPP delivery option. This model is not the same financial model that a bidder will prepare and submit with its proposal; in fact, it is prepared initially by the Authority and its advisers for use in the feasibility analysis and used to compare private delivery option with the traditional public delivery i.e. DBB (European Investment Bank, 2015). SB consists of retained risks and net present costs of service payment which the public sector will pay to private sector per year or half year.

It is important to stress that SB is just an estimation of the project if it will be procured in form of PPP delivery model. On the other hand, a PPP bid proposal is the actual estimation from private sector which is considered as the ex-post VFM.

2.4.4.3 Qualitative Analysis

In creating an overall VFM assessment, it is also important to consider factors that cannot be stated in monetary terms, therefore a qualitative VFM assessment is also required. Although the quantitative assessment, i.e. developing PSC and SB or PPP Bid, establishes a substantial portion of the VFM analysis, it is not the only section of VFM analysis to evaluate the PPP option; indeed, the scope of measurement of the PSC has been focused on financial measures. The second part of VFM analysis which completes the quantitative analysis discussion is the qualitative assessment. This analysis should also be considered in determining whether pursuing a project through a PPP (Victorian Department of Treasury, 2001). The qualitative VFM assessment needs to take account of factors that cannot be expressed in monetary terms, such as any predicted differences in service quality between the delivery options. Unlike the quantitative assessment, the qualitative assessment is often less prescriptive; it will often vary by what the procuring agency believes important to consider depending on the project and other conditions (VDOT, 2011).

Partnerships Victoria (2001) suggests pursuing the qualitative assessment after the completion of the quantitative assessment and after bids have been submitted. According to Partnerships Victoria, the consideration of qualitative factors can make or break the attractiveness of the PPP procurement route especially when the lowest private bid is very close to the PSC; therefore, qualitative assessment should be revisited at every stage of the project (FHWA, 2012).
In considering the impact of the qualitative factors, Partnerships Victoria suggests identifying all material factors that have not been incorporated in the PSC and then considering the impact of these qualitative factors on the private bids. Some examples of qualitative risks according to Partnerships Victoria and VDOT include material costs that cannot be quantified, the reputation and competency of the private bidder, wider benefits or costs that a PPP could bring, the accuracy and comprehensiveness of the information used and assumptions made in the PSC

Overall Assessment:
After developing the quantitative and qualitative analyses for VFM the results of the quantitative and qualitative assessments should be added together for each of PSC and SB or PPP bids in a standard framework to provide a final VFM assessment.

2.4.5 Advantages and Disadvantages of Ex-Ante VFM

When developing PPP and VFM frameworks, it is important to consider the advantages and disadvantages VFM brings to the process of taking projects from planning through to commercial close (FHWA, 2011). For example, the current VFM analysis can provide the public sector sponsor a better understanding of the costs and risks of a project and enhance public support for a PPP. However, with the current VFM analysis it is difficult to ensure that projects are properly evaluated and the analysis is not immune to political influence.

2.4.6 Ex-poste VFM

As mentioned earlier, ex-ante VFM analysis analyzes the project before the public-sector receives the bids to define whether PPP can be an option for the project and how much value for money the project can bring for public. On the other hand, ex-post VFM analysis should be conducted by the owners and/or sponsors to monitor whether the initial VFM is still valid. Ex-post VFM analyses are those VFM conducted after bids have been received by private sector. Once final bids are received from the private sector, the whole of life cost of these bids can be compared to the PSC to determine whether the bids provide value for money to the taxpayer (Government of Western Australia Department of Treasury, 2013).

3.0 METHODOLOGY

3.1 OVERVIEW

This section first introduces various types of ex-post VFM based on the main milestones of the project lifecycle, including commercial close, financial close, substantial completion, and final acceptance. Then, it will define a general framework for ex-post VFM analysis. This general framework will be developed based on current VFM analysis and follows the same project evaluation methodology used in ex-ante VFM analysis. As mentioned previously, this analysis compares net present cost (NPC) cash flows for projects developed by the public sector (PSC) with NPC cash flows for projects procured by the private sector in which the public sector will pay back the private investment based on the availability of the facility to the public.

The main purposes for developing a general ex-post VFM assessment framework are to evaluate the performance of the PPP delivery method during the project life cycle, to investigate the different elements of VFM analysis at different stages. This helps to highlight the critical elements that should be considered in evaluation and inform the decision making process for future projects.

3.2 ASSUMPTIONS

Some assumptions have to be made before discussing an appropriate framework for ex-post VFM analysis:

- The framework has been developed for the routine Design-Build-Finance-Operate-Maintenance PPP model which can be modified for other PPP formats.
- The ex-post VFM framework has been developed for those PPP projects that have availability payment structure.
- The framework has been developed for scenarios with and without project scope changes.
- The ex-post VFM analysis refers to the analyses that occur after receiving bid proposals from the private sector at the points of commercial close
- The quantitative analysis of VFM will be investigated and qualitative analysis will not cover in this research.
- Those risks which were taken during the project will be considered as zero in the ex-post calculation.

3.3 OVERVIEW OF EX-POST VFM FRAMEWORK

Some experts define ex-post VFM as an evaluation method for PPP projects after financial close or after substantial completion. In this study, the ex-post VFM analysis refers to the analyses that occur after receiving bid proposals from the private sector at the points of commercial close.
Ex-post VFM analyses for five different milestones in the project lifecycle will be introduced in the next section. At each of these milestones, some of project data will be available in the form

of actual numbers used to conduct ex-post VFM analyses. For example, at commercial close, private sector entities submit their bids. Therefore, the public sector has the actual bid numbers in ex-post VFM analysis instead of estimated shadow bid, as is the case in ex-ante VFM analysis. In other words, ex-post VFM analysis is a type of re-evaluation or re-estimation of an initial evaluation or estimation VFM analysis. Figure 2 illustrates two VFM analysis ex-ante and ex-post in a simple view. In this figure the amount of actual VFM at commercial close is less than what was calculated in ex-ante VFM analysis.

