ABSTRACT

Title of Document: **Transaction Cost Estimation Model for US Infrastructure Public Private Partnerships.**

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Directed By: Dr. Qingbin Cui, Civil and Environmental Engineering Department

Due to special characteristics of Public Private Partnerships (PPPs), the "transaction cost" in PPPs is more than other delivery methods. Although there have been some attempts to study transaction costs in PPPs in Europe, transaction costs of PPPs in the US has not been explored well, and the need to develop a standard cost breakdown structure to track, measure and estimate transaction costs in PPP projects is paramount. This thesis covers a theoretical discussion about the definition of transaction costs and different factors affecting them, and based on the mapping of PPP transaction activities to project costs, presents a cost breakdown structure (CBS) as well as a cost accounting matrix. This accounting model is justified in chapter four using two case studies: I-495 HOT lanes project in Virginia, and I-595 improvements in Florida. Finally, in chapter 5 a template for an estimating model which can be used in procurement transaction cost estimates is developed based on the data collected from some infrastructure PPP projects in Europe, and applying Bayesian theory.

Key Words: Cost Breakdown Structure, Cost Estimating Model, Procurement Cost, Public Private Partnership, Transaction Cost

TRANSACTION COST MODEL FOR INFRASTRUCTURE PUBLIC PRIVATE PARTNERSHIPS IN THE US

By

MORTEZA FARAJIAN

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Advisory Committee:
Professor Qingbin Cui, Chair
Professor Miroslaw Skibniewski
Professor John Cable

ProQuest LLC
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106-1346

Dedication

I dedicate this thesis to my parents, without their patience, understanding, support, and most of all love, the completion of this work would not have been possible. I also dedicate this work to the soul of my late grandfather who passed away while I was working on this thesis.

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Morteza Farajian

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Chapter 1: Introduction and Overview

1.1 Introduction:

Due to limited financial resources of governments, Public Private Partnerships (PPPs) have emerged as one of the most important ways of delivering infrastructure projects. Use of public private partnerships was widely started in some parts of the world such as the Netherlands, UK, Spain, Australia and South Africa. In the USA, the importance of private partnership was understood in the second half of the twentieth century. For instance, in 1960s, toll roads had been built and developed in the Spain by 1968. In the United Kingdom during 1980s the ruling government had turned to Public Private Partnerships as the preferred method for economic regeneration. (Cui, Sharma, Farajian, 2008)

Compared to traditional delivery approaches, PPPs bundle complex investments and service provisions with different project entities in a single long-term contract. Because of these special characteristics, and also special uncertainties associated with PPP agreements, many transactions and events happen during the life cycle of a PPP project which are not easily predictable and measurable. Therefore, the "transaction cost" of Public Private Partnerships is usually higher compare to other delivery methods such as the traditional design- bid- build approach. (Ho & Tsui, 2009)

Transaction costs are known in economics as the costs associated with executing projects such as searching, negotiating, contracting and enforcing. Earlier studies show transaction costs in other industries are significant. For instance 77% of the total incomes of the U.S. banking industry, or 13% of the total cost of Clean Development Projects are transaction costs. However, transaction costs in PPPs have not been explored well. There is also not enough data to conduct empirical studies regarding transaction cost estimation for PPP projects. Moreover, the available data is not consistent sue to different interpretations in the definition of transaction cost activities

and transaction cost items. Therefore the need to develop a standard cost breakdown structure to estimate and track transaction cost in PPP projects is paramount.

1.2 Importance of the Topic

Although PPPS have been widely used in other parts of the world, they are still new in the United States. The experience of PPPs varies from state to state since it is still quite a new concept for transportation projects. Based on a survey done for the Alabama Department of Transportation (DOT), within the total 34 responded states, seven states are in an identified experienced group, including California, Connecticut, Florida, Minnesota, South Carolina, Texas, and Virginia (Figure 1). Four states use P3, while another fourteen states are planning to implement P3 in their states (Figure 1). There are also eight northwest states where there is no plan to do P3 projects, primarily due to relatively low traffic volume. (Cui, Sharma, & Farajian, 2008)

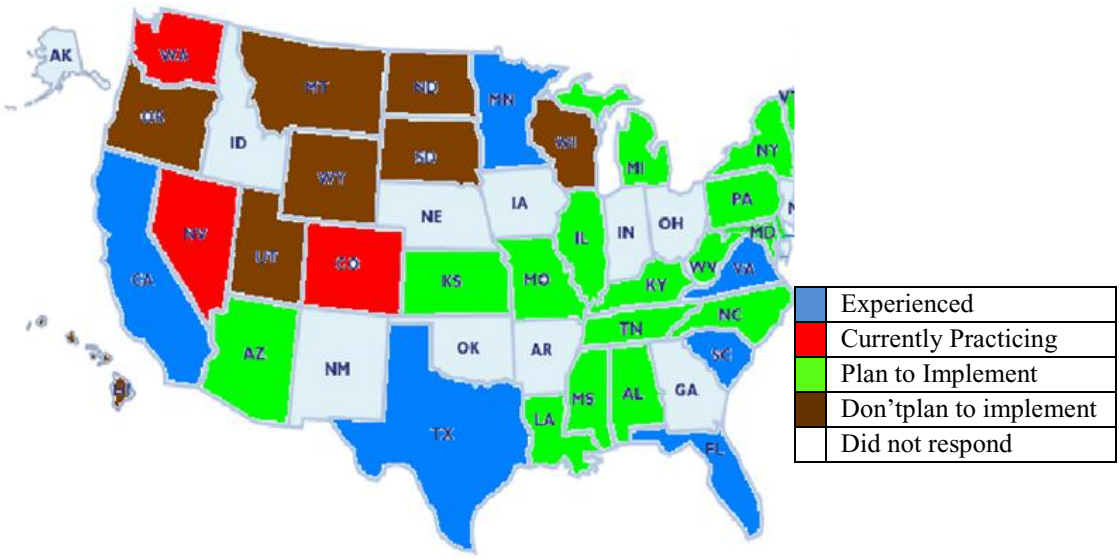

Figure 1: PPP Practice in the US (Cui, Sharma, & Farajian, 2008)

As shown in Figure 1, the number of states who consider themselves experienced in PPPs is much less than the number of states who are currently practicing PPPs and consider themselves inexperienced, or states who have plans to implement it but have no experience yet. As will be shown later in this thesis, even those states that

consider themselves experienced in terms of PPPs many are still struggling with different aspects of PPPs such as transaction costs.

As discussed in Chapter 2, it is believed that PPPs can bring efficiency and cost savings to projects. On the other hand, since PPPs are more complex than traditional delivery methods, and PPP transactions are more costly, there is a need to study different aspects of PPP transactions in order to measure the transaction cost of PPPs. It is very important to measure the transaction cost of PPPs in order to compare with the benefits of PPPs to make sure that doing a project using PPP is financially feasible. Without considering the effect of transaction cost, delivering a project using PPP may be more costly than delivering a project using traditional delivery methods such as design-bid-build.

Another issue that can be addressed here is the fact that some states such as Virginia have passed the legislation – The current PPP legislation status is summarized in appendix 1- to allow state DOTs to bill the transaction costs incurred by the state DOT while procuring a PPP project to the total cost of the project and get reimbursed for such costs. On the other hand, the transaction cost is one of the items which is eligible to be included in the cost of the project while applying for the Transportation Infrastructure Finance and Innovation Act (TIFIA) loan. Therefore, there is a need for a systematic way to estimate it and include it in the cost estimate of the project to maximize the opportunity of using TIFIA in the financial pool of the project.

1.3 State of the Field and the Need

The majority of research and studies on transaction cost of public-private-partnerships have focused on the theoretical and qualitative aspects (Ho & Tsui, 2009); there have been only a few studies, mainly in Europe, trying to quantify transaction costs in PPPs. However, these studies only report the overall transaction cost (Soliño & Santos, 2009), or divide it into public agency transaction cost, winner bidder transaction cost and loser bidder transaction cost (Dudkin & Välilä, 2005).

It should be noted that the PPP program in the US is very different than PPP program in other parts of the world such as European Countries. There are many reasons behind this difference, for instance the US legal system, legislations, lack of experience in terms of PPP projects, etc. These differences can be seen both in terms of the quality and quantity of PPP literature in the research level, and also lack of proper guidelines and standards in the practice level. Therefore, the mentioned studies are mainly based on data from projects in European countries, and the output of those studies may not be fully adaptive to the PPP program in the US. Therefore, there is a need to conduct research to estimate the transaction cost of PPP infrastructure projects in the US in order to include it in the total cost of the project for value for money (VFM) analysis and feasibility studies.

There are many difficulties in the data collection process of this research. The first problem is the inconsistency in the definition of transaction cost among different state DOTs and even with private partners. There is also an inconsistency in different terminologies used for transaction costs. Some people call it procurement cost, some call transaction cost and some others call contract cost. This inconsistency in definition results in inconsistency in data, and makes the analysis of the data almost impossible. In addition, there are many limitations in terms of measuring transaction costs due to limitations of the current accounting systems that state DOTs are using.

Another difficulty in this field is the way that transaction cost is recorded in different projects in different states. Unfortunately, there is no standard guidline or cost accounting system that can address transaction cost issues for PPP projects in the US. Current accounting systems do not allocate the time that each staff works on different projects based on projects. Therefore there is no cost breakdown structure for transaction cost of PPP projects in the US.

Besides the difficulties of measurement and definition that are unique to transaction costs, empirical transaction cost analysis is also subject to the problems found in empirical work more generally. Usually, it is very difficult to find data about transaction cost of PPP infrastructure projects in the US, and even the available data

are not consistent. This issue will be discussed later in chapter 4 while comparing two case studies about the I-495 HOT lanes project in Virginia, and the I-595 improvements project in Florida. The results of these two case studies further support the hypothesis that there is a need for a better accounting system to identify and track transaction cost items to better analyze transaction costs in PPP infrastructure projects in the US.

1.4 Research Methodology:

This thesis sets the needs for research based on a literature review which studies the PPP as a new, innovative approach to financing infrastructure projects, and applies the concepts of transaction cost economics (TCE) in PPPs. In order to do so, the application of TCE in other industries is reviewed, which will be followed by a literature review of the transaction cost in PPPs in other parts of the world particularly in the United States. A general PPP process flowchart is driven based on the PPP practice in different states. This flowchart will be the basis of future developments in this research.

A cost breakdown structure is developed for different activities in a PPP transaction. Different activities in the PPP process flowchart are mapped with different cost items, and based on this mapping a cost accounting matrix is developed. The cost centers in the cost accounting matrix are defined in a way that they can restore as much useful information as possible. For instance the project ID contains the information about the state, the county, and project type and project number. The accounting number also contains information about the party incurred the cost, phase, activity ID, external /internal, direct/indirect. This information will enable the accounting system to have a better cost breakdown structure, and gives the managers and cost estimators to retrieve reports with useful data in a more consistent way.

Later in the study, to validate the discussion in the previous section, two case studies are conducted about the current practice of transaction cost in PPP infrastructure projects in the US. The data for these case studies is retrieved from public

information about projects, phone interviews with project managers or financial managers / advisors. The collected data is analyzed and compared with the results of similar studies in Europe, and finally the two case studies are compared with each other and the expected results from the model developed in previous stage of the case study.

Finally a cost estimation template is developed in this thesis. This model is developed based on Bayesian theorem by developing a Bayesian network. The inputs of the model are the main 4 attributes affecting transaction costs as suggested by literature. The relationships in the model are defined based on the current PPP practice and guidelines in the US. Because of lack of data regarding transaction cost of PPP infrastructure in the US, the conditional relationships (probabilities) are defined based on a study done in Europe. The outcome of this template model is an estimation of transaction cost for different entities enrolled in a PPP project.

1.5 Thesis Outline:

This thesis is organized in six chapters. Chapter 1 is an introduction which establishes the research need and explains the methodology and structure of the thesis. Chapter 2 is a literature review which studies the PPP as a new, innovative approach to financing infrastructure projects, and applies the concepts of transaction cost economics (TCE) in PPPs. In order to do so, the application of TCE in other industries is reviewed, which will be followed by a literature review of the transaction cost in PPPs in other parts of the world.

In Chapter 3, based on the mapping of transaction activities to project costs, the study presents a cost breakdown structure (CBS) for PPP transactions. The hierarchical structure that is developed in this innovative approach to PPP projects covers costs incurred by the public partner associated with PPP transaction activities, such as information searching, preliminary studies, bidding, negotiation, consulting, overseeing, and inspection. As a result of this study, a model with different levels of

CBS' has been developed: one level covers five different stages of PPPs, another level covers cost accounts based on labor, equipment and material, and subcontracting classification. The last level contains the cost centers.

In chapter 4, the tracking model is justified using two case studies: I-595 improvements in Florida as a good practice of tracking transaction costs in a PPP infrastructure project, and the I-495 HOT lanes project in Virginia as a bad example of tracking and recording transaction costs in a PPP infrastructure project.

The last chapter presents a template for an estimating model which can be used in procurement transaction cost estimates. This template has been developed based on the data collected from some infrastructure PPP projects in Europe, and has been designed using Bayesian theory in order to account for the number of bidders (bidding competition level), capital cost of the project, location (PPP program maturity level), and project complexity (uncertainty).

Chapter 2: Literature Review

2.1 Introduction

Over the last few years, many countries have witnessed an increased provision of public goods by private-for-profit firms and not-for-profit-firms. Their involvement in PPP arrangements can vary from designing schools, hospitals, roads, or sanitation facilities, to structuring their financing to include construction, operation, maintenance, management, and ownership. The World Bank estimates that the private sector financed about 20 percent of infrastructure investments—amounting to about US$ 850 billion—in developing countries during the 1990s. Several industrial countries (e.g., Australia, Canada, UK, and Spain) have adopted PPP arrangements to provide education, health, water, and waste management facilities as well as other infrastructure development.

This section of this thesis will review the literature, and gives a general understanding of PPPs, their benefits, and financial mechanism. Before making any comments about PPPs, one should have a good understanding of different aspects of PPPs in order to be able to analyze the performance of PPPs. Reviewing what other scholars have found about PPP delivery method will help us to better develop our model based on their findings. Particularly, the focus of the literature review on PPPs in this thesis is on PPP process flowchart, PPP characteristics and performance measurement.

Like any other new technique, there are some befits and some costs associated with a PPP transaction. It is very important to know about the extra costs that a PPP transaction has because in the cost estimation and value for money (VFM) analysis of a PPP project one needs to account for such costs. Therefore, there is a need to study the transaction cost economics, and the way that people have measured such costs in other industries in order to have a better understanding of how those concepts can be applied in a PPP infrastructure project.

Studying the effect of TCE in PPPs is essential to track the special characteristics associated with them. PPPs have a high uncertainty, bounded rationality, and opportunism behavior as a result of the lengthy life cycle of the project, complex contracting mechanisms, a complex pool of finances, and multiple entities with different interests in a project. The effect of asset specificity due to the special characteristics of highway projects in comparison to other construction projects should also be noted. Thus, it can be concluded that PPPs are highly exposed to transaction cost factors that need to be carefully studied, determined, and tracked with TCE.

This chapter is organized as follows: Section 1 reviews the literature on PPPs. It covers definitions of PPPs as well as characteristics of PPPs and performance measurement of PPP projects. Section 2 talks about the importance of TCE and presents a brief overview of the history of the theory development followed by different attempts to define transaction cost over time. Section 2 also covers some theoretical and methodological issues related to TCE, and defines some terminologies which are being used in this theory. It summarizes the relevant empirical research which is being done in capital project financing using the TCE approach; and finally covers the public private partnership implications of TCE, and analyzes different attempts to estimate transaction costs in PPPs in other parts of the world.

2.2 Public Private Partnerships

2.2.1 Definition

The Canadian Council for Public-Private Partnerships defines a public-private partnership as "a cooperative venture between the public and private sectors, built on the expertise of each partner, that best meets clearly defined public needs through the appropriate allocation of resources, risks and rewards." Other working definitions are better prescribed and speak to the characteristics and changes that must occur within a PPP. According to Wendell C. Lawther's 2002 report, Contracting for the 21st

Century: A Partnership Model, public-private partnerships are further defined as: "Relationships among government agencies and private or nonprofit contractors that should be formed when dealing with services or products of highest complexity. In comparison to traditional design-bid-built, they require radical changes in the roles played by all partners" (NASCIO, 2006). While PPPs have been exercised in many countries over the years, there are still disagreements in how a PPP should be defined. The Office of Public Sector Information in the United Kingdom defines PPPs as "arrangements typified by joint working between the public and private sectors."

PPPs are widespread across a variety of business entities, and, furthermore, the HM Treasury, 2008, states that, "In their broadest sense (PPPs), they can cover all types of collaborations across the public-private sector interface involving collaboratively working together and risk-sharing to deliver policies, services and infrastructure." In Australia, a PPP is defined as "a long-term contract between the public and private sectors where government pays the private sector to deliver infrastructure and related services on behalf, or in support, of government's broader service responsibilities. PPPs typically make the private sector parties who build infrastructure responsible for its condition and performance on a whole-of-life basis" (Australian Government: Infrastructure Australia, 2008). The U.S. DOT's Report to Congress on Public-Private Partnerships (U.S.DOT 2004) defines a PPP as "a contractual agreement formed between public and private sector partners, which allows more private-sector participation than is traditional". This agreement is usually signed between a government agency contracting with a private company to renovate, design, build, operate, maintain a facility or system for a long period of time.

Although PPPs have been in practice for many years in the world, in the US, PPPs have just begun to replace the public provision of infrastructure service in recent years. The surge in PPPs is reflected in the financial press. For example, articles in the Financial Times mentioning this concept increased twenty-fold over the last decade, from 50 in 1995 to 1,153 in 2005 In Britain about 14% of public investment is now done under the so-called Private Finance Initiative (Bennet and Iossa, 2006).

Projects that require large up-front investments, such as highways, water and sewerage, bridges, seaports and airports, hospitals, jails and schools are often provided via PPPs.

PPP's have also proven to cut down costs and the time it takes to deliver projects As shown in Table 1 below, findings of the UK's National Audit Office recorded that the cost overruns for the public sector using PPP procurement is only 22% compared to 73% in the case of conventional procurement. Furthermore, the delay in project delivery using PPP procurement is only 24% compare to 70% in conventional procurement (see Table 1 – Cost and Time Overruns in PPPs vs Traditional Procurement).

Table 1: Cost and Time Overruns in PPPs Vs Traditional Procurement

	Conventional Procurement	PPP Procurement
Cost Overruns for the Public Sector	73%	22%
Delay in Project Delivery	70%	24%

Source: UK's National Audit Office

On the other hand, some consider PPPs as a way for privatization, and argue that public services should be done by non-profit public agencies that are not running for profit. Grimsey and Lewis (2005) reject this notion because with privatization, the government no longer has a direct role in ongoing operations, whereas, with a PPP, the government retains the power to control the quality of the project as well as toll fees. This power is usually addressed in different provisions of PPP agreements.

Although PPPs can help governments fill the gap between available public funds and needed resources, they may increase the cost of procuring, monitoring and enforcing contracts especially when compared to traditional procurement of public investment projects. The main sources of higher procurement costs in PPPs are their long-term

character, ownership and financing structures, and risk-sharing features (Gerti & Timo, 2005). Due to these reasons, and that the degree of contractual complexity in PPPs is high, more attempts to reach agreements results in increased costs associated with a PPP transaction. Consequently, the search (tendering and bidding), contracting, and monitoring processes become more resource-consuming—both in terms of budget and time—than in traditional methods of procuring projects. Negotiating the contract is especially costly mainly because the level of uncertainty in PPPs is high and risk and rewards remain unclear. Although there is a considerable amount of transaction costs associated with PPPs, there is still not enough information about how to define, track, and quantify this cost. In evaluating PPP proposals, it is very important to be able to estimate the transaction costs of the contract to ensure that the higher transaction costs do not erode the cost savings achieved through a PPP structure.

