Assessing the Rise of Design-Build-Finance Delivery in Transportation Infrastructure

Vikas Gurram

Thesis submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Master of Science

In

Civil Engineering

Michael J Garvin, Chair

Tripp Shealy

Raman Kumar

May 13, 2020

Blacksburg, VA

Keywords: Design-Build-Finance, Drivers of DBF, Challenges of DBF

Assessing the Rise of Design-Build-Finance Delivery in Transportation Infrastructure

Vikas Gurram

Abstract

While other alternative project delivery methods have emerged to address the limitations of Design-Bid-Build, Design-Build-Finance (DBF) has surfaced more recently. Although DBF has gained prominence in the past decade, research pertaining to this method is limited. Consequently, this research investigated the use of DBF for the delivery of transportation infrastructure by five State DOTs: Florida, North Carolina, Georgia, Michigan and Texas through a combination of interviews with DOT personnel and investigation of completed or on-going DBF projects. To complement this, subject matter experts (SMEs) were interviewed to obtain a more general market perspective of DBF. As a result, two variants of DBF, DBF – Receivables and DBF – Risk Transfer, were identified; the DOTs investigated and the US more broadly, primarily use the DBF - Receivables variant where the contractor is entitled to payments for the activities completed irrespective of the project's completion. Whereas in the DBF – Risk Transfer variant, the contractor's payments are linked to the completion of the project. Further, DBF is employed on projects that are (i) in need of acceleration, which generates (ii) social and economic benefits such as congestion relief and safety enhancements; such projects are also (iii) subjected to short-term budgetary restrictions, but they typically have (iv) funds programmed in the future. The distinction found in the variants of DBF provides a better understanding of the drivers of DBF, which were validated through interviews. In practice, this distinction also aids public agencies in better identification of the appropriate project delivery method for a given project.

Assessing the Rise of Design-Build-Finance Delivery in Transportation Infrastructure

Vikas Gurram

General Audience Abstract

Infrastructure projects are complex with many stakeholders involved in different stages of the project lifecycle. Design-Bid-Build (DBB) is the conventional method of project delivery for government agencies in the United States for delivery of infrastructure in the in 20th century due to legislation like the Brooks Act of 1972. Alternative project delivery methods, which can be classified into Capital Delivery Methods like Design-Build (DB) and Lifecycle Approach Methods like Design-Build-Finance-Operate-Maintain (DBFOM), have recently re-emerged to overcome the shortcomings of DBB. Design-Build-Finance (DBF) is one such alternative delivery method that has been increasingly used in the past decade to aid public transportation agencies to meet growing infrastructure needs. Significant research has been conducted to determine the drivers of alternative delivery methods like DB and DBFOM. The potential benefits of DBFOM are not found in DBF since a contractor is not involved in the operations and maintenance stages of a project. Moreover, current literature on DBF is limited since it is a contemporary phenomenon. In the US, 11 transportation projects were identified that employed DBF in the past decade. To understand why public agencies are using DBF, this research examined DBF programs in five states using a mix of interviews of key stakeholders and a review of available project documentation. Two variants of DBF with different payment structures and risk profiles were uncovered. Further, agencies tend to employ DBF to accelerate the timeline of a project that has funds programmed in later years and to realize the associated social and economic benefits such as congestion relief or improved safety. However, agencies must consider potential disadvantages such as increased oversight and financing costs when deciding whether or not to use this method.

Contents

List of Figures

List of Tables

1 Introduction

1.1 Background

A project's lifecycle can be divided into five stages namely – Design, Build, Finance, Operation and Maintenance. Different project delivery methods integrate various stages of a project and engage private sector participants at different stages. The practice of collaboration with the private sector and integration of project activities are longstanding. In 1796, Colonel Ebenezer Zane made a deal with the fledgling United States government to build a road (Zane's Trace) from current day Zanesville to Maysville in exchange for land grants at the Muskingum, Hocking and Scioto Rivers along the path of the trace to pay for the surveying costs (Dollarhide 2012, n.d.; Garvin 2010; Longfellow n.d.). This is an example of the government's collaboration with the private sector to develop infrastructure from the time of the nation's founding.

1.1.1 Rise of DBB Method

With the industrial revolution in 19th century, the concept of division of labor gained prominence resulting in the creation of professional organizations. The division of labor prompted the specialization of tasks which led architects to focus on the design aspect of the project lifecycle while builders began to specialize in the construction (Beard et al. 2001). Also, the capital requirements for a construction contractor were quite large compared to an architect, which led to segregation of the businesses. This separation, fueled by the creation of professional societies and legislation like the Miller Act of 1935 to the Brooks Act of 1972 resulted in the use of Design-Bid-Build (DBB) as the conventional project delivery method for public infrastructure (Beard et al. 2001; Miller et al. 2000).

1.1.2 Use of Alternative Project Delivery Methods

In the late 1980s, through a flurry of research by economists, a relationship between infrastructure investment and overall economic productivity was established (Aschauer 1989). This relationship between economic productivity and infrastructure investment, despite whether a direct link exists or not (Gramlich 1994), led to increased interest in a spectrum of alternative project delivery methods for infrastructure delivery. This interest in alternative delivery methods was fueled by studies like Miller et al. (2000) and Macdonald (2002) that identified issues with DBB.

The spectrum of project delivery methods can be classified based on the level of integration of activities over the project lifecycle (Garvin 2010). On one end of the spectrum are methods classified as capital project delivery methods where a contractor is responsible for the project until substantial completion like the Design-Build (DB) method or the Construction Manager/General Contractor (CM/GC) method. These methods are known for, among other things, project schedule acceleration and cost savings. On the other end of the spectrum are the Life Cycle Methods, also called Public-Private Partnerships (PPPs), where a contractor is typically responsible for the project's entire lifecycle including O&M. PPPs are defined as "*a long-term contractual arrangement between the public and private sectors where mutual benefits are sought and where ultimately (a) the private sector provides management and operating services and/or (b) puts private finance at risk*" (Garvin and Bosso 2008). Studies have portrayed PPPs as ways to increase the investment in infrastructure by harnessing private financing capabilities and efficiency gains of the private sector in management and maintenance of public infrastructure (Ke et al. 2011; Osei-Kyei and Chan 2017a). Each government agency has different objectives for involving the private sector in the different stages of project delivery. Some of these objectives include accelerating the project development, on time and on budget construction, leveraging private capital, generating economic activity, life cycle cost efficiencies and effective risk allocation (Ashuri and Mostaan 2015). Moreover, an analysis of PFI projects (a term similar to PPPs in US) through surveys of projects completed until 2003 and again in 2008 in UK showed that PFI projects have a slight edge over traditional procurement in terms of on time and on budget delivery compared to DBB projects (Engel et al. 2010).

1.1.3 Description of DBF

On the spectrum of the project delivery methods as shown in *figure 1*, the Design-Build-Finance (DBF) method lies between Capital Project Delivery Methods (CPDs) and Lifecycle Delivery Methods (LCMs). FHWA defines DBF as a procurement model that allows a single contract between a public agency and the private sector for design, construction and partial or full financing in the development of an infrastructure project (FHWA - Center for Innovative Finance Support n.d.). Unlike the LCMs, long term Operations and Maintenance responsibilities of the facility still lies with the public sector or, in some cases, is handled through separate O&M agreements (FHWA - Center for Innovative Finance Support n.d.).

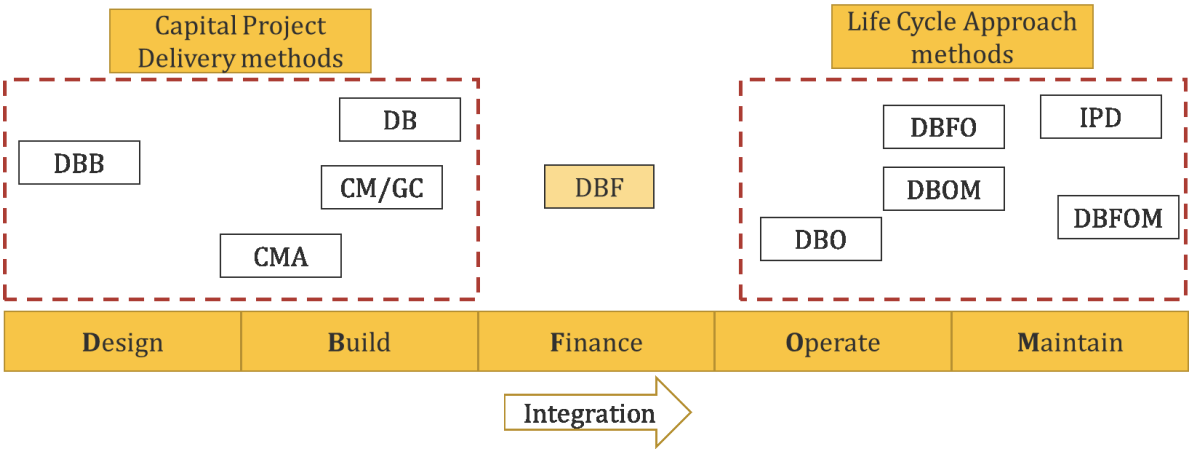

Figure 1: Spectrum of project delivery methods

1.2 Motivation and Research Questions

In the past decade, use of the DBF project delivery method across the United States has increased (FHWA - Center for Innovative Finance Support n.d.). Florida DOT has procured 5 DBF projects from 2007 with the latest project starting in 2017 while Georgia DOT has procured 2 projects in 2013 and 2016. Similarly, North Carolina DOT has procured the I-485 Charlotte Outer Loop in 2011 and Michigan has procured 2 projects in 2008. Most of these projects have just reached completion (including final payment) or are expected to be completed within the next 2 years. DBF is a hybrid of DB and LCMs, comprising characteristics of both. This poses the question of the drivers for the use of DBF. An investigation of existing literature focused on DBF found little information. A review of the existing literature using the search engines Google Scholar, SCOPUS and Web of Science resulted in only 3 relevant studies focused on DBF (Forcael et al. 2011a; Ramsey and Asmar 2016; Stager 1996). The approach for the review is detailed in flowchart in *figure 2*:

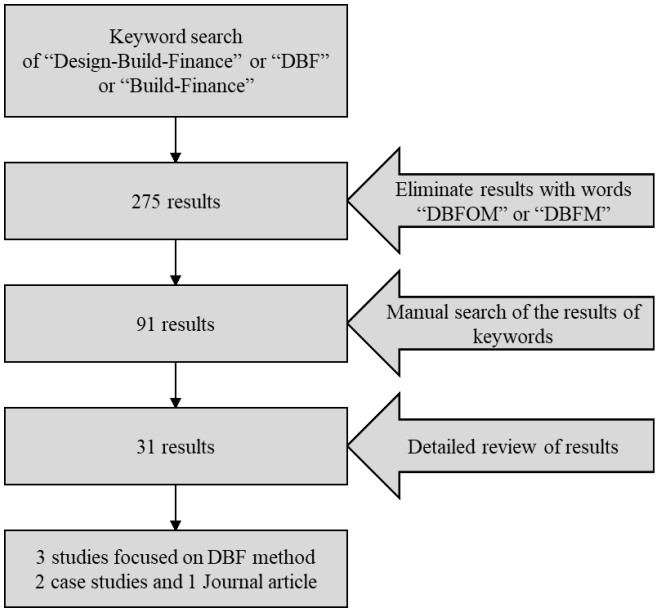

Figure 2: DBF literature search process

Other sources of information include websites and white papers from different DOTs which briefly discuss the possible drivers of DBF (FHWA - Center for Innovative Finance Support n.d.; VDOT n.d.). Although these sources discuss the drivers, these are general perspectives of the agencies, and they do not capture their current decision making process. This indicates a gap in the literature pertaining to DBF, which is gaining prominence. This research addresses this gap by complementing the existing literature through a comprehensive investigation of current DBF programs to ascertain the rationale for its use.

The additional cost of private financing in LCMs is typically justified by the life cycle benefits of these methods. However, in DBF, due to the short-term nature of the financing, the life cycle benefits of LCMs are not obtained. This poses questions about the drivers and motivation of transportation agencies in the US for the use of DBF. The research questions hence are as follows:

- What are the drivers of DBF?
- How are the DBF projects implemented?

1.3 Organization of Thesis

The research investigates the rise of transportation projects in the United States that are implemented using DBF to understand the objectives of the government agencies using this method.

To better present the topic, this document is structured into six sections including the introduction. First section describes the background of project delivery methods and the rise in the use of alternative delivery methods as well as the variants of DBF. The second section explores the drivers for alternative delivery methods like DB and PPPs that the variants of DBF emulate. Through literature review, this section would present the drivers of alternative delivery methods that are relevant to DBF. The second part of the section explores the academic and practice literature of DBF to understand the theoretical drivers of the method. Third section explains the three tier methodology adopted for the research to obtain three different perspectives of different stakeholders involved in a DBF project. Section four discusses the results from the process of interviews and case study preparation including the perspectives of the DOTs, Contractors and Subject Matter experts in using DBF. Based on the results, section 5 presents the recommendations on the use of DBF. Section 6 presents the shortcomings of the current study and areas for further enquiry.

2 Literature Review

Although the literature pertaining to DBF is limited, the drivers for the use of alternative delivery methods are relevant for the use of DBF as well. DBF possesses qualities of DB as well as LMCs. This section is divided into three subsections. The first part of this section explores the some of the drivers for existing alternative delivery methods that are relevant to DBF. The second part delves into the research exploring the use of private finance in infrastructure projects. The final subsection explores the drivers for the use of DBF as per the existing sparse literature on DBF.

2.1 Drivers of Alternative Delivery Methods

The alternative delivery methods have drivers that are common to both Capital Project Delivery methods and Lifecycle Delivery Methods, although the significance of these drivers varies by delivery methods. A summary of the drivers of DB method and LCMs is shown in the *figure 3* below:

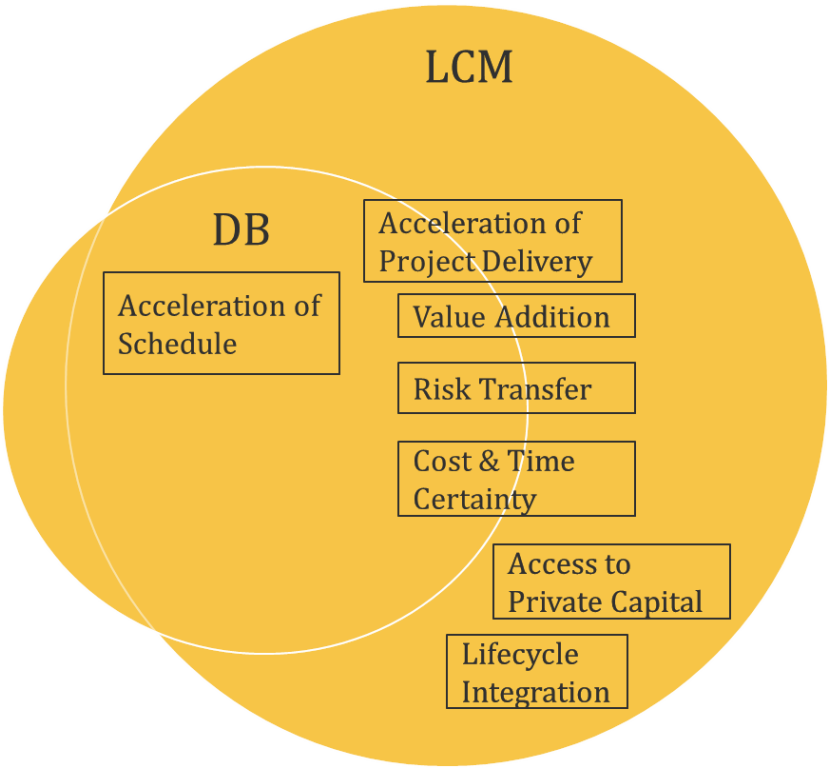

Figure 3: Relevant drivers for Alternative delivery methods

2.1.1 Acceleration of Project Delivery

The scope of alternative delivery methods is usually larger than the traditional DBB projects. Project complexity is a major driver for using alternative delivery methods like DBs and LCMs (Lam et al. 2008; Molenaar and Gransberg 2002). Using Alternative delivery methods, an agency can combine a number of smaller projects of similar nature in the same geographical area into a larger project. For example, consider a project of rehabilitation of a 10 bridges in 3 neighboring counties. In the traditional procurement method using DBB, an Agency has to procure services for designing and building these bridges separately. Using alternative delivery methods, all the separate smaller contracts can be bundled into a single DB or LCM contract. In doing so, an Agency reduces costs through economies of scale and streamlines design and construction process. The larger size of the project attracts bigger developers/contractors resulting in better quality of delivery of the project. Some of the examples of project bundling include $1.1 billion Pennsylvania Rapid Bridge Replacement for 558 structurally deficient bridges, Michigan DOTs $172 million PPP agreement to upgrade and maintain freeway lighting in Metropolitan Detroit, The city of Flagstaff, Arizona's road repair, overlay and safety projects etc. (USDOT FHWA n.d.).