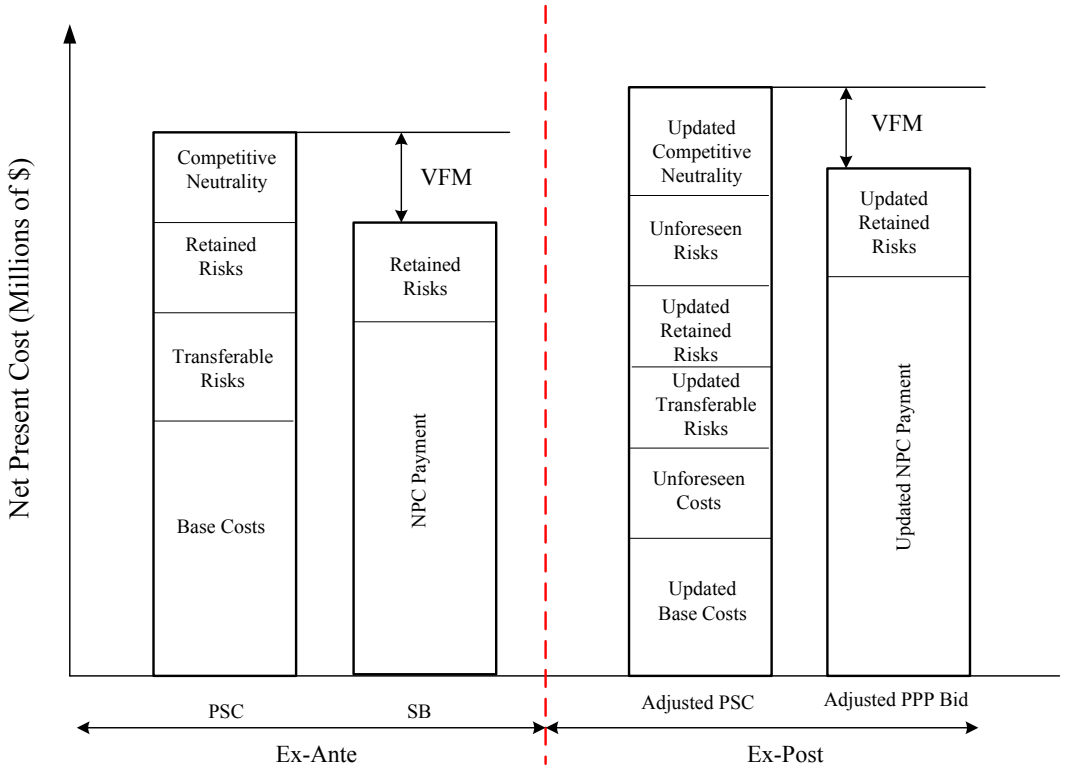

Figure 2: Ex-ante vs. Ex-post VFM analysis at commercial close

In order to develop the ex-post VFM framework, different sections of the ex-ante VFM framework will be updated or adjusted based on the actual data. Project costs will be updated through the project lifecycle, and therefore it is necessary to replace the initial estimations with the actual project costs for such things as construction. Similar to ex-ante VFM analysis, ex-post VFM consists of two major sections: quantitative and qualitative VFM assessment. Although a comprehensive ex-post VFM analysis should take into consideration changes in both quantitative and qualitative analysis, this study focuses only on quantitative analysis.

Several data categories have to be considered in developing the ex-post VFM framework, including time, cost, risk, unforeseen factors, and financial parameters. Each of these groups of data will be elaborated in the following sections.

3.4 PROJECT LIFE CYCLE (TIME)

The first element in developing the comprehensive ex-post VFM framework is the factor of time. In this study, the assumption is that the framework will be developed based on the DBFOM PPP model which can cover the whole project life cycle. In conducting value for money analysis, the first step is to consider the impact of time because the money invested in the project has different values over the course of the project. In other words, one dollar today has less value next year, depending on the discount rates.

There are two reasons that time should be considered in developing VFM analysis, especially in the ex-post VFM framework. First, it is necessary to define different ex-post VFM based on the different milestones. Second, time affects calculations of the NPC or NPV in VFM analysis. Other factors such as costs, risks, and financial parameters could also change with time.

In the first step of developing ex-post VFM framework, the boundary between ex-ante and ex-post VFM should be defined. In this study, commercial close is the borderline between ex-ante and ex-post VFM analysis. Therefore, all VFM analysis before commercial close will be considered as ex-ante and all analyses after commercial close are considered as ex-post VFM analyses. Based on this definition, five different types of ex-post value for money analysis can be introduced (figure 3):

- 1st Ex-post VFM: At commercial close
- 2nd Ex-post VFM: At financial close
- 3rd Ex-post VFM: At substantial completion
- 4th Ex-post VFM: During O&M Phase
- 5th Ex-post VFM: At final acceptance

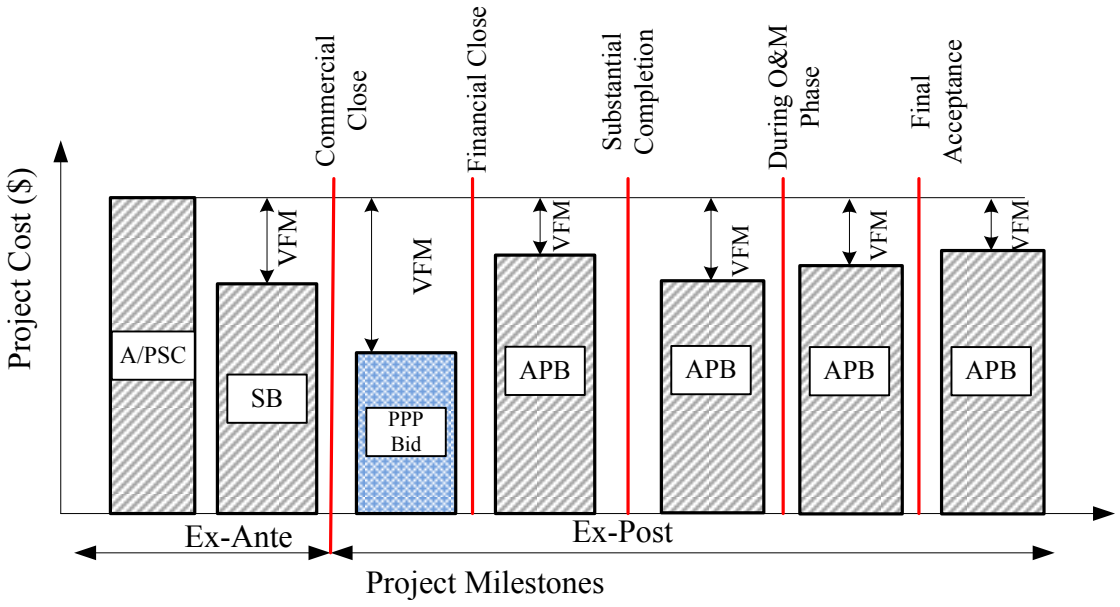

Figure 3: VFM at different milestones

The amount of VFM will be changed during the project lifecycle as actual data becomes available to conduct updated VFM analyses. As mentioned earlier, time will affect the calculation of net present cost or value (NPC/NPV) in determining the VFM of the project. The NPC/NPV formula shows the role of time in the calculation (Ross, 2010).

$$NPV = \sum_{t=1}^{T} \frac{Cash\ Flow_t}{(1+i)^t} - Initial\ Investment \quad \textbf{(3)}$$

Where:
t = Cash flow period
i = Interest rate assumption

The concept of discounted cash flow (DCF) is at the heart of VFM analysis. DCF is the method of valuing a project by using the concept of time value of money, which reflects the fact that present money is more valuable than the same amount of money received in the future. Time value of money computation is based on present value and discounting techniques (Boussabaine, 2014).

There are different types of cash flows for each project: 1) Costs; and 2) Revenue. In PPP projects, private sector entities borrow money from banks, equity investors and lenders to begin the design and construction. Then, the SPV will be compensated by the public-sector after substantial completion. Some of the PPP projects have tolls, so the toll revenue cash flow will be added to the calculations. In VFM analysis, all cash flows should be estimated and discounted to calculate the present values or costs at each of the five milestones to figure out the amount of VFM at each stage.

3.5 UNFORESEEN FACTORS

In order to develop a comprehensive framework for ex-post VFM analysis, factors that were unforeseen in initial estimation such as unforeseen costs and risks will be considered. The effect of these unforeseen factors will be investigated in each of the original PSC and PPP Bid and Adjusted PPP Bid at each milestone.

