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Impact of Project Environment Characteristics on PPP Value Creation and Innovation

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CASE EVIDENCE OF VALUE CREATION AND INNOVATION IN US HIGHWAY P3 PROJECTS

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ABSTRACT

Private sector innovation and creativity are touted as key value drivers of the P3 delivery. Scholars and governments alike have devoted significant attention to P3s and innovation. However, research to date is inconclusive in regard to the occurrence of innovation in P3s and lacks the required transparency to replicate and corroborate findings and conclusions. In order to assess if innovation is present or absent in the United States (US) P3 market, six transportation P3 projects in the US were chosen as cases: i) East End Crossing in Indiana, ii) Elizabeth River Tunnels in Virginia, iii) 1-4 Ultimate Improvements in Florida, iv) 1-77 HOT Lanes in North Carolina, v) North Tarrant Express 3AB in Texas, and vi) SH-288 Toll Lanes in Texas. Project documentation and interviews with key participants identified 60 technical enhancements within the cases. After systematically employing a multi-step rubric, nine of the identified technical enhancements were classified as innovative. Consequently, innovation is present in P3 projects, but minimally so. However, the remaining technical enhancements demonstrate that concessionaires do enhance project value by optimizing a project's design solution, which provides both cost and schedule savings. Further work will determine the influence of key project environment factors on P3 project innovation outcomes.

KEYWORDS

Public-private partnerships, innovation, case studies.

INTRODUCTION

Innovation is a claimed benefit of Public-Private Partnerships (P3s) and an important ingredient in the Value for Money (VfM) philosophy. Grimsey and Lewis (2002) highlight that the public sector needs to ensure VfM to the citizens in order to select a P3 over a traditional delivery of infrastructure. Yet, both government and private companies' documents in the US tend to expect innovative outcomes, but they do not subsequently provide much evidence of such. For instance, "FDOT expects structuring the Project procurement as a PPP [P3] will…allow FDOT and the traveling public to benefit from lifecycle cost optimization and technical innovation from industry" (FDOT, 2007, p. 93). However, subsequent documentation of these

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benefits is extremely limited, although private companies do on occasion prepare briefs or presentations that highlight outcomes such as cost savings.

Previous academic research exploring P3 innovation is also somewhat scarce, and the studies done are generally outside the US market. Further, this research has produced mixed results, so it is inconclusive (Gonzalez and Garvin, 2016). For instance, researchers have essentially explored the relationship between the same set of factors and innovation outcomes, but their findings are contradictory; Leiringer (2006) argued no or limited innovation was uncovered, while Rangel and Galende (2010) indicated innovation was present. In addition, several studies investigating P3 innovation are rather vague in their methodological approach toward its assessment. Given the weight placed on innovation in P3s as both a benefit and a justification of implementation, more research on this topic is needed.

Prior research (Gonzalez and Garvin, 2017) identified a comprehensive set of factors influencing innovation in infrastructure projects. These factors guided a multiple case study design of P3 projects to investigate P3 innovation further in the US P3 highway market. The cases explored will enhance understanding of the realities of this environment and how it impacts innovation outcomes. Consequently, this research: i) generates additional evidence on a topic that is still unsettled and ii) explores a market that to date has received limited attention in this area.

BACKGROUND

PRIOR WORK EXAMINING INNOVATION IN P3 PROJECTS

An investigation of the archival literature that has examined innovation in P3 projects identified seven papers that met the following criteria: i) performed empirical studies of innovation in P3 projects and ii) studied projects that were at least under construction or in operation. A comprehensive appraisal was done to uncover each article's: (1) motivation, (2) methodological basis, (3) approach for defining and assessing innovation, and (4) findings and conclusions.

Research motivation

Leiringer (2006) built upon construction and mainstream innovation theory indicating that several publications that promote P3 innovation were based in "anecdotal evidence and wishful thinking" (p. 303). Exploring some of the claims for the use of P3s, he focused on four arguments that are prominent in P3 for promoting innovation: improved design freedom, collaborative working, risk transfer, and long-term commitment. He highlighted government reports that mention that private sector innovation in P3s aims to achieve VfM. Eaton et al. (2006) based their research on "social and contextual factors that influence the creative and innovative [behavior] of individuals in construction organizations within the limited and constrained context of the PFI" (p. 64). Russell et al. (2006) described how the P3 model is considered a mode of infrastructure acquisition that taps the innovative capacity of the private sector. Part of the motivation for their study was to examine whether the common argument that the higher cost of financing and procurement are outweighed by private sector innovation.

Barlow and Koberle-Gaiser (2008) indicate that governments argued that PFI stimulated innovation from the private sector. To explore this, they use a framework that combines concepts of 'complex products and systems' (CoPS) and 'large technical systems' (LTSs). Rangel and Galende (2010) cite literature that argues that innovation can enable the private sector to provide more cost-efficient services and based their research on the Organization for Economic Co-operation and Development (OECD) Frascati manual for analysis of R&D activities and the Oslo manual for analyzing other innovative activities. Antillon et al. (2016) based their research on the 'promise' that P3s provide cost-saving innovations during the DB phase of the projects. In order to explore this argument, they employed "the lens of innovation theory" (p.1) using Henderson and Clark (1990) work as a foundation. Himmel and Siemiatycki (2017) argue the lack of empirical evidence in the literature that supports the populist arguments from practitioners that innovation is provided in P3 projects as the purpose of their research.