2.1.2 Value Addition

In DBB, the contractor bids on the completed design and specifications. At this point, to incorporate any inputs from the builder, the design has to be changed resulting in resistance to accept any changes by the agency. However, in DB, the bidding takes place on a preliminary design which gives latitude for incorporating builder suggested changes in the final design. To incorporate the private sector innovations into projects, government agencies have also started using Alternate Technical Concepts (ATCs) as a part of the procurement process. Through ATCs, private sector can propose cost/time saving inputs in the final design (FHWA n.d., 2014). An example of ATC in action can be found in the Maryland Intercounty Connector project in which 130 ATCs were submitted by the seven proposers. These ATCs resulted in improving the cost savings of $20 million (Papernik 2009). ATCs are also being used increasingly in other delivery methods like PPPs and CM/GC. Gad et al. (2015) completed a survey of 42 DOTS and a content analysis of 65 ATC projects; their analysis indicated that successful use of ATCs is related to the ability of the agency to safeguard proprietary content and confidentiality. Through

variations of procurement processes, ATCs are incorporated into project delivery methods, especially in DB. This enables the private sector to add value to save public money and improve the quality of infrastructure (Jolley and Garvin 2014; Lam et al. 2008). Output based specifications in PPP contracts encourage the private sector developer to invest in innovation and value addition in the design process to save during the O&M period (Javed et al. 2013; Leiringer 2006; Rangel and Galende 2010).

These studies indicate the involving the private sector early in the project lifecycle increases the possibility of innovation and value addition in the design-process.

2.1.3 Acceleration of Project Schedule

With the integration of design and construction, Alternative delivery projects are known to accelerate the project schedule i.e., projects have an early finish date in comparison to DBB. This is in part because of the ability of the builder to start the preconstruction works prior to the finish of design. Konchar and Sanvido (2002) developed a model built from 328 projects that indicated that DB is at least 33.5% faster than DBB method. DBBs are known to be prone to severe schedule delays during construction. Various other studies from the US and other parts of the world indicate that schedule delay in DB is lower than DBB (Allen Consulting Group and University of Melbourne 2007; Chasey et al. 2012; Minchin et al. 2013; Molenaar et al. 2002; Ramsey and El Asmar 2015). Molenaar and Songer (2002) identified that schedule driven projects are appropriate for a DB since agencies use DB to shorten the project duration (Songer and Molenaar 1996).

2.1.4 Cost and Time Certainty

Alternative delivery methods are argued to provide better delivery of projects in terms of time and budget certainty. Studies from different countries across a range of projects have indicated that alternative delivery methods delivery projects perform better in terms of cost and time certainty. A study of UK PFI projects by the National Audit Office of the UK in 2003 indicated that 76% of PPPs are on completed on time and 78% of the projects are completed within budget, which is significantly higher than traditional projects (Beckett et al. 2009). Similar studies in Australia showed that time overruns during construction for PPPs are in the range of 1.5%-5% while for traditional projects it is in the range of 13-18% (Allen Consulting Group and University of Melbourne 2007; Duffield 2008). Similar results are found in the studies of PPPs in

US and Canada (Chasey et al. 2012; Iacobacci 2010; Ramsey and El Asmar 2015). The rigorous planning and procurement process enables PPPs to ensure cost and time certainty. Budget and Time are identified as a critical factors in a DB selection (Songer and Molenaar 1997).

With the combination of Design and Construction Stages of a project in DB method, a contractor can start the construction of project before the completion of the design process resulting in better time and cost management from the private sector. Gransberg et al., (2000), a study of 21 DBB projects and 11 DB projects, found that DB projects have a cost growth of -1.99% compared to 10.64% for DBB and a schedule growth of -35.7% compared to a 33.5 for DBB. USDOT FHWA, (2006), a study on 11 DBB and 11 DB projects, also showed that DB projects have a schedule growth of -4.2% compared to 4.8% for DBB projects. Other similar studies also showed that DB results in better cost and schedule certainty compared to a DBB method (Konchar and Sanvido 2002; Ramsey and El Asmar 2015; Shrestha et al. 2007; Sullivan et al. 2017)

2.1.5 Risk Allocation

As with every infrastructure project, there are two sources of risks – endogenous and exogenous. There are four general strategies for handling risk – avoid, transfer, share or manage (Nguyen et al. 2018). In using alternative delivery methods, a government agency can transfer or share some of the risks to the private sector through contractual arrangements. However, a cost premium is typically added to the contract value when risks are transferred to the private sector. Hence, while allocating the risks, the party that is better able to manage a risk should be allotted the responsibility(Miller et al. 2000). For example, the private sector can better manage schedule and construction risks. If the private sector is responsible for on time delivery, the builder can sequence the project activities to cover any delays that happen during the construction and still deliver the project on time. Similarly, a government agency is better equipped for right of way acquisition and obtaining permits(Nguyen et al. 2018). An optimal risk allocation will result in lower overall risk adjusted cost to the government. Hence, appropriate risk allocation is a critical success factor for LCMs (Zhang 2005).

2.1.6 Life Cycle Integration

Different stages of the project like design, construction, finance, operations and maintenance are integrated in LCMs. This reduces the interface management risk by a government agency. In

traditional project delivery methods, a government would be responsible for any gaps in communication between designer and contractors, etc. In the case of LCMs, due to integration of project activities, the private sector is responsible for the interface management as the contract specifies the final performance outputs (Liu et al. 2014). Since most LCMs assign O&M responsibilities to the private sector for certain durations, this encourages private sector to invest in value addition during design and construction. This value addition can be in the form of inputs to the project to reduce O&M activities or costs. These features might increase the cost during construction but would result in savings during O&M (FHWA 2016). Through integration, the private sector is incentivized for investing in such activities. Also, since the project budget for O&M activities is established at the start of the project, the condition of the infrastructure remains in a better state for a longer time compared to the government maintenance, which depends on the budget availability(Chan et al. 2009b; Nabers 2017; Wilson and Starler 2008).

2.1.7 Access to Private Capital

LCMs are hailed for their ability to access private capital for building infrastructure, which can overcome balance sheet limitations of government agencies (Nguyen et al. 2018; Price Water House Coopers 2007). With the limited coffers of the government and increasing demand for better infrastructure, the need for alternate forms of financing have become necessary. Through the use of private capital, a government can leverage on the future revenues of the project to pay for the construction. This leads to early construction of facilities and hence result in accessing the social and developmental benefits of acceleration of infrastructure projects. With the use of private capital, the award of these projects are expedited, hence resulting in project acceleration (Bolaños et al. n.d.). Examples of such project acceleration are US 36 express lanes constructed 10-20 years earlier compared to DBB and for the LBJ TEXpress by 19 years compared to DBB (Bolaños et al. n.d.). Through access to private capital, governments can capitalize the projects with revenue generation potential freeing the budget for other projects that are otherwise not feasible.

2.2 Drivers for Private Finance

The use of private finance in infrastructure is driven by different factors for each agency. Ashuri and Mostaan (2015) surveyed 35 state DOT representatives to identify the top ten objectives for the use of private finance in highway projects across DOTs:

1. Developing projects early
2. Expediting the contract award to avoid future cost escalations
3. Developing projects despite funding shortfall in short term or to overcome cash flow constraints
4. Incentivizing project teams for project acceleration
5. Incentivize project teams for on-schedule and on-budget completion
6. Private sector innovations for cost saving
7. Maximize the use of available funds
8. Enhance the agency's image by earlier opening of the projects
9. Decrease project lifecycle costs
10. Early award of the contract to utilize State and Federal funds

These objectives are further confirmed by additional studies examining various topics as illustrated in *Table 1*.

Table 1: Supporting literature for the drivers of private finance

Category	Relevant literature
The use of private finance in PPPs	(Akintoye et al. 2003; Chan et al. 2009a; Demirag et al. 2011; Engel et al. 2010; Fay et al. 2018; Price Water House Coopers 2007; Rao 2018; Vecchi et al. 2017; Vega 1997)
PPP success factors	(Osei-Kyei et al. 2017; Osei-Kyei and Chan 2015, 2017a; b; Warsen et al. 2018)
PPP risk allocation	(Brogaard 2018; Ke et al. 2011; Mostaan and Ashuri 2016; Ng and Loosemore 2007; Nguyen et al. 2018; Ortiz and Buxbaum 2008; Verweij et al. 2017)

2.3 Potential Drivers of DBF

This subsection examines the drivers of DBF as suggested by the limited existing literature. Drivers of DBF identified are as follows:

2.3.1 Advancing Priority Projects

Using DBF, an Agency can expedite the delivery of projects in their program schedule. For example, if a project's funds are programmed in the Years five and six of an Agency's Six Year

Improvement Plan, the agency cannot start the project until year 6 when all the funds are accumulated (Office of Public-Private Partnerships - VDOT 2015).

2.3.2 Flexibility of Payments/Deferring payments

In the case where project funds are programmed for later years in the construction, a DBF contract provides with the short-term gap financing to undertake the project. This provides the agency with flexibility to defer payments to the contractor and undertake more projects with limited budget (FHWA - Center for Innovative Finance Support n.d.). Since these payments can be classified as deferred payments and debt, an Agency can undertake these projects without statutory constraints on State's Debt cap.

2.3.3 Additional Risk Transfer

In DBF, the risk of financing is transferred to the contractor in addition to the DB risks. The contractor bears the risks associated with the financing of the project including repayment, fluctuation of interest rates and other market conditions. This transfer of the risk would lead to additional premium in terms of time and cost to the project (FHWA - Center for Innovative Finance Support n.d.; Office of Public-Private Partnerships - VDOT 2015). DBF allows for the Agency to access different private sector financing options through this method.

2.3.4 Reduction of Project Capital & Lifecycle costs

DBF can reduce the overall costs of the project by reduction in the escalation of project's capital costs and O&M costs due to inflation. By expediting the projects, DBF reduces the capital cost of the project in comparison to the construction of the project a few years later (Office of Public-Private Partnerships - VDOT 2015).

2.3.5 Improvement in Quality of construction

In a DBF project, due to the inclusion of the financing component, an Agency has leverage over the contractor due to deferred payments in case of the construction doesn't meet the specifications (Office of Public-Private Partnerships - VDOT 2015). Since an Agency will be paying the contractor years after the completion of the project, a contractor would ensure that the quality of the construction meets the contractual requirements.

2.3.6 Social & Economic Benefits

By expediting critical projects, public starts receiving benefits from the projects early in terms of social benefits like improved quality of life, environmental benefits, reduced travel times and travel time reliability. Economic benefits include improved business opportunities, job creation opportunities and safety improvements (Office of Public-Private Partnerships - VDOT 2015).

2.4 Point of Departure

The existing literature on alternative delivery methods suggests that the additional cost of the use private financing is complemented by the lifecycle benefits obtained during the O&M phases. However, in a DBF the responsibility of the contractor after the completion of the construction is limited to financing. This poses the question of why agencies use DBF and how are the current projects being implemented. This research addresses these questions and adds to the limited existing research on DBF.

3 Methodology

To understand the use of DBF by Agencies, the research methodology was divided into a two pronged approach to examine agency DBF programs and to obtain a more general market perspective of DBF delivery. A case study approach was adopted where the unit of analysis is the state DBF programs and sub-units are completed or on-going DBF projects. The cases were supplemented by interviews with subject matter experts (SMEs) to provide a broader perspective of DBF selection and implementation. A summary of the methodology of this research is shown in the *Figure 4*.

The research is investigating a contemporary phenomenon – the rise in the use of DBF. Consequently, very little information exists about DBF, even though existing literature has explored why project delivery approaches such as DB and LCMs are used. Hence, the research design adopted provides direct observation and ground truth information about DBF implementation through examination of DBF programs in the US as well as interviews with agency personnel involved in these programs and SMEs familiar with this sector and market.

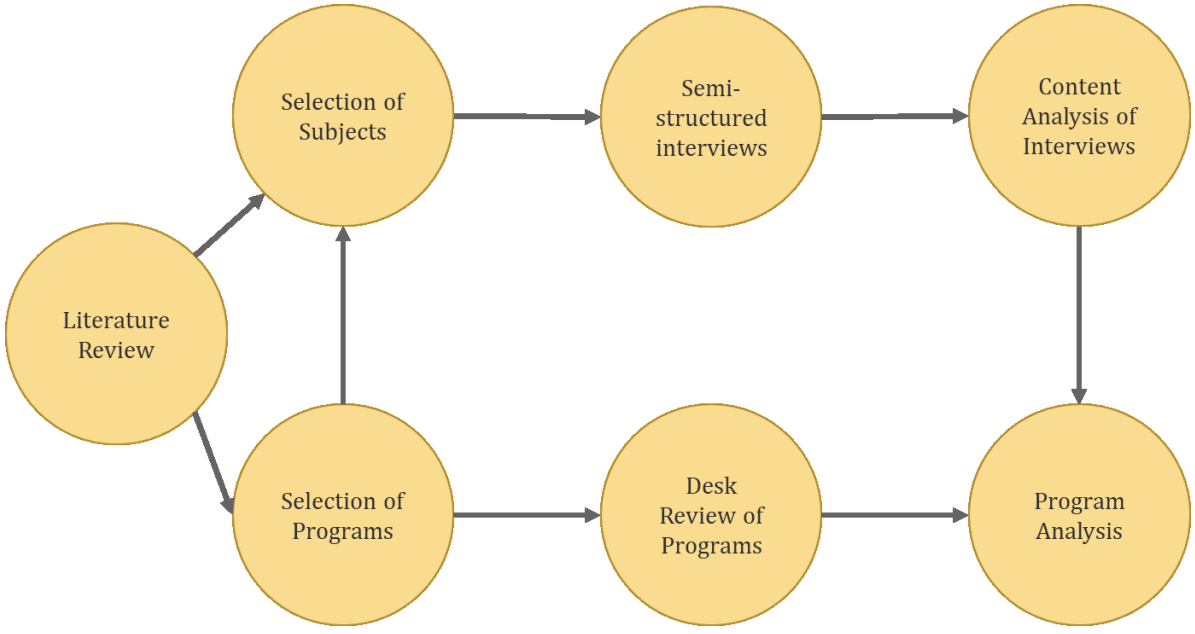

Figure 4: Methodology adopted

3.1 Selection of Programs

By using data on DBF projects from FHWA and Ramsey et. al (2016), five states were identified for analysis. Through a review of completed and ongoing DBF projects in these states, interview subjects were selected and project briefs were prepared. Projects in the selected states are presented in the *table 2*.

Table 2: Summary of projects in the States selected

Location	#	Project	Duration	Cost (millions)
Florida	A	I-395/SR 83611/I-95 Interchange	2017-2022	$ 802
	B	SR 826 / SR 836 Interchange	2009-2016	$ 567.5
	C	I-4/Lee Roy Selmon Expressway Connector Interchange (BF)	2009-2014	$402.5
	D	I-75 Roadway Expansion (iROX)	2007-2010	$458
North Carolina	E	I-485 Charlotte Outer Loop	2011-2015	$139.5
Georgia	F	I-285/SR 400 Improvements	2016-2020	$ 800
	G	Northwest Corridor project	2013-2018	$ 833.7
Michigan	H	M-21 over I-75 Bridge Replacement and State Police Post Demolition Project	2008	$ 7.4
	I	Road rehabilitation and bridge reconstruction on I-69	2008	$ 35.35
Texas	J	Midtown Express	2014- 2018	$1,415.1

3.2 Interview Subject Selection

Infrastructure programs or projects are complex spanning over a period of time with multiple stakeholders involved in the process. Each of these stakeholders have varying agendas which, in

some cases, might be opposing to others. For example, a contractor would want to schedule a project in such a way that their expenses on the project are minimal while an agency might want some part of the project to be built earlier. To understand different perspectives of these stakeholders, the research was structure to acquire two perspectives:

a. Agency Perspective: This category of interviews include DOT personnel at Program level and project personnel involved in DBF projects. Through these interviews, the research understood the drivers of DBF by an agency and the differences in the implementation of DBF project compared to DB and LCM projects.
b. Market Perspective: This category of interviews targeted the general perspectives from subject matter experts and project level perspectives from developers/contractors. These perspectives complement the State Perspectives in understanding the benefits and challenges in using DBF.