Adjusted Quantitative Analysis:
As figure 4 shows, the adjusted quantitative analysis section has two main parts:

- Adjusted Public Sector Comparator (APSC)
- Adjusted PPP Bid (APB)

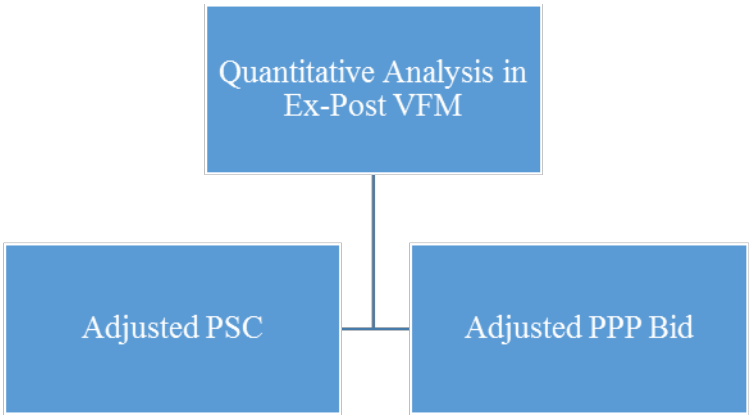

Figure 4: Quantitative Analysis in Ex-post VFM Framework

Adjusted PSC is an updated version of the original PSC from initial VFM analysis considering these unforeseen factors. And APB is an updated version of shadow bid from ex-ante VFM assessment. Each of these two sections will be discussed in more detail.

Developing Adjusted Public Sector Comparator (APSC)

Previously, PSC was described as a whole-life and risk-adjusted cost estimate of the project that is delivered by the public sector. During the development of a PSC, several assumptions are made, including that the public sector can complete the project with the same quality and standards anticipated in a delivery by the private sector; these assumptions will be used in the ex-post VFM analysis(FHWA, 2011).

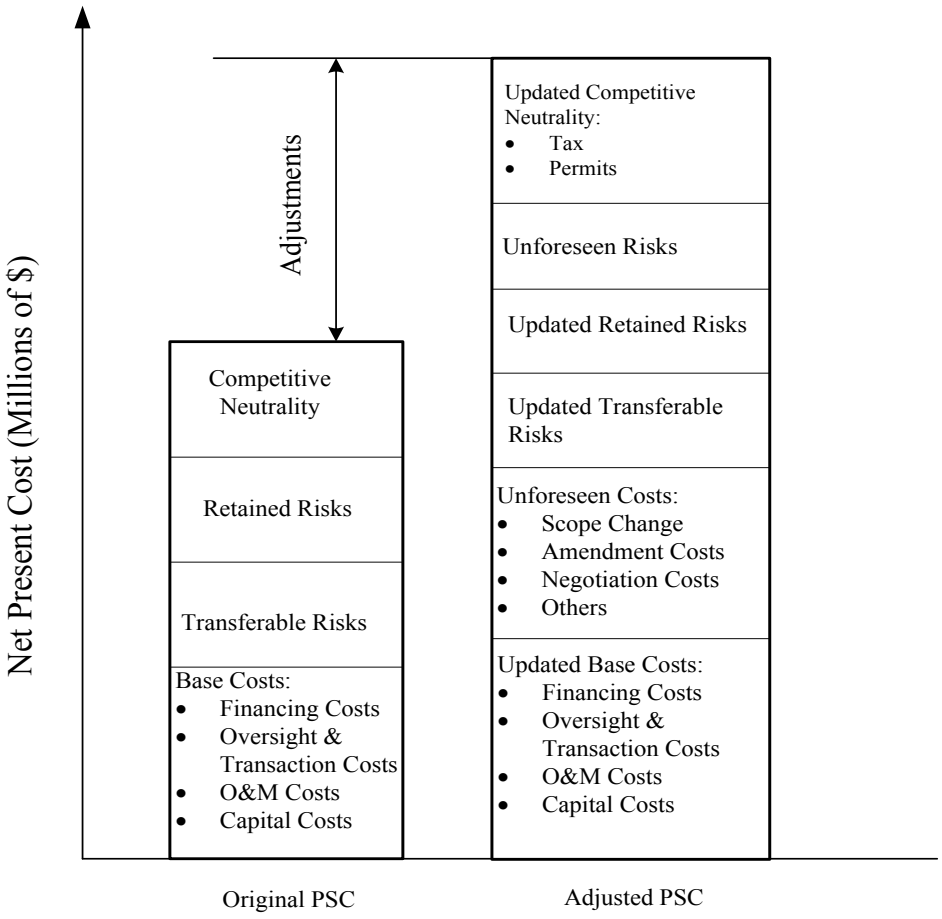

Figure 5: The Original PSC vs Adjusted PSC Structure

In developing the ex-post VFM framework, one of the essential assumptions is that the PSC developed in ex-poste VFM will not be the same as that developed in ex-ante VFM because of unforeseen factors and elements. The VFM therefore has to be updated based on these factors and used as the baseline in ex-post VFM to compare with different Adjusted PPP bids. Figure 5 depicts both original PSC and adjusted PSC to understand the possible differences between PSC of ex-ante and ex-post analysis.

Indeed, the APSC has the same sections and elements including base costs, retained risks, transferable risks, and competitive neutrality (figure 3.8) but all required parts have to be adjusted or updated based on the final project scope. By using the adjusted PSC, we can see clearly how much difference exists between ex-ante and ex-post analysis and how much the ex-ante VFM analysis has changed during the project. Consequently, APSC should be investigated at different milestones to see which of its items need to be updated and adjusted.

Developing Adjusted PPP Bid (APB)

The shadow bid was developed as part of the quantitative assessment of the ex-ante VFM analysis, which was conducted before commercial close. The shadow bid is typically developed using cost estimates made early in the project lifecycle and does not cover changes and

adjustments that occur during the project. In other words, project cost estimates may increase or decrease due to project delays or private efficiency. Therefore, there is a need to review the initial estimate and develop an updated version of the PPP bid evaluation that the private sector submitted at the time of the bid proposal (commercial close). Because of this, the VFM analysis should be continually adjusted and refined throughout the project as a part of the ex-post VFM analysis. This adjustment will be conducted in two forms: firstly, all estimation should be up to date based on the actual data such as costs and risks, and secondly, those unforeseen items in initial evaluation should be added to private sector calculation to cover all aspects of the project. Figure 6 shows different sections of SB, PPP Bid, and Adjusted PPP Bid.