The case of PPPs in the transportation sector is particularly compelling. Congestion costs in the top US metro areas have grown steadily, reaching $63.1 billion in 2003, 60% higher (in real terms) than a decade earlier (Schrank and Lomax, 2005). This fact, combined with budgetary problems and technological improvements in toll collection, has led more than 20 U.S. states to pass legislation allowing the operation of public-private partnerships to build, finance and operate toll-roads, bridges and tunnels ("Paying on the Highway to Get out of First Gear." New York Times, April 28, 2005). Recent examples of PPP contracts in the U.S. transport sector include the Dulles Greenway, the I-495 HOT lanes, the I-595 improvements, the Port of Miami Tunnel, the Southbay Expressway, the Chicago Skyway, the Indiana Toll Road and the Pocahontas Parkway.

As stated before, there are several definitions for "Public-Private Partnership", however, in this paper, PPP is meant to be a design-build-operate-finance delivery (DBOF) of infrastructure project such that (i) assets are controlled by a private firm for a (possibly infinite) term; (ii) during the duration of the contract, the firm is the residual claimant, while the government is the residual claimant at the end of the

concession. However, these claims are ambiguous due to contract incompleteness; and (iii) there is a considerable amount of public planning in the design of the project (Engle et al., 2008).

2.2.2 Characteristics of PPPs

The main characteristic of a PPP, when compared with the traditional approach to the provision of infrastructure, is that it bundles investment and service provisions in a single long term contract. For the duration of the contract, which can be as long as twenty or thirty years, the concessionaire will manage and control the assets, usually in exchange for user fees, which are its compensation for the investment and other costs. At the end of the concessionare, the project reverts to government ownership. (Engle et al., 2008)

As the economics of PPPs are still incorrectly perceived, practice has run ahead of theory. Some practitioners and governments claim that PPPs relieve strained budgets and release public funds, while others suggest that PPPs are appealing because finance, investment and management is delegated to private firms, which are more efficient than government. Despite these seemingly reasonable arguments, the experience with PPPs has resulted in an array of outcomes. Whereas in some cases, previous expectations are met, in many more cases, contracts are renegotiated in favor of the concessionaire, or, conversely, are subject to regulatory takings. Often deadlines are not met, or the project requires substantial subsidies to be finished (Guasch, 2004). The reasoning behind this shortcoming seems to be that the profitability of PPP projects is subject to large exogenous demand uncertainty, which is often not considered properly when designing the contracts. This explains why renegotiations take place when demand is lower than expected, as well as the array of risk sharing agreements that are observed.

Since PPP projects tend to be based on contracts that extend over a long period of time, e.g. 25 years or more, and also are associated with high uncertainty and risk, the contracts are inevitably incomplete in many relevant respects. During the terms of the

contract, unforeseeable events will occur (e.g. technical advances) and many of these events will be unverifiable (e.g., a contractor's effort to improve safety cannot be easily verified). Road projects, for example, can involve a fair amount of uncertainty about the final good that will be produced. This problem is aggravated due to the opportunism of the individual parties to the contract. Therefore, in the presence of bounded rationality and opportunism, one could expect that undertaking a project through a hierarchical structure will result, in principle, in lower transaction costs, (and therefore, fewer incomplete contracts) because the parties to the transactions will behave more cooperatively than under market conditions. Thus, when a hybrid mode of governance such as PPP is utilized, government will need to limit the scope to reduce opportunistic behavior (Soliño, 2008).

2.2.3 Success factors in PPPs

In order to better understand the key success factors in PPPs, one should understand the definition of a success factor first. In a study (Hardcastle et.al) published by Hong Kong University, the critical success factors in PPPs are defined and discussed. (Hardcastle, Edwards, Akintoye, & Li). Based on this study, Rockart (1982) defines Critical Success Factors (CSFs) as: "those few key areas of activity in which favorable results are absolutely necessary for a manager to reach his/her goals." It should be mentioned that the CSF methodology is a procedure that attempts to identify key areas that dictate managerial success. This method is widely used as a management measure in financial services, information systems and the manufacturing industry.

There have also been attempts to apply it in construction management (Sanvido et al., 1992; Yeo, 1991). Hardcastel et.al (2010) studied other factors such as good governance, government support, a stable macroeconomic environment, and a suitable legal and administrative framework. They concluded that sound economic policy, including the available financing market, a strong and good private consortium, good feasibility study/cost-benefit analysis, and effective risk allocation, in parallel with some "Soft" critical success factors such as social

support, commitment of different entities, and mutual benefit are all critical factors for the success of PPP procurement projects. A quick look at the above key success factors reveals that most of them are related to activities of a PPP transaction such as feasibility studies, negotiations, and risk and reward sharing mechanisms during procurement, or partnership mutuality and enforcement after procurement. So, the way that a PPP transaction is managed plays a great role in the overall success or failure of the project. It should be emphasized that a PPP transaction, like any other transaction, is associated with some transaction activities, and some transaction costs which will be further discussed in the next section of this chapter.

2.3 Transaction Cost in Public Private Partnerships

2.3.1 Overview on Transaction Cost Economics (TCE)

A fundamental assumption in economics, known as the Law of One Price, is that in a competitive market, all buyers face the same price. Neoclassical Economic Theory is based on the assumption of an "ideal world" in which the price mechanism exists and the trading value is determined based solely on the supply and demand factors. In this "ideal world", the supplier and the buyer meet in a free market and reach an agreement without any negotiations because the price is already determined by the free market. In this "ideal world," the exchange cost is just the cost of the item itself. The decision to make the trade or not is based on how much an individual or organization should spend to produce the same good or service in house. If the good can be produced at price lower than market price, it is better to produce it in house; otherwise it will be purchased from the market. However, in the "real world," the exchange of goods and services is not that simple.

In the "real economy," if the appropriate price is measured, buyers often face different prices for the same good, even in a competitive market. These price variations are likely to affect what is produced and what exchanges take place in the market, which organizations and specialties survive, and even which rules of the game persist (Benham & Benhal, 2001). Neoclassical Economics suggests a firm's

vertical boundary decisions are determined by technological factors (i.e.: economies of scale or scope) while the Transaction Cost Theory (TCT) distinguishes these decisions to have the possibility of being influenced by characteristics associated with the efficiency of the chosen form of organization. Simply put, the TCT explains what Neoclassical Economics failed to consider: bounded rationality, uncertainty, asset specificity and opportunism behavior in the "real world".

In contrast to the suggestion in Neoclassical Economics that a firms' vertical boundary decisions are determined by technological factors such as economies of scale or scope, the TCT believes that these decisions may also be influenced by characteristics associated with the efficiency of the chosen form of organization. In other words, TCT explains what classic economics ignored: bounded rationality, uncertainty, asset specificity and opportunism behavior in the "real world".

Transaction Cost Theories of Exchange, part of what has been termed the "New Institutional Economics," have been the subject of growing interest in recent years. Originally, an explanation for the scale and scope of the firm, Transaction Cost Theories (TCE) is now used to study a variety of economic phenomena. These range from vertical and lateral integration to transfer pricing, corporate finance, marketing, the organization of work, long-term commercial contracting, franchising, regulation, the multinational corporation, company towns, and other contractual relationships, both formal and informal. The basic belief surrounding TCE is that transactions must be governed as well as designed and carried out, and that certain institutional arrangements affect this governance better than others is now increasingly accepted (Shelanski & Klein, 1995). The purpose of this chapter is to provide a broad picture of transaction costs: their history, definition, foundation, use, measurement and implications. Next, these concepts are studied in the context of PPPs.

British economist Ronald Coase began writing papers discussing the economy in the early 1930s questioning businessmen about the business methodologies they used. One key question involved why firms chose to produce some of their own inputs (vertical integration), and why they sometimes chose to use the market (buying from

independent suppliers) (Hazlett, 1997). In 1937, Coase published his article, "The Nature of the Firm," explaining the basic economics of a business enterprise. It became one of the most influential works in the history of dismal science, outlining the subtle logic of how firms pursue efficiency in a complicated world. The article provided a sophisticated approach when compared to works in 1930s American vogue that wrote toward the belief that a corporation was simply an accident waiting to self-destruct. However, failing to provide an operational framework, Coase's article was neglected for a long time (Klaes, 2000).

The 'neoclassical' literature on transaction costs starts with Coase (1937), and was further developed in the 1950s. This literature defines transaction costs more narrowly, generally models them more explicitly and often analytically identical to transportation charges or taxes (Allen, 1999). In 1960, Coase rearranged the study of economics with his essay "The Problem of Social Cost." It analyzed what happens when economic actions affect third parties.

Although transaction cost theory was first introduced about 80 years ago, and many scholars have done extensive amounts of research in this field since then, there are few direct empirical estimates of transaction costs. One problem is that there is no standard terminology (Benham & Benhal, 2001). Many different definitions of transaction costs appear in literature. They often serve as heuristic devices that are not used actually to measure transaction costs. Although these definitions offer powerful conceptual insight, they have not been translated into widely accepted operational standards.

There are two major branches of literature that have tried to define transaction costs in an economical context. The first branch is the Coasian approach which focuses on the quantification of transaction costs and the impact on volume of trade. The second branch is the New Institutional Economics (NIE) approach propagated by Williamson which emphasizes the design of institutions and contracts to minimize unobservable transaction costs that are not directly quantified (Antinori & Sathaye, 2007). These two approaches form a basis for establishing an analytical framework

but require adaptation for defining and quantifying transaction costs in public private partnership infrastructure projects.

2.3.2 Transaction Cost definition

Coase (1937) defines the term transaction costs as "costs using price mechanisms associated with specifying, negotiating, and enforcing contracts." He argues that if transacting in the market is proved to be too costly, transactions will take place within the boundaries of the firm. Coase provides examples of what he meant by the costs of the price mechanism: discovering what the prices are and negotiating and closing a contract. Arrow (1969) defines transaction costs as "the costs of running the economic system". In the years to follow, Wallis and North (1986) drew a distinction between transformation activities and transaction activities. They define transaction costs as the cost of resources which are consumed for a transaction function rather than a transformation function. They define transaction costs as the costs of processing and conveying information, coordinating, purchasing, marketing, advertising, selling, handling legal matters, shipping, and managing and supervising.

Niehans (1969) defines transaction costs as follows: "The term "transactions costs" or "transfer costs" shall be used for the costs associated with the transfer of ownership from one individual to another. They are a catchall term for a rather heterogeneous assortment of costs. The parties have to communicate; information will be exchanged; contracts are drawn up; the goods must be inspected, weighed and measured; and accounts have to be kept. To a certain extent, transactions involve additional transportation in space over and above what is required to move goods from producer to consumer "(Niehans 1969). Two points are noteworthy in this passage. On the one hand, transaction costs are defined in a very broad way. On the other hand, no distinction is made between transaction costs and transport costs (Klaes, 2000). From the perspective of economic modeling, this strategy facilitated the accommodation of the new cost category within the existing analytical framework.

Toward the mid-1970s, Williamson increasingly emphasized the notion of the transaction in his analysis of governance structures, simultaneously starting to refer to his approach as the "transaction cost approach" (Williamson 1974). He writes "The

costs of writing and executing complex contracts across a market vary with the characteristics of the human decision makers who are involved with the transaction on the one hand, and the objective properties of the market on the other …" (Williamson, 1974). In 1985, Williamson defined transaction costs to include the costs of drafting, negotiating and enforcing an agreement, and also the costs of governance and bonding costs to secure commitments (Williamson, 1985). This is the result of Williamson's strategy to operationalize transaction costs, not by elaborating on the concept itself, but by replacing it with a detailed analysis of contractual and organization arrangements (Klaes, 2000).

Unlike the previous approaches where transaction costs have an exact value, Williamson's approach provides the notion that transaction costs have relative values and can be different from one market to another or from one organization to another. Williamson's analysis takes place as an exploration of the causes which give rise to transaction costs (Klaes, 2000). In the same manner, Davis (1986) defines transaction costs as those costs associated with "greasing markets," including the costs of obtaining information, monitoring behavior, compensating intermediaries, and enforcing contracts. From another point of view, North (1990) explains the transaction costs as "the costs of measuring the valuable attributes of what is being exchanged and the costs of protecting rights and policing and enforcing agreements."

Alchian and Woodward (1988) distinguish between two types of transactions: exchange transactions involving the transfer of property rights and contracting transactions involving negotiating and enforcing promises about performance.

By comparing all definitions, the transaction cost in this report is assumed to be the sum of the costs associated with searching for a contract, finding a partner, and engaging in exchange and contracting activities, which are separated from the direct costs of production.

2.3.3 Transaction Cost Economics Theorem and Terminology

After defining transaction costs, it is important to discuss how to measure transaction costs. However, before assessing transaction costs, one should be familiar with the concepts of TCE and the different terminologies used in this theorem. This section covers these terminologies and discusses how they are related to transaction costs in the TCE context. Some of the most important terminology discussed in this section are as follows: idiosyncratic transactions, asset specificity, bounded rationality, frequency of trades, complexity and uncertainty.

- Asset Specificity

Asset specificity is defined as the extent to which the investments made to support a particular transaction have a higher value to that transaction than they would have if they were redeployed for any other purpose (McGuinness, 1994). Williamson (1975, 1985, 1986) argues that transaction-specific assets are not redeployable and that physical and human investments are specialized and unique to a task. In other words, asset specificity is referred to as the degree to which a party is tied to a transaction or investment. For example, asset specificity is high in PPP infrastructure projects due to the characteristics of these projects. If a private company invests in a PPP infrastructure project, it will not be able to effortlessly change its business plans and stop work on the project without losing the investments. In typical real estate contracts, the land and the building structures have value even though the project is not completed and it is always possible to sell them any time before project completion. In a PPP infrastructure project, however, it is nearly impossible to sell an incomplete road.

- Opportunism

Opportunism has been defined by Williamson as self-interest seeking with guile. In other words, it recognizes that businesses and individuals will sometimes seek to exploit a situation to their own advantage (Williamson, 1979). This does not imply that those persons involved in transactions act opportunistically all of the time, rather, it recognizes that the risk of opportunism is often present. This risk is greater when

there exists a small number bargaining problem (Williamson, 1979). For example, the fewer the number of alternative suppliers available to a buyer, the more likely it is that an existing supplier will act opportunistically to alter the terms of the business relationship to their own advantage. They can accomplish this by demanding a higher price than previously agreed upon. Due to conflicts in the interests of different entities in PPPs, this phenomena is often imperative in PPPs. One method to reduce opportunistic behavior of different parties is to implement a fair risk and reward negotiation in order to increase the interdependence magnitude of the contract. This methodology will be further discussed in subsequent sections.

- Uncertainty

Due to the characteristics of the real market, uncertainty about future events is clearly a common feature of many trading relationships. Sales volume uncertainty due to volatile market conditions is an obvious example. Empirical studies sometimes treat this kind of uncertainty as an independent variable, regressing the choice of organizational form on the variance of sales or another variable without including any measure of asset specificity in the model. However, in absent fixed investments, TCE does not predict that uncertainty itself would lead to hierarchical governance.

When there are no relationship-specific investments at stake, it may be less costly for a firm to contract in the market for goods and services in an uncertain environment than to assume the risk of producing them internally. This way, the effect of uncertainty depends on competitive conditions. If there is no asset specificity and there are many potential suppliers of a component for which future demand is uncertain, it may be cheaper to buy the component than to make it internally.

The specific responses that exchange parties manifest depend on whether the environment is certain or uncertain. Environments that are characterized by relatively few or a rare occurrence of problems tend to develop a fixed set of routines for dealing with environmental elements (Ryu, 2006). These exchange parties deal with

the same environment concerns regularly and conventions for handling the minor or rare interruptions tend to be respected industry-wide.

Ryu (2006) uses an analysis from the responses of 137 purchasing managers in manufacturing firms that supported the proposition that changes in the level of uncertainty due to external circumstances increase the extent to which the manufacturers monitor the suppliers when the interdependence magnitude is low. He claims that environmental uncertainty has no effect on monitoring when interdependence magnitude is high. These results provide an important addition to transaction cost theory; the inclusion of inter-organizational interdependence in transaction cost theory increases the understanding of inter-organizational governance.

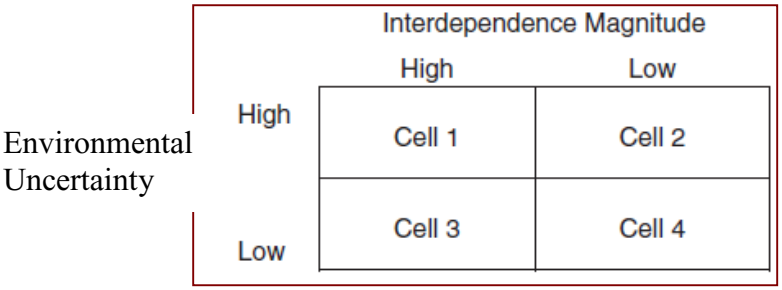

Figure 2: The Four Groups Characterized by Two Levels of Internal and External Environments (Source: Ryu, 2006)

Cells 1 & 3 reflect an instance in accordance with the bilateral deterrence theory, that depicts when interdependence magnitude is high, exchange parties are each vulnerable to retaliation from the other. Thus, an attempt to control exchange partners through overt governance (monitoring) produces a greater likelihood of retaliation. Cell 2 represents highly uncertain environments which lead to the development of the condition in which the information about the environment is asymmetrically distributed between exchange parties.Cell 4 represents a low interdependence environment which allows parties to behave opportunistically due to low retaliation power (Ryu, 2006).

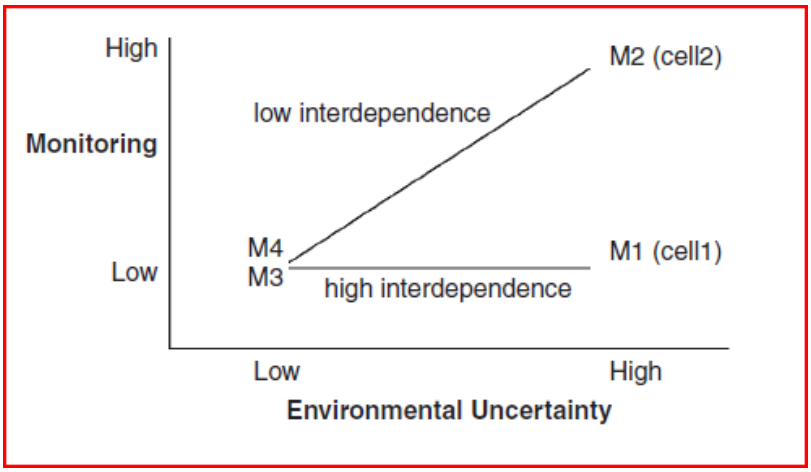

Figure 3: A Model for the Influence of Internal and External Environments on Monitoring (Ryu, 2006)

2.3.4 Measuring Transaction Costs

The empirical work in TCE uses a variety of econometric and historical methods. In general, these studies fall into one of the following three categories: qualitative case studies, quantitative case studies, and cross-sectional econometric analyses. Williamson's (1976) study of cable TV franchising in Oakland, California is an example of the first category, while Masten's (1984) investigation of contracting practices in a large aerospace corporation is an example of the second. Levy's (1985) study of vertical integration across industries is an example of the third category. Most of the empirical literature in TCE consists of various kinds of case analyses. This is primarily because quantifying the main variables of interest to transaction cost economists – such as asset specificity, uncertainty, frequency - are difficult to measure consistently across firms and industries. Typically, these characteristics are estimated based on surveys or interviews. For example, a manager might be asked to rate on a Likert-type scale of 1 to 7 the degree to which an investment has value in outside uses. Such data are definitely subject to the general limits of survey data, for example, that they are based on the respondents' stated beliefs, rather than on their beliefs or valuations as revealed through choice. More importantly, since these measurements are based on ordinal rankings, it is hard to compare them from industry to industry. What is ranked as a relatively specialized asset in one firm may be rated differently in another firm or industry. Similarly, what one firm considers a

comparatively uncertain production process may be the standard operating environment in another firm. Therefore, Multi-industry studies may contain variables that are labeled the same thing but are really incommensurable or, conversely, may contain variables that are identical but labeled differently.