Methodological basis

Leiringer (2006) employed a multi method research design that included four case studies where data was collected through observational fieldwork, site visits, and interviews of senior personnel with experience in the following countries: Australia, Finland, Germany, Poland, Spain, Sweden, and the UK. Eaton et al. (2006) performed an empirical study of four PFI case studies utilizing text analysis of semi-structured interviews with senior construction industry practitioners and field-notes of interviews with client, special purpose vehicle (SPV), and contractor representatives. Russell et al. (2006) employed three case studies; the Confederation Bridge in Canada, university student housing in Canada (pursued as a P3 but later performed as a design-bid-build), and the Øresund Tunnel in Sweden.

Barlow and Koberle-Gaiser (2008) research consisted of six case studies of hospitals built under the PFI model in the UK with the National Health Services (NHS). They performed semi-structured interviews with experts from the NHS, the Department of Health, and PFI consultants. Rangel and Galende (2010) research consisted of a quantitative investigation using a questionnaire, which was sent to nine companies with P3 agreements. These companies had 68 highways concessions in Spain operating between 1996 and 2005. Antillon et al. (2016) utilized case studies as well to perform their research. Their study is the only paper of the seven papers identified to explore the US P3 market, exploring three case studies: i) Presidio Parkway Phase 2, ii) US 36 Managed Lanes Phase 2, and iii) Elizabeth River Tunnels. Himmel and Siemiatycki (2017) used mixed methods exploring the data on winning and losing proposals for 50 P3 projects procured by Infrastructure Ontario, performing semi-structured interviews to 17 participants, and subsequently performing two case studies.

Approach for defining and assessing innovation

Leiringer (2006) utilized the OECD definition of innovation: "Technological product and process (TPP) innovations comprise implemented technologically new products and processes and significant technological improvements in products and processes" (p. 303). Eaton et al. (2006) defined innovation as "the successful implementation of creative ideas; for something to be classified as creative it has to be novel to only the unit of adoption be it the individual, project team or organization" (p. 66). Russell et al. (2006) defined innovation "as the use of advanced technologies, methodologies, and creative concepts that result in a positive incremental change in basic project performance metrics. Metric concept includes time, cost, revenue, quality, scope and capacity, safety and environmental impact" (p. 1523). Barlow and Koberle-Gaiser (2008) defined innovation as design innovation, in the sense of physical adaptability, the "ability of a building to economically accommodate future changing requirements" (p. 1392). Rangel and Galende (2010) defined innovation according to the OECD Oslo Manual; "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (p. 50).

Antillon et al. (2016) defined innovation as the "implementation of a new or significantly improved technological change, in product or process design, that strategically benefits or improves the long-term lifecycle performance of a project" (p. 3). Once identified as an innovation, they used the level of change and the impact on components of the project in order to classify the impact of the innovation. Although these changes were hinted in the paper, it is not clear how they reached their conclusions. Although Himmel and Siemiatycki (2017) discussed the definitions of innovation used in other works in the innovation literature. The definition they used in their analysis was the one used by Infrastructure Ontario: "evolutionary novelties that raise the quality of the built structure, improve user efficiency and lower cost" (p. 8).They measured the innovation on the projects using two measures: i) variability on evaluation scores between bidders, where a bigger variability will indicate innovation; and ii) the difference between the winning bids cost and the original budgeted cost by Infrastructure Ontario, where a bigger difference highlighted higher innovation in the project.

Findings and conclusions

Leiringer (2006) found that P3 construction contracts are written in a "stringent" fashion, so their structure inhibits innovation. He also observed that the literature states that innovation and risk go hand-in-hand, and innovation brings uncertainty. He concluded that the common arguments that promote innovation in P3s – improved design freedom, collaborative working, risk transfer, and long-term commitment – are questionable. Eaton et al. (2006) found that construction companies want to innovate given the pressure they receive from clients to reduce costs and accelerate construction. Their results indicated innovation was largely unrealized. They found that the amount of impediments surpasses the stimulants, thus stifling innovation. Russell et al. (2006) identified 22 factors that might act as drivers or inhibitors of innovation in P3s. Their evidence was more anecdotal and not significantly founded on documentation; hence, they were unable to make strong conclusions about the presence of innovation. Barlow and Koberle-Gaiser (2008) uncovered two potential factors that affected innovation in PFI projects; first, the use of the public sector comparator (PSC) created pressure to drive cost down and hence reduced innovation, and second, the difference in culture between public and private parties hindered innovation, since interviewees in their study saw a “public sector mentality” that did not allow them to “think outside the box.”

Rangel and Galende (2010) proposed a model to study four characteristics in P3 contracts that could promote innovation: i) type of risk assumed by the private party, ii) transfer of design responsibility, iii) provision of penalties against private party, and iv) competition between bidders. Their results showed significant relationships between research and development (R&D), an influential factor for the promotion of innovation, and three of the characteristics: type of risk assumed by the private party, provision of penalties against private party, and competition between bidders. They suggest that further studies are required to determine if these or other characteristics affect commercial or organizational innovation. Antillon et al. (2016) uncovered innovation occurring in these P3 projects and concluded that contract timing has an influence on the amount and level of innovations that can occur in P3s. Himmel and Siemiatycki (2017) found cost-saving solutions are favored by the private sector given the innovation incentives present, that the innovations that occur are mainly incremental in nature that seek to find the “most efficient design for the project” (p. 14), and focus on new construction methods or technologies.

Summary

While definitions of innovation were provided in the paper set, the approaches taken to assess innovation in P3 projects varied in their transparency and clarity; in other words, replication of their findings would prove challenging. While Antillon et al. provided a general framework; other studies (such as Leiringer, Barlow and Koberle-Gaiser, and Rangel and Galende) were less clear about how they assessed the occurrence of innovation.