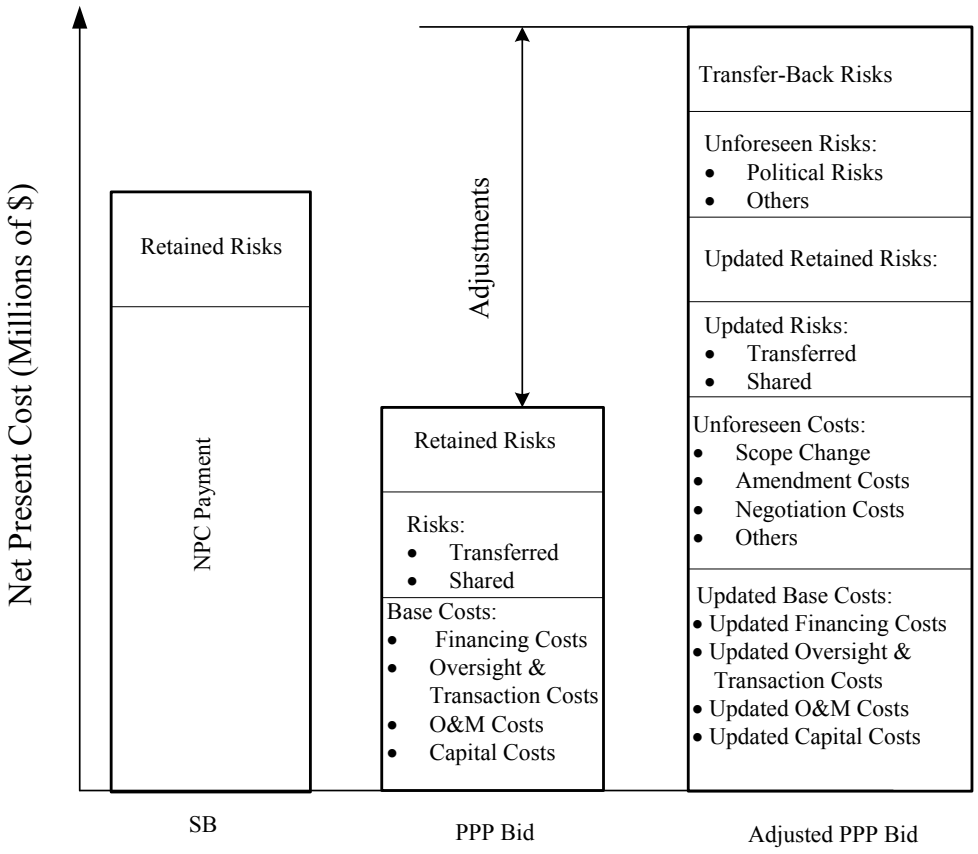

Figure 6: SB vs PPP Bid and Adjusted PPP Bid Structure

APB is comprised of different elements such as updated or adjusted project base costs, unforeseen costs, updated private risks, updated retained risks, unforeseen risks and transfer back risks, those risks that were transferred to private initially but they transferred back to the public in reality. APB is based on the NPC calculation, then APB is compared with adjusted PSC to assess whether or not the project still brings the value for money for the public sector. Figure 6 shows the main components of adjusted PPP bid. At each milestone, APB's components will be changed and they should be updated to show the actual situation of VFM on that stage. For example, financing costs often change at financial close after long negotiations between the SPV and banks. These modifications should be reflected in ex-post VFM.

3.6 PROJECT BASE COSTS

As mentioned previously, project base cost is one of the main elements in the VFM analysis and will appear in several forms including raw PSC, base cost of ex-ante and base cost of APB of the ex-post VFM analysis. Base costs of APB themselves consist of different type of costs including capital costs, O&M costs, financing costs, and transaction costs (figure 7).

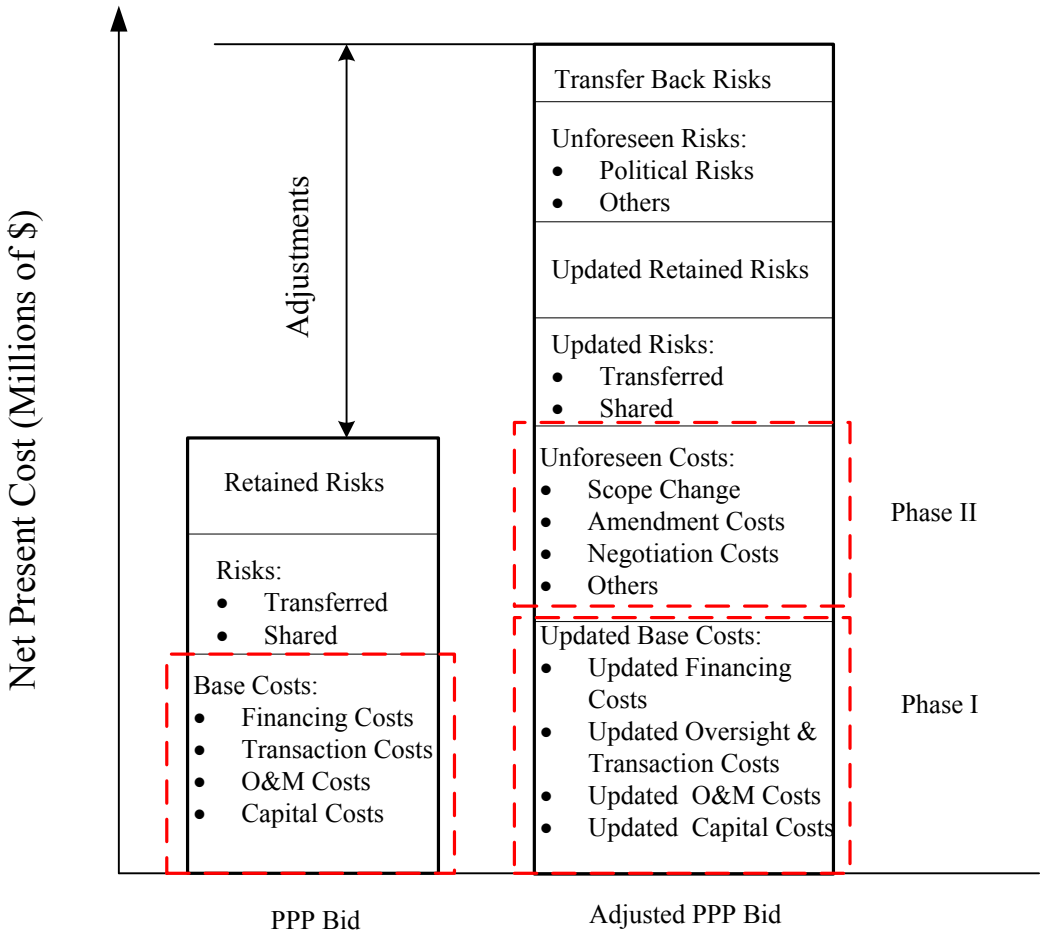

Figure 7: Adjusted PPP Bid Based on Scope Change

Adjusted PPP Bid Base Cost

As figure 7 shows the process of adjusting the project costs will be done in two phases: phase one will include adjusting and updating each of the elements of base costs previously estimated and replacing them with the actual data. The second phase will include adding those unforeseen costs, which might be created by scope changes and other factors during the project and should be considered in developing the ex-post VFM analysis.

The APB base cost accounts for the base costs of delivering the project under the private procurement; these base costs are the capital, operating costs and transaction costs of project. In order to have a fair comparison between adjusted PSC (from ex-ante VFM) and Adjusted PPP Bid, the calculations should assume that the private sector will deliver the project at the same

standard the public-sector required for the project. In other words, the base costs of Adjusted PPP Bid calculates the costs associated with building, owning, operating, maintaining, and delivering the service.

In most of the PPP Projects, the cost section is generally categorized into six main categories:

- Capital Costs
    - Construction Costs
    - Design Costs
- O&M Costs
    - Annual Operating Costs
    - Annual Routine Maintenance Costs
    - Periodic Maintenance Costs
- Transaction Costs
    - Contract Management Costs
        - Dispute resolution
        - External Consultants
        - Feasibility Studies
    - Initiation and Procurement Costs
- Right of Way (ROW) Costs
- Financing Costs
- Special Purpose Vehicle (SPV) Costs

At each project milestone, these costs have to be adjusted based on the most up-to-date, or actual, costs in order to re-assess the VFM analysis to get ex-post VFM. After adjusting the costs at each stage, a number of key performance indicators (KPIs) can be used to track the cost change as a part of the post evaluation of PPP projects by having the actual numbers. These KPIs illustrate how costs at different sections have been changed and can also define the differences between ex-ante and ex-post VFM elements in terms of different costs. These KPIs include costs growth, project costs outcome and contract award costs growth.

3.6.1 Project Base Costs at Different Stages

In the process of developing the framework of ex-post VFM analysis, different categories of costs should be re-evaluated or updated during the project lifecycle using actual or most up to date costs. In this sub-section, each cost category will be reviewed at different milestones. Table 1 illustrates the version of cost calculations at different stages of the project, which are the estimated, updated, and actual version of the costs.