Besides these measurement difficulties, empirical research in TCE is often hampered by confusion about definitions, which also leads to questioning the empirical parameterizations of key variables. The primary conceptual problem that we have found lies in the treatment of uncertainty as a factor that raises transaction costs and increases the probability of integration. This confusion may explain some seemingly contradictory results on the effects of sales volume uncertainty on the vertical integration decision.

At the level of the whole economy, Wallis and North (1986) have calculated that transaction costs (or rather the transactions sector of the economy) represented fully 40-8% of the GNP of America in 1970. Their division of costs into transaction costs and transformation costs is, unfortunately, unlikely to be translatable into business decision-making. In a perceptive comment on the Wallis and North article, Davis adds a comment highly relevant to our current endeavor, quoting Charles Plott as saying 'transaction costs are a useful notion whose usefulness declines proportionately with the preciseness of the definition' (cited by Davis, 1986, p. 149).

Figure 4 below shows how different people have tried to measure transaction costs in different industries. Colby (1990) uses the classical definition of transaction costs and categorizes them into four main items: searching cost, preliminary studies cost, negotiation costs and approval costs. Noi (2002) attempts to estimate the Aid Transaction Costs in Vietnam and categorizes transaction costs into three main categories: project identification and appraisal, negotiations and contracting, and finally project implementation, monitoring and evaluation. In Antinori and Sathaye's (2007) study regarding assessing transaction costs of project-based greenhouse gas emissions trading, they develop the model based on search cost, feasibility studies cost, negotiations, monitoring and control, obtaining approvals, and insurance cost.

The United Nations Development Programme's (2009) studies regarding transaction costs in the Clean Development Mechanism (CDM) Projects are some examples of attempts that have been done to assess transaction costs in different industries by categorizing them into design costs, other CDM costs including registration, other potential costs, opportunity costs and also self insurance costs.

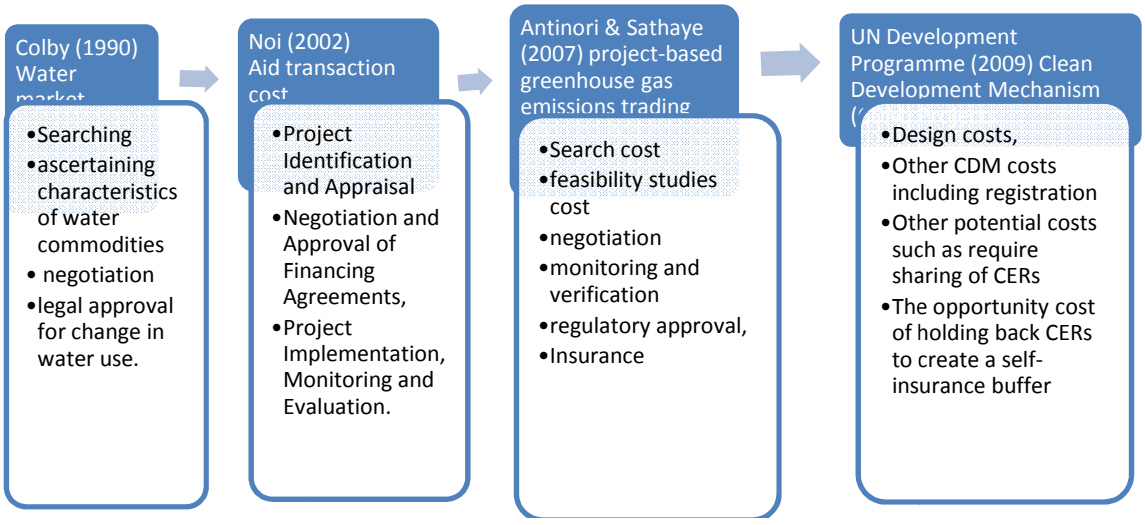

Figure 3: Categorizing transaction cost in transaction cost measurement attempts

2.4 Measuring transactions costs in PPPs

2.4.1 Introduction

There are several reasons why transaction costs in PPPs can be high, especially compared to traditional procurements of public investment projects. These reasons are mainly because of the characteristics of PPPs such as their being long-term, ownership and financing structures, and risk-sharing features. Due to all of these

reasons, the degree of contractual incompleteness in PPPs is high. Transaction costs in PPPs are also high because there is a need for an extensive attempt to deal with uncertainties and reduce the contractual incompleteness as well as contract enforcement and conflict resolution. Therefore, the search (tendering and bidding), contracting, and monitoring processes become more resource-consuming than in traditional short-term contracting aimed to supply assets, rather than services, to the public sector. Negotiation of the contract is also costly. Also, due to high uncertainty and complexity of PPPs, there is a need for consulting and advisory services. Such costs are not limited to the pre-delivery phase, as renegotiation is almost inevitable in contracts that stretch over decades. Also, a PPP is established for service provisions using privately owned assets while different entities with conflicts in their interest might entail higher monitoring costs than in-house provision of the same service.

2.4.2 Theoretical works

There have also been some attempts to estimate transaction costs in PPP projects. Ho and Tsui (2009) tried to identify some major variables such as principal-principal and renegotiation problems as well as soft budget constraints and their effects on transaction costs in PPPs. They suggest that some transaction cost sensitive variables such as specific characteristics of the project itself and certain conditions characterizing institutional environments can have a significant effect on transaction costs. Although they explain the effect of some variables on transaction costs in a PPP model, their study does not reflect the situation in the US. For instance, due to the public procurement procedure, transparency rules, and regulations in the United States, it is almost impossible to face principal-principal problems in which "the controlling principal who appoints the major directors of its board and top managers of the firm might exploit private information and dominant positions to appropriate from minority shareholders" (Ho & Tsui, 2009).

2.4.3 Empirical works

In another study, Soliño & Santos (2009) try to distinguish, at every stage, between external costs (such as technical, legal and financial advice) and in-house costs such

as project preparation costs. These costs considered include the Environmental Impact Assessment, feasibility study, preliminary design, and bidding costs including tender documentation preparation and costs for negotiation**.** Their study is based on data collected from different infrastructure projects in the European Union (EU) that suggests a model to estimate the transaction cost of PPPs based on some variables (i.e.: type of project, capital cost of project, procurement duration, location, and number of bidders). Their study cannot be fully be implemented as an estimating model in the United States mainly because their data is based on projects in the EU. In addition to this issue, the PPP model in the EU is better developed and more mature than the PPP model in the United States. Therefore, there is a higher amount uncertainity associated with the PPP model in the United States that may result in higher transaction costs when compared to the EU model. It should also be noted that Soliño & Santos (2009) categorize transaction costs only into two main categories: external and internal. Their research does not consider a cost breakdown structure with different levels of cost items to better track and record transaction costs in PPP agreements.

Another step to identify and measure transaction costs has been taken by Gerti Dudkin and Timo Välilä (Dudkin & Välilä, 2005). According to the data collected from projects financed by the European Investment Bank, they have concluded that the level of transaction costs in the procurement phase of infrastructure projects are, on average, about 10 percent of the capital value of the project. They have divided these transaction costs into three categories consisting of public sector, winning bidders, and losing bidders as depicted in Figure 4 below. Based on their research, the overall transaction cost of the project for the public sector, is about 2-3% of the capital value of the project., the winning bidder 4-5%, and the losing bidders is about 2-5%.

Figure 4: Transaction cost in PPP projects in EU countries (Dudkin & Välilä, 2005)

To summarize, transaction costs to the public sector and the winning bidder vary between countries (legal systems) and sectors, and they are significantly higher in small projects (below £25 million) and in projects that have a long procurement time (over 50 months). In contrast, neither experience in setting up partnerships nor the number of bidders affect the costs to the public sector and the winning bidder. This is in contrast with findings of Santos (2009) and Tsui (2009).

2.4.4 Important Factors Affecting Transaction Costs of PPPs

There are many factors that can affect the percentage of transaction costs in PPPs. For instance, size of the project, number of bidders, complexity of the project, market value of the project, and location of the project..

- **Size of the Project**

One of the most important factors in estimating transaction costs of PPP infrastructure projects is the size of the project. Usually, a transaction cost is reported as a percentage of the total capital cost of the project, however, when the size of project increases, this percentage changes. The transaction cost for smaller projects is usually

higher than larger projects in terms of the percentage of the total capital cost of the project. This occurs because no matter what the size of the project, many of the transaction activities stay the same. However, since the complexity of larger projects is usually higher than smaller projects, transaction activities may cost more; but this increase in cost is not proportional to the increase in capital cost of the project. Figure 5 depicts projects costs with respect to transaction costs during the procurement phase of a project.

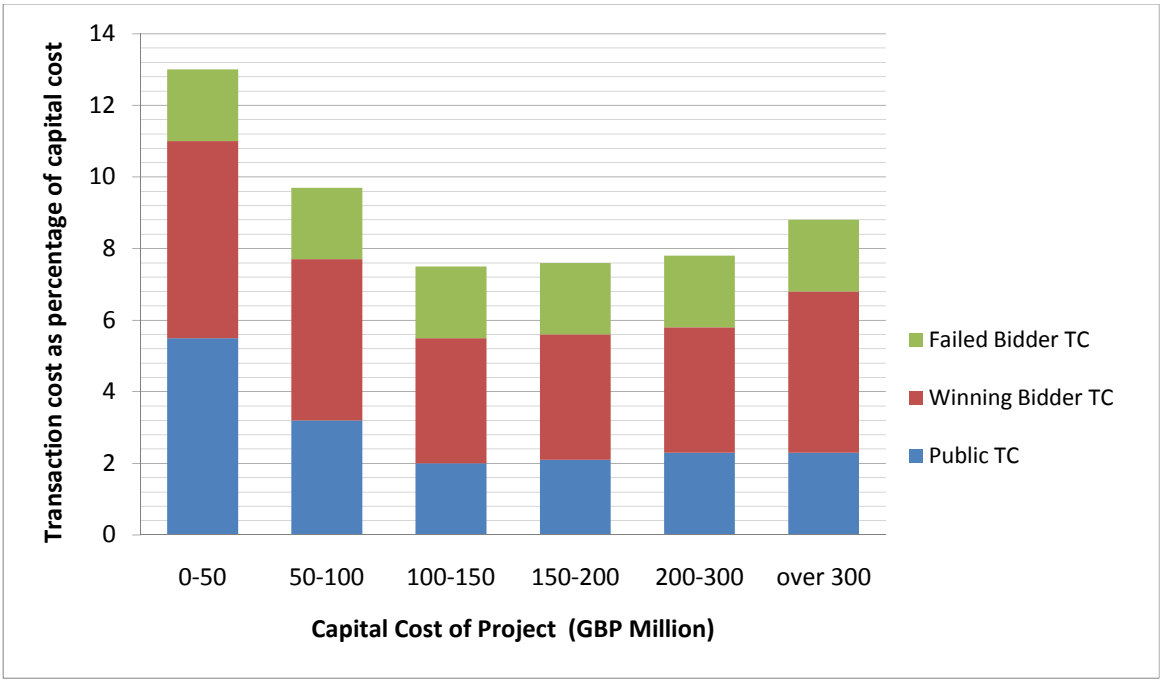

Figure 5: Procurement phase transaction cost based on capital value of the project. (Source: EIB, NAO, PAC)

- **Number of bidders**

The next factor which plays a role in percentage of transaction cost is the number of bidders. In the event of a lesser amount of competition, transaction costs during the project initiation and procurement phases will be relatively low, but it is likely that total project costs will be higher due to a weaker competitive procurement process. One would expect the public-sector cost of bidding to increase with the number of bidders. This is due to more work for the public agency in terms of pre

screening, and proposal evaluations, and also due to the increase in the transaction cost of losing bidders. On the other hand, transaction costs in the project initiation and procurement phases will be relatively lower, but it is likely that the total project cost will be higher due to less competitive procurement process. Figure 6 below outlines the transaction costs as a percentage of capital cost with respect to the number of bidders in the procurement phase.

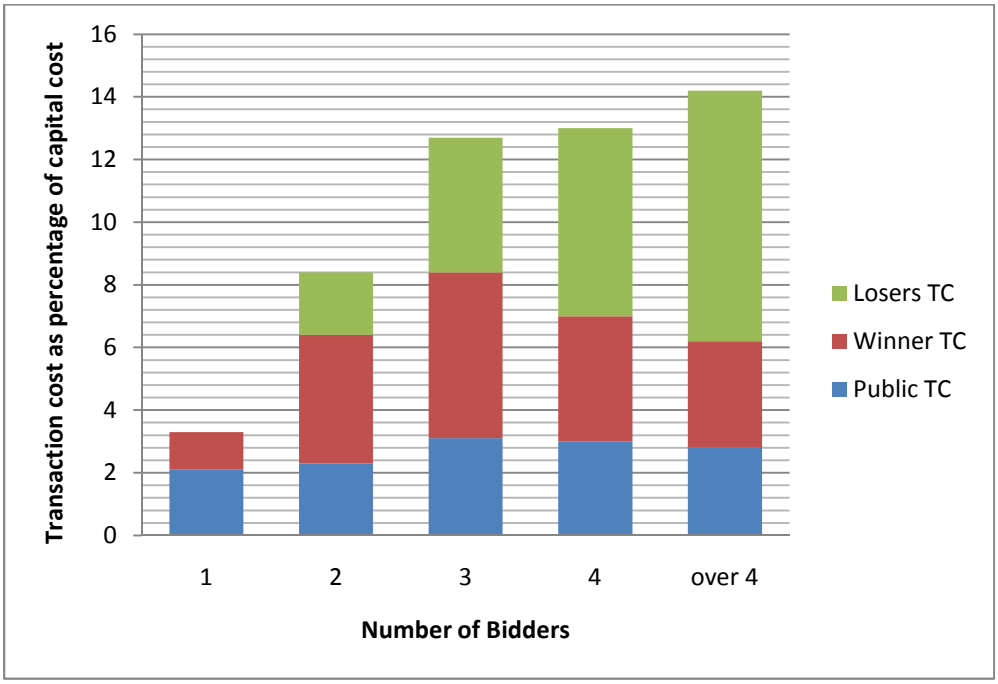

Figure 6: Procurement phase transaction cost based on number of bidders. (Source: (Dudkin & Välilä, 2005))

- **PPP program maturity (Location)**

Another factor that affects transaction costs in PPPs is the location of the project. The meaning of location in this context is not the actually geographic location of the project, but the country or state in which the project will be constructed. In another perspective, the location can be defined as the maturity level of the PPP program in the region in which a PPP project is going to be procured. This maturity level can be

defined as having enough legal supports for PPPs, having enough resources for PPPs both in terms of manpower and knowledge, and also having enough previous experience with other projects using PPP as the delivery method. Some countries like the United Kingdom (UK) have a tremendous amount of experience and resources for PPPs. Some other countries are new in this field and the PPP program in those countries is not as mature as the PPP program in UK. Because of the experience effect, they incur more transaction costs. There are many factors that determine whether the country is advanced in terms of PPPs or if the PPP program in that country is still under development. Having a good legislator base, having enough experience in terms of previous PPP contracts, having enough resources in-house in terms of experienced staff and consultants and having good partners who have already worked with them on other projects can all be determinant factors in this case. For instance, the Texas Department of Transportation (TxDOT) has already contracted for some PPP projects such as SH-130, and has invested on gathering enough resources for their PPP projects, while having a good legislative base for their program. The transaction cost that a PPP project in Texas will incur should be less than then transaction cost of a PPP project in Georgia in which Georgia Department of transportation (GADOt) has just started developing their PPP program

- **Complexity**

Another issue that can increase the transaction cost in PPP projects is the level of complexity of the project. Complexity increases uncertainty or risk and, will increase the likelihood of having higher transaction costs. The specific responses that different parties in PPPs manifest depend on the certainty of the environment. Due to the mentioned characteristics of PPPs, such as the rare occurrence of contracts, the long life cycle of the agreement, and complex revenue streams and traffic volume studies, environments associated with PPPs are relatively more unstable than environments associated with traditional delivery methods. This environmental instability increases the procurement cost.

A PPP model is a mixture of an economic model and a political model, thus, the PPP model is greater in complexity than the two models discussed. In a PPP model, different entities have different goals; the public agency tries to maximize the social benefits and minimize the political costs. The private agency tries to maximize the Rate of Return (ROR) on their investment and minimize the capital cost. Therefore, high opportunism from both sides is encountered in PPPs, making the negotiations more expensive for both sides. PPPs are also associated with high levels of behavioral uncertainty and environmental uncertainty. As a result, transaction costs associated with procurement of PPPs is higher in terms of feasibility studies and negotiations.

It should be noted that aside from negotiating transaction costs (during initiation and procurement phases of the project), any PPP will have monitoring and enforcement costs over the life cycle of the project (after procurement during the contract management phase). To better understand the effect of environmental uncertainty on monitoring and enforcement costs in PPPs, the results of Ryu's (2006) analysis can be used to better explain the relationship between environmental uncertainty and interdependence magnitude with transaction costs. If a PPP contract is negotiated professionally, the risks and rewards in the PPP agreement are fairly shared between the two parties, and the interdependence magnitude of the transaction is high. In other words, a concrete PPP agreement should be negotiated in a way that if the project is successful, both parties can reap the benefits; if the project fails, both parties bear the losses. In this case according to Ryu's analysis, the monitoring cost will be lower or there will be a high-monitoring cost based on the level of uncertainty.

- **Uncertainty and Interdependence Magnitude**

Figure 7 shows how uncertainty and interdependence magnitude can affect the total transaction cost, as well as transaction costs during initiation and negotiation phases (N), and transaction costs during monitoring and enforcement phases (M). Cells 2 and 3 represent traditional delivery methods in which due to the characteristics of the contract, the environmental uncertainty is lower, and so the total transaction costs are smaller. Cells 1 and 4 represent the situations with a high levels of uncertainty, such

as in PPPs, with the total amount of transaction costs higher due to higher levels of uncertainty associated with the project. From another perspective, cells 1 and 2 represent the situation in which success or failure of one party is not highly related to the success or failure of the other party. For instance a lump sum contract in which cost overruns is borne only by the contractor. Cells 3 and 4 represent situations in which risks and rewards are fairly divided between the two parties. In other words, they represent a high interdependence and a perfect partnership. According to Ryu's analysis, when the interdependence magnitude is high, different entities of the contract are each vulnerable to retaliation from the other. Thus, an attempt to control different entities through monitoring produces a high likelihood of retaliation. Cell 1 represents highly uncertain environments that lead to the development of the condition in which the information about the environment is asymmetrically distributed between contract parties. Cell 2 represents a low-interdependence environment that allows parties to behave opportunistically (Ryo, 2006).