Further, four of the seven studies (Leiringer, Eaton et al., Russell et al., and Barlow and Koberle-Gaiser) did not uncover or uncovered limited innovation while the remaining three (Rangel and Galende, Antillon et al., and Himmel and Siemiatycki) found innovation. Numerous authors have argued that innovation is a key value driver for P3s; yet, the research examined here is inconclusive.

FACTORS INFLUENCING INNOVATION

The literature examining factors that act as barriers and enablers for the occurrence of innovation in infrastructure projects is rich. In particular, numerous authors (e.g., Tatum, 1984; Blayse and Manley, 2004; Bossink, 2004) have examined the factors, either enablers or inhibitors, of innovation in the construction industry, but this literature is fragmented. For instance, some research (Gambatese and Hallowell, 2011a) has explored leading indicators like: owner influence, innovation champions, collaboration, and integration; while other research (Gambatese and Hallowell, 2011b) has focused on causative factors such as: cost, productivity, and market share; while others (Tatum, 1984) have studied both. In addition, some authors have studied such factors in the context of P3s (Eaton et al., 2006; Russell et al., 2006); however, the relative significance of innovation factors within P3s has received limited attention.

Consequently, Gonzalez and Garvin (2017) completed an extensive review of the literature to identify factors that may impede or stimulate innovation in infrastructure project settings. These factors were placed into categories ranging from client characteristics to procurement processes. Further assessment of the literature distinguished categories most often linked with P3 outcomes such as innovation. Five categories were identified as particularly influential in P3 project settings: client characteristics, project organizational structure, procurement processes, project type, and risk profile.

POINT OF DEPARTURE

Innovation is viewed as integral to the value proposition of P3s. Although the archival literature examined does not negate that P3s could promote innovation, it shows limited evidence of its existence. Moreover, the number of studies examining innovation in P3s is quite limited; this is surprising given the emphasis innovation receives in the overall VfM equation. Further, research focused on the US market has yet to emerge. Accordingly, further investigation of this issue is necessary to both advance the state of knowledge and to provide evidence for interested stakeholders, i.e. the general public and legislators, of whether the innovation that P3 advocates and theorists are promising is occurring. The sparsity of evidence, the inconclusiveness of prior work, and the limited exploration of the US P3 market indicate the need to answer the following questions:

- **Is innovation present or absent in US P3 projects?**
- **If present, what type of innovation is it?**

METHODOLOGY

A multi-case study approach explores whether innovation is present and assesses the influence of innovation factors in the overall environment. According to Yin (1994) and Taylor et al. (2011), special attention has to be taken with the selection of the cases and the units of analysis, so they are relevant to the questions being studied. The technical enhancements proposed in P3 projects are the unit of analysis for this study.

Yin (1994) explains how case studies must be carefully selected so the set "(a) predicts similar results (a literal replication) or (b) produce contrasting results but for predictable reasons (a theoretical replication)" (p. 46). In this research, projects that are currently under construction are selected, and alternative replication logics are present. The set provides the opportunity to study projects with the same payment mechanism, projects in different jurisdictions but with the same payment mechanisms, and projects with the same contractors.

CASE STUDY SELECTION

Garvin and Bosso (2008) proposed that "a P3 is 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 [equity] at risk" (p. 163). Using this definition, then the contemporary US P3 highway project universe is 26, considering projects from 1993 to the present that have reached financial close.

A deliberate process is followed to select the cases for this research. Hence, projects implemented in the 1990's that are atypical of the current US P3 market and leases of brownfield assets where significant design & construction stages are limited are discarded. Similarly, projects that are not currently under construction are also discarded since activities or circumstances that might influence innovation are likely not easily recalled by human subjects or are undocumented. From the remaining projects, the innovation factors identified in the literature guide the selection of cases. While numerous factors were identified, the following are selected for their explanatory potential: i) *procurement approach*: competitive vs. non-competitive; ii) *public sector client*: leading vs. lagging; iii) *project type and scale*: fixed crossings vs. managed lanes and scale – \$500 million < contract value < \$1,000 million vs. contract value > \$1,000 million; and iv) *payment risk*: demand (tolls) vs. availability payments. Table 1 presents the cases selected based on the four factors identified along with additional relevant information.

Table 1: Selected Case Study Projects

Factors / Projects	**Financial close**	**Jurisdiction**	**Client**	**Project Type**	**Scale (Contract Value $100K)**	**Procurement Approach**	**Payment Risk**
Elizabeth River Tunnels (ERT)	April 2012	Virginia	Leading	Fixed Crossing	2,100	Predevelopment agreement	Demand Risk
East End Crossing (EEC)	March 2013	Indiana	Lagging	Fixed Crossing	763	Competitive	Availability Payment
N. Tarr. Exp. 3A&B (NTE)	September 2013	Texas	Leading	Managed Lanes	1,350	Predevelopment agreement	Demand Risk
I-4 Ultimate Imp. (I4)	September 2014	Florida	Leading	Managed Lanes	2,323	Competitive	Availability Payment
I-77 HL Charlotte (I77)	May 2015	North Carolina	Lagging	Managed Lanes	655	Competitive, but only one bidder submitted a proposal for the project	Demand Risk
SH 288 Toll Lanes (SH288)	May 2016	Texas	Leading	Managed Lanes	800	Competitive	Demand Risk