Table 1: Cost Categories in Different Stages of the Project

Cost Category	Before Commercial Close	@ Commercial Close	@ Financial Close	@ Substantial Completion	During O&M Phase	@ Final Acceptance
Construction Costs	E[1]	E	E	U[2]	A[3]	A
Operating Costs	E	E	E	E	U	A
Routine & Periodic Maintenance Costs	E	E	E	E	U	A
Transaction Costs	E	E	E	U	A	A
Financing Costs	E	E	A	A	A	A
ROW Costs	E	E	E	A	A	A
SPV Costs	E	U	U	U	U	A

Stage 1-Before Commercial Close-Ex-ante VFM
Before reaching the commercial close, public-sector uses the previous project records to estimate the total costs of the project to prepare the shadow bid which is the ex-ante VFM analysis. Therefore, all the costs are estimates and are not actual (Table 3.2).

Stage 2-At Commercial Close-1st Ex-post VFM
At commercial close, private-sector also uses its previous database to prepare the bid documents to bid the project. All costs are the estimations and are not actual numbers in first ex-post VFM.

Stage 3-At Financial Close-2nd Ex-post VFM
At financial close, only the SPV cost will be updated and all other cost categories will remain constant.

Stage 4-At Substantial Completion-3rd Ex-post VFM
At this milestone, SPV cost, transaction costs, and the capital costs i.e. design and construction costs will be updated in the ex-post VFM analysis. Moreover, ROW costs and financing costs are the actual. In contrast, O&M costs are still constant.

Stage 5-During O&M Phase-4th Ex-post VFM
In this period of time, O&M costs will be updated at set intervals for example, after 5, 10, 20 years from the beginning of the O&M stage depending on the availability of the data. The O&M costs play an important role in conducting this version of ex-post VFM. Additionally, the actual costs of design, construction costs, ROW, financing, and transaction costs will be applied in this ex-post VFM. The SPV costs will be updated in this stage as well.

[1] Estimation
[2] Updated
[3] Actual

Stage 6-At Final Acceptance-5th Ex-post VFM
At final acceptance *when* the private officially will deliver the project to the public-sector after the concession period, all the costs will be in actual form.

3.7 PROJECT RISKS

Another key element of the Adjusted PPP Bid is the project risks which include transferable and shared risk from the public sector point of view. In order to adjust the project risks previous risks, unforeseen risks and those risks which transferred back to the public should be considered (see figure 8).

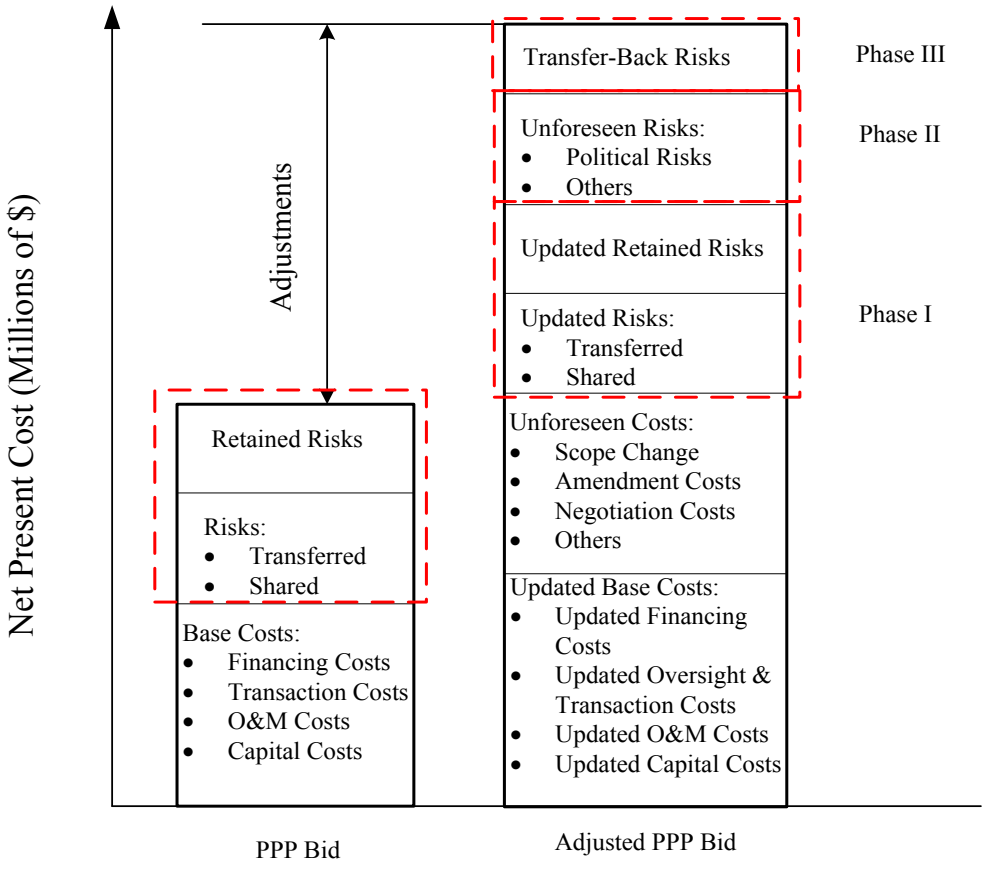

Figure 8: PPP Bid and Adjusted PPP Bid Risks

Risk management is the heart of the concession arrangement and VFM analysis, but there is a major lack of historical data to develop risk cost estimation to be used through the project life cycle. Consequently, the risk probability and risk estimations are not well founded. Previous studies show that in most of the concessions the probability of a risk remained the same, which is clearly not the case as the risk patterns will change when the facility transfers to the operational stage (G. Dewulf, 2012).

As mentioned previously, risk analysis in VFM analysis consists of three main parts: 1) Risk matrix or register, 2) Risk allocations, 3) Risk pricing. These three sections will also be applied in developing ex-post VFM framework. In this document, the risk matrix and risk allocation will be discussed at different milestones of the project. A solution to calculate and adjust the risk cost at different stages will be suggested.

Risk Matrix

Risk in a PPP *project* relates to the uncertain outcomes which can affect directly the project in terms of financial and services. The risks can be categorized based on their types. Risk matrix usually has been used to define different risks in the project. Risks are categorized based on the phase of the project into the five groups including political risks, construction risks, site related risks, completion risks, O&M risks, termination risks and financial risks (A. Akintoye, 2009; G. Dewulf, 2012).

The first step is to re-build the risk matrix for ex-post VFM analysis and figure out what kind of risks are present at each stage of ex-post VFM. For example, the risk of changing in law is kind of a risk for PPP project that should be considered in VFM analysis during the project and it exists in all stages.

Risk Allocation

The second issue related to project risks is how to allocate risks to the best parties, whether public or private. It is believed that risk transfer can improve risk management and makes PPPs more cost-efficient than traditional public procurement. In fact, the principle is that risks should be transferred to those who can control them at lowest cost. Therefore, public-sector should retain those risks that private sector cannot control cost-effectively or the cost of taking those risks by private will be so high that it is no longer efficient.

In ex-ante VFM analysis, there is an initial risks allocation which should be updated or adjusted in ex-post VFM analysis during the project. For example, force major, which will be shared between two parties, may transfer to the public after financial close; this is really dependent on the type of the project and opinion of risk consultants. Indeed, the initial risk allocation plays a role as baseline and should be reviewed by experts to get updates. Literature shows that there are minor revisions for risk allocation in ex-post VFM analysis.

Risk Pricing

The last section of the risk analysis addresses how the costs of allocated risks will be determined. Estimating risk costs is an essential part of the VFM analysis in PPP procurement process. Public and private sectors have different points of view with regard to estimating the cost of the risks allocated in PPP project based on their database gained from previous PPP projects; therefore, the amount of risk costs that public and private sector considers in PSC and SB is not the same as what the private sector or SPV studies in APB.