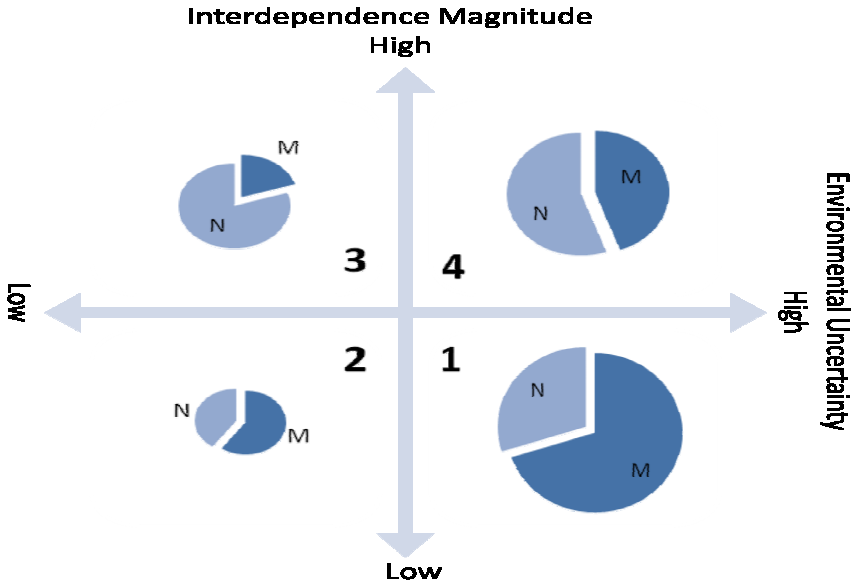

Figure 7: The Transaction cost quadrant (modified from Ryu, 2006)

2.5 Literature Review Discussion

The literature review of this study covers a broad review on PPPs and transaction cost economics, and uses the concepts of transaction cost economics in the PPPs. Based

on the literature review, we know that transaction cost is an important factor in PPPs, and many scholars and experts and have emphasized the importance of this topic. There are also some theoretical studies (Ho, 2009) which covers the importance of different factors associated with transaction costs in PPPs. The literature review also reveals some empirical studies about transaction cost measurement in some PPP projects in European countries, and reports the results of those studies.

Although there have been some attempts to measure the transaction costs in PPP projects, those projects are either theoretical discussions, or based on data from PPP projects in other parts of the world such as EU. The concern here is that the PPP program in the US is very different than the PPP program in EU. For instance the PPP program is still in the US, and there are not enough guidelines and standards available to practice PPP. Also, the legal system in the US is different which makes the PPP process flowchart in the US different than the one in EU. We can also add the effect of different financial structure, procurement legislations and also the effect of bureaucracy to the mentioned list. Therefore; those numbers cannot be necessarily true about PPP infrastructure projects in the US.

It should be also mentioned that those studies cover transaction costs in a very broad way, and report only the overall transaction cost o the project for the private section, winning bidder and loser bidders. Although those numbers are very important, but if one want to have a more accurate estimation about transaction cost during different phases of the project and for different transaction activities, there is a need for a better accounting system that can track and record transaction cost items and give a more useful reports based on different filtering options. The next chapter of this study focuses on developing such accounting system in order to increase the accuracy of cost accounting system for PPP infrastructure projects, and so the accuracy of transaction cost estimation models.

Chapter 3: Transaction Cost Accounting Model

3.1 Introduction:

As literature review suggests, there are many inconsistencies in definition of transaction costs and so many difficulties in measurement and recording such costs. Usually, it is very difficult to find data about transaction costs of PPP infrastructure projects in the US, and even the available data are not consistent. This issue will be further discussed in the following chapter while comparing two case studies about the I-495 HOT lanes project in Virginia, and the I-595 improvements project in Florida. These case studies emphasize the need for a better accounting system to identify and track transaction cost items in order to better analyze transaction costs in PPP infrastructure projects in the US.

A PPP project accounting system is not very different than a normal construction projects. However, since the PPP process is more complex than normal construction projects, understanding the whole process of the project is the first step in developing a cost accounting system. It is very important to lay different tasks during the life cycle of the project, and evaluate what are the main important factors that the cost accounting system should be able to restore. After developing the project transaction activities, there is a need to do a cost breakdown structure to evaluate the cost items associated with different tasks. Those cost items will be mapped to transaction activities to account for all different costs incurred during a PPP transaction. Then the cost coding system will be defined based on the requirements for restoring data, and also characteristics of PPP projects. Figure 8 shows different steps used in this chapter to develop the cost accounting model for PPP infrastructure projects in the US.

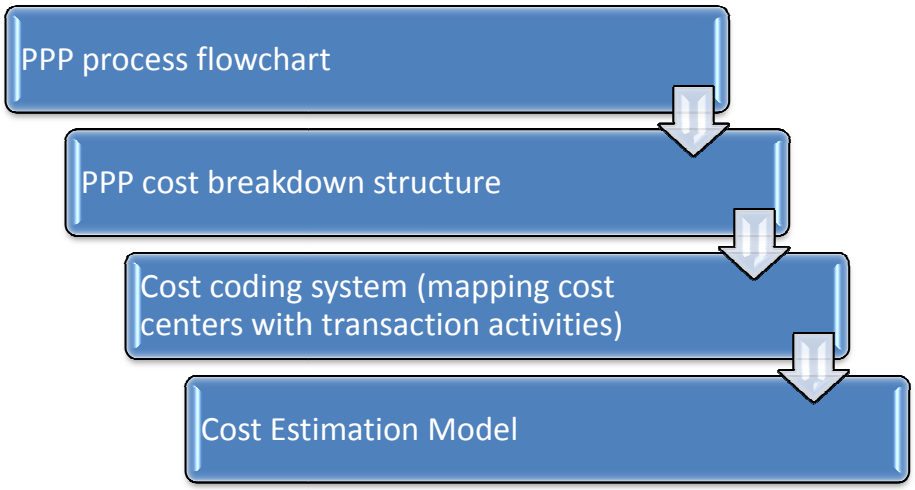

Figure 8: Transaction Cost Accounting System Development

This chapter develops a platform to identify the main factors that affect transaction costs of PPPs in the US, and develops a cost accounting model to identify and track transaction costs in PPPs in the US. A PPP process flowchart for the US will be developed based on the information available from PPP infrastructure projects in the US, and procurement legislation of different states. The main factors that affect PPPs in the US in each stage of the PPP process flowchart will be identified and discussed in section 2. Section 3 presents a cost breakdown structure (CBS) for different transaction cost activities in PPP projects. Section 4 is about mapping the PPP process flowchart with different transaction cost items in order to develop a cost accounting model to identify and track transaction costs of a PPP infrastructure project. A cost coding system is developed and discussed in this section.

3.2 PPP Transaction Process in the US

Before developing a CBS, it is necessary to have a general PPP process flowchart based on federal and local PPP legislations and regulations. It should be noted that the legislation and regulations vary among different states, which result in different PPP process flowcharts. However, in this research we have come up with a general process flowchart which can be adapted for different states with some minor changes.

In order to develop this process flowchart, PPP legislature in three different states, Texas, Virginia and Florida, were reviewed, and PPP practice and experience in these states was studied by conducting interviews with each state's Department of Transportation (DOT) officials. Figure 9 shows the PPP process flowchart that is being developed based on the information obtained from interviews and legislation.

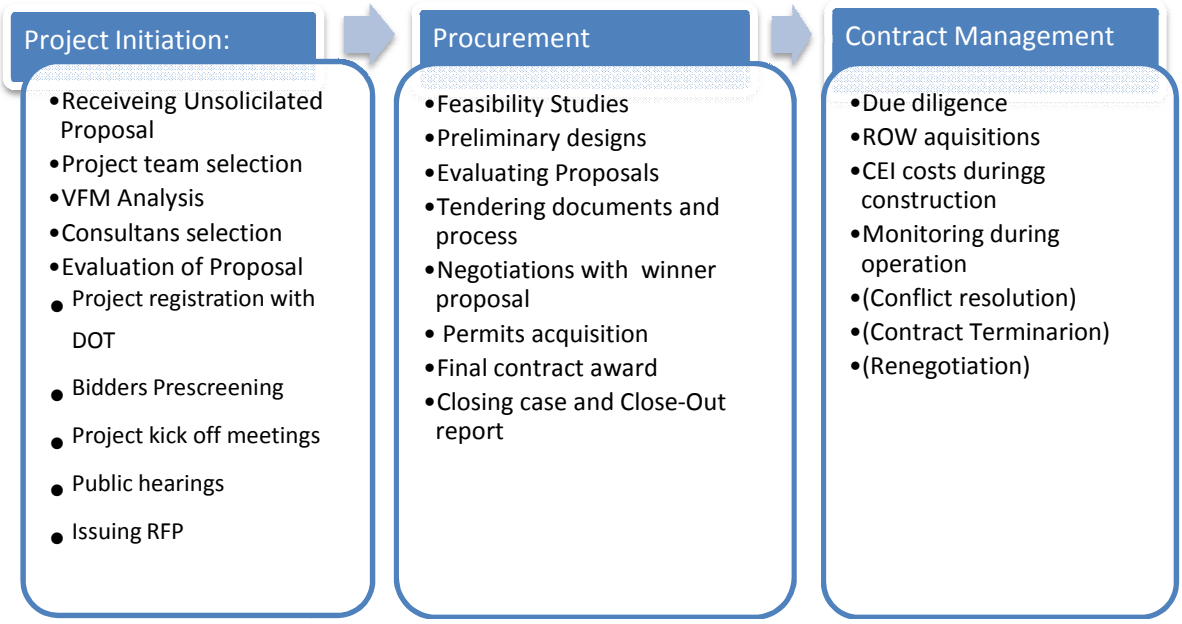

Figure 9: PPP Process transaction activities flowchart in the U.S.

In any PPP project, there are some stages that occur through the life cycle of the project: project initiation, project procurement and contract management. Some people may combine project initiation and procurement together, but in this section, they are discussed separately to emphasize the difference between PPP lifecycle and traditional delivery lifecycle. It should also be noted that Figure 9 was developed based on the PPP procurement of three states in the US: Texas, Florida and Virginia.

Virginia DOT has a six-step project procurement process, following receipt of an unsolicited bid or the response(s) to a bid request, as follows:

1. Department-Level Quality Control Review
2. Review of Proposal(s) by Independent Review Panel (IRP)

3. Commonwealth Transportation Board (CTB) Review and Recommendation
4. Final Selection of Detailed Proposals
5. Negotiate Draft Interim/Comprehensive Agreement
6. Execution of Interim/Comprehensive Agreement

Project initiation occurs during the early stages of the PPP life cycle and is a component for both the bidders and owners (government). Generally, in PPPs, the DOT receives an unsolicited proposal from a private entity who has a business idea and is interested in investing in a project. The first response of the DOT will be to assign this project to a DOT project manager and select team members who will help facilitate the evaluation of the proposal. An evaluation of the cost and elements of the bid will be performed by the DOT to select the best delivery method for the project, and evaluate whether the DOT can fund the project through their own resources, or if they should use a PPP. If the preliminary evaluation of the project passes the minimum screening standards of the DOT and they decide to form a partnership with a private company, then the project will be officially registered with DOT and a Request for proposal (RFP) or a Bid Advertisement will be prepared and issued in order to start a competitive procurement. It should be noted that DOTs usually have a prescreening of bidders in order to prequalify the bidders who can enter the process.

The next step after project initiation is project procurement. For the bidder, that means responding to the RFP or the Bid Announcement. In this step for the government or owner, various proposals received from potential private partners will be evaluated in order to select the best proposal. Usually, DOTs use advisors and consultants to prepare a business plans, feasibility studies, and also to assist in legal and contracting issues. After selecting the best proposal,. The DOT will begin negotiating with the winning bidder. It should be noted that since selection of the best proposal in PPPs is a subjective process, the best proposal is not necessarily the lowest bid, although different states mandate a low bid award. This process usually takes several months or years -for instance it took more than 10 years for I-495 and

about 2 years for I-595- since DOT will need to obtain the necessary permits and resolve issues that may arise. Sharing risks and rewards is also done through extensive negotiations by developing some provisions in the contract which explains the risk / reward mechanism. They should also conduct public hearings which usually take place during the planning and environmental phases. There are specific requirements when conducting hearings such as time notification, recording of testimony, public comment period after the public hearing, etc. The last step of the procurement process is signing the contract.

Once the procurement process is complete, the contract management phase begins. This phase can be divided into two sub-phases: construction contract management and operations and maintenance (O & M) contract management. During construction, the DOT should establish an office which will mainly be responsible for quality control to ensure the construction follows industry standards and contract specifications. This team is also responsible for document management and controls to keep all the necessary data for DOT records. Another responsibility of DOT during the construction phase is holding audits and informational meetings to make certain they collaborate with the public because public support is very crucial for any project, specifically PPP projects that impose toll on roadways. That is because in general people are sensitive in being charged for tolls, and DOTs do not want to face polital costs of loosing public supports. DOT is also responsible for the O & M quality controls during the operation phase of the project. They should regularly check the facility, toll rates and toll incomes, and the financial status of the project. In some contracts such as I-595, DOT is responsible for collecting tolls so they should also consider the transaction cost of Toll collection in their estimations. In most contracts, there is a mechanism to share income or bear losses, thus, DOT staff should monitor the project regularly to check that all the provisions of the contract are fulfilled.

3.3 Cost Breakdown Structure and Transaction Cost Mapping

The next step after developing and identifying the main factors that affect transaction costs in different stages of PPP represented by a process flowchart, is developing a cost breakdown structure in order to map different cost accounts with every process activity. Figure 10 illustrates a CBS from a public agency point of view where transaction costs are divided into two main factors: initiation / procurement costs and contract management costs. Initiation and procurement costs are related to the first two phases of the PPP process flowchart and are mainly related to the activities prior to signing the contract. Contract management costs are mainly related to the activities that occur after closing out procurement of the contract (after signing the contract) such as O&M quality controls, contract enforcement, and dispute resolutions.

Level 3 of the CBS represents whether the cost has been incurred internally by the state DOT or incurred externally due to having consultants or advisors. It should be noted that the term external refers to payments of DOT are not on the payroll system of DOTs. In other words, DOT receives bills for such services and pays the bills. This is different than when DOT pays salary to its employees.

Level 4 represents different activities that can result in transaction costs. Level 5 divides the costs associated with those activities into two categories: direct costs which can be directly calculated based on resources (in terms of labor hour, equipment or material spent to accomplish those activities) or indirect costs which can be calculated based on assigning overhead and general administration costs to the project. Finally, the last level represents the cost items.

Figure 10: Transaction Cost Breakdown Structure

It should be noted that given the current available information, it is very difficult to collect data for the contract management phase because the PPP model in the US is still very new and there are not enough projects and data to support this section of the model. However, the data for the procurement phase of some projects in three different states – Texas, Virginia and Florida – supports the evaluation of the model

for preciseness and accuracy. The external transaction costs associated with PPP projects are easy to obtain since most of these costs are recorded as separate bills in the accounting system of projects. However, it is very difficult to obtain detailed data about the internal transaction costs because each state has a different accounting system and they usually do not record this level of detail.

The second level of CBS developed in this study can be used as a tracking model by state DOTs to record and track the transaction costs associated with PPP infrastructure development projects. This model is essential for state DOTs because according to their PPP legislation, they can calculate the transaction cost that state DOTs incur while delivering a project using PPPs and add it to the total cost of the project in order to be reimbursed for their costs. This model is greater in detail and helps state DOTs to track and record transaction costs in different levels of a CBS.

3.4 PPP cost coding system

After extensive efforts to collect data regarding the transaction cost of infrastructure PPP projects in the US, there has only been little success in collecting data. As it will be presented in the next chapter in case studies, even the collected data is not consistent. Therefore, it can be concluded that there is an inconsistency in the way transaction costs are defined, tracked and recorded in different states. It is apparent that there is a need for a standard accounting model which can be used in different PPP projects in order to collect and record transaction cost items. This section will describe how to develop such systems by mapping between the developed CBS in the previous section and transaction cost accounts.

The accounting model that has been developed in this paper is similar to the cost accounting system which has been developed by Construction Specification Institute (CSI). However, this system is based on special characteristics of PPPs, and it is designed in a way that maximizes the accessibility to the transaction cost items. This system can generate reports based on different filters in order to detailed transaction costs. Figure 11 illustrates how the cost coding system is designed.

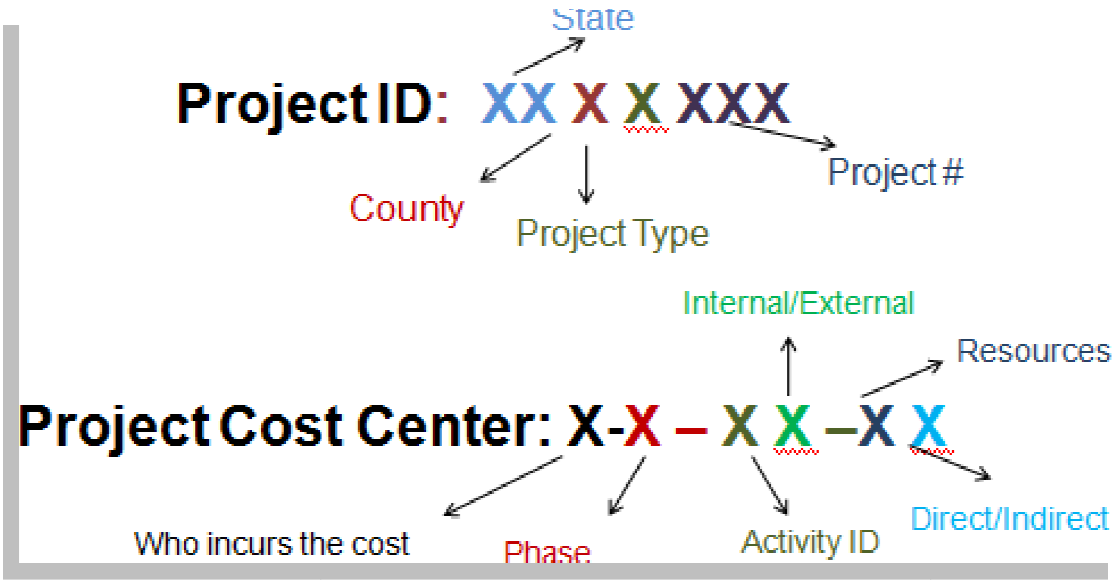

Figure 11: Cost Coding System

As illustrated in figure 11, the cost coding system consists of two separate numbers. The first number represents the projects ID, and the second number represents the project cost center. Project ID consists of 7 digits – it can be more or less depending on requirements. The first 2 digits represent the state. The third digit represents the type of project; for instance railway, roadway, tunnel, bridge, etc. The last 3 digits represent the project number.

Similarly the project cost center consists of 6 digits. The first digit represents who incures the cost; for instance public sector, winning bidder or loser bidders. The second number represents the three different phases of a PPP agreement based on the mentioned PPP process flowchart in Figure 9. The third digit represents different transaction activities in each phase again from figure 9. The fourth digit tells us whether DOT paid those costs through a bill (external) or through normal salaries to its own employees or office budget (internal). The fifth digit represents the resources which have been consumed for that activity such as manpower, equipments or material. This is explained in the cost coding matrix in figure 12. The last digit shows

whether those costs are incurred directly, or they have been calculated indirectly, for instance overhead allocation.

Project Activity Number=XX			
	Internal Costs (1)		External Costs (2)
	Labor (1)	Material & Equipments (2)	Consultants(3)
Initiation	X-1 - XX -11	X-1 XX - 21	X-1 XX-31
Procurement	X-2 -XX -11	X-2 XX - 21	X-2 XX- 31
Contract mang	X-3 –XX- 11	X-3 XX -31	X-3 XX- 31

Figure 12: Cost Accounts Coding Matrix

In this model, the consulting cost is usually based on lump sum or hourly rate bills for the design that state DOTs receive from their consultants. However, the internal costs are calculated based on labor, material, and equipment costs. Labor costs can be calculated by calculating the number of people who have worked on each project, the number of hours that they have spent, and their hourly payroll rate. These people can be manager(s), permanent project team members, or supporting staff who are DOT employees that have been temporarily ask by the project team to deliver a task. There are also office expenses and travel costs which can be tracked and recorded under material and equipment costs. However, there are some other transaction costs which cannot be tracked directly. These costs are related to the overhead and general administration costs in DOTs. An overhead rate based on the average overhead rate for similar projects in each DOT can be used in order to account for these costs. The model also accounts for inflation rates and price escalation adjustments since transaction costs of PPPs occur over life cycle of PPP agreements which are usually several or many years, causing inflation rates to play a significant role in the accuracy of tracking and recording data.