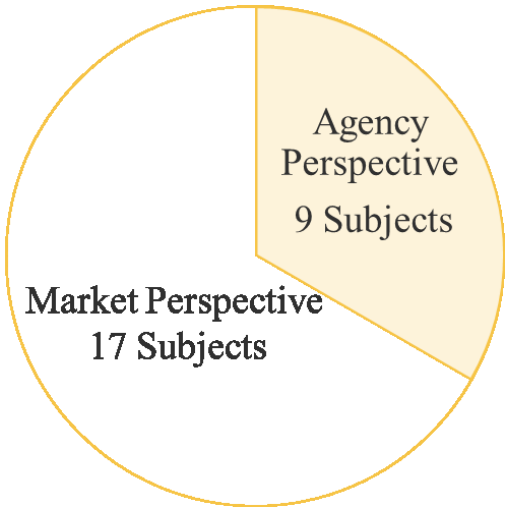

Figure 5: Category of subjects

Through these interviews, this research aimed at providing perspectives at three levels namely General perspectives by Subject Matter Experts (SMEs), DOT program level perspectives by DOT personnel and Project perspectives by DOT project personnel and Contractors. The *table 3* summarizes the experience of interviews and their current positions. *Figure 6* depicts the levels of perspectives obtained from different interviewees.

Table 3: Summary of Interview Subjects

Category	Position Summary	Average Experience (Range)
Subject Matter Experts	Infrastructure Advisors, Leaders & Senior Management in development companies, Legal advisors etc.	27 Years (7 – 40 Years)
DOT Personnel	Public Sector Leaders, Public Sector Senior Management, Project Managers	23 Years (13-40 Years)
Contractors	Senior Management	15 Years (13-17 Years)

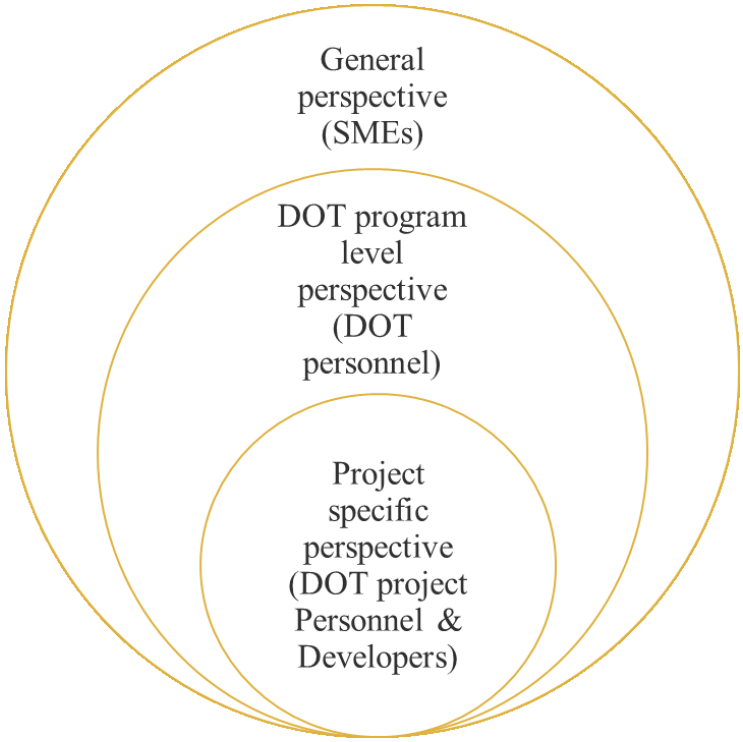

Figure 6: Levels of perspectives obtained

3.3 Desk Review of Programs

A search was conducted to identify publicly available information on the DBF programs of the states and the projects like Project RFPs, Contracts, News Articles, Presentations, project websites and blogs. This data is used into preparing project briefs which were used in

understanding the past and current DBF project structures used by selected states as a part of the program analysis. The project briefs prepared using this information and complemented by semi-structured interviews are presented in *Appendix B.* A summary of the project briefs is presented in the *table 4* below: These project cases are presented in Appendix – II.

Table 4: Summary of project briefs

State	#	Project	Location	Duration	Cost	Contractor	Financial Structure
FL	B1	I-395/SR 83611/I-95 Interchange	Miami, Florida	2017-2022	$ 802 Millions	Archer Western-de Moya (AW-dMG) - Design-Build Joint Venture	• Schedule of Payments released during procurement • Contractor finances the difference in costs and funds available each quarter
	B2	SR 826 / SR 836 Interchange	Miami, Florida	2009-2016	$ 567.5 Millions	Community Asphalt Corporation / Condotte America, Inc. / The de Moya Group, Inc. - Design-Build Joint Venture	• Schedule of Payments released during procurement • Contractor finances the difference in costs and funds available each quarter
	B3	I-4/Lee Roy Selmon Expressway Connector Interchange (BF)	Tampa, Florida	2009-2014	$402.5 Millions	PCL/Archer Western - Joint venture of PCL Civil Constructors Inc. and Archer Western Contractors	• Schedule of Payments released during procurement • Contractor finances the difference in costs and funds available each quarter
	B4	I-75 Roadway Expansion (iROX)	Collier & Lees Counties, Florida	2007-2010	$458 Millions	ACCI/API - Joint venture of Anderson Columbia Co. and Ajax Paving Industries	• Schedule of Payments released during procurement • Contractor finances the difference in costs and funds available each quarter

State	#	Project	Location	Duration	Cost	Contractor	Financial Structure
NC	B5	I-485 Charlotte Outer Loop	Charlotte, North Carolina	2011-2015	$139.5 Millions	Blythe Construction Inc./Wilbur Smith Associates (now CDM Smith)	• Schedule of Payments released during procurement • Contractor finances the difference in costs and funds available each quarter
GA	B6	I-285/SR 400 Improvements	Fulton & DeKalb Counties, Georgia	2016-2020	$ 800 Millions	North Perimeter Contractors, a Joint Venture of Ferrovial Agroman, The Louis Berger Group and Neel-Shaffer Inc.	• Redeemable project certificates issued to contractor for completed activities
	B7	Northwest Corridor project	Atlanta, Georgia	2013-2018	$ 833.7	Northwest Express Roadbuilders, a consortium comprising of Archer Western Contractors, The Hubbard Group and Parsons Corporation	• Contractor financed 10% of the each of the invoice • Agency pays the financed amount over a span of 5 years after completion
MI	n/a	M-21 over I-75 Bridge Replacement	Genesee County, Michigan	2008	$ 7.4	Data not available	• Balloon Payment upon substantial completion for part of the project

State	#	Project	Location	Duration	Cost	Contractor	Financial Structure
		and State Police Post Demolition Project					• Rest of the project cost paid in fixed quarterly payments thereafter
	n/a	Road rehabilitation and bridge reconstruction on I-69	Michigan	2008	$ 35.35	Data not available	• Balloon Payment upon substantial completion for part of the project • Rest of the project cost paid in fixed quarterly payments thereafter
TX	B8	Midtown Express	Dallas – Fort worth, Texas	2014-2018	$1,415.1	Southgate Mobility Partners consisting of Kiewit Development Company, Kiewit Infrastructure South Co	No private financing used

3.4 Semi-Structured Interviews

To better understand the perspectives of the interview subjects, the interviews are designed as semi-structured interviews to provide the investigator and subject leeway to further discuss details that arise during the interview. The interview questionnaire and other required documents are prepared confirming to the rules of Institutional Research Board (IRB) for Human Research Protection Program. A Research Protocol was prepared and submitted to IRB for approval. The questionnaire for each of the categories of the subjects is presented in *Appendix A*. Adhering to the guidelines suggested by IRB for this research (*IRB-19-814*), these interviews were recorded using call recording software (Google Voice or Zoom) and transcribed for further analysis. A copy of the approval letter from IRB is presented in *Appendix C.*

3.5 Content Analysis

The interviews of subjects selected are recorded and transcribed into word documents. An alpha-numeric system is used to anonymize any identifying details of the interviewees and the key for decryption is stored in a separate password protected file. A qualitative analysis is performed on these transcripts using coding methods described in Saldaña (2013). The transcripts are analyzed over multiple rounds to identify relevant quotes and phrases describing the drivers of DBF as well as the considerations in implementation of DBF projects. The coding methods used in content analysis are as follows:

- Initial coding: Identify essential information from data
- Structural coding: Categorize the data into segments by similarities, differences, relationships

For example, consider the following quote from one of the interviews conducted:

> *In our experience in Florida, it can move projects up 5 years and you can have a project finished before you can even start construction (as per schedule). It allows for low cost of capital. Bank terms are favorable. They trust the DOTs to payback. I think it has been able to expedite a lot of contracts. I think we have got 3 or 4 projects in Florida that have been mega projects, without DBF method, never would have happened or would have been delayed by 3-5 years.*

This quote includes information on different aspects of the research like the drivers and implementation details of a DBF project. In the initial stages of coding, quotes are

categorized into the basic themes of ‘drivers’ and ‘implementation’. These quotes are further analyzed to develop sub-themes in each of the categories. For example, the quote “it can move projects up 5 years and you can have a project finished before you can even start construction (as per schedule)” is categorized into the “drivers” theme in the initial stages of coding and then assigned to the sub-theme of “project acceleration” in the drivers theme in the subsequent stages of analysis.

4 Results

4.1 Variants of DBF

DBF is characterized rather simply in the existing literature. However, the research uncovered variants of DBF that significantly differ in a project's drivers and risk profile.

The first variant is referred to as the DBF – Receivables method (DBF–Rec), where the contractor does not carry completion risk. In this variant of DBF, the contractor receives progress payments periodically for work completed as per agreed terms. The contractor finances the difference between the cost accrued and funds available from the agency for that payment period. The agency then typically repays the contractor the difference no more than ten years after the completion of the project. In this variant, the contractor is entitled to progress payments even if the project is not complete. For example, if the Agency has accepted 50% of the work as completed, the contractor is entitled to the payments for the completed tasks, even if the project is not completed for any reason. In the US, this variant is widely used by the DOTs to expedite projects. Since the risk transferred to the contractor is minimal in this case, financial close involves less cost and time.

The second variant of DBF is called the DBF – Risk transfer method (DBF-Risk). In this method, the contractor receives payments after the completion of the project or when set targets are met. Even if part of the work is accepted by the agency, the contractor is not entitled to compensation until completion of the project or a fixed milestone. For example, in a project using DBF-Risk, the contract terms might indicate that the contractor is entitled to payment for completion of the initial 20% of the project only after the completion of 50% of the project. If, for instance, the contractor only completes 40% of the agreed project activities due to any reasons, they are not entitled to the payments for completing 20% of the project or for any subsequent payments corresponding to completing 40% of the project. This variant results in more risk transfer to the contractor and hence financier. Consequently, the cost of private financing in this variant might be more than the cost of financing in the receivables variant. This variant of DBF was used by Michigan DOT and in transportation and healthcare projects in Canada (S11, S12A, S12B). *Figure 7* illustrates the variants of DBF on the spectrum of project delivery methods.

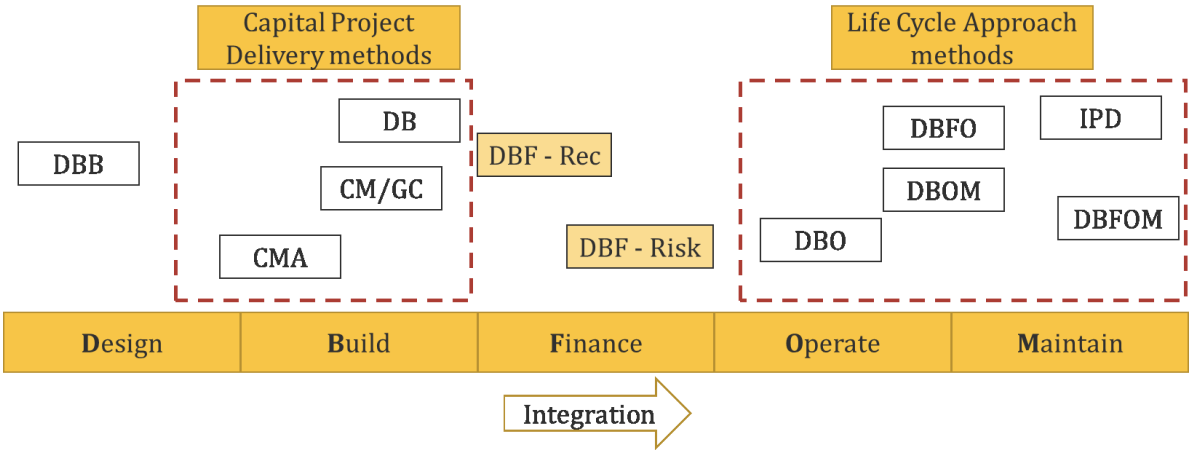

Figure 7: Variants of DBF

4.2 Agency DBF Programs

4.2.1 Common Factors for Selecting DBF

Interviews with agency personnel indicated that DBF is one of the methods available in the toolset for an Agency to get accelerate a project timeline. As noted by a DOT representative "*If we have a district that need to get a piece done faster, or if we need to advance it if it is a high priority, we use DBF*" (D05A). Once the need for accelerating the project is identified, and funds required for the project are not available at the time of procurement, DBF method is considered. As noted by another DOT representative "*You actually have to have the project in our work program and funded in other years. You are just moving the project up…These projects, typically, are funded but funded 6-7 years out. If we don't have a project funded at all (in work program), we look at different solutions*" (D05B). Other sources of financing mechanisms that are considered as alternatives to DBF include Grant Anticipation Revenue Vehicles (GARVEEs), Transportation Infrastructure Finance and Innovation Act (TIFIA) loans, Private Activity Bond (PAB) allocation and State Infrastructure Bank Loans.

Apart from the need to accelerate a project with a short-term funding gap, DOTs consider the following factors in the decision making process:

- Project Size
- Innovation in the project
- Workforce availability for project
- Number of projects in the region at a given time
- Debt Cap requirements of the State

4.2.2 Additional Considerations of Agencies for DBF selection

Another aspect of a DBF is that there is a significant increase in "administration" from the agency in terms of procurement than a DB and in design review process compared to a PPP. The finance team of an Agency needs to be "involved longer" in a DBF to evaluate: (1) "extra language in the project documents" (D04, D05A, D05B), (2) the financing proposal and (3) the financials of the bidders to ensure that they satisfy the procurement requirements compared to a DB. This results in a longer DBF procurement duration compared to DB. In addition, the Agency seeks an active role in reviewing designs of the contractor compared to a PPP due to O&M considerations in a DBF as by a DOT representative "…*that they are going to have to collaborate with us more than in a normal PPP, because we will be going to get it back and have to maintain it. So, on DBF, we take a more active role in looking and reviewing their designs…*" Another perspective is that the inclusion of private financing allows for better schedule outcomes due to the interest of lenders in a DBF. As stated by a DOT representative "*The financial parties that are involved have an interest in the schedule adherence of the project. In regular DB, it's strictly be in the purview of the owner*" (D04). Finally, the representatives of the agencies interviewed did not see improvement in quality of construction as a factor in considering DBF. Agencies believe that best quality is expected independent of the project delivery method used (D04, P01A, P01B, P02, P03).

4.2.3 DBF Programs of Different States

Different structures of DBF are used by different states in the US. This section examines the variations in the use of DBF by each state. *Table 5* summarizes the variant and characteristics of DBF employed in Florida, North Carolina, Georgia, Michigan and Texas.