DATA COLLECTION & ANALYSIS

Utilizing project documentation and semi-structured interviews of 23 public and private sector participants with direct knowledge of the case study projects, technical enhancements proposed by concessionaire teams in these cases were assessed to determine project-level value creation and innovation. These enhancements were either submitted in compliance with the project's specifications or submitted and accepted through each project's defined Alternative Technical Concepts (ATC) process. A multi-step rubric was employed to assess whether each technical enhancement generated value and qualified as an innovation; the rubric was developed from prior work by Slaughter (2000), Russell et. al. (2006), Hartmann (2006) and Gambatese and Hallowell (2011b). The foundation for the multi-step rubric is the definition of innovation:

> *"Innovation is the actual use of a nontrivial change and improvement in a process, product, or system that is novel" (Slaughter, 1998, p. 226) "to the company developing or using it" (Slaughter, 2000, p. 2); and has the "potential of solving problems" (Hartmann, 2006, p. 572) or has the potential to diffuse "beyond just the initial project" (Gambatese and Hallowell, 2011b, p. 556).*

The rubric first employed a binary assessment of the following elements:

- Actual use - Was it applied in the project?
- Nontrivial - Does it entail more than just a scope modification or cost reduction?
- Change - Does it deviate from current practice and standards?
- Improvement - Does it provide a positive change?
- Process, product, or system - Does it entail a new process, product or system?
- Novel - Is it novel to the jurisdiction, client, or company?

This was done to differentiate between enhancements that solely generate value versus those that generate value and qualify as innovative. An enhancement deemed innovative was then evaluated to determine its degree of change in both core concepts and system linkages as shown in Figure 1. For example, an enhancement that reinforces core concepts and does not alter system linkages was classified as an incremental innovation whereas one that transforms core concepts and system linkages was classified as a system innovation. A modular innovation is a more significant improvement with a modification of core concepts but no changes in the links between other components of the project. An architectural innovation is one in which a small improvement in a core concept occurs, but prompts changes in the links between other elements or systems of the project. In addition, interviewees were queried about their views of the project environment and how it influences both value and innovation.

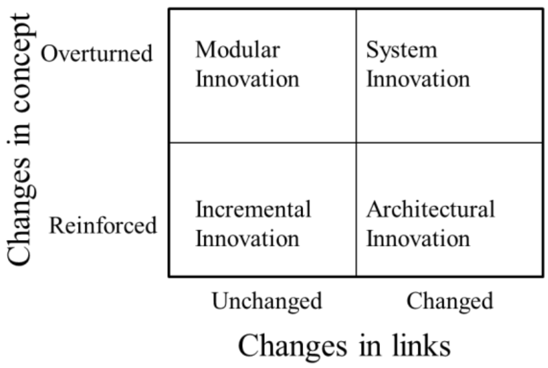

Figure 1: Framework to Classify Innovation (adapted from: Henderson and Clark, 1990 and Slaughter, 2000)

FINDINGS

INNOVATIVE TECHNICAL ENHANCEMENTS

The analysis of project documentation and interview data for the six projects uncovered 60 technical enhancements; a description and assessment of the complete set of technical enhancements identified are included in Appendix A. Interviewees generally considered the enhancements as "innovative." Table 2 provides a summary.

Table 2: Summary of Identified Technical Enhancements

Project	Technical Enhancements Identified	Proposed as Compliant	Proposed as ATCs	Innovative Technical Enhancements
I4	25	0	25	2
EEC	7	0	7	2
ERT	6	6	0	4
NTE	6	6	0	1
I77	11	8	3	0
SH288	5	3	2	0
Total	**60**	**23**	**37**	**9**

However, after completing the binary assessment of the framework to determine if a technical enhancement is innovative, only nine complied with all elements of the rubric and hence were classified as innovation. Interestingly, all levels of innovation were identified, except radical innovations. Table 3 summarizes the technical enhancements assessed as innovative; subsequent sections explain how they were classified into the different levels of innovation. Interviews responses are indicated by quotations and attributed to the interviewee using I1, I2, I3, etc. If multiple references are listed, the quote is attributed to the first and corroborated by those following.

Table 3: Innovative Technical Enhancements

#	Project	Description
Incremental		
1	I4	Use of precast edge girders that incorporate a curb along the external edge of the girder that eliminates the need for overhang falsework in the bridge deck
2	NTE	Conveyer system for reuse of pavement instead of trucks
Modular		
3	ERT	Use of a deluge fire suppression system, not previously used in Virginia
4	ERT	Use of jet-fans for ventilation system instead of transverse ventilation system
5	I4	Use of maturity meters to test concrete strength before 14 days and open roadway sooner to traffic
Architectural		
6	ERT	Tunnel cross section (box type) instead of circular

#	Project	Description
7	EEC	Optimized tunnel cross section and utilities within it
8	EEC	Shorten tunnel length by 220 feet on the south and 50 feet on the north, additionally reduced pillar width from 40 to 35 feet on south portal and widen to 40 feet subsequently inside the tunnel
System		
9	ERT	Immersed concrete tunnel instead of steel tube encased in concrete tunnel

Incremental

Two technical enhancements were classified at the lowest level of innovation. An incremental innovation is a small improvement that reinforces the concepts in current practice with unchanged or minimal impacts in the links with other components of the project. Incremental innovations were found on the I4 and NTE projects.

The technical enhancement identified in the I4 project was a submitted ATC by the winning proposer for the use of precast edge beams with deck form curbs, something not used previously in Florida and not specified in FDOT’s structures manual and design standards. The ATC used a “FIB (Florida I Beam) pre-stressed beam or equivalent section with a modified top flange that incorporates a curb along the external edge of the exterior girder… a concrete ‘curb’ would be cast on the edge of the top flange that acts as the deck form and eliminates the need for overhang falsework” (I4, Proposal). According to the concessionaire, the utilization of this incremental innovation will save $450K in crew time and an additional $140K in construction, while increasing safety for employees and the traveling public by avoiding the use of falsework on site. This technical enhancement is classified as incremental given its small improvement in practice and no impacts in the links to other activities.