Chapter 4: Case study

4.1 Introduction

The model developed in chapter 3 is developed in a way that it can restore as much useful information as possible about different cost items regarding different project activities in different phases of the project. This model will enable accountants to better record and track the transaction cost, and helps researchers and estimators to have access to more detailed information about transaction cost centers. However, this model should be validated in order to proof that recording transaction costs in more details will help DOTs to better assess transaction costs, and so get reimbursed by project financial resources.

In order to validate the model, we have contacted 7 different projects in three different states which are believed to be the pioneers in PPP infrastructure programs in the US: Texas, Virginia and Florida. Table 2 shows the information of different projects which were initially selected and contacted for transaction cost data.

Only 2 out of these seven projects responded, and sent us the financial information about their transaction costs. Therefore, two case studies have been conducted in this chapter. The first case study is I-595 improvements in Florida, and the second case study is I-495 HOT lanes in Virginia. The following two sections of this chapter will study these two cases, followed by a discussion section which will compare the two cases with the model, and also drives conclusions from the alignment of the case studies with the model. This chapter validates the point that a better accounting system can help state DOTs in better tracking and recording transaction costs associated with a PPP projects, and will lead them to be better financially reimbursed.

Table 2: Targeted PPP Infrastructure Projects

Location	Virginia			Florida	Texas		
Project Name	I-495 Hot Lanes	I-95/395 Hot Lanes	U.S. Route 460	I-595	IH-635 Managed Lanes	SH 130 (seg 5 & 6)	North Tarrant Express
Delivery/Contract Method	DBFOM			DBFOM	DBFOM	DBFOM	DBFOM
Construction Duration	5 years			5 years	5 years	5	
Operation Duration	80 years			35 years	52 years	50	52 years
Fiscal Year approved	2008	2006	2010	2008	2009	2007	2009
Funding sources							
State and federal							
Concessionaire's financing							
GARVEE							
GO bond							
TIFIA Loan	$589	157.3		$603	$800	$430	$650
Private activity	$589				$400		$398
Senior Banking Debt		859		$781.10		$685.80	
Senior term Facility Debt					$400		
State infrastructure bank loan							
Section 129 loan							
Other:	State of Virginia Grant			FDOT qualifying dvlpm funds			
	$409			$232			
Equity							
Private	350.00	270.00		$207.70	$598.50	$209.80	$426
State					$445		$573
Revenue (toll or interest)		55.3		$10	$34.50	$2.30	
Check total	$1,937	$1,342	$0	$1,834	$2,678	$1,328	$2,047
Total according to documents	1938.00	1341.60		$1,833.60	$2,678	$1,327.90	$2,047
Equity/total	0.18	0.20		0.11	0.22	0.16	0.21

4.2 Case study 1: I-595 (Florida)

4.2.1 Project description

The I-595 corridor was opened to traffic in 1989, coordinating the movement of high traffic volumes connecting western parts of the Southeast Florida region with the north-south freeway and principal roadways to the east, including I-75, Florida's Turnpike, SR 7, I-95 and US 1. The project made a large financial contribution to the

development of the neighborhoods along the project corridor, and because of these developments the travel demand within the corridor increased at a gross rate more than the long-range traffic forecasts used in the traffic studies of the project. Therefore, the need for improvements of the project was paramount in order to meet the new demands.

Given the high traffic demands, the expansion of I-595 had been considered since 1994. The I-595 Corridor Roadway Improvements project was initiated preliminarily to increase the traffic capacity of I-595 to meet the new demands. This project consists of the reconstruction and widening of the I-595 mainline and also all associated improvements to bridges and ramps from the I-75/Sawgrass Expressway interchange to the I-595/I-95 interchange. The total length of this project is approximately 10.5 miles, and the total cost is estimated to reach $1,833.6 million (in present value in 2009 dollars, given a 5% discount rate).

A major component of the project is the construction of three express toll lanes known as I-595Express. These lanes will serve express traffic and will be operated as managed lanes with variable tolls to optimize traffic flow. The revenue generated from these lanes will be used to pay back project debt and also is profit for equity holders.

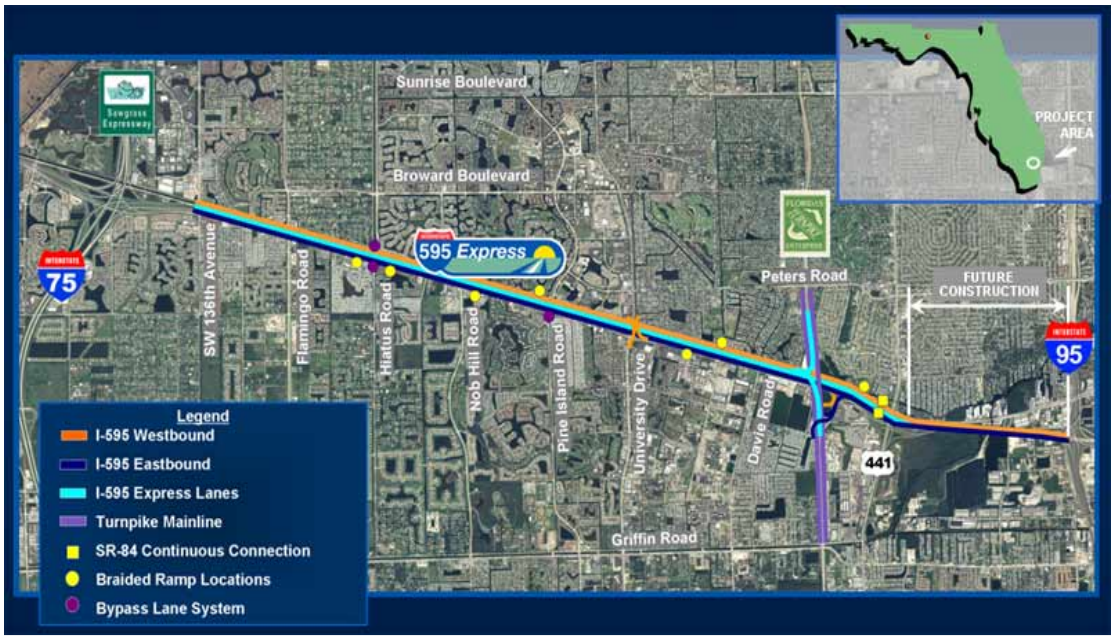

Figure 13: I-595 Improvements map (Source: Florida Department of Transportation (FDOT))

The project is being implemented as a public-private partnership between Florida DOT (FDOT) and I-595 Express, LLC (ACS Infrastructure Development) as Concessionaire to design, build, finance, operate, and maintain the roadway for a 35-year term. FDOT will provide management oversight of the contract; will install, test, operate and maintain all tolling equipment for the express lanes; and will set the toll rates and retain the toll revenue.

Due to the complexity of the project agreement as a Design-Build-Finance-Operate-Maintain (DBFOM), there are many consultants and advisors associated with this project. The advisors of this project are listed as follows:

To the sponsor:

- Legal Advisor: Dewey & LeBoeuf LLP
- Financial Advisor: Macquarie Capital (USA) Inc.
- Technical Advisor: Scott Wilson, Plc.

To Lender:

- Legal Advisor: Simpson Thacher & Bartlett LLP

To Authority:

- Legal Advisor: Nossaman LLP - legal
- Financial Advisor: Jeffrey A. Parker & Associates, Inc.
- Technical Advisor: Reynolds, Smith and Hills, Inc.
- Construction Oversight: The Corradino Group

To USDOT TIFIA Joint Project Office (JPO):

- TIFIA Legal Advisor: Hawkins Delafield & Wood LLP
- TIFIA Financial Advisor: Taylor-DeJongh

Table 3: I-595 Improvements Project Description

Lead Public Agency:	Florida Department of Transportation (FDOT)
Estimated Cost	$1.835 billion
Contract Type	Design-Build-Finance-Operate-Maintain (DBFOM)
Contract Duration	35 years (including construction)
Construction Begins	2009
Operation Begins	Spring 2014 (estimated)
Facility Ownership	FDOT
Fare Setting Authority	FDOT
Availability and Acceptance Payments	FDOT will pay the concessionaire $65.9 million per year in availability payments as well $685.6 million in facility acceptance payments for the timely construction of the facility within pre-defined standards. The concessionaire would be eligible to receive availability payments once substantial completion on the project is achieved and the project operating period begins. Substantial completion includes the construction of all traffic lanes, which is expected to take place in 2014.
Value-for-Money Analysis	A value-for-money analysis in 2007 concluded that a DBFOM with availability payments would provide a greater value to the public sector (about $24M to $104M) compared to a DBFOM contract while concessionaire keeps the revenues generated from the project. An updated value-for-money analysis in 2009 found that the $65.9M annual availability payment was 8 percent lower than the $71.9M payment that was estimated prior to contract procurement.

It should also be noted that FDOT used a 2 step procurement process as follows in order to enhance the procurement process of this projects. A Request for Qualification (RFQ) was released after publishing a Project Information Memorandum (PIM) on October 2007. Six different private ventures submitted their Statements of Qualification, and FDOT selected four of them in the first step to make a short list. A Request for Proposals (RFP) was issued for the four short-listed ventures in 2007, and the best value proposal was selected in October 2008.

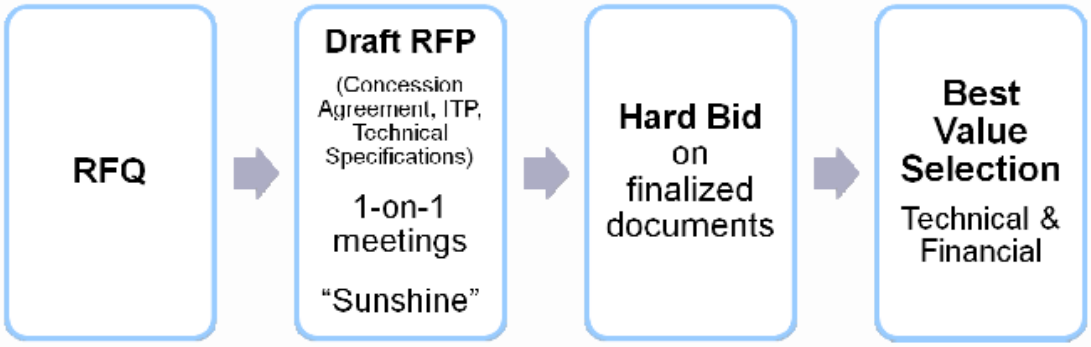

Figure 14: I-595 improvements procurement process (Source: (Parker, 2008))

4.2.2 Project financing

The financing package for this project is relatively unique in that the concessionaire is raising funds through different sources. The senior bank loans ($782 million) come from a 12-bank club (Spanish, French and Australian banks), and the TIFIA loans ($603 million) are exactly equal to 33% of the total eligible costs of the project. The I-595 Express, LLC, is the official borrower for the TIFIA loan. The interest rate on the TIFIA loan on this project is 3.64 % (the current TIFIA interest rate is 4.74% for a 35-year loan as of Thursday, April 15, 2010).

From the concessionaire's perspective, the maximum use of TIFIA loans decreases the money required for debt service due to the lower TIFIA interest rate (4.74% for a 35-year loan as of Thursday, April 15, 2010 compared to 6.58% for a senior bank

loan), and enhances the free cash flow (FCF) of the project. The first interest payment on the TIFIA loan is scheduled for June 2014 (the ramp up period is 5 years after project completion in 2009). Principal repayments are scheduled to begin in 2031 and final maturity is scheduled for June 2042. The TIFIA loan is backed up by a lien on availability payments made by FDOT to I-595 Express, LLC.

There are also some fees associated with TIFIA loan as follows:

- The TIFIA JPO will require each applicant to pay a non-refundable Application Fee of $50,000.
- Each borrower will be required to pay a Transaction Fee equal to the costs incurred by the TIFIA JPO in negotiating the credit agreement. This credit processing fee will typically range from $200,000- $300,000.
- Borrowers will be required to pay an $11,500 Loan Servicing Fee annually, due by November 15.
- Borrowers also will be required to pay a Monitoring Fee as defined in the credit agreement.

Depending on the life cycle of the TIFIA loan and also some other costs of the JPO in negotiations, the TIFIA fee may range from $700,000 to $1,100,000.

The bank debt on this project has an interest rate of 6.58% and a 10-year maturity. There is an option to refinance these loans later through the life cycle of the project by new bank loans, bond issues, and/or Private Activity Bonds (PABs). If there is a gain due to refinancing the loans at a better interest rate, FDOT would take a share of the gains equal to 50% of the gain. In addition, FDOT has the option to purchase the project debt, if it is in default. (Minnesota Department of Transportation, 2009)

In addition, the consortium partners have agreed to provide an estimated $208 million in equity. This is almost equal to 11.3% of the total cost of the project which is lower than the equity / total cost ration on other projects (about 15% to 20% - refer to Appendix 4). Table 4 lists the sources of funds, and share of each source in the total cost of the project for the I-595 project.

Table 4: Source of Funds for I-595 Improvements Project

Source	Amount	% of total cost
Bank Loans	$782 million	**42.6**
TIFIA	$603 million	**32.9**
Equity	$208 million	**11.3**
Revenues	$10 million	**0.5**
FDOT Grants	$232 Million	**12.7**
Total	1, 835 million	**100.00**

Source: Florida Department of Transportation (FDOT)

4.2.3 Project transaction cost

In order to received the transaction cost of I-595 Improvements project, the project manager of the project, financial management office, and the financial advisor of the project were contacted separately. Table 5 summarizes the results of the information which was obtained through different sources for this project.

Table 5: I-595 improvements project transaction costs reported by FDOT

	I-595	
Source	**Amount ($)**	**% of Total**
Financial Advisors	**2,200,000**	**10%**
Architecture & Engineering Consultants	**14,850,000**	**70%**
CEI	**1,900,000**	**9%**
Legal Consultants	**2,400,000**	**11%**
Business Consultants	**N/A**	**- --**
FDOT Internal Costs	**N/A**	**- ---**
Total TC	**21,350,000**	**100%**

Source: Florida Department of Transportation (FDOT)

Having a quick look at the above table reveals that FDOT is not recording detailed data about different transaction activities. It also shows that FDOT is not using an internal time / cost allocation system in order to track the internal transaction costs that it incurs. However, they may have accounted for those internal cost items in the Construction Engineering and Inspection (CEI) section. It should be noted that the above transaction costs are the transaction costs of the project till July 2009. In other words, those transaction costs are mainly procurement cost of I-505 project from FDOT point of view which is approximately 1.1% of the total cost of the project.

There are also some other cost items that have been reported for this project which are mainly related to the operation phase of the project. Table 6 summarizes those items. The top cells of this table also shows how FDOT is using cost centers based on different phases of the project, different section and also different activity numbers.

Table 6: Estimated Cost Items for I-595 Improvements Project

Fiscal Year	Phase/sequence 52 01 Final Acceptance payments (Capital Costs)	Phase/sequence 52 02 Capital portion (capex of) availability pmts	Phase/sequence 82 01 O & M (opex) portion of availability pmts	Phase/sequence 82 02 Est Cost of future resurfacing	Total Concession Payments	FM# 420809-1 FM# 420809-23 Phase/sequence 31,32 01,02,03, 04 Preliminary Engineering	FM# 420809-2 Phase/sequence 32 01, 02, 03, 04 Stipends	FM# 420809-3 Phase/sequence 5A 01 Construction Bonus	FM# 420809-4 Phase/sequence 56 01 Utilities	FM# 420809-5 Phase/sequence 66, 62 01 CEI	FM# 420809-7 Phase/sequence 62 01 Geotech	FM# 421854-1 FM# 421854-2 FM# 421854-3 Phase/sequence 4x01 Right of Way	FM# 4239 76-1 Phase/sequence 84, 94 01 Bus rapid transit	FM# 424408-1 Phase/sequence 52 01 Reserve for concessionare issues	FM# To be Determined Phase/sequence TBD FTE Transaction Fees (Toll collection fees)	Total Project Cost
2008					-	15,429,442	7,795,000		24,700	100,000		13,545,656		50,000		36,944,798
2009					-	4,500,000			1,183,800	2,800,000	200,000	65,920,573		1,674,979		76,281,152
2010					-	4,500,000			24,700	4,900,000	650,000		15,700,000	3,000,000		28,774,700
2011					-	4,500,000				5,450,000	425,000		2,100,000			12,475,000
2012					-	3,000,000				5,725,000	425,000		2,100,000			11,250,000
2013	19,680,001	56,686,965	14,575,435		90,942,401	3,125,000		50,000,000		6,888,100	425,000		2,100,000			153,480,501
2014	109,631,000	58,370,529	14,976,260		176,978,189	3,125,000					425,000	425,000	2,100,000		227,000	189,280,189
2015	71,712,000	60,104,954	15,388,107		147,205,061	125,000							2,100,000		563,000	149,993,061
2016	95,434,000	61,890,529	15,811,280		173,135,809	125,000							2,100,000		757,000	176,117,809
2017	123,173,000	63,729,189	16,246,090		203,148,279	125,000							2,100,000		912,000	206,285,279
2018	217,622,000	65,622,511	16,692,858		299,937,369	125,000									1,021,000	301,083,369
2019	162,444,000	67,572,123	17,151,911		247,168,034	125,000									1,113,000	248,406,034
2020	78,736,000	69,579,699	17,623,589		165,959,288	125,000									1,214,000	167,298,288
2021	13,098,000	71,646,964	18,108,237		102,853,201	125,000									1,308,000	104,286,201
2022		73,775,693	18,606,214		92,381,907	125,000									1,394,000	93,900,907
2023		75,967,716	19,117,885		95,085,601	125,000									1,487,000	96,697,601
2024		78,224,914	19,643,627		97,868,541	125,000									1,585,000	99,578,541
2025		54,293,728	20,183,826	26,255,500	100,733,054	125,000									1,690,000	102,548,054
2026		55,965,128	20,738,882	26,977,526	103,681,536	125,000									1,801,000	105,607,536
2027		57,687,842	21,309,201	27,719,408	106,716,451	125,000									1,921,000	108,762,451
2028		87,945,133	21,895,204		109,840,337	125,000									2,048,000	112,013,337
2029		90,558,483	22,497,322		113,055,805	125,000									2,183,000	115,363,805
2030		93,249,543	23,115,998		116,365,543	125,000									2,327,000	118,817,543
2031		96,020,633	23,751,688		119,772,321	125,000									2,460,000	122,357,321
2032		98,874,127	24,404,860		123,278,987	125,000									2,578,000	125,981,987
2033		101,812,481	25,075,594		126,888,475	125,000									2,702,000	129,715,475
2034		104,838,218	25,765,583		130,603,801	125,000									2,832,000	133,560,801
2035		107,953,940	26,474,137		134,428,077	125,000									2,968,000	137,521,077
2036		111,162,325	27,202,176		138,364,501	125,000									3,110,000	141,599,501
2037		114,466,130	27,950,236		142,416,366	125,000									3,260,000	145,801,366
2038		117,868,194	28,718,867		146,587,061	125,000									3,416,000	150,128,061
2039		121,371,443	29,508,636		150,880,079	125,000									3,581,000	154,586,079
2040		124,978,887	30,320,123		155,299,010	125,000									3,753,000	159,177,010
2041		88,168,013	31,153,927	40,525,613	159,847,555	125,000									3,913,000	163,885,555
2042		90,678,791	32,010,660	41,640,067	164,529,518	125,000									4,061,000	168,715,518
2043		93,672,696	32,890,953	42,785,169	169,348,818	125,000									4,215,000	173,688,818
2044		35,320,469	8,495,032		43,815,501	125,000									1,099,000	45,039,501
Totals	885,550,001	2,614,937,925	698,909,766	205,903,283	4,405,300,975	41,804,442	7,795,000	50,000,000	1,235,000	25,863,100	2,550,000	79,891,229	30,400,000	4,724,979	66,400,000	4,715,964,725

Source: Florida Department of Transportation (FDOT)

4.3 Case Study 2: I-495 (Virginia)

4.3.1 Project description

The I-495 HOT Lanes project is a 14 mile highway project on the Capital Beltway in Northern Virginia. The project will involve the construction of four high-occupancy-toll (HOT) lanes along the Capital Beltway (I-495) between the Springfield Interchange and the Dulles Tollway. There will be two HOT Lanes in each direction, which will employ electronic tolling and dynamic pricing to manage traffic flow. High occupancy vehicles with three or more people (HOV 3+), buses, law enforcement vehicles, and emergency vehicles will be exempt from paying tolls.