Table 5: State wise adaptation of DBF variants

State	DBF Variant and Characteristics
Florida	• DBF – Receivable • Partial private financing • Schedule of payments
North Carolina	• DBF – Receivable • Partial private financing • Schedule of payments
Georgia	• DBF – Receivable • Certificate issuance for project tasks
Michigan	• DBF – Risk Transfer • Balloon payment at substantial completion covering partial costs • Fixed payments thereafter
Texas[1]	• DBF – Receivable • Partial financing

4.2.3.1 Florida

Florida DOT has considerable experience in the use of DBF with over 5 projects in the past decade. The projects include

- I-395/SR83611/I-95 Interchange reconstruction project, 2017-2022, with a total project cost of $ 802 million
- SR 826/SR 836 Interchange reconstruction project, 2009-2016, with a total project cost of $567.5 million
- I-4/Lee Roy Selmon Expressway Connector Interchange project, 2009-2014, with a total project cost of $ 402.5 million
- I-75 Roadway Expansion (iROX) project, 2007-2010, with a total project cost of $458 million

The DBF projects in Florida used receivables structure of payments. FDOT issues a Schedule of Payments or "payout curve" (P01A, P01B) indicating how much funds are available each quarter during the letting of the project. The contractor submits an invoice for the amount of

[1] Texas did not use the DBF as funds required for the project became available after the procurement

construction completed; however, the agency only releases the amount of funds available. The contractor finances the balance until the funds are available. For example, consider the I-395/SR83611/I-95 Interchange reconstruction project in Miami. For the October – December Quarter of 2020, the funds available for the I-395 reconstruction part of the project, as shown in *Table 9* of Appendix B1, are $35 million. If the construction costs for the I-395 reconstruction part of the project in that quarter are $40 million, then contractor will only receive $35 million for that quarter as payment. The contractor will have to finance the $5 million until FDOT has the funds available in subsequent quarters. Consider the following quote by an FDOT representative explaining this process:

> *If you have a $10 million job today and you are going to have $10 million 2-3 years from now, they are going to have to wait for it (the payments in a DBF) and those funds are going to come as per the program. Just because the work is complete today doesn't mean you (contractor) are getting the total money (today)*

So the agency would model how the funds are paid out based on availability into a "cash availability schedule" or "pay out curve" or "schedule of payments".

At a program level, FDOT uses DBF to primarily alter the project timeline. DBF is one of the methods available for the agency to accelerate a project. In a DB or DBB procurement, the legislation stipulates that FDOT have all the funds necessary "upfront" or "in the bank" (P01A, P01B) before letting a project. If a project were to take 3 years to complete and if the agency programmed the funds for the project in 3 years hence, in a DB or DBB procurement, the project cannot be procured until the end of the 3rd year. By using DBF, FDOT can procure the project in the first year by issuing a schedule of payments without having to marshal all the funds. By accelerating the project timeline, FDOT reduces the capital costs of projects, which would be escalated in the future for inflation. An FDOT representative commented, "*Your costs are lower today than a year or two from now when all the funds are available*." Other common factors considered in a DBF selection used by FDOT are discussed in sections 4.2.1 and 4.2.2. Project briefs used to evaluate FDOT's DBF program are included in Appendix B1-B4.

4.2.3.2 North Carolina

The structure of DBF-Receivables method used by NCDOT is similar to FDOT. NCDOT implemented I-485 Charlotte Outer Loop project of cost $139.5 million during 2011 to 2015 using DBF. NCDOT releases a schedule of payments during the procurement stage indicating

the availability of funds over a period of time. For example, every quarter, the contractor would submit an invoice for the amount of the work completed. NCDOT, however, would release the amount of the invoice to the extent the funds are available as indicated in the Schedule of Payments during the procurement. The contractor would finance the difference between the invoice amount and the funds available until the funds become available. If there are additional funds available in any quarter, the funds would roll over to the funds available for next quarter. NCDOT used DBF on a critical project when all the necessary funds for the project could not be obtained at the start of the project. However, in NCDOT's only DBF project, the agency was able to achieve savings through competitive procurement where the final bid price was lower than the department's estimate resulting in reduction of the need for private financing significantly (S09). NCDOT's plans to use DBF for future projects are unclear as the Agency did not respond to any requests for information and interviews. The project brief of project in North Carolina project can be found in Appendix B5

4.2.3.3 Georgia

GDOT has completed one DBF project and has another ongoing DBF project. GDOT has used the DBF-Receivables variant. The financial structure of both the projects differ in terms of amount of financing and the financing structure. In the completed project, the North West Corridor (NWC) project, 10% of the project's overall value was financed through contractor financing. The agency retained part of each invoice amount so that the payments withheld until one year prior to substantial completion matched the agreed amount of private financing. As noted by a GDOT representative "*... (contractor) had to have (used) 10% of that money (10% of project cost or total financing) prior to substantial completion of the project*" (P03). GDOT then would make payments to the contractor post completion.

The recently procured DBF project, Transform 285/400, differs in the financial structure and payment structure. In the Transform 285/400 project, GDOT would issue "certificates" for the amount of work completed, which would be paid based on the available funds. The contractor can pledge the certificates to lenders who would pay the contractor then and receive payments from GDOT later. The contractor acquired a commercial loan and would pledge the certificates based on the "project company's cash flows". Based on the observations, it can be noted that GDOT is adapting its use of DBF to match its cash flow. GDOT has 4 projects in the immediate pipeline, possibly using DBF and the financial structure of these projects should be observed for further study.

Apart from the common factors discussed in Sections 4.2.1 and 4.2.2, GDOT considers DBF for projects over $ 300 million. As noted by a GDOT representative "*we do DB for projects up to $300 million all the time. Normally for DBF, we consider it at $300 million but definitely move into it as a selection category at about $500 million in the mega project range".* For GDOT to use a DBF project, it should also fit in with its program of DB and PPPs in terms of budget. Case studies for the two projects of GDOT can be found in Appendix B6-B7.

4.2.3.4 Michigan

MDOT used DBF for two projects in 2008. First was a bridge replacement project titled 'M-21 (Corunna Road) over I-75 (S02 of 25032) Bridge Replacement and State Police Post Demolition in Genesee County' with the final bid price of $7.4 million. The second project was a road rehabilitation and bridge reconstruction project on I-69, from Lapeer Co. Line to Miller Road with a final bid price of $35.35 million. MDOT has not done any new projects since then. The payment structure for these projects partially transfers the completion risk of the project to the contractor. In these projects, the contractor receives the first payment upon substantial completion and a quarterly payment of a fixed fee until the final acceptance of the project. Upon final acceptance, MDOT pays the contractor the balance value of the total contract price less any deductions. Project briefs for these projects were not prepared due to the unavailability of data.

As noted by MDOT representative, for MDOT to consider DBF for a project,

> *It would be in a scenario in which the project is critically important and we identified a gap in funding/financing and related to cost/benefit analysis or evaluation of a business case….when a business case can be made that the improvements would provide a greater benefit than the disadvantages including an increased cost in capital and the limited field of bidders that would qualify.*

4.2.3.5 Texas

TxDOT has procured Midtown Express (SH183 Managed lanes) project using DBF+O&M method. In the initial structure of the project, the contractor would receive monthly payments based on the "prosecution of work defined by a cost-loaded schedule" (PBS-3) for part of the construction costs while the contractor finances the rest of the construction cost. The contractor would be issued with certificates for the amounts earned, which would be paid in annual payments starting one year from substantial completion until all the certificates had

been paid with a total repayment period of no more than 5 years using TxDOT's funds. However, during the construction period, additional public funds became available and TxDOT elected to remove the private financing element before it was drawn, essentially converting the project to a DB during construction. TxDOT representatives indicated that it cannot pursue any further DBF projects due to statutory limitations.

4.3 Market Perspective

To complement the opinions of DOTs and project personnel in the use of DBF, due to their perceived vested interest in expediting critical projects, this research interviewed Subject Matter Experts and Contractors. The following sub-sections presents their perspectives.

4.3.1 Subject Matter Experts

The major drivers of a DBF identified by SMEs are: (i) acceleration of project schedule, (ii) improving an Agency's budgetary flexibility, (iii) increased due-diligence, (iv) completing critical projects, and (v) social and economic benefits of delivering the projects early. The views of the SMEs are illustrated by these representative quotes:

> *The cases where the projects warrant modest additional cost, when the project allocations are spread out across number of years and when the public benefits by developing the project earlier and/or when the economic environment may make it worthwhile to do short term financing to deliver the project sooner. When those circumstances are aligned, then the DBF method can be appropriate.*

> *I think it is appropriate when they don't have all the money and there is an urgent need for project delivery and they have a way to pay that gap back.*

> *… (DBF) has its place in the toolbox for different agencies to get the projects forward. It is a means by which an agency when it doesn't have all the necessary funds, can get the project done.*

A strong majority of the SMEs consider DBF similar to DB even though the enabling legislation bundles them with PPPs. It is described as a DB with a private sector financing component added to it (D02, P02, S04, S05). Apart from the financing side, DBF projects do not differ from DB projects. Additional benefits of quality, innovation, schedule adherence,

etc. are not achieved through the use as DBF compared to a DB as the DBF projects are similar to DB in terms of implementation. A quote from an SME on quality is as follows "*To me, quality is defined by the contractual requirements. So, I don't know if there is an incentive in having the financing in there.*" However, in comparison to a DBB, a DBF project achieves better innovation/value addition and cost and schedule adherence during the implementation of the project. An SME noted that, "*the best comparison of DBF is not with DB but not doing anything. If somebody could do DB, they wouldn't be doing DBF*" (S11). This is because if the Agency has the budgetary resources available to carry out a project as a DB, it would not consider using DBF. An Agency uses DBF is when there is no budgetary flexibility to use any of the other methods on projects that need to be accelerated. So, in an ideal comparison, the project is delayed until the funds are available. Hence, the social and economic benefits of expediting a project should be compared to additional cost of using private finance in DBF.

Some SMEs indicated that it would be advantageous to use an LCM/PPP method instead of a DBF for these projects as the LCM/PPP methods consider the lifecycle costs, which can compensate for the additional costs of private financing where O&M is possible (S04, S06). As noted by an SME "*DBF doesn't have that inherent value that you can achieve from DBFM and DBFOM models. And the reason is the finances are only in place up to 5 years and doesn't allow transfer of significant O&M, lifecycle risks to the contractor.*" (S06). As noted by another SME "*The total term of a DBF is maybe 10 years (construction + financing)… O&M risks and warranty risks cannot be fully realized in the DBF method (because of the short term).*" (S08).

Another SME indicated that agencies use DBF when transfer of O&M responsibilities is nor preferred. The reasons for this could vary. Some of the reasons are existing O&M contracts, size of the projects leading to infeasible business case, minimal requirements for Operations or Maintenance, Agency's current capabilities to better manage O&M. An example by the SME illustrates this, "*Sometimes the agencies don't like to lose control over the O&M of facility. Sometimes it's not efficient. For example, if you have managed lanes in between general purpose lanes, is it efficient to have two operators?*" (S02). Another example would be the construction of a metro transit station as a part of network. It would be inefficient to have multiple tariffs to the users for using that station, if developed using DBFOM method. In cases like these, where transferring O&M responsibilities is not feasible/ not preferred and the department is short on funds to carry out a critical project, DBF can be used.

Some SMEs also indicated that the addition of private financing increases due diligence from the lenders (S04, S05, S07, S10). However, other SMEs as well as contractors indicated that the due-diligence benefits for the projects are not obtained in the current DBF projects in the US as they use DBF – Rec method (S01, S11, S12A, S12B, C01, C03). As noted by an SME "*The due diligence will not be on the construction if it is a receivables based financing. If you have it conditioned on completion or on progress, there will be more.*" The lenders do not perform due-diligence in terms of constructability reviews, etc. for such projects. However, additional due-diligence is performed on the contractor's finances before the project, which acts as a proxy of the ability of the contractor to complete the project without any financial trouble.

4.3.2 Contractors

While only a limited number of contractor representatives were interviewed, these representatives indicated that DBF projects with partial financing are favorable to the use of DBF while the projects with significant financing does not attract the contractors. In the projects with partial financing requirements, the additional risk transfer to the contractor is minimal as the financiers only evaluate the credit worthiness of the contractors and the implementing agency. This results in the "low cost of capital" for these projects as the financiers trust that "DOTs will pay back." The majority of the projects in the US use DBF-Rec variant. When this variant is used, the additional risk transfer to the contractor is minimal compared to a DB.

In the implementation of DBF project compared to a DB, the contractors did not find any significant changes in the construction apart from additional documentation and management of the financial aspects of the project. The quality of delivery, schedule and innovations in the design process does not vary from the DB process in the receivables structure as the contractor expects the project standards to be the same irrespective of the project delivery method (C01, C02, C03). A minor difference in a DBF project scheduling is observed where sequencing project activities reduces financing carried by the contractor, if that does not affect the final delivery of the project (C02). But this is not a significant difference and the developers would not change the sequence of activities if it impacts the project schedule. For example, in an intersection reconstruction project, assume the collector lanes are scheduled to be constructed at the start of the project in a DB schedule. In a DBF project, if the developer reduces the financing carried by constructing the lanes at the end of the project and not

impact the overall schedule of the project, the developer might choose to change the sequence of project activities.

Based on the interviews with the contractors, it is also observed that the smaller DBF projects with partial financing attract traditional DB contractors while the larger DBF projects with significant financing requirements attract traditional PPP developers. This difference plays a key role in the explanation of differences in expectations. In smaller projects, the contractors are accustomed to the inputs or involvement of agency in the design process as the O&M responsibilities after the construction lie with the agency. In contrast, on larger projects where the PPP developers participate, the developers are used to the autonomy of PPP projects as the O&M responsibilities lie with the developer for a longer period. In a DBF project, however, the agency is responsible for the O&M immediately after construction. This leads to mismatched expectations resulting in friction between contractor and Agency.

Interviews with the contractors suggested that the returns for the DB contractors performing DBF projects on smaller projects are better compares to a larger contractor with a significant portion of the project financed. This is because of the cost and effort required to obtain financing for these projects. As mentioned, due to the risk profile of the projects, smaller projects receive no or minimal due diligence and hence lower cost of borrowing. In larger projects, the additional cost and effort of the due-diligence by the financiers resulting in higher cost of capital reducing the returns for PPP developers.

5 Discussion and Recommendations

Based on the case studies and interviews with SMEs, DOT personnel, Project Personnel and Contractors, following are the drivers and challenges in the implementation of DBF.

5.1 Drivers

5.1.1 Acceleration of Project Delivery

In using DBF, an agency can alter the timeline of the project to deliver it earlier. In some cases, multiple smaller projects can be combined to form a larger project that can be delivered by a single contractor and gaining economies of scale. By bundling the smaller projects, the Agency eliminates multiple mobilization payments for each individual project. An instance of bundling was observed in the I-395/SR 83611/I-95 interchange reconstruction project. The smaller projects of (i) SR 836 Improvements ($186 million), (ii) SR 836 Westbound Connector ($35 million) and (iii) I-95 Pavement Reconstruction ($25 million) are bundled with the I-395 Reconstruction project ($556 million) into a single DBF contract. While the objective for accelerating a project might differ, the acceleration of the project delivery is the primary driver of the use of DBF.

5.1.2 Social and Economic Benefits

Another major driver for using DBF by the Agency is the criticality of a project. For an Agency to consider using DBF for a project, it should be a high priority project. Through DBF, an Agency can deliver high priority projects that are critical to the region like an evacuation route or redevelopment of a congested intersection earlier compared to DB or DBB methods. The time value of the benefits received by completing the projects early through the use of DBF for accelerating the project delivery should outweigh the additional costs of using DBF. Examples of some of the tangible benefits include time saved by reduction of congestion, reduction in vehicle maintenance, etc. Intangible include the environmental benefits like reduction in air, sound and light pollution, improvement in the wellbeing of the citizens etc.