In the NTE case, the use of a conveyer belt system to carry materials over traffic from the stockpile to the placement site was classified as incremental. “Traditionally we would have loaded it in trucks and hauled it to the other side. What they ended up doing was running a conveyer belt through one of the forms for the bridge beds, so they ran a conveyer belt through that form, put it on the conveyer belt on one side, and use the conveyer belt to convey it over the traffic to the other side where they were actually placing it. That saved us a ton of money, a ton of cost in trucking…and it also kept all those trucks out of the lanes where we had motorists… So that was an innovation in safety and project cost.” (I16). This construction technique was innovative for TxDOT and is one they indicate that they will use again. This is an incremental innovation because it was an improvement in the practice that lowered hauling cost and increased safety in the project, but the interaction with the other components remained the same because the crushed concrete was used in the same way as it was originally intended.

Modular

The I4 project provides an example of a modular innovation. In this case, the winning proposer, submitted an ATC to use maturity meters to test concrete compressive strength instead of waiting 14 days for testing representative cylinders before opening sections of pavement to traffic. The approved ATC allowed the use "ASTM C1074 (Standard Practice for Estimating Concrete Strength by the Maturity Method) in order to determine the compressive strength of the concrete pavement. Should the Maturity Method show the concrete to have sufficient compressive strength, that section of roadway may be opened to traffic earlier than the planned 14 calendar days" (I4, Proposal). While ASTM 1074 was adopted by ASTM in 1987, it is not adopted by FDOT; their standards require that "test cylinders, made in accordance with ASTM C31 and tested in accordance with ASTM C39, indicate a compressive strength of at least 2200 psi" (I4, Proposal). This ATC is a modular innovation since it represents a shift in the approach in the determination of compressive strength of concrete earlier but with no changes in the links with other elements. The use of this innovation reduced the schedule by ten substantial completion days, which, according to the winning proposer, translates to $1.1million in savings.

The second technical enhancement classified as a modular innovation occurred in the ERT project; it is the use of a deluge fire suppression system. The "sprinkler system or deluge system for the tunnels which is very unusual in the States…a deluge system which is like a sprinkler system on steroids, deluge meaning it's like you are standing in a hurricane" (I21). In this case this is a modular innovation because it provides a significant change in a core concept not previously used in Virginia without changes in links with other elements. Interestingly, this innovation could have impacted the design of the ventilation system, but VDOT decided to be more conservative and keep both systems as if the other was not present: "If you are going to pay all the money and rely on that system, those systems can be very effective at limiting the fire size and so why wouldn't you take advantage of that and downsize the ventilation system from say a 100 MW to 20 or 40 MW so you could have some savings and the state's position was they had never had a longitudinal ventilation system or a deluge system. So these are two systems they had no operating experience with. So, from their perspective they weren't comfortable with counting on both systems operating, they were more comfortable assuming one was going to operate and maybe the other wasn't. So it is a little bit of belt and suspenders, perfectly understandable" (I21). The ERT ventilation system is the third modular innovation. The use of a jet-fan ventilation system, which moves the air longitudinally with traffic instead of the traditional transverse ventilation system, brings a new technology not previously used by VDOT. As with the deluge system, the jet-fan provides a significant improvement in practice overturning the core concept, but with no changes in the links with other elements of the project.

Architectural

Of the nine identified innovative technical enhancements, three were architectural. Interestingly, these three are from tunnel designs in the ERT and EEC project. The winning proposer for the EEC project submitted two ATCs related to the tunnel design. The first one requested a change in the position of the portals of the tunnels, shortening the tunnel in the south by 220 feet and in the north by 50 feet, for a total tunnel reduction of 270 feet. Additionally, this ATC requested a reduced pillar width in the south portal from 40 to 35 feet providing improved constructability. Together this generated significant savings: "the winning proponent, their profile was compliant for about 2/3 of the length of the tunnel, but outside the envelope for about 1/4 of the tunnel length so they bear all that risk in that zone but they saved quite a lot of money in rock excavation and a much better balanced project from an earthwork stand point" (I5). The incorporation of this ATC also reduces the size of the fire, ventilation, lighting, and drainage systems within the tunnel. This allowed a deduction on the availability payment of $1.1 million which translates to a net present value of approximately $21 million. The other ATC related to the tunnel was an optimization of the tunnel cross section and its systems. This was a partially accepted ATC, given several of the items within it were deemed compliant with the technical requirements of the project. This architectural innovation of optimizing the cross section of the tunnel allowed the concessionaire to: “reduce the required liner reinforcement and allow for a more suitable reinforcement size and spacing. Due to the tight constraints in which the reinforcement is to be installed above the formwork, the ATC will improve the construction safety of those placing the material. The increased reinforcement spacing will allow for proper concrete consolidation between the bars and provide a higher quality concrete liner” (EEC, ATC 14). This ATC also optimized the fire suppression system allowing the scope reduction of the ventilation system, which will lower operation and maintenance costs due to lower energy consumption. These two ATCs provide small improvements within a core concept, but prompted and required changes in the links with other components of the project.