The toll amount will be based on demand and will fluctuate throughout the day to reflect real-time traffic conditions. The concessionaire is not restricted in its ability to set toll rates and impose increases. Figure 15 provides a map of the HOT lanes project, including the planned nine entry and exit points to the general purpose lanes. Figure 15 shows a representative cross-section of the project.

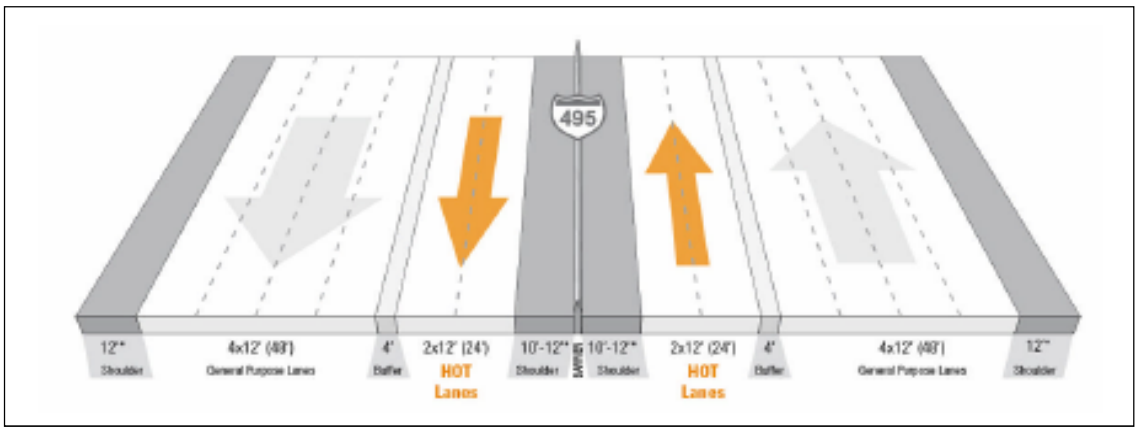

Figure 15: Representative Cross-Section (*Source: I-495 Project Website)*

Transurban/Fluor signed an 85year contract with VDOT to design, build, finance and operate, and maintain this project for 85 years through a concession agreement. The main elements of this agreement represent the following unique issues:

i. The project is delivered through a DBFOM contract for HOT lanes, greenfields project.

ii. Project procurement was initiated as a result of an unsolicited proposal that yielded no competitive proposals.

iii. Private Activity Bonds (PAB) and TIFIA loans are used in the financial pool for the project.

iv. The concession duration is 85 years which represents the longest term for a greenfields project in the United States (Laursen, 2009).

v. The construction duration of the project is scheduled to be 5 years.

vi. The procurement process of the project started in 1994, and finished in 2008. The total procurement duration is 15 years. Table 7 shows the project procurement timeline for I-495 HOT lanes.

Table 7: I-495 Procurement Timeline

1994	VDOT completes a Major Investment Study, concluding highway improvements promoting the use of High Occupancy Vehicles and bus travel would be the most effective strategy to serve current and future demand on the Beltway.
1998	Federal Highway Administration (FHWA) and VDOT initiate an Environmental Assessment of a variety of plans to improve the Beltway; In response to public feedback, the FHWA escalates its review from an Environmental Assessment to an Environmental Impact Statement (EIS).
2002	FHWA approves the EIS, including three HOV alternatives and 15 specific concepts to improve the Beltway; VDOT seeks community input on the plans during three public hearings and significantly scales back the project in response to public concerns.
2002	In June 2002, Fluor submitted an unsolicited proposal to VDOT. In accordance with the Implementation Guidelines of the PPTA, VDOT posted and published a notice of the conceptual proposal. No additional responses were received as a result of this announcement.
2003	In July 2003, VDOT approved Fluor's conceptual proposal and Fluor submitted a detailed proposal in October 2003
2004	VDOT hosts public meetings to present and solicit public input on both a traditional HOV and a HOT lanes plan; 64 percent of comments received from the public support the HOT lanes plan.
2004	Negotiations with Fluor and Transurban started in October 2004.
2005	On January 19, the Commonwealth Transportation Board selects the HOT lanes plan as the locally preferred alternative; On April 18, FHWA signs the Final EIS and releases it for public comment; After a public review period, the National Capital Region Transportation Planning Board votes to include the Beltway HOT lanes project in the region's Constrained Long-Range Plan.

2005	After 5 months of negotiation, the original comprehensive agreement was signed on April 25, 2005.
2006	On June 29, FHWA releases its Record of Decision that approved selection of the HOT lanes plan for the Capital Beltway.
2007	FHWA releases a re-evaluation of the Record of Decision and determines project scope enhancements have no significant environmental impact; On December 21, TIFIA loan of the project was approved. VDOT and Fluor-Transurban sign final partnership agreement, and , an amended contract was signed to account for the transfer of the rights and responsibilities of Fluor -Transurban to Capital Beltway Express LLC, a company that was created to design, build, finance, operate, and maintain the project.
2008	In July 2008, project construction began, and the construction is expected to be completed in 2013.

(Source: VDOT)

It should be noted that project cost estimates increased after the receipt of the unsolicited proposal, which included a high-level overview of total capital costs. During the review of project feasibility and the public involvement process, project scope and costs increased. After signing the concessionaire between VDOT and Flour-Transurban in 2007, the agreement was approved in 2008 and procurement was completed officially in 2008 by VDOT. In July 2008, project construction began, and the project is expected to be completed in 2013. Table 8 summarizes the main elements of the I-495 HOT Lanes Project.

Table 8: I-495 HOT Lanes Project Description

Public Agency:	of Transportation (VDOT)
Project Description	Construct 14-mile, HOT lanes with two lanes in each direction on the Capital Beltway (I-495). The project will also involve the replacement of more than 50 bridges and overpasses.
Estimated Cost	$1.998 billion
Contract Type	Design, Build, Finance, Operate and Maintain (DBFOM)
Contract Duration	85-years (5-year construction and 80 years operation)
Constr Begins	July 2008
Operation Begins	Mid-2013
Revenue Sharing	Actual revenues that are in excess of the base case financial model are shared with VDOT at increasing percentages.
Facility Ownership	VDOT retains ownership and oversight to ensure that the project will be constructed, operated and maintained in accordance with the contract.
Toll Rate	The concessionaire, Capital Beltway Express LLC, has the authority

Authority	to set tolls.
Value for Money	Because the contract was awarded after the receipt of an unsolicited proposal, it appears that VDOT achieved some cost savings by avoiding a full-scale competitive procurement. However, this does not mean the total cost of project is less because VDOT could get a better price, or a lower concession period if there was a more competitive bidding.

4.3.2 Project financing

The financing package included a mix of TIFIA loans, Private Activity Bond (PAB), a grant from the Commonwealth, private equity, and interest income on the privately issued debt. The project has a debt to equity ratio of approximately 60/40, including the grant funds provided by the state. The private partner is supposed to raise enough funds to cover 80% of the total cost of the project.

The TIFIA loan agreement was signed on December 21 2007. TIFIA interest payments are expected to begin in 2018, which is 5 years after construction is completed (ramp up period). Principal repayments are scheduled to begin in 2033, 20 years after operation of the project begins. The TIFIA loan is structured with five years of capitalized interest during construction followed by five years of partially capitalized interest during ramp-up; then current interest only for 15 years followed by 15 years of interest plus principal. This payment plan helps the project to substantially free cash flow and increase the debt capacity of the project.

Revenues generated from tolls are estimated to cover all project costs, including debt service, O & M, transaction costs. The first thing that will be paid each year is O & M expenses. Next, senior bonds will be paid as well as TIFIA. After paying for junior bonds, the private company can collect its return on equity.

The ROR equity will be calculated each year, and based on the actual ROR, VDOT may get a share of the profit based on revenue sharing mechanism designed in the contract. This is called “permit fee” in contract documents.

Table 9: Sources of Funds for I-495 HOT Project

Source	Amount ($ Million)	% of Total
TIFIA	$585.6	**29%**
Private Activity Bonds (PABs)	$585.5	**29%**
Private Equity	$348.7	**17%**
State of Virginia	**$408.9**	**20%**
Interest Income	$69.3	**3%**
Total	**$1,998.0**	**100%**

Source: Federal Highway Administration (FHWA)

Project Transaction Cost

VDOT reported their transaction costs as follows:

Table 10: I-495 HOT Lanes Project Transaction Costs Reported by VDOT

Source	Amount ($)	% of Total
Financial Advisors	1,520,000	30%
Architectural & Engineering	280,000	6%
Legal Consultants	257,000	5%
Business Consultants	1,345,000	27%
VDOT Internal Costs	1,600,000	32%
Total	5,002,000	100.00%

Source: Virginia Department of Transportation (VDOT)

The first thing that can be noticed about their reported transaction cost is lack of a detailed cost breakdown structure (CBS). The total cost of this project according to VDOT is $1.929 M. Based on this data the reported transaction costs of the I-495 HOT lanes project is only %0.26 of the capital cost of the project. A comparison between these data and estimates in other PPP projects reveals that the transaction cost reported by VDOT is significantly lower than transaction costs in other PPP

projects. For instance, TxDOT uses %10 as a rule of thumb to account for transaction costs in their PPP projects. The public sector pays usually 2-4% of the total capital cost of the project during procurement phases of a PPP project in the EU (Dudkin & Välilä, 2005). Further investigations reveal that there are different offices in VDOT which work on PPP projects. Based on the discussion in Section 4 of this paper, the budget of those offices should be divided among all different PPP projects. For instance, according to the report to the Commonwealth of Virginia, the budget of Enterprise Applications Public-Private-Partnership Office (EAPPPO) in 2008 was $11M. In another report (Annual Report on Initiatives for Outsourcing, Privatization and Downsizing within VDOT, 2009) VDOT reports the total cost of the projects under PPTA as $9.12B, meaning the cost of I-495 HOT Lanes projects accounts for 33% of the total PPP projects in Virginia. So, it is logical to add 33% of the total budget of the offices which work for PPP projects to the transaction cost of I-495 HOT lanes project. VDOT also reports its obligations for this project as $550M in the construction phase (Annual Report on Initiatives for Outsourcing, Privatization and Downsizing within VDOT, 2009); while according to Table 2, the obligations of the Commonwealth of Virginia is $408.9M. It is not clear where the $141.1M difference between these two reported numbers is accounted for.

It should also be noted that VDOT has not reported all the probable transaction costs of this project. The reported transaction costs are only related to the procurement phase of the project, however, there are more transaction activities during the project's life cycle which have not been addressed. For instance:

- Back office operations related to the collection of electronic tolls.
- ROW acquisition costs. Based on the contract, VDOT will initiate and handle condemnation proceedings if the concessionaire is unable to reach a negotiated settlement with the affected landowners.
- VDOT should do regular and quality control inspections to ensure the provisions of the contract are followed by the concessionaire.

Another reason that the reported transaction cost of this project is less than expected may be the lack of competition. It should be noted that the reported transaction cost is the transaction cost during searching and negotiation phases. While VDOT did publish a public notice regarding the receipt of Fluor's conceptual proposal, it did not receive any other competing proposals. This can be a huge disadvantage associated with this transaction which can result in higher contractual costs and also higher monitoring and enforcement transaction costs later during other phases of the project's life cycle. There are also some provisions in the contract that create obligations to VDOT which may result in higher transaction costs in the future. For instance, back office operations related to the collection of electronic tolls on the HOT lanes, establishing a management committee to coordinate operations of the HOT and general purpose lanes, ROW acquisitions if they exceed $42,011,750.00, handling condemnation if the concessionaire is unable to reach a negotiated settlement with the affected land owner. VDOT is also responsible for the acquisition of ROW related to the following: (1) the remediation of hazardous materials; (2) property outside of the project area; and (3) the construction of the HOT lanes operation center. VDOT is also obligated to pay the concessionaire about 70% of the average toll, if the number of HOV vehicles exceeds 24% of total traffic for 45 minutes in a given period.

4.4 Comparison of Case Studies and Conclusions

In order to better compare the performance of VDOT and FDOT in terms of tracking and recording transaction costs of I-494 HOT lanes and I-595 Improvements projects, the percentage of each category of transaction cost from the total transaction cost is calculated in table 11. The numbers derived in this table better illustrated that FDOT has done a better job in terms of recording the transaction costs. Their reported transaction cost (1.1%) is much closer to the transaction cost of PPP projects in EU (2%), however, it is still less. This can be because the table represents the reported transaction cost of I-595 Improvements till July 2009, which does not include the transaction cost of the project during the operation phase. So, the total transaction cost of the project during the lifecycle of the project will increase.

Table 11: Comparison of case studies

	I-495		I-595	
Source	Amount ($)	% of total	Amount ($)	% of Total
Financial Advisors	1,520,000	30.39%	2,200,000	10%
Arch & Eng Consultants	280,000	5.60%	14,850,000	70%
CEI	N/A	---	1,900,000	9%
Legal Consultants	257,000	5.14%	2,400,000	11%
Business Consultants	1,345,000	26.89%	N/A	- --
VDOT Internal Costs	1,600,000	31.99%	N/A	- ---
Total TC	5,002,000	100.00%	21,350,000	100%
Project Cost	1,998,000.000		1,835,000,000	
TC/ total capital cost	0.3%		1.1%	

In order to demonstrate the importance of the cost accounting system in tracking and recording transaction costs, the two different case studies are aligned with the model in table 12, and the alignment results are drawn based on the reported transaction cost reported in figure 16 in order to show that more alignment with the cost accounting model results in better tracking and recording of transaction costs.

Table 12: Aligning case studies with the model

Cost Accounting information	I-495 Alignment	I-595 Alignment	Model Total
Projects ID	100%	100%	100
Who incurs the cost	67%	67%	100
Phase	33%	67%	100
Activity ID	0	50%	100
Time/resource allocation	0	0	100
Direct / Indirect	50%	100%	100
Internal / External	50%	70%	100
Total Alignment	42%	57%	100

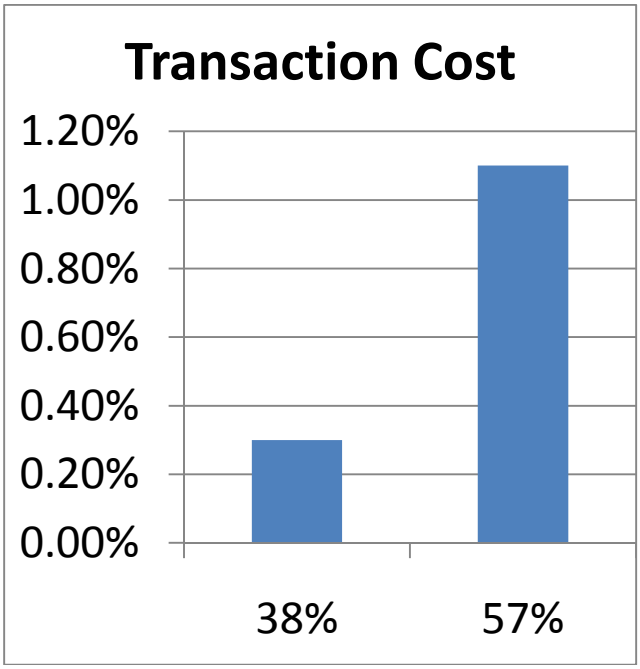

Figure 16: Alignment with the model Vs Reported transaction cost

Chapter 5: Bayesian Transaction Cost Estimation Template

5.1 Introduction

So far, this thesis has covered some theoretical discussions about transaction costs in PPP infrastructure projects, its main sources and effects on the performance of the project. In Chapter 3, the main factors affecting transaction costs were evaluated, and the effect of each one of them on transaction costs during the life cycle of the project is discussed. Chapter 3 also covered the PPP process flowchart, and cost breakdown structure as well as a cost accounting system for tracking transaction costs. Chapter 4 described issues discussed in Chapter 3 by discussing the transaction cost items during the life cycle of a PPP infrastructure project in the context of two case studies, I-595 as a good example, and I-495 as a poor example.

This chapter of the thesis aims to develop a transaction cost estimation model based on the information obtained in previous chapters. This chapter uses the discussion about the main sources of transaction costs in Chapter 3 to choose the four main inputs of the model: Number of Bidders, Project Value, Procurement time and PPP Maturity Level. The relationship between these four elements and different transaction cost categories within the lifecycle of the project is defined based on the work of other scholars covered in the literature review discussion of Chapter 2. Later, a Bayesian Network is used to connect different nodes in the model based on the relationships. The Bayesian Theory is used to relate the nodes because there is great uncertainty in the data, and the Bayesian Model is one of the models that can handle this uncertainty to produce acceptable results.

To construct the Bayesian Network, there is a need for conditional probabilities or relationships. This model uses conditional relationships instead of conditional probabilities. For example, it defines P(TC of public l number of bidders) as the percentage of transaction cost of public agency if the number of bidders is known. In

order to obtain this number, the data from an EIB study about transaction cost in PPP projects (Dudkin & Välilä study, 2005) is used. The next section of this chapter will discuss how the model is developed based on this data, and finally the last section of this chapter will discuss model limitations and the need for future research to make this model more accurate based on data from infrastructure PPP projects in the US.

5.2 Model Development Phases

The following flowchart describes the process of development of the Bayesian Network.