5.1.3 Project Budget Flexibility

Although the existing literature suggests that budgetary flexibility provided by DBF through deferred payment is the primary reason for the use of the method, this research did not find this necessarily to be the case. In states like Florida, DBF payments are considered as a part

of the State's debt cap. This eliminates the benefits offered by DBF as a tool to overcome the debt cap for some states. However, in states like Georgia, DBF payments are not considered as a part of the State's debt cap. In the Transform 285/400 project with total cost for construction of $453 million, GDOT issued certificates for completion of project activities, so the payments for these certificates are not counted towards the state's debt cap.

While not all states utilize the benefit of DBF to overcome the debt cap, all of them use DBF as one of the tools to identify funds for accelerating a project. State legislation typically dictates that all of the necessary funds for a project are available in the letting/procurement stage. As discussed in the example in section 4, if a project takes three years to complete and funds for the project are available over three year period, an Agency cannot start the procurement until the end of three years when all the funds are accumulated. This restricts the ability of an Agency to complete projects that are critical to a region. DBF provides an Agency the ability to adjust the budgetary funding allocation for a project to overcome these restrictions.

5.1.4 Capital Programming Flexibility

The budgetary flexibility that DBF can provide to a specific project also translates into programmatic flexibility for an Agency. As stated previously, delivery via DBB or DB typically requires that the necessary funds are available. Since budgetary funds are finite, this limits the number of projects an Agency can deliver in a capital program; consequently, some projects may be deferred. However, DBF allows an Agency to identify candidate projects for delivery by this method, so an Agency can allocate its existing pool of funds across more projects. As long as an Agency can identify projects suitable for DBF, this flexibility gives it more discretion over which projects to include in a capital program.

5.1.5 Reduction in Capital and O&M Costs

In using DBF, an Agency accelerates the project delivery by a few years. If the project is to be completed later, there is an increase in the overall cost of the project through material and labor inflation. For example, consider a project in Florida with a total cost of $500 million of capital costs in FY 2019-2020 dollar value. If the project were to follow DB or DBB method of delivery, it would take five years for the FDOT to accumulate the project funds. If the project were to be delivered through DBF through complete financing of the project at estimated 5% interest rate (D05A, D05B) for 5 years, the overall project cost would be $638.14 million [$ 500 million * 1.05^5]. However when comparing the cost of DBF project,

we should also account for escalation of project cost over time due to inflation. To account for the cost of inflation for starting the project in FY 2024-2025, we utilize the inflation factor multiplier for the year 24/25 in Part III, Chapter 1, subsection Construction Cost and Inflation Factors of the Work Program Instructions for FY 20/21-24/25 developed by the economists of FDOT shown in the *table 6* below. The effective cost of the project developed in the year 2024-2025 in terms of 2019-2020 dollar value is $572 million [$500 million * 1.144]. So, the additional cost of using the private finance in DBF is not $138.14 million [$638.14 - $500], but $ 66.14 million [$638.14 - $575]. So the Agency should compare the cost of $66.14 million to the tangible and intangible benefits obtained by delivering the project early when making a decision on whether or not to use DBF on a project. By using DBF, the Agency completes the project earlier reducing the capital and O&M costs through inflation savings as depicted in the example above.

Table 6: Construction Cost Inflation Factors for FDOT

Fiscal Year	Inflation Factor	Multiplier	Fiscal Year	Inflation Factor	Multiplier
20/21	2.6%	1.026	25/26	3.0%	1.178
21/22	2.6%	1.053	26/27	3.1%	1.214
22/23	2.7%	1.081	27/28	3.2%	1.253
23/24	2.8%	1.111	28/29	3.3%	1.295
24/25	2.9%	1.144	29/30	3.3%	1.337
Note: Base Year is 2019/2020 Source: FDOT Work Program instructions 2019					

5.1.6 Beneficial Market Conditions

In certain times where the market conditions facilitate lower borrowing costs, it is beneficial for an Agency to complete the projects early. For example, with the Federal Funds rate at 0.25 in March of 2020, the cost of borrowing for private sector would be similar to the Agency's cost of borrowing or slightly higher. This benefits the Agency to use private financing to overcome the legislative limits of the State and complete the projects early at costs similar to DB or DBB procurement. These conditions would drive the decision of the agency in using DBF for accelerated project delivery.

5.1.7 Risk Transfer

In using DBF, an Agency can transfer certain risks to the private sector through structuring of the contract. In general, DBF transfers the risk of financing to contractor. The contractor is responsible for obtaining the partial or complete financing of the project and for the repayment to the lender. In case of DBF – Risk Transfer, the contract also transfers the risk of

completion of the project to the contractor. Consider the DBF projects by Michigan DOT. In both their projects, the contractor was not entitled to any payments until the completion of the project, so the contractor carried the completion risk on those projects; further, the contractor's financier had to bare this risk as well. However, an agency should consider the additional costs of transferring the risks to the contractor in terms of time and money. Some of the other risks that can be transferred to contractor include construction completion risk, land acquisition risk, risks of project cost increase, etc.

5.1.8 Inability/Unfeasibility to Transfer O&M Responsibilities

In certain cases, an Agency cannot transfer the O&M responsibilities of a project to a private contractor to use an LCM/PPP methods of project delivery. Some projects "really don't fit the category" to transfer O&M over "30-35 year term" (D04) due to difficulties in transfer of O&M responsibilities. For example, consider development of a metro transit station which is part of an operational metro line. If the transit agency was to use a LCM with concession agreement with fees collection, it would result in different charges for users of that particular station compared to other stations making it troublesome for the end-user. Also, the agency would already have O&M crew in place for the managing the rest of the network. Other example for this would be the redevelopment of an intersection or a bridge in highway corridor. If there is an operator for the larger section of the corridor already in place, it would be impractical to have multiple tolls in a section of the highway corridor. Such instances restrict the Agency's ability to transfer O&M responsibilities to a private contractor of DBF projects.

Also, as observed from the current DBF projects, the size of the projects is larger than typical DB projects and smaller than PPP projects. This makes it impractical in terms of cost for the agency to transfer the O&M responsibilities to the contractor.

5.2 Disadvantages/Challenges

5.2.1 Mismatched Expectations

In using DBF, the expectation of the Agency differ when compared to traditional LCMs/PPPs. The Agency is responsible for the O&M post construction of the facility. When a PPP developer is selected for a DBF project, it was observed that there is a mismatch in the expectations between the developers and the Agency. The agency plays "active role in looking and reviewing the designs" (D04) as they are responsible for O&M post completion while the developer is used to autonomy in the design process of a PPP project with O&M

responsibilities for longer durations. This is a cause of friction between the Agency and developer on large DBF projects. However, this has not been observed in smaller projects with traditional DB contractors undertaking DBF projects based on the limited interviews with contractors and Agencies.

In larger DBF projects, the agency expects to transfer higher risks at lower costs. However, for the PPP developers, the DBF projects lie in the smaller project size category of projects and the additional work required to complete the project may not justify the marginal profits. This results in dissatisfaction to a developer when additional risk are transferred without a significant rise in profits.

5.2.2 Additional Costs (Surety and lender bonds in risk transfer variant)

Using DBF requires advisory and administrative work from the Agency during planning, procurement and execution (D04, P01A, P01B, P03, P04). When an agency is considering the use of DBF, it should take into account the additional costs that might be acquired in this process. If the Agency is developing the DBF program, it would increase the advisory cost of initial projects as the Agency has to hire external consultants compared to an Agency that has a well-developed DBF program (D05A, D05B).

5.2.3 Conflict of Responsibilities

Another consideration for the DBF-Risk Transfer variation is conflict in the responsibilities between Lender and Surety to complete the project. In the event of a default by the contractor, there is a conflict between the lender and surety to complete the project. A lender would want to complete the project as soon as possible to recuperate the invested capital while the surety would like to sue the contractor for any additional payments required for completion of the project delaying the project's completion (S11). This conflict results in delay of the project completion and inconvenience to the parties involved in the transaction. Apart of the inconvenience, the current process of procurement in a DBF - Risk Transfer variant requires the contractor to provide assurances twice to a surety and a lender. This creates additional cost to the contractor which is transferred to the project. Hence, the Agency should consider this issue while using a DBF.

5.2.4 Due Diligence

Although there is general consensus through literature and experts that there is an increased due-diligence by the lender in a DBF project, it has been observed that the diligence is limited to the contractor and the Agency in a DBF – Receivables structure (S01, C01). Since

there is limited exposure to the lender in this variant, the lender does not perform diligence on the project. Some of the factors that the lender typically consider in a DBF project include the creditworthiness of the Agency, ability of the contractor to complete a job and financial health of the contractor. This reduction in the diligence however, results in lower processing times and cost for financing by the contractor which are then translated to the project.

In the DBF – Risk Transfer variant, since there lender is exposed to the risk of completion, the due-diligence also includes the project. This increases the time required for financial close and the cost of the project.

5.2.5 Reduction in Competition

A factor considered in the decision making of a DBF project is the size of the project. With larger project size of DBF compared to DB/DBB projects and inclusion of the private financing, smaller contractors of traditional DB/DBB projects are eliminated from the competition due to the financial requirements in the proposal or their inability to acquire appropriate assurances from lenders. This results in reduction of competition during procurement as it pushes the smaller prime contractors out (D02). However, the impact of the project size and financing size on competition in DBF projects needs to be further analyzed and is not included in the scope of this study.

5.2.6 Uncertainty in the Use of Private Finance

In DBF projects where the payments are made after the completion of the project, typically less than 10 years. If the project fails after the warranty period and before the completion of the payments, the department ends up paying for project that failed without any recourse to the contractor. This adds uncertainty when using the private finance to the Agency (D02).

5.3 Prevailing Perspective of DBF versus Findings of Current Study

The prevailing perspectives of DBF found in the existing literature do not fully align with the findings of this investigation. First, most practice-based literature does not differentiate between the variants of the DBF method; this is very significant distinction. In addition, comparing the drivers from existing literature against the current practices adopted in and perspectives from the field illustrates some key differences. For example, the prevailing literature considers increased due-diligence on a project from the lenders/financial institutions as a driver for the use of DBF. However, when the variants of DBF are considered, the DBF Receivables variant does not improve the due diligence on the project as the lenders are not

exposed to the project risks. So, increased due-diligence does not apply to the DBF – Receivables variant. *Table 7* compares the key drivers in the existing literature with the findings for the different variants of DBF from current study:

Table 7: Comparison of literature with findings from current study

Driver	Current Literature	DBF – Receivables	DBF – Risk Transfer
Acceleration of critical projects	Increases	Increases	Increases
Budget flexibility for Agency	Increases	Increases	Increases
Agency's ability to overcome Debt Cap restrictions	Increases as the payments are not considered part of Debt Caps	Varies for each State Agency	Varies for each State Agency
Quality of work delivered by contractor	Increases due to the involvement of private finance	Does not change as the quality depends on the contract requirements	Does not change as the quality depends on the contract requirements
Agency's ability to transfer project risks to contractors	Increases due to the inclusion of private finance in the contract	Minimum risks are transferred to the contractor to facilitate lower interest rates and faster financial close	Better risk transfer in terms of completion and financing risks
Due-Diligence on the project	Increases as the lenders perform diligence on the project independently	Does not increase as the lender's exposure to project risks are minimal	Increases as the lenders perform diligence on the project independently

5.4 Implications for Practice

An Agency when considering the use of a DBF, should realize that there are advantages and disadvantages of using each of the DBF variants. If the Agency's objective is to attain

minimal cost of private financing to complete the project, a DBF-Receivables structure with minimal transfer of additional risk should be considered. The Agency should try to keep the financial structure simple as any complexity in the structure of the project will lead to additional cost and time in the terms of financing and transaction costs.

If the agency wants to transfer risks to the contractor using DBF-Risk Transfer variant, the agency should be prepared for additional transaction and financing costs as well as time taken for the contractor to achieve financial close. Also, in the DBF-Risk Transfer variant since the lender bears risk of completion, Agency should consider if it requires separate Surety bond as this would lead to additional cost to the contractor which translated to the increased project costs.

For better utilizing DBF, an Agency should be clear on the objectives for using any of the variants and should not compare drivers of one DBF variant with the other and try to overcome the disparity in expectations with contractor during the procurement process.

5.5 Comparison of DB with variants of DBF

Many agencies have used DB extensively to deliver transportation infrastructure; the use of DBF to date has been far more selective. *Table 8* compares the differences between DB and the two variants of DBF: DBF – Receivables and DBF – Risk Transfer.

Table 8: Comparison of DB, DBF- Receivables and DBF - Risk Transfer

Key Factors	DB	DBF – Receivables	DBF – Risk Transfer
Project Acceleration	Agency needs to have all the funds required for project during the procurement/letting stage; if not, this can result in delay until all the funds are available in some cases	Agency can start a project without accumulating all the necessary funds	Agency can start a project without accumulating all the necessary funds
Social and Economic Factors	Critical projects might be delayed if funds are not available	Public benefits by delivering the projects early through congestion reduction, improved standards of living etc.	Public benefits by delivering the projects early through congestion reduction, improved standards of living etc.

Key Factors	DB	DBF – Receivables	DBF – Risk Transfer
Payment Structure	Payments are typically made based on progress	Schedule of payments, payout curve methods or certificates of completion methods are used in lieu of milestones	Balloon payments are made at substantial completion (or established milestones) followed by fixed payments
Risk Transfer	Traditional risks are transferred	Limited financing risks are transferred to the contractor	Better risk transfer including financing and completion risks are transferred to the contractor
Financing	Interest rates for financing are based on creditworthiness of the Agency	Interest rates depend on the creditworthiness of Agency and contractor	Interest rates depend on the creditworthiness of Agency, contractor and complexity of the project
	Rates are based on Agency alone, so typically low	Rates based on both parties, so likely higher than the Agency rate	Rates based on parties and project, so likely highest due to additional risk exposure for lender
	No additional time and effort required for obtaining private financing	Additional time and effort required for obtaining private financing	Higher additional time and effort required for obtaining private financing
Transaction costs	Typical transaction costs for Agency to review project documents	Additional transaction costs for reviewing financing proposal as well as contract documents	Additional transaction costs for reviewing financing proposal as well as contract documents
Due-Diligence	Lender due-diligence is limited to creditworthiness of the Agency	Additional lender due-diligence is carried out on the financial condition of the contractor and ability to complete project	In addition to contractor's abilities, lender due-diligence is carried out on design and construction risk
	No Additional due-diligence costs added to overall project cost	Minimal/no additional costs of due-diligence added to overall project costs	Additional due-diligence costs added to overall project cost

Key Factors	DB	DBF – Receivables	DBF – Risk Transfer
Third Party Conflicts	No conflicts between Lender and Surety	No conflicts between Lender and Surety	Surety and Lender might be in conflict if contractor fails to complete the project

Table 8 illustrates the associated trade-offs between DB and the variants of DBF. For instance, DBF can accelerate the timeline of projects and also transfer risks to contractors, but these advantages come with increased financing and transaction costs. Hence, DBF is not a panacea; rather, it is an option that Agencies must carefully consider before selecting it for a particular project.

6 Conclusion

The purpose of this study is to understand the drivers of Design-Build-Finance for public sector agencies and its implementation. The research methodology described the process to arrive at the drivers of DBF and the structure of the DBF projects.

6.1 Objectives and Contributions

The overarching objectives of this research were to investigate how and why DBF is being used by Agencies in delivery of transportation infrastructure. To understand how DBF is being employed, implementation of past and current DBF projects were investigated. This research looked at the different financing models used by the Agencies in these projects. Through the study of these models, supplemented by the interviews of SMEs, two variants of the DBF method were identified. The current literature does not differentiate between the DBF variants.

To understand why DBF is being used, the drivers of DBF were identified through literature review and interviews from DBF practitioners. Without the distinction of the DBF variants, when the drivers from the current literature are compared to the current use of DBF in practice and the drivers as suggested by different DOTs, a disparity was observed. With the distinction between the DBF-Receivables and DBF-Risk Transfer, drivers identified in the literature were not as relevant as indicated. For instance, additional risk transfer and increased cost of private financing are factors applicable for the DBF- Risk Transfer variant while not applicable to the DBF- Receivables variant; similarly, lower administrative and financing costs and better procurement durations were factors of the DBF – Receivables variant while not applicable to DBF- Risk Transfer.