As discussed earlier, the general formula to quantify the risk is shown below:

$$\textbf{Risk Value=Probability of Occurrence} \times \textbf{Risk Cost (Impact) (4)}$$

Therefore, the risk value simultaneously depends on the probability of occurrence and the cost or impact of that risk. Risk costs will capture all possible costs that are not considered in direct and indirect costs which are discussed in previous sections. Once risks have been quantified and allocated to the best party, their values needs to be incorporated into the ex-post VFM analysis in order to have fair comparison between original PSC and risk –adjusted APB. Therefore both parts i.e., the probability and the impact need to be adjusted at each stage.

The challenge for experts in developing ex-post VFM analysis is coming up with the probability of the risks at different milestones. Because of this, there is a need to conduct a comprehensive investigation through all risks mentioned in the risk matrix at different milestones. At each stage of the project some of the risks may be taken, some may still exist, and some new risks might be added to the initial risk register. After substantial completion, construction risk has been already taken and will not exist anymore. Therefore, these risks should be taken out from risk matrix and assessment to reflect the actual situation of the project risks on that specific milestone.

Therefore, the value for each of the risk categories should be updated or adjusted to make the ex-post VFM analysis. These computations are really dependent on the availability of data from concessionaire to provide enough information to make the re-evaluation of the risk assessment possible for public-sector.

Adjusted Risk Value= Adjusted Probability of Occurrence × Adjusted Risk Cost (5)

Adjusted risk costs consist of those elements involved in risk calculation which have been changed during the project. It should be mentioned again that each project has its own specific risk matrix; therefore, there is no way to elaborate details in general way. Adjusted risk cost can be gained directly from the actual costs of the project.

Moreover, the adjusted probability of occurrence can be calculated by repeating the risk workshop experts who participated in initial risk workshop for the project. Bayesian theory can be applied in calculating the adjusted probability of occurrence at different milestones. The original formula for Bayesian Theorem is:

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)} \quad \textbf{(6)}$$

Where:

- P(A|B) is the posterior probability
- P(B|A) is the likelihood
- P(A) is the prior probability

The Bayesian concepts will be applied to adjust the initial probability of occurrence at each stage. Therefore P(A|B) means the probability of happening risk A by knowing the probability of happening B.

3.8 PROJECT FINANCIAL PARAMETERS

The last significant element in developing the ex-post VFM framework is the project financial parameters. Indeed, these parameters define the financial structure of the project and elaborate on

the percentage of equity, debt and loan contributions in the project. Financial parameters contain different indicators such as interest rate of senior bond and TIFIA, ADSCR, return on equity, and discount rate. The definition and formula of discount rate will be explained in depth in Appendix A.

As mentioned earlier, choosing an appropriate discount rate is one of the most important decisions in time value of money. Because the discount rate will affect the acceptance or rejection of investment options under consideration. The choice of the discount rate is critical in the comparison between the original PSC and the APB of ex-post VFM analysis. Most of the time PSC and SB have the same discount rate but APB which is the adjusted version of PPP bid can have a different discount rate. The result of the VFM analysis in both ex-ante and ex-post is very sensitive to small changes in the discount rate. A discount rate is selected to reflect the different costs and revenues which occur at different stages of the project lifecycle (Boussabaine, 2014). Financial close is the key milestone in project life cycle. In fact, the financial parameters before financial close all are based on the current conditions of the market and are estimations. After financial close, however, they are actual numbers which will remain constant during the project lifecycle.

4.0 CASE STUDY RESULTS AND DISCUSSION

4.1 INTRODUCTION AND OVERVIEW

In this section, a hypothetical case study will be used to demonstrate the VFM analysis. In addition, influential assumptions including time, costs, risks, unforeseen factors, and financial parameters which are significant in developing VFM analysis will be considered. Then, the results of each VFM analysis will be presented in terms of present value (PV) of PSC, SB/APB and availability payment (AP). In order to investigate the effect of discount rates on the VFM, the analysis was conducted for different discount rates including 5.5%, 7.5%, 8.5%, and 9.2%.

A complementary discussion about the methods of choosing the appropriate discount rate will be provided in appendix A. Finally, a comprehensive comparison of VFMs and APs for different stages of the project will be discussed. This case study has been selected to evaluate ex-post VFM frameworks in PPP projects. Furthermore, it has been used to assess current ex-ante VFM analysis in order to show how reliable it is and how VFM will be changed throughout the project lifecycle.

The VFM analysis will be presented at different stages:

- Ex-ante VFM-Arup/PB Inputs/Original-Commercial close
- Ex-ante VFM-Arup/PB inputs/UMD Model-Commercial close
- Ex-post VFM (I)-GLC Inputs/Original-Commercial close (Bid Proposal)
- Ex-post VFM (I)-GLC Inputs/UMD Model-Commercial close
- Ex-post VFM (II)-GLC Inputs/UMD Model-Financial close
- Ex-post VFM (III)-GLC Inputs/UMD Model-During construction
- Ex-post VFM (IV)-GLC Inputs/UMD Model-Substantial completion
- Ex-post VFM (V)-GLC Inputs/UMD Model-Final acceptance

P3 VALUE analytical tools, which were developed by FHWA, includes risk assessment tool, Public-Sector Comparator tool, Shadow Bid tool, and Financial Assessment tool, are being used to develop VFM analyses at different stages of the project. Additional details regarding the P3 VALUE tools are provided in the appendix B.

Ex-ante VFM Analysis Assumptions and Results

Commercial close is used as the border of ex-ante and ex-post in VFM analysis. Therefore, the analysis before commercial close is named "ex-ante VFM" and after that is called "ex-post VFM" analysis. In this section, two groups of results of ex-ant value for money analysis will be discussed.

4.1.1 Ex ante VFM – Commercial Close

At this stage of a project, which is before commercial close, all data are estimates based on project specifics and similar previous PPP projects throughout the United States. The same timing assumptions are being used in both PSC and SB, but data for cost, risk and financing assumptions are different, which will be discussed in more detail.

Timing Assumptions**:**
Base date is the date to which all costs and revenues are being discounted and NPV or NPC will be presented. The year 2009 was arbitrarily used as the base date of this analysis and discounted all costs and revenues cash flows to the 2009 dollar. All timing assumptions are presented in the below table.

Cost Assumptions:
In VFM analysis, different project cost cash flows are being considered, including design, construction, tax, financing, operation, and maintenance and rehabilitation costs. The below table includes various cost assumptions included in this analysis.

Risk Assumptions:
As private firms are often unwilling to share risk data, it was assumed that there was a limited availability of data for this project. This assumption was made to illustrate the need for the public sector to have better data availability in this area. This inconsistency is represented in the risk assumptions table below.

Financing Assumptions:
There is no financial structure in the PSC because all the costs are paid for by public. However, the SB or Adjusted PPP Bid (APB) has financial structure; therefore, financial input data are needed to develop the financial model.

The case study is assumed to have been financed by three parts: a commercial senior loan, a TIFIA loan and an equity contribution from the private finance partner. The financial data used in the VFM are illustrated in the table below. Additionally, Appendix A elaborates on each of these factors in more depth.

VFM Analysis Results:
The initial VFM analysis results show that the PPP procurement method can save $137.1 million for the public sector over the life of the project. In this analysis, the amount of money that the public-sector should pay to the private sector as availability payment (AP), based on the availability of the road to the public, is $35 million.

Results show that low discount rates decrease the amount of VFM; therefore, there is a range of discount rates that gives the optimum VFM. Results show that all APs are the same and AP is independent from the discount rate. By increasing the discount rate VFM will increase. Therefore, the public sector has to choose the appropriate discount rate to cover all circumstances of the project.