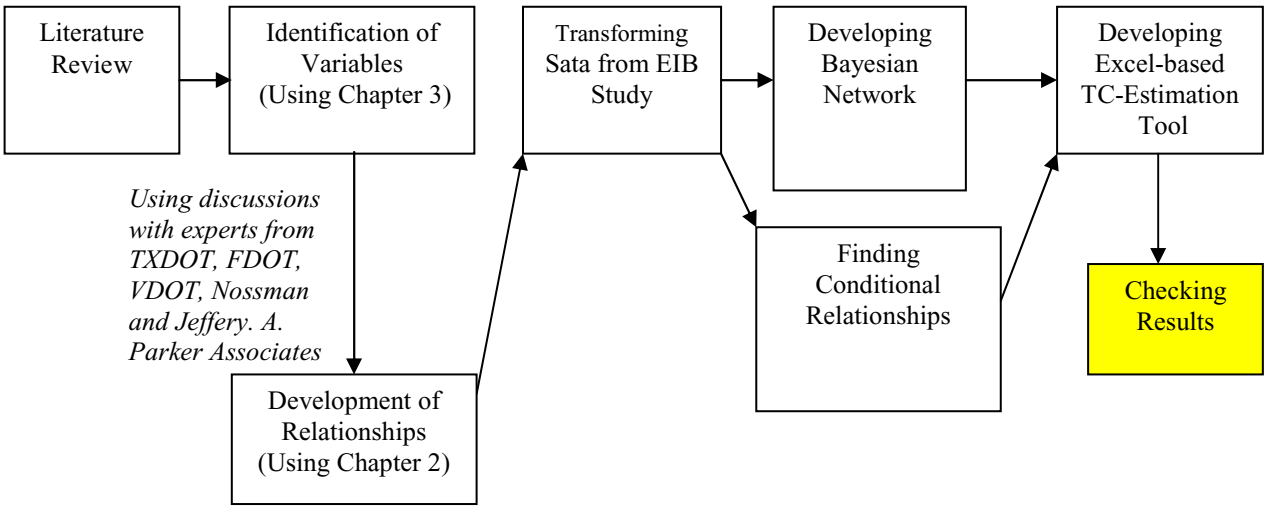

Figure 17: TC-Estimation model development

5.3 Variables and calculations in the excel based Model

This model is an Excel-based model created based on Bayesian Theory. The variables of the model are the main four variables of transaction costs identified in Chapter 3, Section 2. These four variables are as follows:

- Number of Bidders
- Project Value
- Procurement time (PPP Complexity)
- PPP Maturity Level

For instance, the user will be asked to enter data for the number of bidders and project value based on the available data, and data for project complexity and PPP maturity level based on their best judgment. These data will be future interpreted to corresponding values based on some transitional equations which will relate the entered data to the data available from the EIB study about transaction costs of PPP projects in the EU. For instance, they have reported the transaction cost of public sector as 2.1% for 1 bidder, 2.4% if 2 bidders, 3.4% if 3 bidders, and 3.1% if 4 bidders. We can interpret the results as follows:

If the user enters 1 bidder in the model, the model will automatically generate the corresponding number for it in the Bayesian Model as 0. 0 means no competition. Likewise, if the user puts 2, 3 or 4 and more the Excel sheet will transform these numbers to 0.25, 0.5, 0.75 and 1 correspondingly. It is obvious that the model interprets having four or more bidders as 1, meaning there is a full level of competitive bidding process.

It should be noted that the following data has been used in order to calculate the public transaction cost due to the number of bidders in the model.

P (public TC l competitive bidding) = 0.035

P (number of bidders l not competitive bidding) = 0.021

To check this numbers we can plug the four numbers into the model and compare the output of the model with the data from the EIB study.

Table 13: Sample Calculation for Transformation of Input Variables

Entered Number of Bidders	Corresponding Number in Excel	Estimated Public TC by the Model	Public TC Reported in EBI Report	% difference
1	0	0.021	0.021	0
2	0.25	0.024	0.024	0
3	0.75	0.028	0.034	9 %
4	1	0.035	0.031	5%

The same process is used to define all conditional relationships being used in the model. All relationships have been checked using a similar table in order to make sure that the output of the model is close to the reported data in the EIB study about transaction costs in PPP projects in EU.

In the case of having more information about the project, we can calculate the posterior relationships based on the prior data using Bayesian Theorem and the following formula:

$$P(A|B) = \frac{P(B|A)P(A)}{P(B|A)P(A)+P(B|\text{not } A)P(\text{not } A)}$$

Table 14: Conditional Relationships Defined Based on EIB Study Data

A	*B*	*P(AlB)*
Failing bidder TC	Number of Bidders (competition)	0.08
Failing bidder TC	Number of Bidders (no competition)	0
Failing bidder TC	Capital Value (high)	0.03
Failing bidder TC	Capital Value (low)	0.02
DOT TC	Number of Bidders (competition)	0.035
DOT TC	Number of Bidders (no competition)	0.021
DOT TC	Capital Value (high)	0.02
DOT TC	Capital Value (low)	0.05
DOT TC	Procurement Time(long)	0.038
DOT TC	Procurement Time (Short)	0.018
DOT TC	Experience (high)	0.02
DOT TC	Experience (low)	0.04
Winner Bidder TC	Number of Bidders (competition)	0.031
Winner Bidder TC	Number of Bidders (no competition)	0.013
Winner Bidder TC	Experience (high)	0.035
Winner Bidder TC	Experience (low)	0.06
Winner Bidder TC	Capital Value (high)	0.05
Winner Bidder TC	Capital Value (low)	0.022
Winner Bidder TC	Procurement time(long)	0.06
Winner Bidder TC	Procurement time (Short)	0.05

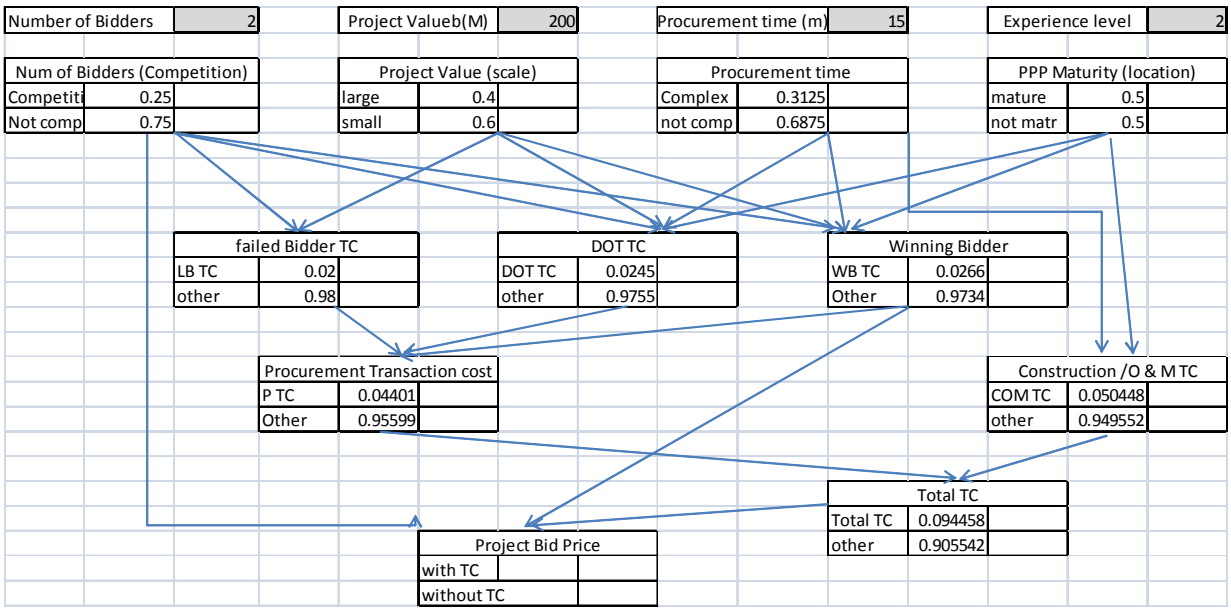

Figure 18: Screen Shot from Excel-based Transaction Cost Estimation Model

5.4 Model Limits

It should also be noted that many costs on the public side are step functions. For instance, the legal and financial costs may not be that different between a $700 million project and a $1 billion project. This research has tried to eliminate this effect as much as possible by defining a utility function for different variables in the Bayesian transaction cost estimation model. This utility function is defined based on available data from PPP projects in Europe published by the European Investment Bank (EIB). This function is bounded by a maximum and minimum value based on the data, to account for the economy of scale.

Also, one should be mindful of the fishing net problem - many projects in the U.S. incur costs and then never reach financial closure. For example, on the Missouri Bridges, I understand (second-hand) that MoDOT elected to not hire sophisticated financial advisors at all nor legal advisors at first. They brought in legal advisors after the project ran into trouble. In the end, the project failed as a PPP. MoDOT

thinks this is because the financial market turned. However, within the industry it is believed that they did not know what they were doing on certain fronts and missed key opportunities to advance the project and make it feasible. So, it is not clear whether MoDOT's procurement costs can be viewed as representative or just another cost. Mr. Mike Parker, the financial advisor for the I-595 Project, calls this the "penny-wise / pound foolish" issue.

Similarly, sometimes agencies draft loose contracts or negotiate sole source arrangements; the procurement cost may be lower (at least on the public side) but the long-term result is more costly to the public. Also, at times the public agency can spend money to facilitate better proposals; for example, undertaking baseline surveys. This might appear to increase public sector costs, yet is reducing the private sector bid costs and potentially the overall cost of the project. In a sole source pre-development arrangement, the private side may spend a lot to advance the project but can sometimes be offered reimbursement for costs if the project does not reach closure.

5.5 Future research development

The development of this model is solely based on the data available from PPP projects in EU countries. It is highly suggested that scholars study the effect of each variable on different categories of transaction cost based on data from infrastructure PPP projects in the US. Upon receipt of such data from PPP projects in the US, the conditional relationships of this study can be modified to get more accurate results.

Chapter 6: Conclusion

6.1 Final Conclusion

As the current chapter has sought to explain, the dissertation shall focus upon assessing the transaction cost of PPPs . The main argument behind the need for estimating transaction costs is the fact that it will help all entities of the PPP to have a better understanding of the financial status of the project and prevent future losses. Meanwhile, public agencies can get reimbursed for the transaction costs that they incur while entering a PPP agreement by billing those costs to the project, and private companies can enjoy using higher amount of TIFIA credit from the federal government since transaction cost is considered as an eligible cost in calculation of a TIFIA loan.

This thesis provides a platform for modeling transaction costs in infrastructure PPPs. It has developed a PPP process flowchart for infrastructure projects, and suggests a CBS, and a cost accounting system that can be used to better track and record transaction costs. It also compares two practices of transaction costs in two different projects as case studies to justify the cost accounting model and its benefits for the project. This thesis also suggests a cost estimation template to estimate the transaction cost of projects as a percentage of total capital cost of the project. This template has been developed based on the data collected from infrastructure PPP projects in Europe, and has been designed using Bayesian theory in order to account for the number of bidders (bidding competition level), capital cost of the project, location (PPP program maturity level), and project complexity (uncertainty).

Despite the referenced shortcomings or limitations, the fact remains that the study satisfied its outlined objectives and validated its hypotheses. The position adopted by the study was that there is a need for a good data accounting system in the US to track and record transaction costs, and such a system does not exist in many states. The case study of the I-495 HOT Lanes Project supports this statement.

The literature also suggested that the transaction cost of PPPs is high, and there is a need to assess this cost to make sure that an increase in transaction costs does not demolish the cost benefits of PPPs. That statement was ultimately studied through discussion of the factors affecting transaction costs of PPPs, and future estimates by a Bayesian Model based on data from European projects.

The conclusion reached, therefore, is that while PPPs can be implemented in public sector projects to fill the financing gap between available resources and demands, it is very important to measure the costs of such partnerships to make sure the benefit to cost ratio is higher than one. Successful implementation of PPPs is not guaranteed and can only occur if the costs and revenues are evaluated realistically. One of the most important costs which plays a great role in the success or failure of PPPs is the transaction cost of PPPs which was discussed in-depth in this thesis.

6.2 Contribution of Research

Chapter 2 of the study were devoted to an in-depth review of Public Private Partnerships and transaction cost economics literature with a specific focus upon assessing transaction cost in PPPs. Apart from framing the research's focus, providing readers with an overview of, and background to public private partnership concepts and transaction cost theory, the literature review chapters functioned to direct the research towards an in-depth exploration of comparatively unexplored issues within transaction cost measurement 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 a good accounting system to track and record transaction costs incurred by different entities in a PPP infrastructure project. The literature review, data collection limitations, and comparison of case studies show the need for such a system 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 a cost accounting matrix based on the work breakdown structure and general PPP process flowchart. This system can be used as a basis for accounting systems to have a standard mechanism to assess transaction costs in PPPs.

The last contribution of this study is the development of a Bayesian Network to estimate transaction costs of PPPs based on some variables suggested by the literature such as number of bidders (bidding competition level), capital cost of the project, location (PPP program maturity level), and project complexity (uncertainty). This network is built based on data from some European countries, and keeps the doors open for future research to enhance the accuracy by collecting data from US infrastructure PPP projects.

6.3 Implications of the Study

The field study led to the production of conceptual models which make an important contribution to assessing the transaction cost of PPPs in the US. Theory, as it currently stands, largely tends towards the qualitative aspects of transaction costs in PPPs; however, this research prepares a foundation for quantitative studies of transaction costs in PPPs in the US.

The findings of this research can be used by both the private and public sectors interested in PPPs. As the literature review suggests, some states such as Virginia have passed legislation to allow state DOTs to bill the transaction costs incurred by the state DOT while procuring a PPP project to the total cost of the project and get reimbursed for such costs. On the other hand, transaction cost is one of the items which is eligible to be included in the cost of project while applying for a TIFIA loan. Therefore, there is a need for a systematic way to estimate it and include it in the cost estimation of the project in order to maximize the opportunity of using TIFIA in the financial pool of the project.

6.4 Limitations of the Study and Future Work

Even as the importance of the study was emphasized in the introductory chapter, it is necessary to conclude with a concession to the study's limitations. Such a concession, 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 the transaction cost, but it has used Bayesian Theory to develop a network to estimate such costs. 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 transaction costs of PPPs in the US is almost impossible

. Lack of enough data makes it almost impossible to do any regression or statistical analysis on the current data. Therefore, because of the mentioned limitations the only available choice was to use a case-based methodology to justify the accounting model, and a Bayesian Network to develop a cost estimate model. Uncertainty in the data collected in this research is high, and Bayesian Models are powerful in terms of accounting for it. Therefore, a Bayesian Network is used for a transaction cost estimate model. However, this model should be further justified by collecting more data from PPP projects in the US.

Appendices

Appendix 1: Current PPP legislation status in the US

State	Statute
AK	ALASKA STAT. §§ 19.75.111, .113, .211, .221, .330, .332, .334, .336, .338, .340, .241, .915, .920, .980 [1]
CA	CAL. STS. & HIGH. CODE §§ 143, 149 to 149.6, 149.7 [2] CAL. GOV. CODE §§ 5956 to 5956.10 [3]
CO	COLO. REV. STAT. §§ 43-1-1201 to 43-1-1209; 43-4-801 to 43-4-812; 43-3-201 to 43-3-416[4] HB 08-1354 [5]
DE	DEL. CODE ANN. tit. 2, §§ 2001 to 2012 (2008) [6]
FL	FLA. STAT. ANN. §§ 334.30, 338.22 to 338.251 (2007) [7] Amended by HB985 (2007)[8]
GA	GA. CODE. ANN. §§ 32-2-78 to 32-2-80 [9]

[1] HTTP://WWW.LEGIS.STATE.AK.US/CGIBIN/FOLIOISA.DLL/STATTX06/QUERY=19!2E75!2E111/DOC/{@9161}.

[2] http://www.leginfo.ca.gov/cgi-bin/displaycode?section=shc&group=00001-01000&file=90-155.6

[3] http://www.leginfo.ca.gov/cgi-bin/displaycode?section=gov&group=05001-06000&file=5956-5956.10

[4] http://198.187.128.12/colorado/lpext.dll/Infobase4/6703c?fn=document-frame.htm&f=templates&2.0

[5] http://www.leg.state.co.us/CLICS/CLICS2008A/csl.nsf/fsbillcont3/5EA1856BEB382D9A872573FC0067B4D2?Open&file=1354_enr.pdf

[6] http://delcode.delaware.gov/title2/c020/index.shtml

[7] http://www.flsenate.gov/Statutes/index.cfm?App_mode=Display_Index&Title_Request=XXVI#TitleXXVI

[8] http://www.myfloridahouse.gov/Sections/Documents/loaddoc.aspx?FileName=_h0985er.doc&DocumentType=Bill&BillNumber=0985&Session=2007

[9] http://www.lexis-nexis.com/hottopics/gacode/

MD	MD. CODE REGS. 11.07.06 [10] MD. CODE ANN. TRANSP. § 8-204 [11]
MN	MINN. STAT. §§ 160.84 to 160.93 (2007) [12]
MS	S.B. 2375, 2007 Leg., Reg. Sess. (Ms. 2007). [13]
NC	N.C. GEN. STATE. §§ 136-89.180 to 136-89.198 [14]
OR	OR. REV. STAT. §§ 367.800 to 367.826. [15] OR. REV. STAT. §§ 383.001 to 383.019 [16]
PR	P.R. LAWS ANN. tit. 9, §§ 2001 to 2021
TX	TEX. TRANSP. CODE ANN. §§ 223.001 to 223.209; 227.001 to 227.083; 228.001 to 228.254; 370.001 to 370.365 [17]
VA	VA. CODE ANN. §§ 56-556 to 56-575 [18]
WA	WASH. REV. CODE §§ 47.29.010 to 47.29.900; 47.46.010 to 47.46.900 [19]

Appendix 2:

Previous attempts to measure transaction cost in capital projects

To examine the transaction cost breakdown structure in the work of other scholars, we have examined a few papers and have summarized the reviews in this section. These papers are referenced within the paper by the authors name and year of publication. The following information explains how different scholars have applied transaction cost economics in different capital projects to create a transaction cost breakdown and quantify the transaction cost in capital projects.

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[10] HTTP://WWW.DSD.STATE.MD.US/COMAR/SUBTITLE_CHAPTERS/11_CHAPTERS.HTML

[11] http://www.michie.com/maryland/lpext.dll?f=templates&fn=main-h.htm&cp=mdcode
[12] http://www.revisor.leg.state.mn.us/revisor/pages/statute/statute_chapter_toc.php?chapter=160
[13] http://billstatus.ls.state.ms.us/2007/pdf/history/SB/SB2375.htm#title
[14] http://www.ncleg.net/EnactedLegislation/Statutes/HTML/ByArticle/Chapter_136/Article_6H.html
[15] http://www.leg.state.or.us/ors/367.html
[16] http://www.leg.state.or.us/ors/383.html
[17] http://tlo2.tlc.state.tx.us/statutes/tn.toc.htm
[18] http://leg1.state.va.us/cgi-bin/legp504.exe?000+cod+TOC560000000220000000000000
[19] http://apps.leg.wa.gov/rcw/default.aspx?Cite=47

Paper 1: Transaction Costs in PPP Transport Infrastructure Projects (Soliño & Santos, 2009)

1) Project preparation costs
   a) Preliminary studies, including Environmental Impact Assessment
   b) Feasibility study
   c) Preliminary design

2) Bidding costs
   a) Tender documentation preparation
   b) Negotiation costs

Note: This study tried to distinguish, at every stage, between external costs (such as technical, legal and financial advice) and in-house costs.

Paper 2: Assessing Transaction Costs of Project-based Greenhouse Gas Emissions Trading (Antinori & Sathaye, 2007)

1) Search cost
   a) Identifying the project
   b) Selecting the project
   c) Selecting project partners
   d) Selecting project consultants

   Note: Search costs for a project are likely to depend on institutional constraints, firm experience, and search procedures. For the latter, the search process may include a single project or a set of projects, as in the case of a call for proposals that generates numerous applicants. In a call for proposals, search costs will be shared across projects, thus reducing the search cost per project.

2) Feasibility Studies cost
   a) GHG baseline assessment and the
      Determination of the appropriateness of its addition.
   b) Engineering
   c) Marketing
   d) Baseline and environmental assessments to
      determine the overall viability of the project
   e) Pre-feasibility study.

3) Negotiation
   a) Obtaining permits
   b) Arranging financing
   c) Negotiating emission-reduction purchase contracts
   d) Marketing and contracting for GHG credits.

4) Monitoring and Verification:
   a) Monitoring plan preparation prior to the project start date, and continual monitoring and verification of a project's GHG savings
   b) Developing a protocol
   c) Regular monitoring/reporting of emission reductions
   d) Third party verification of reductions.