Through interviews with SMEs and DOT Personnel involved at the program level and project level, this research developed an expanded and richer list of drivers and challenges for the use of DBF in transportation infrastructure delivery.

6.2 Limitations

This study is focused on the current and completed projects in the US which used DBF-receivables variant. The sample size of the projects is too small to generalize the results. The desk review for the case studies is limited to publicly available project documents. Commercially sensitive data like financing proposals and interest rates obtained by the

contractors could not be obtained. The sample size of the interviewees in terms of contractors is limited. Some of the projects are much older which led to change in the positions of the people involved in the projects and limited availability of project data. The case studies are carried out only on transportation infrastructure projects.

6.3 Recommendations for Future Research

Future studies could include projects in other countries like Canada (DBF), India (HAM methods) to increase the sample size to be able to generalize the results. Qualitative Comparative Analysis could be carried out on the results of the new sample set to better generalize the methods. Studies on the other variants of DBF could be carried out on projects in other countries. Future research could also include other sectors like health care to understand the differences in the use of DBF between different sectors. Other recommendations for future research in the topic include investigation into the extent of increase in project cost between DB, DBF- Receivables and DBF –Risk Transfer variants by comparing the projects of similar scope and size using these delivery methods.

Bibliography

AASHTO. (n.d.). *Project : I-75 EXPANSION (IROX)*. 6–11.

Akintoye, A., Hardcastle, C., Beck, M., Chinyio, E., and Asenova, D. (2003). "Achieving best value in private finance initiative project procurement." *Construction Management and Economics*, 21(5), 461–470.

Allen Consulting Group, and University of Melbourne. (2007). *Performance of PPPs and Traditional Procurement in Australia*. *Report to Infrastructure Partnerships Australia*, Melbourne.

Aschauer, D. A. (1989). "Is public expenditure productive?" *Journal of Monetary Economics*, 23(2), 177–200.

Ashuri, B., and Mostaan, K. (2015). "State of Private Financing in Development of Highway Projects in the United States." *Journal of Management in Engineering*, 31(6), 04015002.

Beard, J. L., Loulakis, M. C., and Wundram, E. C. (2001). *Design Build: Planning through Development*. The McGraw-Hill.

Beckett, M., Drazin, S., Finlay, D., Kingsley-Smith, H., Martin, N., Neathey, R., Robertson, J., and Wynniatt, M. (2009). *Performance of PFI Construction*. London.

Bolaños, L., Transue, M., Wheeler, P., and Gifford, J. L. (n.d.). *U.S. Surface Transportation Public-Private Partnerships: Objectives and Evidence*. Arlington.

Brogaard, L. (2018). "Business Value in Public-Private Partnerships: The Positive Impact of Trust and Task-Relevant Competencies on Business Outcomes in PPPs." *International Public Management Journal*, 1–26.

Chan, C., Forwood, D., Roper, H., and Sayers, C. (2009a). *Public Infrastructure Financing : An International Prespective*. *Productivity Commission Staff Working Paper*.

Chan, C., Forwood, D., Roper, H., and Sayers, C. (2009b). *Public Infrastructure Financing : An International Prespective*. *Productivity Commission Staff Working Paper*.

Chasey, A. D., Maddex, W. E., and Bansal, A. (2012). "Comparison of Public–Private Partnerships and Traditional Procurement Methods in North American Highway Construction." *Transportation Research Record: Journal of the Transportation Research Board*, 2268(1), 26–32.

Demirag, I., Khadaroo, I., Stapleton, P., and Stevenson, C. (2011). "Risks and the financing of PPP: Perspectives from the financiers." *The British Accounting Review*, 43(4), 294–310.

Dollarhide, B. (2012). "Getting Stumped on Zane's Trace." *www.genealogyblog.com*, <https://www.genealogyblog.com/?p=18354> (Apr. 15, 2019).

Dollarhide, W. (n.d.). "Map guide to american migration routes_1735-1815." 20.

Duffield, C. (2008). *Report on the performance of PPP projects in Australia when compared with a representative sample of traditionally procured infrastructure projects*. *Report to the National PPP Forum by The University of Melbourne*, Melbourne.

Engel, E., Fischer, R., and Galetovic, A. (2010). *The economics of infrastructure finance: Public-private partnerships versus public provision*. *EIB Papers*.

Fay, M., Martimort, D., and Straub, S. (2018). *Funding and Financing Infrastructure : The Complementarity between Public and Private Finance ∗*. Policy Research Working Paper.

FDOT. (n.d.). "I-395/SR 836/I-95 Design-Build Project." *www.fdotmiamidade.com*, <http://www.fdotmiamidade.com/i395designproject> (Oct. 4, 2019).

FDOT. (2009). *Build-Finance Request For Proposals for I-4/Lee Roy Selmon Expressway Connector Interchange from the Lee Roy Selmon Expressway to I-4 Hillsborough County, Florida*.

FDOT. (2016). *Request For Proposal for SR-836 / I-395 from West of I-95 to MacArthur Causeway Bridge And I-95 Pavement Reconstruction And I-95 Southbound to SR-836 Westbound And SR-836 from West of NW 17 th Avenue to Midtown Interchange (SR-836/I-395/I-95)*.

FHWA. (n.d.). "EDC-2: Alternative Technical Concepts (ATC)." <https://www.fhwa.dot.gov/innovation/everydaycounts/edc-2/atc.cfm> (Sep. 4, 2019a).

FHWA. (n.d.). "Project Profile: I-395/SR 83611/I-95 Interchange Project." *www.fhwa.dot.gov*, <https://www.fhwa.dot.gov/ipd/project_profiles/fl_i395_sr83611_i95.aspx> (Oct. 4, 2019b).

FHWA. (n.d.). "Project Profiles: I-75 Roadway Expansion (iROX)."

<https://www.fhwa.dot.gov/ipd/project_profiles/fl_i75_roadway_expansion_irox.aspx> (Oct. 28, 2019c).

FHWA. (n.d.). “Project Profiles: SR 826 / SR 836 Interchange Reconstruction.” *www.fhwa.dot.gov*, <https://www.fhwa.dot.gov/ipd/project_profiles/fl_sr826_sr836_interchange_reconstruction.aspx> (Oct. 14, 2019d).

FHWA. (n.d.). “Project Profiles: I-4 / Selmon Expressway Connector.” <https://www.fhwa.dot.gov/ipd/project_profiles/fl_i4_selmon_expressway_connector.aspx> (Oct. 28, 2019e).

FHWA. (n.d.). “FHWA Active Project Status Report.” <https://fhwaapps.fhwa.dot.gov/foisp/publicActive.do> (Oct. 28, 2019f).

FHWA. (n.d.). “Project Profiles: I-485 Charlotte Loop.” <https://www.fhwa.dot.gov/ipd/project_profiles/nc_i485_charlotte_outer_loop.aspx> (Oct. 9, 2019g).

FHWA. (n.d.). “ Project Profile: I-285 / SR 400 Interchange Reconstruction.” <https://www.fhwa.dot.gov/ipd/project_profiles/ga_i285_sr400.aspx> (Apr. 4, 2020h).

FHWA. (n.d.). “Project Profiles: Northwest Corridor.” *https://www.fhwa.dot.gov/*, <https://www.fhwa.dot.gov/ipd/project_profiles/ga_northwest_corridor_project.aspx> (Oct. 8, 2019i).

FHWA. (n.d.). “Project Profile: Midtown Express (SH 183 Managed Lanes).” <https://www.fhwa.dot.gov/ipd/project_profiles/tx_midtown_express.aspx> (Oct. 7, 2019j).

FHWA. (2014). “ATC: Use with Design-Build Contracting.” <https://connectdot.connectsolutions.com/p3y6j8rw00a/?proto=true> (Sep. 4, 2019).

FHWA. (2016). “Defining PPPs and Their Benefits.” <https://www.fhwa.dot.gov/reports/pppwave/03.htm> (Sep. 4, 2019).

FHWA - Center for Innovative Finance Support. (n.d.). “Design Build Finance (DBF).” <https://www.fhwa.dot.gov/ipd/alternative_project_delivery/defined/new_build_facilities/dbf.aspx> (Apr. 22, 2019).

Forcael, E., Ellis, R., and Jaramillo, F. (2011a). “Design-Build-Finance in the US: The case

of iROX, I-75 Road Expansion Project." *Revista de la Construccion*, 10(1), 24–35.

Forcael, E., Ellis, R., and Jaramillo, F. (2011b). "Design-Build-Finance in the US: The case of iROX, I-75 Road Expansion Project." *Revista de la Construccion*, 10(1), 24–35.

Gad, G. M., Gransberg, D. D., and Loulakis, M. (2015). "Policies and Procedures for Successful Implementation of Alternative Technical Concepts." *Transportation Research Record: Journal of the Transportation Research Board*, 2504(1), 78–86.

Garvin, M. J. (2010). "Enabling development of the transportation public-private partnership market in the United States." *Journal of Construction Engineering and Management*, 136(4), 402–411.

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

GDOT. (2012). *RFQ to Develop, Design, Construct and Finance the Northwest Corridor Project*.

Gramlich, E. M. (1994). "Infrastructure Investment: A Review Essay." *Journal of Economic Literature*, 32(3), 1176–1196.

Gransberg, D. D., Runde, D. F., and Stergios, J. (2000). "The effect of innovative highway construction contract methods."

Iacobacci, M. (2010). *Dispelling the Myths: A Pan-Canadian Assessment of Public-Private Partnerships for Infrastructure Investments*. Ottawa.

Javed, A. A., Lam, P. T. I., and Zou, P. X. W. (2013). "Output-based specifications for PPP projects: lessons for facilities management from Australia." *Journal of Facilities Management*, Emerald Group Publishing Ltd., 11(1), 5–30.

Jolley, N. P., and Garvin, M. J. (2014). "Alternative Technical Concepts in Transportation Public Private Partnerships: Assessment of and Recommendations for the Process." 19.

Ke, Y., Wang, S., Chan, A. P. C., and Cheung, E. (2011). "Understanding the risks in China's PPP projects: Ranking of their probability and consequence." *Engineering, Construction and Architectural Management*, 18(5), 481–496.

Konchar, M., and Sanvido, V. (2002). "Comparison of U.S. Project Delivery Systems." *Journal of Construction Engineering and Management*, 124(6), 435–444.

Lam, E. W., Chan, A. P., and Chan, D. W. (2008). “Determinants of Successful Design-Build Projects.” *Journal of Construction Engineering and Management*, 134(5), 333–341.

Leiringer, R. (2006). “Technological innovation in PPPs: Incentives, opportunities and actions.” *Construction Management and Economics*, Taylor & Francis , 24(3), 301–308.

Levy, S. M. (2011). *Public-Private Partnerships: Case Studies in Infrastructure Development*. American Society of Civil Engineers, Reston, VA.

Liu, J., Peter, ;, Love, E. D., Smith, J., Regan, M., and Davis, P. R. (2014). “Life Cycle Critical Success Factors for Public-Private Partnership Infrastructure Projects.”

Longfellow, R. (n.d.). “Zane’s Trace - Back in Time - General Highway History - Highway History - Federal Highway Administration.” *USDOT - Federal Highway Administration*, <https://www.fhwa.dot.gov/infrastructure/back0803.cfm> (Apr. 15, 2019).

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

Miami-Dade Expressway Authority. (2014). *SR826/Palmetto Expressway and SR836/Dolphin Expressway Interchange Reconstruction Presentaion*.

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

Minchin, R. E., Li, X., Issa, R. R., and Vargas, G. G. (2013). “Comparison of Cost and Time Performance of Design-Build and Design-Bid-Build Delivery Systems in Florida.” *Journal of Construction Engineering and Management*, 139(10), 04013007.

Molenaar, K. R., and Gransberg, D. D. (2002). “Design-Builder Selection for Small Highway Projects.” *Journal of Management in Engineering*, 17(4), 214–223.

Molenaar, K. R., and Songer, A. D. (2002). “Model for Public Sector Design-Build Project Selection.” *Journal of Construction Engineering and Management*, 124(6), 467–479.

Molenaar, K. R., Songer, A. D., and Barash, M. (2002). “Public-Sector Design/Build Evolution and Performance.” *Journal of Management in Engineering*, 15(2), 54–62.

Mostaan, K., and Ashuri, B. (2016). “Challenges and Enablers for Private Sector Involvement in Delivery of Highway Public–Private Partnerships in the United States.” *Journal of Management in Engineering*, 33(3), 04016047.

Nabers, M. (2017). “Deferred maintenance...the same as debt? Really?” <https://www.spartnerships.com/deferred-maintenancethe-debt/> (Sep. 4, 2019).

NCDOT. (2010). *RFP for DESIGN-BUILD PROJECT*.

Ng, A., and Loosemore, M. (2007). “Risk allocation in the private provision of public infrastructure.” *International Journal of Project Management*, 25(1), 66–76.

Nguyen, D. A., Garvin, M. J., and Gonzalez, E. E. (2018). “Risk Allocation in U.S. Public-Private Partnership Highway Project Contracts.” *Journal of Construction Engineering and Management*, 144(5), 04018017.

Office of Public-Private Partnerships - VDOT. (2015). *White Paper on Pilot Program for Design-Build-Finance Delivery Model*.

Ortiz, I. N., and Buxbaum, J. N. (2008). “Protecting the Public Interest in Long-Term Concession Agreements for Transportation Infrastructure.” *Public Works Management & Policy*, 13(2), 126–137.

Osei-Kyei, R., and Chan, A. P. C. (2015). “Review Studies on the critical sucess factors for public private partnership (PPP) projects.” *International Journal of Project Management*.

Osei-Kyei, R., and Chan, A. P. C. (2017a). “Comparative Analysis of the Success Criteria for Public–Private Partnership Projects in Ghana and Hong Kong.” *Project Management Journal*, 48(4), 80–92.

Osei-Kyei, R., and Chan, A. P. C. (2017b). “Implementation constraints in public-private partnership: Empirical comparison between developing and developed economies/countries.” *Journal of Facilities Management*, 15(1), 90–106.

Osei-Kyei, R., Chan, A. P. C., Javed, A. A., and Ameyaw, E. E. (2017). “Critical success criteria for public-private partnership projects: international experts’ opinion.” *International Journal of Strategic Property Management*, 21(1), 87–100.

Papernik, B. G. (2009). “Using Alternative Technical Concepts to Improve Design-Build and PPP Procurements.” <http://www.nossaman.com/using-alternative-technical-concepts-improve-designbuild-ppp> (Jul. 24, 2019).

Price Water House Coopers. (2007). “The value of PFI Hanging in the balance (sheet)?” *IRFS*.

Ramsey, D., and Asmar, M. El. (2016). “Analysis of Funding Sources for Design-Build-Finance (DBF) Public-Private Partnership (PPP) Projects in the U.S. Transportation Sector: An Ongoing National Study.” *Construction Research Congress 2016*, American Society of Civil Engineers, Reston, VA, 331–340.

Ramsey, D. W., and El Asmar, M. (2015). “Cost and Schedule Performance Benchmarks of U.S. Transportation Public-Private Partnership Projects.” *Transportation Research Record: Journal of the Transportation Research Board*, 2504(1), 58–65.

Rangel, T., and Galende, J. (2010). “Innovation in public-private partnerships (PPPs): The Spanish case of highway concessions.” *Public Money and Management*, Taylor & Francis , 30(1), 49–54.

Rao, V. (2018). *An Empirical Analysis of the Factors that Influence Infrastructure Project Financing by Banks in Select Asian Economies*. *ADB Economics Working Paper Series*.

Saldaña, J. (2013). *The Coding Manual for Qualitative Researchers*. *Sage Publications*.

Shrestha, P. P., Migliaccio, G. C., O’Connor, J. T., and Gibson, G. E. (2007). “Benchmarking of Large Design–Build Highway Projects.” *Transportation Research Record: Journal of the Transportation Research Board*, 1994(1), 17–25.

Songer, A. D., and Molenaar, K. R. (1996). “Selecting design-build: Public and private sector owner attitudes.” *Journal of Management in Engineering*, ASCE - American Society of Civil Engineers, 12(6), 47–53.

Songer, A. D., and Molenaar, K. R. (1997). “Project characteristics for successful public-sector design-build.” *Journal of Construction Engineering and Management*, 123(1), 34–40.