4.1.2 Ex-post VFM Analysis Assumptions and Results

The ex-post VFM analysis will be developed at five different key milestones of the project: commercial close, financial close, during the construction, substantial completion, and after final acceptance using P3 VALUE tools. These ex-post analyses will be conducted based on the availability of data provided by the concessionaire for each of these milestones. At each milestone, some of the data can be replaced with the actual, other data will still be estimates, and other sets of data will be updated considering the progress of the project on that specific milestone. The assumptions and data at each milestone will be presented, after which the VFM analysis will be conducted and the results investigated for several discount rates, including 5.5%, 7.5%, 8.5%, and 9.2%.

4.1.3 Ex-post VFM – Commercial Close

In this case study it is now assumed that a bidder has been selected and has provided various types of data including construction, operation & maintenance costs and financial data that was used to prepare the bid proposal. As mentioned previously, it was assumed that the risk data and its VFM analysis were not provided as this is often considered proprietary information. To develop the ex-post VFM analysis, the PSC used in the ex-ante VFM analysis will be adjusted and employed.

Timing Assumptions:
It is assumed that the bidder will have different timing assumptions including but not limited to the base year to discount all lifecycle costs and cash flows, and the concession period. The below table represents these assumed costs. As with the ex-ante VFM, cost assumptions contain design, construction, financing, operation and maintenance costs at the commercial close stage.

Risk Data:
As mentioned previously, it is assumed that the risk data was considered proprietary and not provided to the public sector. Because of this, the risk data utilized previously in the ex-ante analysis will also be utilized for the ex-poste analysis.

Financing Assumptions:
As with the ex-ante VFM analysis, there is no financial structure in the PSC because all the costs are paid for by the public. Assumptions for how the private sector takes advantage of using debt and loan to finance the project in the PPP case are included in the table below. Several data are required to develop the financial model, such as loan interest rates, and percentage of contribution of debt and equity. At commercial close, it was assumed that the case study's construction was financed by two debt issues-a commercial senior loan and a TIFIA loan as well as an equity contribution from the private finance partner.

Results:
Ex-post VFM analysis results are showing that PPP procurement method can save $210.9 million for public sector considering whole project life. In this analysis, the amount of money that the public-sector should pay back to private because of the availability of the road to the public is $21.9 million which is almost 13 million dollars below the AP calculated previously.

The analysis was repeated for different discount rate to investigate the effect of different discount rate on VFM and AP (Table 4.17). Results show that low discount rate decreases the amount of VFM; therefore, there is a range of discount rate that gives the optimum VFM. Results show that all availability payments are the same and independent from the amount of discount rate.

4.1.4 Ex-post VFM – Financial Close

The second ex-post VFM analysis conducted the analysis after financial close. After commercial close, public and private sectors negotiate with each other to reach to the final financial factors. Selected bidder also negotiates with banks and equity investors regarding interest rates, maturity period, and other financial parameters. Therefore, ex-post VFM analysis should be conducted at financial close to consider these changes after commercial close. After financial close, these factors will not change. At this point, all data are the same as the previous stage and the only data that will be changed are financial parameters. These financial parameters are the actual ones used in the project.

Financing Assumptions:
As mentioned earlier, there is no financial structure for the PSC case. However, the updated PPP Bid (APB) has financial structure. Some of the data has been changed during the time between the two milestones (i.e., commercial close and financial close). At commercial close, the TIFIA loan was assumed to be one trench long term loan, but at financial close the TIFIA loan is assumed to consist of two trenches: Trench A and Trench B with different amount, interest rates and tenor. This change is used to illustrate changing values and how they can alter the VFM.

Results:
After updating the financial assumption at the financial close stage, the Ex-post VFM analysis results are showing that PPP procurement method can save $233.7 million for the public sector. In this analysis, the amount of money that the public-sector should pay back to the private because of the availability of the road to the public in the form of availability payments is $20.1 million. This amount is almost 1.8 million dollars below the AP calculating at commercial close or bid time. Changes in financial factors created this variance between the two projected availability payments at financial close and commercial close.

The analysis was repeated for different discount rates to see the effect of different discount rates on VFM and AP. As with the previous examples, results show that low discount rate decreases the amount of VFM; therefore, there is a range of discount rate that gives the optimum VFM. Results show that all APs are the same and independent from the amount of discount rate.

4.1.5 Ex-post VFM – During Construction

The third ex-post VFM analysis belongs to the construction period. During the construction period several assumptions like time and costs could be updated and changed because of delays and cost overruns. However, financing assumptions are the same as assumption at financial close. Risk assumptions also are the same as commercial close because of the assumed lack of information regarding risks. To develop the ex-post VFM analysis, the PSC is the same that was used in the ex-ante VFM analysis.

Timing Assumptions:
The timing assumptions for this section will be updated based on various assumed changes including modified base year, length of construction and concession period. The below table illustrates these changes.

Cost Assumptions:
As with previous analyses, assumptions include design, construction, financing and operation and maintenance costs. All are included in the below table.

Results:
Ex-post VFM analysis results are showing that the PPP procurement method can save $246.1 million for the public sector when considering the whole project life. In this analysis, the amount of money that the public-sector should pay back to the private-sector because of the availability of the road to the public is $21.9 million, which is almost 13 million dollars below the AP calculating previously. Similar to before, the analysis was repeated with different discount rates. Results show that low discount rate decreases the amount of VFM; therefore, there is a range of discount rate that gives the optimum VFM. Results show that all APs are the same and independent from the discount rate.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONTRIBUTION OF RESEARCH

Chapter 2 of the study were devoted to an in-depth review of Public Private Partnerships and value for money analysis literature with a specific focus upon assessing ex-ante VFM analysis in PPPs. Apart from framing the research's focus, providing readers with an overview of, and background to public private partnership concepts and value for money analysis, the literature review chapters functioned to direct the research towards an in-depth exploration of comparatively unexplored issues within value for money analysis specifically ex-post VFM framework in PPPs. This brings us directly to the question of the research's contribution to the field. The research has made three contributions to the field of PPPs, each of which shall now be briefly highlighted.

The first contribution lies in the discovery of the need for ex-post VFM analysis framework to track VFM at different milestones in a PPP infrastructure projects. The literature review, experts interviews show the need for such a framework and analysis in order to enhance the financial feasibility of PPPs both for private and public entities.

The second contribution of this research lies in the development of general framework for the ex-post value for money analysis. This framework can be used as a benchmark to develop the VFM analysis after commercial close in PPP projects.

The third contribution is the comparison between developed ex-post VFM framework with ex-ante VFM analysis. The last contribution of this study is the suggestion of using the Bayesian Network or expert's opinion in order to adjust the risks probability in ex-post VFM analysis.

5.2 IMPLICATIONS OF THE STUDY

This study can be applied in all PPP projects which may be at different stages of their project lifecycle. For example, ex-post VFM can be applied for those PPP project are in construction, those are in O&M phase, and also should be used in PPPs which are done. Ex-post VFM analysis shows how much those PPP project can attain value for money both for public and private sector.