The third architectural innovation was identified in the cross section (Figure 2) of the new Midtown tunnel in the ERT project. “In the early discussion or design period it became evident that we could dig a shallower trench if we went to a flat box structure as opposed to a circular structure, which is shallower. It made a huge difference to the amount of material we had to drench from the bottom of the river and that then allowed us to change the tunnel type from steel to concrete” (I21). The selection of this shallower box type cross section influenced the selection of the jet-fan ventilation system (a modular innovation discussed previously): “Here going with a shallower structure which reduced the dredge we went with jet-fans, so there were no ducts. Fans mounted in the roadway itself, the roadway prism so to speak, that blow air only in one direction, so it is a longitudinal ventilation system. That allowed for a more efficient ventilation system that allowed it to handle a much larger fire so it saves money” (I21). This enhancement highlights a change in a core concept, a tunnel cross section, influencing other elements of the system, in this case the selection of the ventilation system.

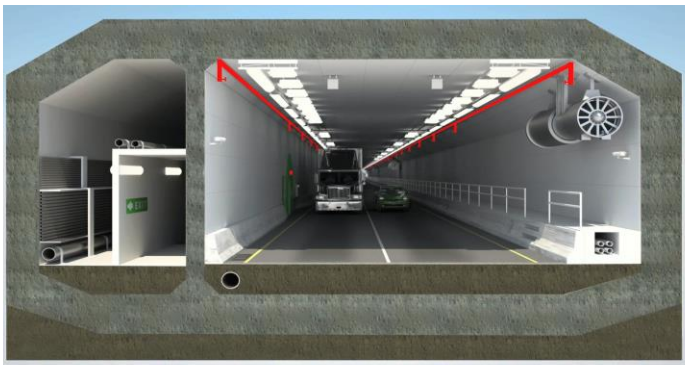

Figure 2: Cross section of ERT tunnel showing jet-fan and deluge system (ERT, 2017)

System

One of the nine innovations identified was classified as a system innovation. Moreover, the selection of a box type cross section, the architectural innovation in the ERT project just discussed, influenced the selection of a concrete tunnel instead of a steel-shell tunnel. In this case, the use of an immersed concrete tunnel is composed of complementary innovations that make this a system innovation. The private consortium suggested a curved alignment to avoid excavating next to the existing tunnel to avoid damaging the structure. “The initial VDOT proposal had envisioned building a new tunnel parallel and very close to the existing tunnel which will require, once placing an immersed tunnel you will need to make a very deep excavation…sediments under water don't stand up well, you have to lay the slopes back at a very flat angle of about 3:1 and the closer you get the new excavation to the old tunnel the more of the old tunnel you take soil off and you risk uncovering it. Basically you then subject the existing tunnel to an un-trussed horizontal load that makes the old tunnel want to slide into your new hole” (I21). The new alignment, not previously considered by VDOT, introduced “a very broad S curve underwater in the tunnel to get the new tunnel further away from the existing tunnel” (I21). The tunnel was built in 11 sections in a dry-dock facility in Maryland using a specially designed concrete mixture. The tunnel sections were built with temporary bulkheads so they can float. They were then towed to the jobsite and prepared for immersion.

A dredge barge with a crane was used to excavate the trench where the tunnel was placed, approximately 1.5 million cubic yards of sediments were removed (ERT, 2017). Once the excavation was finished, approximately 2 feet of gravel was placed and leveled at the required slope where the tunnel will rest. The 11 tunnel sections were placed one per month using "a special 'catamaran' barge with placing girders spanning the opening between the barge halls. The barge was capable of receiving, supporting, ballasting, and lowering the negatively buoyant" (ERT, 2017) sections of the tunnel. To achieve the negative buoyancy required, temporary water tanks were placed in the tunnel sections and filled with 4 million gallons of water (Forster, 2014). Given the curved alignment and to ensure the vertical and horizontal alignment of the sections, removable survey towers attached to the sections combined with GPS technology were used. Each section of the tunnel was outfitted with thick rubber seals that once in place and the water was pumped out created a water tight seal between sections. After placing the sections, the excavation was backfilled to prevent horizontal displacement and covered. Finally, an armor stone cover was provided to prevent damage to the tunnel from anchors or scour.

The use of an immersed concrete tunnel is certainly innovative: “All tunnels down here, all the immersed tunnel here are steel binocular tunnels, they are basically big steel tubes underwater and there is an air duct above and air duct below and the road is in the middle…it required getting everybody comfortable with a different structure type and a different layout of the structure” (I21). The change in core concepts in means and methods to build, transport, and place the tunnel sections and the changes in links and interaction between the elements make this a system innovation. The classification of the identified innovations is shown below in Figure 3.

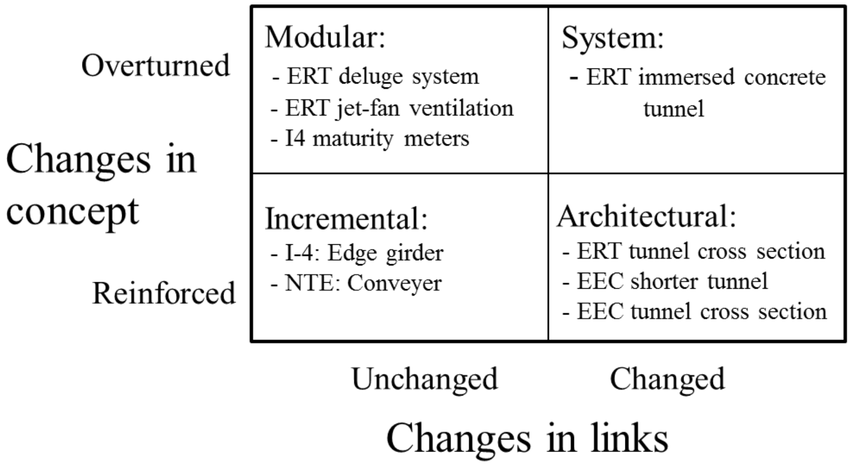

Figure 3: Classification of Identified Innovative Technical Enhancements

Value Added Technical Enhancements

The other 51 technical enhancements analyzed did not meet the innovation threshold for different reasons; however, they still provided added value to the projects. In several instances the technical enhancements complied with all elements of the rubric except the novelty aspect to the jurisdiction. This was the case with the use of weathering steel in the EEC and ERT projects, the use of a roundabout in the EEC project, and the use of reclaimed aggregates and high definition CCTV in the I4 project. However, a majority of the ATCs and elements mentioned as innovative in the interviews or the proposals highlight the use of value-adding approaches from the private concessionaire to optimize the preliminary design of the project to reduce the construction of bridges and overpasses by redesigning intersections and saving millions of dollars in construction.