Stager, D. K. (1996). “ORGANIZING AND MANAGING A FINANCE-DESIGN-BUILD PROJECT IN TURKEY: FOURTH ROEBLING LECTURE, 1995 8.” *Journal of Construction Engineering and Management*, 122(3), 199–204.

Sullivan, J., Asce, S. M., Mounir, ;, Asmar, E., Asce, A. M., Chalhoub, ; Jad, and Obeid, H. (2017). “Two Decades of Performance Comparisons for Design-Build, Construction Manager at Risk, and Design-Bid-Build: Quantitative Analysis of the State of Knowledge on Project Cost, Schedule, and Quality Alternative Project Delivery in Construction Performance of.” *J. Constr. Eng. Manage. J. Constr. Eng. Manage*, 143(6), 4017009.

USDOT FHWA. (n.d.). “Bundled Facilities Overview.” <https://www.fhwa.dot.gov/ipd/alternative_project_delivery/defined/bundled_facilities/default.aspx> (Apr. 5, 2020).

USDOT FHWA. (2006). *Design-Build Effectiveness Study-As Required by TEA-21 Section 1307(f)*. Washington D.C.

VDOT. (n.d.). *White Paper on Pilot Program for Design-Build-Finance Delivery Model*.

Vecchi, V., Hellowell, M., della Croce, R., and Gatti, S. (2017). “Government policies to enhance access to credit for infrastructure-based PPPs: an approach to classification and appraisal.” *Public Money & Management*, 37(2), 133–140.

Vega, A. O. (1997). “Risk Allocation in Infrastructure Financing.” *The Journal of Project Finance*, 3(2), 38–42.

Verweij, S., Teisman, G. R., and Gerrits, L. M. (2017). “Implementing Public–Private Partnerships: How Management Responses to Events Produce (Un) Satisfactory Outcomes.” *Public Works Management and Policy*, 22(2), 119–139.

Warsen, R., Nederhand, J., Klijn, E. H., Grotenbreg, S., and Koppenjan, J. (2018). “What makes public-private partnerships work? Survey research into the outcomes and the quality of cooperation in PPPs.” *Public Management Review*, 20(8), 1165–1185.

Wilson, E., and Starler, N. (2008). *Budget Constraints and the Corps Consideration of Public-Private Par tnerships : Where Is the Money Going to Come From ?*

Zhang, X. (2005). “Critical Success Factors for Public–Private Partnerships in Infrastructure Development.” *Journal of Construction Engineering and Management*, 131(1), 3–14.

Appendices

A1 Semi-structured interview questionnaire for SME

Questions

1. How many years have you been involved in the construction/transportation infrastructure industry?
2. Can you please give a brief description of your current position and responsibilities?
    a. How long have you been in this role?
    b. What positions did you hold prior to this one?
3. What is your general perspective of DBF?
    a. How is it different from DB and PPPs?
    b. What are the additional responsibilities of each party involved in DBF?
4. What are the benefits of using DBF?
    a. Please identify specific drivers of DBF.
    b. When is it appropriate to use DBF?
5. Are these benefits achieved in the current projects across the US?
    a. How is the use of DBF justified by the agencies?
6. What are the disadvantages or challenges in using DBF?
7. Do you have experience with or knowledge of any current projects? If so, please discuss benefits or challenges associated with these projects?
8. Are the perceived benefits adequate to overcome the additional cost of private financing & additional transaction costs?
9. Is there a difference in the following aspects of project between DBF and DB?
    a. Quality of delivery
    b. Schedule Adherence
    c. Risk allocation
    d. Value addition
    e. Construction Inspection

A2 Semi-structured interview questionnaire for DOT personnel

Questions

1. How many years have you been involved in the construction/transportation infrastructure industry?
2. Can you please give a brief description of your current position and responsibilities?
    a. How long have you been in this role?
    b. What positions did you hold prior to this one?
3. How would you describe DBF?
    a. How is it different from DB and PPPs?
    b. What are the additional responsibilities of each party involved in DBF?
    c. What is the additional cost of using DBF in terms of financing and transaction costs?
4. What are the benefits of using DBF?
    a. Drivers of DBF
        i. Improved delivery, bridging mechanism, etc.
    b. When is it appropriate to use DBF?
5. What are the disadvantages or challenges in using DBF?
6. Please briefly describe the DBF projects of the agency
    a. Current projects
    b. Completed projects
7. Did the agency receive the expected benefits in these projects? If so, why? If not, why not?
    a. Are the challenges/costs justified based on the benefits?
    b. Describe overall experience with: procurement, project management, construction inspection, etc.
    c. Describe lessons learned
8. Will the agency use DBF in future?
    a. Explain why or why not.
9. What are the characteristics of future projects that could be considered for DBF?
    a. Describe specific features that should be present in a project using DBF.
10. What are the methods in which the agency can finance a project?
11. At a program level, why did the agency choose DBF for some projects and DB for others?
12. Is there a difference in the following aspects of project between DBF and DB?
    a. Quality of delivery
    b. Schedule Adherence
    c. Risk allocation
    d. Value addition
    e. Construction Inspection

A3 Semi-structured interview questionnaire for project personnel

Questions

1. How many years have you been involved in the construction/transportation infrastructure industry?
2. Can you please give a brief description of your current position and responsibilities?
    a. How long have you been in this role?
    b. What positions did you hold prior to this one?
3. What was your role and responsibilities in {Project Name}?
4. How would you describe DBF?
    a. How is it different from DB and PPPs?
    b. What are the additional responsibilities of each party involved in DBF?
    c. What are the additional costs of using DBF?
        i. Describe additional financing costs
        ii. Describe additional transaction costs
5. In general, what are the benefits of using DBF?
    a. Drivers of DBF
        i. Bridging mechanism
    b. When is it appropriate to use DBF?
6. In general, what are the disadvantages or challenges of DBF?
7. Describe the experience of using DBF for {Project Name}
    a. How was the procurement different?
    b. How was construction oversight/inspection different?
    c. How were payments structured?
        i. Describe difference with traditional projects; how was this beneficial or challenging?
    d. Key lessons from implementation of DBF for the project
    e. Overall experience with DBF
        i. Did project deliver expected benefits?
        ii. Would you recommend its use again? Why or why not?
8. What are the characteristics of future projects that could be considered for DBF?
    a. Describe specific features that should be present in a project using DBF.
9. Is there a difference in the following aspects of project between DBF and DB?
    a. Quality of delivery
    b. Schedule Adherence
    c. Risk allocation
    d. Value addition
    e. Construction Inspection

B1 Project Brief of I-395/SR 83611/I-95 Interchange Project

Name of the project: I-395/SR 83611/I-95 Interchange Project

Location: Miami, Florida

Project Authority: Florida Department of Transportation (FDOT) District Six, Miami-Dade Expressway Authority (MDX)

Description: The project comprises of three projects combined into a single DBF contract to alleviate congestion at the interchange of I-395 SR 836 and I-95 (Midtown interchange) in downtown of Miami (FHWA n.d.). The three projects are as follows;

- I-395 Improvements: The project will completely reconstruct approximately 1.4 mile stretch of I-395 from Midtown interchange to MacArthur Causeway along with a signature bridge over the downtown of Miami in six sweeping arches creating high vertical clearance allowing for sunlight and development of communal spaces in the area. The project includes adding capacity to I-395 by making it three through lanes in each direction along with changes to the positions of the ramps (FDOT n.d.).
- SR 836 Improvements: SR 836 improvements include double decking beginning at the east of toll gantry at NW 17 Avenue and touching down I-395 east of I-95, avoiding I-95 interchange. The double decked section will have two lanes in each direction, allowing drivers towards Watson Island, Port Miami and Miami Beach to bypass Midtown Interchange. The existing infrastructure of SR 836 will act as collector-distributor system for the drivers to enter and exit local roads and I-95, increasing the safety by reducing the weaving movements (FDOT n.d.).
- I-95 Concrete Replacement Project: This project includes replacement of concrete pavement on both northbound and southbound lanes between NW 8 Street to NW 29 Street along with addition of an auxiliary lane along northbound I-95 from North of NW 17 Street to NW 29 Street to receive additional traffic from SR 836 ramp enhancing the flow of traffic from through Midtown Interchange (FDOT n.d.).

Background: FDOT and MDX have collaborated and combined all three projects into a single DBF project to better deliver the project in terms of schedule certainty. The total project cost is estimated to be $ 802 million. The cost of each of the subprojects is as follows:

- I-395 Reconstruction (FDOT) - $556 million
- SR 836 Improvements (MDX) - $186 million

- SR 836 Westbound Connector (FDOT) - $35 million
- I-95 Pavement Reconstruction (FDOT) - $25 million

Financial structure of the project: The financial structure of the project is similar to that of a DB project. The agency will make payments to the contractor based on the work completed. The department has released a cash availability schedule to the bidders as a part of the RFP. The department would pay the contractor based on the cash availability schedule. The surplus cash that has not been used by the end of a particular quarter would be added to the available cash for the next quarter. If at any point of the time, the cost of completed work is more than the cash available, the contractor has to cover the funding gap through private equity or commercial loan. The selected bidder in the procurement process has submitted a letter of commitment (FDOT 2016; FHWA n.d.). The following tables indicates the cash availability schedule as per RFP for each of the three sub-projects.

Table 9: Cash Availability Schedule for project B1

Project	I-395 Reconstruction				
Fiscal Year	July 1	October 1	January 1	April 1	Total
2017	-	-	34,380,690	5,000,000	39,380,690
2018	25,000,000	20,000,000	5,223,655	20,000,000	70,223,655
2019	12,473,998	20,000,000	20,000,000	20,000,000	72,473,998
2020	37,644,650	35,000,000	35,000,000	5,000,000	112,644,650
2021	19,135,698	30,000,000	30,000,000	25,000,000	104,135,698
2022	30,000,000	30,000,000	20,000,000	20,000,000	100,000,000
2023	10,000,000	10,000,000	37,058,489	-	57,058,489
Project	I-95 SB to SR 836 WB Connector				
Fiscal Year	July 1	October 1	January 1	April 1	Total
2017	-	-	-	-	0
2018	-	-	-	-	0
2019	-	-	-	-	0
2020	-	-	-	14,000,000	14,000,000
2021	-	-	-	14,000,000	14,000,000
2022	-	7,000,000	-	-	7,000,000
2023	-	-	-	-	0
Project	I-95 Pavement Reconstruction				
Fiscal Year	July 1	October 1	January 1	April 1	Total
2017	-	-	-	-	0
2018	-	-	14,526,345	-	14,526,345
2019	7,526,002	-	-	-	7,526,002
2020	864,302	-	-	-	864,302

2021	-	-	-	-	0
2022	-	-	-	-	0
2023	-	-	-	-	0
Source: FDOT					

Funding: The project is funded by two sources, FDOT funds ($626 million) which includes Federal funds, State Motor Fuels Tax, Vehicle licensing Fee etc. and MDX funds ($186 million) obtained through toll revenue bonds (FHWA n.d.).

Procurement: The procurement for the project followed four phases. In phase one, an agency's committee selected Design-Build firms based on qualifications submitted after an industry forum. The selected firms were paid a stipend to produce aesthetic signature bridge design which will be evaluated on a Pass/Fail basis in phase two. The shortlisted agencies would then produce draft ATCs and a technical proposal in phase three. In the final phase, the shortlisted firms submitted their financial and price proposal based on which a preferred bidder was selected. Archer Western-de Moya (AW-dMG) - Design-Build Joint Venture consisting of Archer Western Contractors and the de Moya Group was selected in May 2017 as the preferred bidder (FHWA n.d.).

B2 Project Brief of SR 826 / SR 836 Interchange Reconstruction Project

Name of the project: SR 826 / SR 836 Interchange Reconstruction Project

Location: Miami, Florida

Project authority: Florida Department of Transportation (FDOT), Miami-Dade Expressway Authority (MDX)

Duration: November 30, 2009- September 27, 2016. Final payment was made on March 2, 2017.

Cost: The total cost of the project, including preliminary engineering, environmental, right of way, construction, rail, utilities and construction engineering inspection, is $832.9 million. The Design-Build-Finance contract value for the project is $567.5 million (FHWA n.d.; Miami-Dade Expressway Authority 2014).

Description: The SR 826 / SR 836 interchange reconstruction project extends from the north-south State Route (SR) 826 (Palmetto Expressway) and intersects the tolled east-west SR 836 (Dolphin Expressway) at the southwest corner of Miami International Airport. The major project components of the projects include: (FHWA n.d.; Miami-Dade Expressway Authority 2014)

- Reconstruction and widening along both SR 826 (from just north of SW 8 Street to NW 25 Street) and SR 836 (from just east of NW 87 Avenue to NW 57 Avenue)
- Construction of a new four-level interchange between the two expressways providing direct access in all directions
- Reconstruction and modification to the SR 826 interchange with Flagler Street to the south and to the SR 836 interchange with Milam Dairy Road to the east
- Construction of connector ramps and frontage roads for local traffic movements eliminating the need to use mainline SR 826 and SR 836
- Installation of Intelligent Transportation Systems (ITS) cameras and sensors allowing for real-time traffic updates, as well as assisting in the rapid deployment of first responders and Road Rangers to clear disabled and accident vehicles from travel lanes
- Other connecting local street reconstruction

Background: This project is the final section of the 12 part Palmetto Expressway Improvement Program that started in 1990s. This project consisted of widening, bridge replacement, and geometric improvements along the existing 16-mile corridor extending

from SR 5/US 1 in south Miami-Dade County to just north of NW 154 Street in northern Miami-Dade County (FHWA n.d.; Miami-Dade Expressway Authority 2014).

Financial Structure of the project: The private sector participants were paid according to the cash availability schedule that was presented to the bidders as a part of the procurement. The selected bidder submitted a letter of commitment to cover any gaps in the payments during construction commercial loan.

Funding: The project used funds from the following sources:

- Federal funds - $376.0 million
- Recovery Act stimulus funding - $89.2 million
- State funds (state motor fuels tax, vehicle license fee, right-of-way bonds, and documentary stamp collections) - $118.5 million
- MDX funds (toll revenue bond proceeds) - $241.2 million
- Miami-Dade County Water and Sewer Department Joint Participation Agreement - $8.1 million

Procurement: The procurement followed one stage two step process with separate technical and price proposals in best-value selection. The bidders were asked to bid on different design alternatives and the proposal with maximum scope for least value was selected as preferred bidder. The selected bidder for the project is Community Asphalt Corporation / Condotte America, Inc. / The de Moya Group, Inc. - Design-Build Joint Venture (FHWA n.d.).

B3 Project Brief of I-4/Lee Roy Selmon Expressway Connector Interchange Project

Name of the Project: I-4/Lee Roy Selmon Expressway Connector Interchange Project

Location: Tampa, Florida

Project Authority: Florida Department of Transportation

Duration: 2009-2014

Description: The I-4/Lee Roy Selmon Expressway Interchange is a limited-access interchange from the Lee Roy Selmon Expressway north along the west side of 31st Street to I-4 in Hillsborough County. It is an elevated roadway with a series of separate lanes for trucks and other vehicles (FDOT 2009).

Background: This is a Build-Finance project i.e., the agency has completed design and the contractors bid for the quantities of work to be completed. The total cost of the project was $402.5 million (FHWA n.d.).

Financial Structure of the project: The agency's representative will calculate a monthly estimate of the work that will be completed and respective quantities of the materials. The total cost of the invoice will be the lower of cost of the construction or the available funds. The contractor is assured preference in allocation of state funds in further years. The contractor has the right to withdraw if the agency fails to make payment due to non-availability of funds as per the schedule given in the RFP illustrated below (FDOT 2009).