5.3 LIMITATIONS OF THE STUDY AND FUTURE WORK

Even it was mentioned in chapter one about the importance of conducting this research in PPP worlds, it is necessary to conclude with a concern to the study's limitations. Such a concern, will apart from framing the study in the sense that it outlines the basis upon which it should be judged, support the previously stated recommendations for future research. It is very possible that the present study be judged on the basis of that which it has not covered. Accordingly, one

need acknowledge that the study has not suggested a formula to estimate risks after they were taken, but it has used Bayesian Theory to develop a concept as a suggestion to evaluate these kind of risks. The main reason lies in the fact that PPP programs in the US are not well established yet, and therefore collecting accurate data especially about different type of risks at different stages of PPPs in the US is really difficult or it should say it is almost impossible. Lack of enough data makes it almost impossible to apply suggested Bayesian formula to estimate new risks probability. Therefore, because of the mentioned limitations the only available choice was to use initial estimation in ex-post VFM analysis too.

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APPENDIX A

DISCOUNT RATES

The existing approaches to the discount rate applied for VFM analysis in countries considered relatively more experienced in the P3 field are considered below:

- **Social Time Preference Rate**–the value society places on consumption of goods and services now, for example as applied in the U.K.

- **Project Specific Rate (pre-tax time-weighted WACC)**–as proposed by Partnerships BC, Canada

- **Differentiated Discount Rates (Public sector comparator rate vs. P3 rate)**–the current Risk-free Rate (to reflect the time value of money) with a premium added to account for the systematic risk, as applied in Australia

The Social Time Preference Rate

The 2003 U.K. "Green Book," the U.K. HM Treasury's guidance for appraisal and evaluation of government projects applicable to P3-PSC comparisons, uses a "social time preference" (STP) rate, deriving from classic concepts in welfare economics fleshed out in the 1950s and 1960s. The STP rate reflects the value society places on consumption of goods and services now, compared with consumption in the future.

The Green Book STP rate is the sum of few components:

- An inter-temporal preference rate

- A "catastrophe risk" rate

- A third component that takes into account the idea (roughly) that as per capita income increases, people will care less about additional income, and this increases their preference for money today relative to money in the future.

- The inflation rate

In 2003 the STP real discount rate (i.e., before inflation) was revised and estimated to be 3.5 percent, which was reduced from 6 percent. This is referred to as the "recommended" discount rate, which applies to all types of projects at multiple decision points during the project phase, including for feasibility studies that evaluate the economic benefits and costs of undertaking a project investment (Investment decision). This rate is also used for the procurement decision analysis that determines the appropriate procurement process (traditional vs. P3).

In the United States the closest equivalent to the STP rate is established by the Federal government's Office of Management Budget under Circular A-94 "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," published in 1992. The real discount rate applicable to evaluate the government's investment decision for projects with social benefits is 7 percent. This rate has not been changed since that time. Prior to 1992, the real discount rate was 10 percent.

In both STP rate cases noted above (U.K. and U.S.), the nominal discount rate that is required to discount nominal cash flows (i.e., cash flows that include the effect of inflation) is taken to be equal to the sum of the real discount rate (U.S. 7.0%) as adjusted for the assumed annual rate of inflation (U.S. 2.2%). This would result in an estimate for the United States of 9.2%.

Project Pre-Tax Time-Weighted WACC

British Columbia's agency Partnerships BC, the most experienced province in Canada in the P3 field, has a standard methodology to perform P3 evaluations. These are presented in the draft document entitled "Methodology for Quantitative Procurement Options Analysis," released in August 2009, as part of its guidance documents. The document proposes a methodology to perform VFM analysis and also provides guidelines for estimating the discount rate.

Partnership BC's approach on the discount rate for VFM analysis differs substantially from the one in the U.K. because it results in the application of different discount rates to different decision points in the project phase. The first decision point, the investment decision, is when the government determines whether if should fund the construction of an infrastructure asset. The second decision point, the procurement decision, is when the government determines whether to assume the risk of holding and operating an infrastructure asset rather than having those functions taken on by the private sector. The investment decision is evaluated using a social discount rate reflecting the opportunity cost of capital from society's viewpoint. Typically, the cost/benefit decision of whether the government should fund an infrastructure project includes the assessment of social costs (environmental and social public costs) and benefits (heath, convenience, etc.) that are not necessarily reflected in the price individuals would pay to use infrastructure.

The procurement decision is an asset portfolio management decision: whether the infrastructure asset under consideration should be included in a government's asset portfolio or owned by a private partner. According to Partnership BC's approach, the risk profile and considerations of the project are similar whether the project is delivered by the public sector or the private sector, although the cash flows may be different because of the differences in the ways the risks are managed by each. Since in the type of P3 approach considered for this Project the revenues received by the P3 concessionaire are the same as the payments made by the Project Sponsors (i.e., the P3 concessionaire has no other revenues other than the payments received from the public sector), the revenue return to the government from the P3 investment is very similar, if not exactly the same as, the revenue return to the P3 concessionaire. Based on Partnership BC's rationale, as a result of the above the government should discount costs and revenues using essentially the same cost of capital of the P3 concessionaire. Partnership BC's methodology to

establish the discount rate is based on investment portfolio theory. This approach involves basing the discount rate on the cost of capital for a particular project, expressed as the weighted average cost of capital (WACC) of the various project funding sources such as debt and equity. In order to correctly apply the WACC as the discount rate for a project, consideration needs to be given to the manner in which the capital structure and consequently, the WACC, changes over the life of the project. To accurately model the project over the term of the partnership, the pre-tax time weighted WACC is used. The pre-tax, time-weighted WACC for the base case DBFOM option is 8.50%.

Differentiated Discount Rates

The Council of Australia Governments endorsed the National Public Private Partnership Policy and Guidelines on 29 November 2008, which apply to all Australian, State and Territory Government agencies. Australia's methodology agrees with Partnership BC's approach that different discount rates may be appropriate to different decision points: investment fund decision versus procurement decision. While in the former the social discount rate is appropriate, in the latter case a project specific rate should be estimated.

However, the discount rate methodology for procurement analysis differs in that 1) it distinguishes between PSC and P3 discount rates, the PSC is discounted using the risk free rate, while the P3 option is discounted using the project specific rate, and 2) the framework to estimating the project specific discount rate is based on Capital Asset Pricing Model (CAPM) and not on WACC. The Discount Rate determined by CAPM includes the current Risk-free Rate (to reflect the time value of money) and adds a premium for the systematic risk40 of the project being analyzed. The difference compared to Partnership BC's approach is in that the Risk-free Rate is applied to the cash flows of the PSC, while the discount rate determined by CAPM, which is the Risk-free Rate plus the premium for systematic risk, is applied to the private sector cash flows in the P3 approach. As risks are being transferred from the government to the private sector, the project's inherent rate derived from the CAPM analysis increases.

The Capital Asset Pricing Model (CAPM) says $Ra = R_f + \beta_a (R_m - R_f)$

- R_a is the required return on assets whose risk class is designated by the Beta or Systematic Risk (the Project Rate).

- R_f is the Risk-free Rate and is taken to be the yield to maturity of a 10-year Commonwealth Bond.

- β_a is the Asset Beta, which reflects the degree that asset returns (returns of a particular project) are expected to vary with returns of the market (a well-Diversified Portfolio of assets or projects).

- (R_m-R_f) is the return over the Risk-free Rate (the market risk premium or equity risk premium) that investors would need or expect in order to invest in an asset. The market risk premium in real terms is taken to be 6 percent.

According to the Australian National Public Private Partnership Policy and Guidelines, the PSC cash flows should always be discounted using the risk free rate, while the discount rate for discounting the P3 cash flows should be the risk free rate plus a proportion (which can be from 0% to 100%) of the project risk premium, reflecting the proportion of the systematic risk that is transferred.

Annex 3 of the National Public Private Partnership Policy and Guidelines provides indicative Betas and project risk premiums for different infrastructure sectors, for example, as figure A1 below shows, the rate of return or discount rate for a transportation project procurement decision would typically be around 8 percent.