The I4 project provides several instances in which the ATCs while not innovative provided substantial savings by optimizing the design. A clear example is the Michigan-Kaley Interchange Realignment (ATC 19); the original design had the roadway going over a relic sinkhole via a flyover. By realigning the roadway and avoiding the relic sinkhole, the concessionaire estimated savings of $39 million and 36 days on substantial completion. An interviewee mentioned how they achieved this optimization by requesting deviations to some ramp widths and exit velocities to avoid the relic sinkhole; by changing the geometry "versus trying to drive deep piles and put that section on a bridge, we moved it over. We managed to realign the roadway, adjust different ramps and things in another interchange so that we could squeeze by the relic sinkhole, again, just a better engineering solution" (I22).

A similar situation was found on SH288, where the reconfiguration of the IH 610 interchange allowed the relocation of toll lanes at grade, eliminating the need for a fifth level interchange. "The result was an interchange that was more connected, better driver experience, because they don't have to drive through a fifth level giant ramp over this whole interchange, reduction of environmental impacts if you don't have this huge structure, and a huge impact to the traffic and revenue study [we] were able to project a lot more revenue and in the end we were able to give a concession payment to TxDOT of $25 million at financial close" (I11).

Another example of this type of optimization is seen in the NTE project. This project benefitted from not having the environmental impact statement (EIS) finished when the private partner got involved. A private participant mentioned this allowed the project to become an "enhanced ATC" (I23) process that permitted the submission of creative ideas. After performing traffic and revenue studies and analyzing connectivity and congestion issues within the project, the concessionaire suggested the extension of the managed lanes by 1.2 miles. This provided new connections and increased revenue to the asset. The added revenue paid for the new construction and reduced the public contribution by $150 million (Saenz de Ormijana and Rubio, 2015).

NEXT STAGE

The next stage of this research will analyze the case study information to explore how project environment characteristics affect P3 innovation outcomes. Based on the case evidence examined to date, procurement processes, client characteristics, and specifications are most influential.

CONCLUSIONS

This research analyzed project documentation and interview data to identify technical enhancements in six US highway P3 projects. Consequently, 60 technical enhancements were identified. After employing the multi-step assessment framework, nine technical enhancements met the innovation threshold and were classified. All levels of innovation were uncovered, except radical innovation. This is not surprising as a radical innovation is described by Slaughter (2000) as something completely new that makes prior technology, process, or product completely obsolete.

The remaining 51 technical enhancements, although not innovative, did provide value to the projects providing savings in construction cost and time. The technical enhancements show that the private sector generates value mainly by optimizing the design solutions – essentially, their engagement in the procurement process brought additional "value engineering" in each case. This optimization appears enhanced in projects where the client is experienced in the procurement of P3 projects, like Texas, Virginia, and Florida; further, it is also appears that significant innovation or value engineering is more likely when the private concessionaire is engaged earlier in project development process – the single system innovation example, the immersed concrete tunnel, was found in the ERT case and the extension of a project's footprint, which reduced the public contribution by $150 million, was found in the NTE case. Observations such as these will be further explored in the next stage of this research by analyzing the identified innovation and value added technical enhancements against the four project factors: client characteristics, procurement processes, project type, and risk profile.

This research contributes to the body of knowledge by employing a framework for assessing and classifying innovation in a systematic, transparent, and replicable way that allows the corroboration of findings and can be utilized by future researchers. Additionally, this investigation contributes to the body of work on innovation in P3s by providing new findings of a market that has not been studied in depth. Further, this research provides information to practitioners, that engaging the private sector creates more value so than innovation.

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APPENDIX A

Identified Technical Enhancements

All of the these identified technical enhancements and ATCs form part of the proposal submitted by the winning proposers and were actually used in the projects, hence all comply with element 'A' of the rubric employed in this research to identify and assess innovation.

A. Actual use - Was it applied in the project?
B. Nontrivial - Does it entail more than just a scope modification or cost reduction?
C. Change - Does it deviate from current practice and standards?
D. Improvement - Does it provide a positive change?
E. Process, product, or system - Does it entail a new process, product or system (PPS)?
F. Novel - Is it novel to the jurisdiction, client, or company?

SH288								
#	Description	A	B	C	D	E	F	Meets Threshold
1	ATC 5A: Reconfiguration of IH 610 interchange; this ATC relocates toll lanes at grade instead of having them at a fifth level flyover in the interchange, it also increases connectivity between SH288 and IH 610 towards the general purpose lanes and new managed lanes	Y	Y	N	Y	N	N	Alters interchange from original configuration and provides substantial savings by eliminating a fifth level flyover, and is expected to increase revenue; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
2	ATC 5D: This ATC is contingent to ATC 5A; it provides improvements to the toll configuration by eliminating ingresses an egresses to the managed lanes at Reed Road given the new connectors added in ATC 5A	Y	Y	N	Y	N	N	Increases safety due to the elimination of the ingresses and egresses of the managed lanes toward the general purpose lanes and vice versa given the new movements incorporated in ATC 5A; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.