Table 10: Cash Availability Schedule for Project B3

Cash Availability Schedule: Project Number: 258415-1-52					
Fiscal Year	July 1	October 1	January 1	April 1	Total
2009	$0	$0	$0	$0	$0
2010	$91,380,329	$0	$0	$0	$91,380,329
2011	$0	$0	$0	$0	$0
2012	$0	$0	$0	$0	$0
2013	$80,000,001	$137,513	$1,673,611	$4,992,191	$86,803,316
2014	$8,175,854	$11,315,499	$15,348,747	$18,000,089	$52,840,189
2015	$19,582,298	$21,881,937	$23,096,191	$22,024,368	$86,584,794
2016	$21,225,113	$20,068,409	$17,673,127	$14,517,948	$73,484,597
2017	$12,862,606	$10,081,074	$7,519,252	$9,650,466	$40,113,398
2018	$3,236,978	$2,095,439	$1,285,115	$3,353,932	$9,971,464
Total	$236,463,179	$65,579,871	$66,596,043	$72,538,994	$441,178,087
Cash Availability Schedule: Project Number: 258415-1-56					
Fiscal Year	July 1	October 1	January 1	April 1	Total
2009	$0	$0	$0	$0	$0

2010	$0	$0	$0	$0	$0
2011	$0	$0	$0	$0	$0
2012	$0	$0	$0	$0	$0
2013	$0	$4,072	$49,561	$147,836	$201,469
2014	$242,124	$332,684	$425,171	$445,379	$1,445,358
2015	$436,271	$450,654	$431,685	$387,907	$1,706,517
2016	$369,639	$326,796	$267,101	$199,656	$1,163,192
2017	$161,464	$104,528	$64,106	$167,294	$497,392
2018	$0	$0	$0	$0	$0
Total	$1,209,498	$1,218,734	$1,237,624	$1,348,072	$5,013,928
Source: FDOT					

The contractor for this project has obtained part of the financing for a group of banks listed below and used equity for the rest of the financing (FHWA n.d.).

- PrivateBank and Trust Co.
- Export Development Canada
- Lloyds TSB Bank
- Société Générale

Funding: The funding sources for this project are as follows (FHWA n.d.):

- Federal funds - $203 million
- ARRA grant - $105 million ($18.2 million for pre-construction support)
- State funds - $10 million
- Toll revenue bonds - $80 million
- Local/toll funds - $22.7 million

Procurement: The procurement for this project followed one stage two step process. After an interest forum for the industry, the agency released an RFP to which the bidders have responded. After the release of RFP, the interested bidders attended a mandatory pre-bid meeting (FDOT 2009). PCL/Archer Western - Joint venture of PCL Civil Constructors Inc. and Archer Western Contractors was selected as a preferred bidder in the procurement process (FHWA n.d.).

B4 Project Brief of I-75 Roadway Expansion (iROX) Project

Name of the project: I-75 Roadway Expansion (iROX) Project

Location: Collier and Lee Counties, Florida

Duration: 2007-2010

Project Authority: Florida Department of Transportation (FDOT)

Description: The I-75 expansion project (iROX) widening of I-75 lanes in Collier and Lee counties. The components of the project are as follows (AASHTO n.d.; FHWA n.d., n.d.):

- Resurfacing and widening of 30 miles of I-75 from four lanes to six lanes from Golden Gate Parkway in Collier County to Colonial Blvd. in Lee County and addition of 12-foot travel lane and 10-foot paved shoulders
- Reconstructing the Immokalee Road interchange in Collier County
- Coordination with adjacent projects in the corridor including the Regional Traffic Management Center/ITS project, Lee County Estero Parkway extension bridge, I-75/Bonita Beach Rd interchange and I-75 from Colonial Blvd. to SR 82 widening

Background: The project comprised of 9 smaller DBB projects that were aimed to be completed by 2012. The agency decided to bundle the smaller projects into a single DBF contract to be constructed by a single contractor to obtain savings through economies of scale (Forcael et al. 2011b; Levy 2011). The funding for the final parts of the projects were not secured at the time of the project proposal. So the agency modified the contract to provide "bridge financing". The value of the final DBF contract is $458 million (Levy 2011).

Financial Structure of the project: The project is a lump sum contract for the designated work. The agency has identified the funding sources for the part of the project. The funding for the final parts of the project were not identified at the time of project development. So, at any point of the time, if the value of works completed exceeds the funds that the agency possess, the contractor would provide financing until the agency obtains the funding. The design & construction part of the project was estimated to be three years and the payments will be made in five years (Forcael et al. 2011b). Following is the payment plan of FDOT for the project:

Table 11: Payment Plan for Project B4

Year	Payments
2007	$123,681,345

2008	$77,90,312
2009	$78,925,287
2010	$74,078,847
2011	$49,541,524
2012	$26,359,252
Source: (Forcael et al. 2011b)	

Funding: Following are the sources of the funds used for the project (FHWA n.d.)

- Federal funds - $340 million
- State Growth Management Funds (GMR) - $81.6 million
- State Transportation Regional Incentive Program (TRIP) funds - $4.9 million
- State funds (excluding GMR and TRIP) - $26.3 million
- Local funds - $4.9 million

Financing: The contractor had to provide a bond of value $600 million dollars to ensure that project is completed in case of bankruptcy. Information on the financing arrangements of the contractor is not available.

Procurement: Each bidder for the project has to submit technical proposal and three bid price proposals for each of the three alternatives. A compensated score is calculated based on technical score, bid price of the alternative and the duration of the project as per schedule. The bidder and the alternative with the lowest compensated score was selected as preferred bidder. Two bidders submitted final proposals for evaluation (Forcael et al. 2011b). ACCI/API - Joint venture of Anderson Columbia Co. and Ajax Paving Industries were selected through the procurement process (FHWA n.d.).

B5 Project Brief of I-485 Charlotte Loop

Name of the project: I-485 Charlotte Loop

Location: Charlotte, North Carolina

Duration: 2011-2015

Project Authority: North Carolina Department of Transportation (NCDOT)

Description: The project is the last phase of I-485 Charlotte Outer Loop connecting I-77 and I-85. The project extends over an approximate length of 5.1 miles from NC 115 to I-85 north of Charlotte. The proposed improvements include a divided eight lane facility, interchange improvements, service road realignment, and bridge construction (FHWA n.d.; NCDOT 2010).

Background: The total cost of the project is $139.5 million.

Financial structure of the project:

The agency has an estimated maximum price of $156 million for the project. The cash availability schedule is as follows:

Table 12: Schedule of Payments for Project B5

Financial Year	July 1	October 1	January 1	April 1	Total
2011	9.7	5.6	4.2	8.4	27.9
2012	8.4	4.2	4.2	11.1	27.9
2013	12.5	5.6	5.6	7.0	30.7
2014	9.7	5.6	5.6	5.6	26.5
2015	9.7	4.2	4.2	2.8	20.9
2016	5.1	2.2	0.8	0.8	8.9
2017	0.9	0.8	0.8	0.8	3.3
2018	0.9	0.8	0.8	0.8	3.3
2019	0.9	0.8	0.8	0.8	3.3
2020	0.9	0.8	0.8	0.8	3.3
Total			156.0		
Source: NCDOT					

As per the RFP, at any point of the time, the cumulative payments requested exceeds the cumulative cash availability, the agency will reduce the invoice by the same amount. The contractor can add the same to the next invoice. If the total project cost from the proposal is lower than the cash availability, the difference will be deducted from last payments that are to be made.

Financing: Information on the financing arrangements of the contractor is not available.

Procurement: The procurement followed one stage two step process with separate technical and price proposals. Through the procurement process, the agency selected Blythe Construction Inc./Wilbur Smith Associates (now CDM Smith) as the preferred bidder (FHWA n.d.).

B6 Project Brief of I-285 & SR 400 Improvements (Transform 285/400)

Name of the project: I-285 & SR 400 Improvements (Transform 285/400)

Location: Fulton and DeKalb Counties, Atlanta metropolitan area, Georgia

Project authority: Georgia Department of Transportation (GDOT)/State Road and Tollway Authority (SRTA)

Background: Georgia DOT has combined two standalone projects, I-285/SR-400 interchange reconstruction and SR 400 collector distributor lanes into a single DBF project called Transform 285/400 with an estimated cost of 800 million. The project goals are

- Reduce traffic congestion
- Enhance safety
- Improve operational efficiency
- Save 12,500 hours per day by 2020
- Reduce weaving along I-285 and SR 400
- Improve ramp geometry at I-285/SR 400 interchange
- Prevent worsening traffic delays over time
- Support regional growth and development

The project has been a top transportation priority for GDOT for many years but delayed due to the lack of funding. An initiative to fund the project through Transportation Special Purpose Local-Option Sales Tax (TSPLOST) in 2012 has been rejected by the public. GDOT in partnership with SRTA has structured the project as a DBF with partial contractor financing. Other partners of the project include The Perimeter Community Improvement Districts (PCIDs), PATH foundation and the City of Sandy Springs.

Description: The construction of the project began in February 2017 and is expected to be complete in late 2020. The contractor/contractor for the project is North Perimeter Contractors (NPC), a subsidiary of Ferrovial Agroman US Corp. The project includes the construction of the following:

- Addition of collector-distributor lanes on SR 400 and I-285
- Reconstruction of Mount Vernon Highway bridge over SR 400
- Reconstruction of Abernathy Road and SR 400 interchange as a diverging diamond interchange (DDI)
- Reconstruction of Peachtree Dunwoody Road bridge over I-285

- Reconstruction of Glenridge Drive bridge over I-285

Funding: The total project cost is $803 million including planning, preliminary design, environmental approval, right of way acquisition, oversight, final design, construction, finance charges, construction engineering and inspection, binding and insurance. The cost of the Design-Build part of contract is $460 million. An upfront payment of approximately 231 million is made to the contractor before the start of the construction through bonds issued by SRTA ($130 million), funds from Perimeter Community Improvement Districts ($10 million) and State motor fuels tax ($81 Million). Post construction, the payments will be made by SRTA using Federal funds and State motor fuel tax revenue.

Financing: During the construction, a tax exempt loan of $458 million is issued by Bank of America to the contractor that will mature in 2022. Upon approved completion of each project milestone, SRTA would release approved project certificate under which the payment will be made. The contractor may sell, assign or pledge the project payments under an approved project certificate to lender. GDOT or SRTA are not liable for any debt service or financing costs except for any such pledged payments through approved project certificates.

Procurement: The Agency selected North Perimeter Contractors, a Joint Venture of Ferrovial Agroman, The Louis Berger Group and Neel-Shaffer Inc. as the preferred bidder for the project through competitive procurement (FHWA n.d.).

B7 Project Brief of Northwest Corridor Project

Name of the project: Northwest Corridor Project

Location: Atlanta, Georgia

Project Authority: Georgia Department of Transportation (GDOT), State Roadway and Toll Authority (SRTA)

Duration: 2013-2018

Description: The Northwest Corridor project extends 29.5 miles along I-75 and I-575. The project, through manged lanes, intends to provide reliable travel times through the dynamic tolling to maintain a speed above 45 miles per hour in the project. It includes the following components(FHWA n.d.):

- The extension of managed lanes from the current end of the high occupancy vehicle (HOV) lanes along I-75 at Akers Mill Road south of I-285
- Two reversible tolled managed lanes to the west of the existing general purpose lanes along I-75 between I-285 north and I-575
- One reversible tolled managed lane in the median along I-75 between I-575 and Hickory Grove Road and along I-575 to Sixes Road

Background: An intergovernmental agreement was made between GDOT and SRTA for collaboration for this project. The total cost of the project is $ 833.7 million.

Financial Structure of the project: Of the total project cost, about $500 million are provided through GDOT's funds. SRTA will receive a TIFIA loan, to be matured in 2053, by gross pledge of toll revenues of the project, subordinated in the cash flow to first lien obligations. The contractor will finance $59.9 million which will be repaid by using toll bonds to be released by SRTA of the magnitude $10 million and GDOT funds (motor fuel tax) (FHWA n.d.; GDOT 2012).

Funding & Financing:

- State motor fuel taxes - $232.9 million
- GDOT program funds (Federal and State) - $265.9 million
- TIFIA loan - $275.0 million
- SRTA toll bonds - $ 10 million
- Contractor financing - $ 59.9 million

Information on the financing arrangements of the contractor is not available.

Procurement: The procurement followed two stage process. An RFQ was released to interested private sector participants. Qualified bidders were given an RFP. Northwest Express Roadbuilders, a consortium comprising of Archer Western Contractors, The Hubbard Group and Parsons Corporation was selected as preferred bidder for the project based on Best-value selection (FHWA n.d.).

B8 Project Brief of Midtown Express (SH 183 Managed Lanes)

Name of the project: Midtown Express (SH 183 Managed Lanes)

Location: Dallas-Fort Worth Metroplex, Texas

Duration: Nov 2014- 2018

Project Authority: Texas Department of Transportation (TxDOT)

Description: The project is conceived to increase capacity and reconstruct portions of SH 183, SH 114 and Loop 12. The project will increase capacity of the three roadways by adding a managed toll lane, TEXpress lane, in both directions in the following regions (FHWA n.d.):

- SH 183 - 14.8 miles from SH 121 to I-35E
- SH 114 - 10.5 miles from SH 183 to International Parkway (westbound only from SH 161 to International Parkway)
- Loop 12 - 2.5 miles from SH 183 to I-35E

Background: The project is structured as DBF + O&M contracts. The total project cost of $1,415.1 million is as divided as follows:

- $847.6 million – Design & Construction
- $576.5 million – Preliminary engineering& environmental, Right of way acquisition, tolling systems, project management, professional services, risk mitigation and contingency

The cost of the O&M contract for 25 years is $171.8 million in 2014 dollars.

Financial Structure of the project: The contractor provided two price proposals, a Design and Construction proposal and an O&M proposal. Of the $847.6 million of the Design & Construction cost, TxDOT will provide $600 million during construction as progress payments. The contractor shall carry the financing of the balance $247.6 million which TxDOT will pay the contractor through annual payments in 5 years during the O&M period.

Funding: The funding sources for Design and construction of the project are paid through a combination Federal and state funds as follows:

- Federal funds - $680.5 million
- State Funds (Taxes, general funds etc.) - $387.1 million
- State/Federal Funds (expended until 2014) - $347.5 million

The cost of O&M will be paid through tolls collected by TxDOT. If the tolls collected are insufficient to cover the O&M payments, TxDOT will pay the rest through state funds. If the tolls collected exceed the projected amounts, the additional revenue will be shared.

Financing: The Agency did not use the private financing component of the DBF process as the funds available for DB part of the project become available.

Procurement: The procurement for the project followed a two stage process. A RFQ was released after consultation with the private sector and based on the responses, RFP was released to qualified bidders. Southgate Mobility Partners consisting of Kiewit Development Company, Kiewit Infrastructure South Co., Austin Bridge & Road LP and Parsons Transportation Group (design) is the selected bidder (FHWA n.d.).

C IRB Approval Letter

Division of Scholarly Integrity and
Research Compliance
Institutional Review Board
North End Center, Suite 4120 (MC 0497)
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-3732
irb@vt.edu
http://www.research.vt.edu/sirc/hrpp

MEMORANDUM

DATE: October 25, 2019

TO: Michael J Garvin, Vikas Gurram

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires January 29, 2021)

PROTOCOL TITLE: Assessing the Rise of Design Build Finance (DBF) Delivery Method in Transportation Infrastructure Delivery

IRB NUMBER: **19-814**

Effective October 25, 2019, the Virginia Tech Human Research Protection Program (HRPP) and Institutional Review Board (IRB) determined that this protocol meets the criteria for exemption from IRB review under 45 CFR 46.104(d) category(ies) 2(ii).

Ongoing IRB review and approval by this organization is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities impact the exempt determination, please submit a new request to the IRB for a determination.

This exempt determination does not apply to any collaborating institution(s). The Virginia Tech HRPP and IRB cannot provide an exemption that overrides the jurisdiction of a local IRB or other institutional mechanism for determining exemptions.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

https://secure.research.vt.edu/external/irb/responsibilities.htm

(Please review responsibilities before beginning your research.)

PROTOCOL INFORMATION:

Determined As:	**Exempt, under 45 CFR 46.104(d) category(ies) 2(ii)**
Protocol Determination Date:	**October 25, 2019**

ASSOCIATED FUNDING:

The table on the following page indicates whether grant proposals are related to this protocol, and which of the listed proposals, if any, have been compared to this protocol, if required.

Date*	OSP Number	Sponsor	Grant Comparison Conducted?

* Date this proposal number was compared, assessed as not requiring comparison, or comparison information was revised.

If this protocol is to cover any other grant proposals, please contact the HRPP office (irb@vt.edu) immediately.