5) Regulatory approval
   a) The validation cost incurred ex-ante to confirm that the project is eligible for claiming reductions.
   b) Ex-post certification .
   c) The registering and certification by a national and/or international regulatory body.

6) Insurance
   a) Insuring cost of the emission reductions.
   b) Self-insure by portfolio diversification cost
   c) Pooling projects

Paper 3: Transaction Costs in Clean Development Mechanism (CDM) Projects (United Nation's Development Programme)

1) Project design costs:
   a) Preparing project design document
   b) Submit it for approval.
   c) communicating with government
   d) consulting costs

2) Other CDM costs
   a) registration fees
   b) CDM Executive Board may impose additional costs on companies involved in the CDM to be generated from proceeds of CDM projects, some of which may not be

directly related to the project, but rather reflect costs associated with implementing the Kyoto Protocol. For instance:

c) Adaptation: Two per cent of CDM project proceeds will be levied for use as an adaptation fund except in the case of the least develop developed countries. For all other projects, this levy is compulsory.

3) Other potential costs
   a) Some host countries also require sharing of CERs(several countries levy this in the form of a tax; Chile, for example)
   b) Insurance services to ensure delivery of contracted CER, or the opportunity cost of holding back CERs to create a self-insurance buffer may also add to the tranasaction costs.

Figure 17: Transaction Cost Estimate for CDM Projects (United Nation's Development Programme)

CDM PROJECT CYCLE	CARBON TRANSACTION CONSULTANT'S ESTIMATE OF COST (IN US$)
UP-FRONT (PRE-OPERATIONAL) COSTS:	
1. Feasibility assessment	5,000-20,000
2. Preparation of the project design document	25,000-40,000
3. Registration	10,000
4. Validation	10,000-15,000
5. Legal Work	20,000-25,000
TOTAL UP-FRONT COSTS:	70,000-110,000
Operational Phase Costs:	
1. Sale of CERs	Success fee in region of 5-10 per cent of CER value. Higher for a small project than a large project.
2. Risk mitigation[3]	1-3 per cent of CER value yearly. Mitigation against loss of incremental value as a consequence of project risk.
3. Monitoring and verification	3,000-15,000 per year [4].

Paper 4: Aid Transaction Costs in Viet Nam (Noi, 2000)

1. Project Identification and Appraisal
   a. **Information requirements during identification vary between government and donors.** Donors require much more information at this stage of the project cycle than government.29 Requirements vary across donors, but generally include data on general economic conditions in Vietnam, outlook for the relevant sector, socio-economic information etc., which would not be collected if a project was undertaken without donor assistance. Some donors, especially those

with a large grounds presence, gather the data themselves. However, many others ask the line Ministry to collect the information on their behalf. This means for example that MARD has to contact other departments, such as the Ministry of Finance, MPI, Social Welfare and others. This will often takes considerable time and causes delays in the pre appraisal process.

b. **Delays at this stage are exacerbated by the incentives that MARD has to priorities projects which are already in the preparation stage**, where donor funding has already been secured. These take priority over those only in pre-appraisal, thus causing further delays.
c. **Limited Vietnamese input during preparation and project design**. This is due to the tight resource constraints under which government departments are expected to operate at this stage of the project cycle. No additional GoV budget allocations for projects are approved until after appraisal, so departments and other agencies must fund project preparation from their limited recurrent budget allocations, which is difficult where field visits or specialist consultancy services are required.
d. **Imbalance between national and international participation**. Donors rely heavily on international consultants. The national input in the preparation phase, from national consultants and MARD, is very small. In practice this has had two consequences. Firstly, projects are prepared according to donor procedures. This causes transaction costs for government, as its own procedures differ from those of donors. It also raises accountability issues, as the international consultants tend to be accountable to the donor only.
e. **Reduced government ownership and sustainability.** In almost all projects there is a clear distinction between staff who prepare a project and staff who implement it. As a rule, PMUs are only set up after the preparing and negotiating the project. PMU staff are, therefore, not involved in preparation. This leads to two types of problems and costs: PMU staff do not know as much about the background and content of the project than if they had been involved from the start; and more importantly ownership of and commitment to the project is lower. This was the general perception of government and donor staff interviewed.
f. **Centralized government structures.** Centralized decision making is also a big constraint on the government side, and a protracted appraisal process is a cause of delay in project start up. These delays appear to result from:

i. A multi-stage review process, particularly for large projects, requiring appraisals for inclusion in the plan, as preliminary proposals and subsequently following detailed feasibility studies;
ii. A multi-level appraisal process, involving line agencies and provincial governments, MPI and, for large projects, the National Project Evaluation Committee;
iii. Multi-agency consultations during project design and appraisal, sometimes further hampered by poor communication between agencies.

g. **Donor understanding of intra-Governmental relationships is often scant**. Many donors are unclear about how they should relate to different government institutions at different stages in the process leading to project approval. This is partly because Government decision-making requires multiple levels of approval, and the division of roles and powers between the line Ministry, MPI, the Office of the Government and Provincial authorities regarding project approval are not well understood.

h. **Technical appraisal by government may be cursory.** Grant financed projects, particularly those for technical assistance, are subject to only cursory appraisal. This is partly due to the limited appraisal capacity within government, particularly at provincial level, but also because agencies regard such resources as "free". Besides, in the absence of a clearly defined strategy and appraisal criteria, there may be no clearly articulated basis for rejecting a proposal36 resulting in technically weak or inappropriate projects receiving approval and result in problems and transaction costs during subsequent project implementation.

2. Negotiation and Approval of Financing Agreements

a. **Centralization of** approval of financing agreements **and requirements for wide consultation** may be a source of delay in project start-up.

b. **Where negotiations run into problems these are often related to shortcomings during project preparation**, e.g. not taking into account local conditions sufficiently. Revisions during negotiations can substantially raise transaction costs and lead to long delays, especially if revisions mean revisiting or duplicating preparation work.

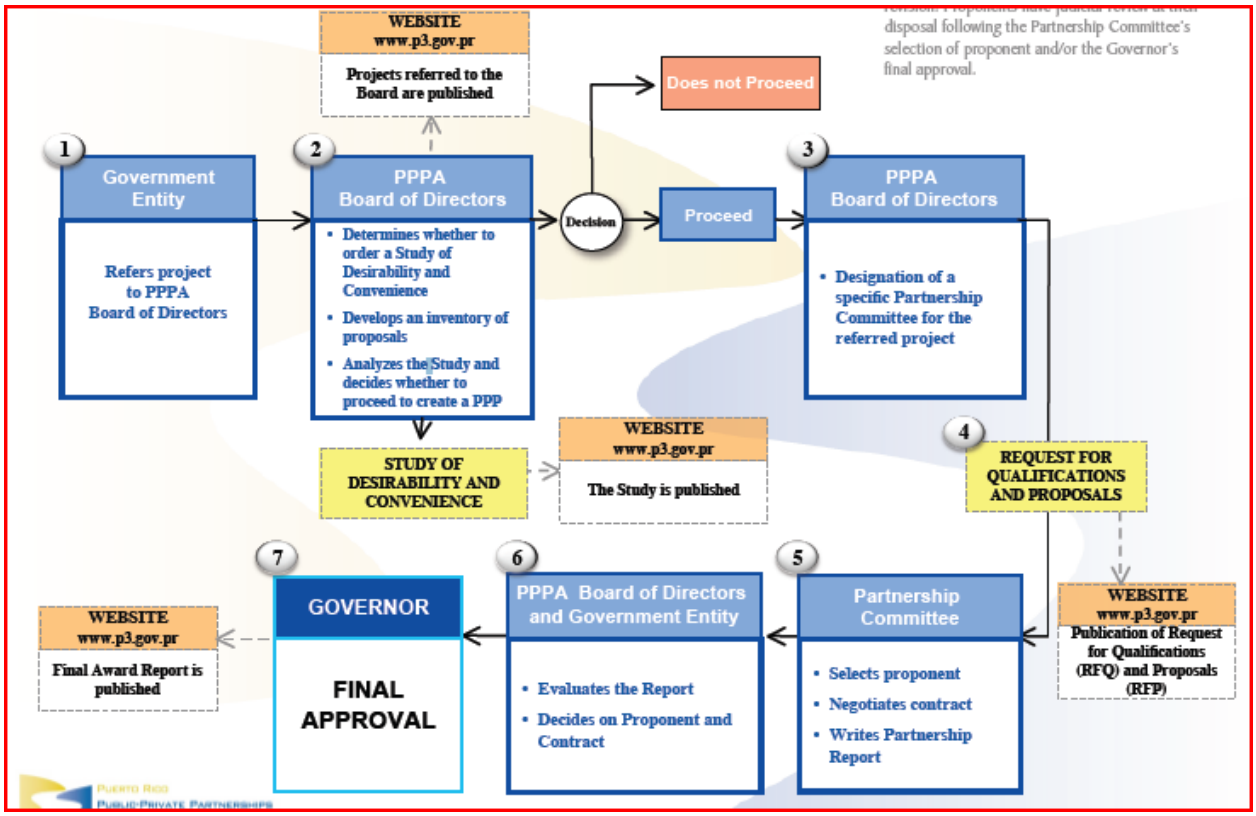
c. **The financing structure of the project**. Main areas of negotiation include the balance between government and donor financing, and between capital and recurrent expenditure. Government tends to be

more focused on capital expenditure, and on several occasions has asked donors to reduce recurrent expenditures (consumables), and instead put them 'into the project' (capital expenditure).

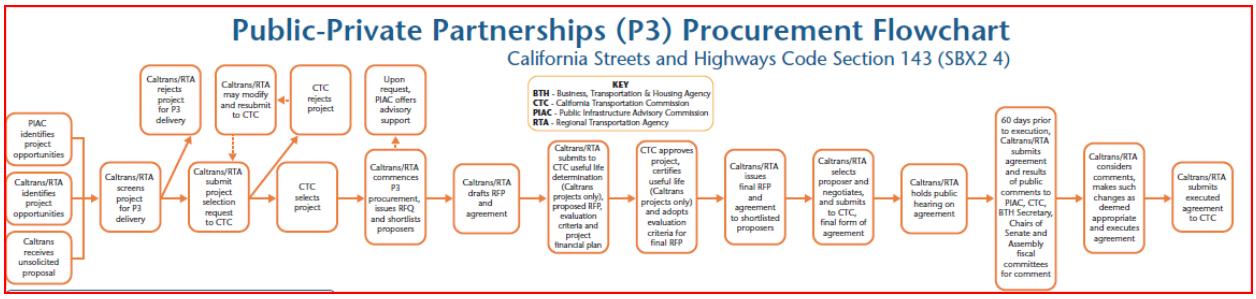
d. **Problems with information exchange during the negotiation phase.**

3. Project Implementation, Monitoring and Evaluation
    a. **Costs arising from the need to follow multiple procedures.** Transaction costs arise from the duplication involved in having parallel (Government and donor) procedures.
    b. **Government procurement authority is over-centralised**, and long delays occur as requests, information and approvals travel up and down the government hierarchy.
    c. **Financial management and reporting.** PMUs prepare annual and quarterly reports on project implementation, the receipt and use of capital by source of funds, and an assessment of implementation results are sent through the parent agency to MPI, MOF and the Office of Government. However, even within Government's own systems there is an element of duplication.
    d. **Delays in receipt of government funds** have been another source of transaction costs.
    e. **The use of PMUs – and indirect costs.** Responsibility for project implementation is usually delegated to PMUs, headed by a Project Director and staffed by both permanent line-agency and contracted personnel. PMUs vary considerably in size, some having only five permanent staff others as many as 150.

Appendix 3: PPP projects flow diagram examples



Approval Process of Public-Private Partnerships in Puerto Rico (Source: http://www.p3.gov.pr/Eng/Legal/Documents/ApprovalProcessPPP.pdf)



Public-Private-Partnership Procurement Flowchart in California (Source: http://74.125.113.132/search?q=cache:aXpjs31pNMsJ:www.business.ca.gov/GSLibrary/Downloads/download.ashx%3Ffile%3Dsites/1832/17450/382627/P3%2520Brochure.pdf+Public+Private+Partnership+Process+Flowchart&cd=6&hl=en&ct=clnk&gl=us)

Appendix 4:Transaction Cost Data Collection Sheets

1. Version 1

	Low	Medium	High
How expensive is the total estimated budget for the project?	1		
What is the uncertainty/complexity of the project?		1	
What is the location/frequency of the project?	1		

What is the total cost of project?

In-House costs		**External Costs**	
Office expenses and supplies		Waiting time	
Permits		Permits	
Proposal evaluation		Legislator	
Estimation expenses		Political costs	
Accounting services		Opportunity cost	
Legal services		R & D	
Advertising expenses		Administration cost	
Public relations			
office assistance (payroll)			
traveling and shipments			
Insurance			
Audit fees			
Employee benefits			

2. Transaction Cost Data Sheet (Version 2)

	Low	Medium	High
What is the number of the bidders?	1		
What is the uncertainty/complexity of the project?		1	
What is the PPP maturity of different entities of the project?	1		

What is the total cost of project?	
What is the duration of the project?	

In-House costs

	# of employees	Hours	payroll rate	Total Cost
1) Search cost				
a) Identifying the project				
b) Prescreening the project				
c) selecting project team				
d) Selecting project consultants				
2) Feasibility Studies cost				
a) Engineering and technical				
b) Market				
c) environmental studies				
e) Public opinion/ legislature/ political				
3) Negotiation:				
a) the costs of obtaining necessary permits and approvals				
b) preparing bidding documents				
c) negotiating contract / Bidding				
d) marketing and advertising				
Total Direct In-House TC				
OH (net multiplier 3)				
Total In-House TC				

Notes

OH will be assumed to be 160% which is the industry average in construction projects in private companies.
A multiplier of 1.15 will be used in order to account for the inefficiency of the public agency compare to private companies.
For simplicity purposes, the political cost, opportunity cost and communication costs are not being considered.

External Costs

Technical consultant	

Legal Consultant	
Financial Consultant	
Total TC (In-house+ External)	

External Costs

Technical consultant	
Legal Consultant	
Financial Consultant	
Total TC (In-house+ External)	

3. Transaction Cost Data Sheet (Version 3)

	Total Cost $ (K)		How important is this cost? N/A	Low	Average	High
-LEGAL CONSULTANT FEES:						
-AUDIT FEES:						
-ARCHITECTURAL/ENGIEERING CONSULTIG						
-PUBLIC RELATIONS CONSULTANT:						
-ACCOUNTING CONSULTANT:						
-FINANCIAL/BUSIESS CONSULTANT:						
-ENVIRONMENTAL CONSULTANT						
-OTHER (PLEASE SPECIFY):						

	No.		RATE/ Day			How important is this cost? N/A	Low	Average	High
0	X	0.0	=	**0**					
0	X	0.0	=	**0**					
0	X	0.0	=	**0**					
0	X	0.0	=	**0**					
0	X	0.0	=	**0**					
	0	X	0.0	=	**0**				

0	X	0.0	=	0

TOTAL = 0

ENGINEERING

No.		RATE/ Day		
0	X	0.0	=	0
0	X	0.0	=	0
0	X	0.0	=	0
0	X	0.0	=	0
0	X	0.0	=	0
0	X	0.0	=	0
0	X	0.0	=	0
0	X	0.0	=	0
			=	0

TOTAL =

How important is this cost?			
N/A	Low	Average	High

SALARIED STAFF EMPLOYEE BENEFITS

	0.0	
	0.0	
	0.0	
	0	

How important is this cost?			
N/A	Low	Average	High

SUM OF Staff Salaries =

PERCENT =

TOTAL =

TRAVEL TIME PAY = 0

-	----------	=	0
No.	Rate / Day	=	0

How important is this cost?			
N/A	Low	Average	High

0

:	0	X	0.0
:	0	X	0.0
:	0	X	0.0

TOTAL =

OFFICE EQUIPMENT AND SUPPLIES

- **----------**

		How important is this cost?			
COST($)		**N/A**	**Low**	**Average**	**High**
0.0					
0.0					
0.0					
0.0					
0.0					
0.0					

-OFFICE RENT:
-EQUIPMENT(CARS/COMPUTERS /FURNITURE):
-PAYROLL & ACC. SOFTWARE & HARDWARE:
-SURVEYING EQUP. & SUPPLIES :
-REPRODUCTION EQUP. & SUPPL.:
-DRAFTING EQUP. & SUPPLIES :
-CONSULTING, TESTING & INSP.:
-
OTHERS
:

TOTAL =

How important is this cost?

COST($)		**N/A**	**Low**	**Average**	**High**

INSURANCE PREMIUMS
NON-INSURED CLAIMS
OTHER

TOTAL =

		How important is this cost?			
COST($)		**N/A**	**Low**	**Average**	**High**

-LONG DISTANCE CALLS & MAIL EXPENSES
-
OTHERS
:

TOTAL =

BONUS OR PENALTY	
-	----------
PERMITS	
-	----------
PARENT DEPARTMENT COSTS	
-	----------
TOTAL DIRECT (PAYROLLS)	
-	----------
TOTAL INDIRECT	
-	----------
ESCALATION	
-	----------

COST($)

COST($)		How important is this cost?			
		N/A	Low	Average	High

COST($)

Appendix 4: Project information data for PPP infrastructure projects in the US

Financial Information			
Location	Texas		
Project Name	IH-635 Managed Lanes	SH 130 (seg 5 & 6)	North Tarrant Express
Delivery/Contract Method	DBFOM	DBFOM	DBFOM
Construction Duration	5 years	5	
Operation Duration	52 years	50	52 years
Fiscal Year approved	2009	2007	2009
Funding sources			
State and federal			
Concessionaire's financing			
GARVEE			
GO bond			
TIFIA Loan	$800	$430	$650
Private activity	$400		$398
Senior Banking Debt		$685.80	
Senior term Facility Debt	$400		
State infrastructure bank loan			
Section 129 loan			
Other:			
Equity			
Private	$598.50	$209.80	$426
State	$445		$573
Revenue (toll or interest)	$34.50	$2.30	
Check total	$2,678	$1,328	#REF!
Total according to documents	$2,678	$1,327.90	$2,047
Equity/total	0.22	0.16	0.21

Financial Information			
Location	Virginia		
Project Name	I-495 Hot Lanes	I-95/395 Hot Lanes	U.S. Route 460
Delivery/Contract Method	DBFOM		
Construction Duration	5 years		
Operation Duration	80 years		
Fiscal Year approved	2008	2006	2010
Funding sources			
State and federal			
Concessionaire's financing			
GARVEE			
GO bond			
TIFIA Loan	$589	157.3	
Private activity	$589		
Senior Banking Debt		859	
Senior term Facility Debt			
State infrastructure bank loan			
Section 129 loan			
Other:	State of Virginia Grant		
	$409		
Equity			
Private	350.00	270.00	
State			
Revenue (toll or interest)		55.3	
Check total	$1,937	$1,342	$0
Total according to documents	1938.00	1341.60	
Equity/total	0.18	0.20	

Financial Information	
Location	Florida
Project Name	I-595
Delivery/Contract Method	DBFOM
Construction Duration	5 years
Operation Duration	35 years
Fiscal Year approved	2008
Funding sources	
State and federal	
Concessionaire's financing	
GARVEE	
GO bond	
TIFIA Loan	$603
Private activity	
Senior Banking Debt	$781.10
Senior term Facility Debt	
State infrastructure bank loan	
Section 129 loan	
Other:	FDOT qualifying dvlpm funds
	$232
Equity	
Private	$207.70
State	
Revenue (toll or interest)	$10
Check total	$1,834
Total according to documents	$1,833.60
Equity/total	0.11

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