3	"Innovative Concept" from proposal document: Potential to increase design speed from 60 to 65 mph north of Belfort and from 60 to 70 mph south of Belfort, improving traffic and functionality	Y	Y	N	Y	N	N	The change in design speed will improve traffic and the functionality of the managed lanes providing a nontrivial improvement to the usage of the managed lanes; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
4	"Innovative Concept" from proposal document: Realignment of ramps south of IH 610 between Almeda and SH288 providing a reduction on right of way acquisition from 40 feet to 15 feet	Y	Y	N	Y	N	N	The realignment will provide savings in right of way acquisition costs, providing a nontrivial improvement in the cost of the project; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
5	"Innovative Concept" from proposal document: Realignment of a portion of SH288 to avoid the re-localization of two existing storm water pumps, an opening in the inside barrier will be left in place to provide access to maintenance vehicles	Y	Y	N	Y	N	N	The realignment of SH 288 in Brays Bayou provides a nontrivial improvement in project cost by avoiding the re-localization of two storm water pumps and the respective utilities; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
						I77		
#	Description	A	B	C	D	E	F	Meets Threshold
6	ATC-1: Optimization of I-77/I-85 interchange design by reallocating the HOT lanes eliminating a third level structure and reducing noise impacts to residential community	Y	Y	N	Y	N	N	The optimization of the interchange eliminates a third level flyover providing substantial savings; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
7	ATC 9: Provide a variance to bridge widths over Lake Norman allowing the widening of the existing structures towards the median instead of outside avoiding encroaching on the lake	Y	N	N	Y	N	N	By widening the bridge in the median instead of towards the lake there are improvements by diminishing potential environmental impacts to the lake; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
8	ATC 16: Sound barriers to remain and not demolished as original scope by reducing shoulder width	Y	N	N	N	N	N	By reducing the shoulder with, sound barriers built ten years prior will remain in place; but this does not comply with any of the elements of the rubric except actual use.
9	"Other Innovations" from proposal document: Temporary detour road to alleviate impacts during construction	Y	N	N	N	N	N	The use of a temporary detour road alleviates traffic during construction; but this does not comply with any of the elements of the rubric except actual use.

10	"Other Innovations" from proposal document: Construction access directly from existing overpasses to median to minimize disturbances in traffic	Y	N	N	N	N	N	The use of the existing overpasses to provide access points to the construction of the managed lanes minimizes impacts to traffic and improves safety; but this does not comply with any of the elements of the rubric except actual use.
11	"Other Innovations" from proposal document: Maximizing the use of existing pavement by separating HOT lanes in a portion of highway	Y	N	N	N	N	N	The alignment of the managed lanes avoided new construction by using existing pavement; but this does not comply with any of the elements of the rubric except actual use.
12	"Other Innovations" from proposal document: Optimization of I-277/I-77 Interchange design by modifying horizontal alignment and reducing the use of straddle bents to just one	Y	Y	N	Y	N	N	The improvement in horizontal alignment allowed a reduction in straddle bents; but this is not a deviation in standard practice, does not provide a new PPS, and is not novel.
13	"Other Innovations" from proposal document: I-77 realignment to minimize impacts to historical properties	Y	N	N	N	N	N	The realignment of the highway reduced impacts to historical properties; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
14	"Other Innovations" from proposal document: Compatibility with Charlotte Railroad Improvement and Safety Program (CRISP) and current design	Y	N	N	N	N	N	Realigning the expansion of the highway to avoid reconstruction given a foreseen expansion of the railroad; but this is not a deviation in standard practice, does not provide a new PPS, and is not novel.
15	Reducing shoulder pavement thickness	Y	N	N	N	N	N	The reduction of shoulder thickness is just a cost reduction; it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
16	Addition of lanes to avoid weaving from managed lanes to general purpose lanes	Y	Y	N	Y	N	N	The addition of lanes to avoid weaving between the ingress and egress points of the managed lanes increases the safety aspects of the project; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
EEC								
#	Description	A	B	C	D	E	F	Meets Threshold

17	ATC 3: Replace a crossover diverging diamond and traffic signals with two multi-lane roundabouts	Y	Y	Y	Y	Y	N	The use of the roundabout in lieu of the original design provided a solution that saved in: right of way acquisition, construction cost, and time; it will also have lower O&M costs and increase traffic safety. Additionally, it provides a potential reduction of $900K in monthly availability payments (MAP); but the use of roundabouts is novel to the region of the project but not to InDOT or the state of Indiana.
18	ATC 4: Provide an alternative access road instead of the realignment of existing road and construction of new bridge	Y	Y	N	Y	N	N	The use of an alternate access point allowed the avoidance of realigning an existing road and the construction of a new bridge structure improving traffic in the community, and lowering environmental impacts while providing a potential MAP saving of $70K; but this is not a deviation in standard practice, does not provide a new PPS, and is not novel.
19	ATC 5: Shorten tunnel length by 220 feet on the south and 50 feet on the north, additionally reduced pillar width from 40 to 35 feet on south portal and widen to 40 feet subsequently inside the tunnel	Y	Y	Y	Y	Y	Y	Shorten tunnel length by 270 feet, avoided shale layer to reduce temporary support, shortened project duration as tunnel was on critical path, avoided the disposition of 500K CY of material. The MAP will be lowered by an estimated $1.1MM.
20	ATC 6: Elimination of a 840 feet flyover ramp and replacement with a single point interchange	Y	Y	N	Y	N	N	The elimination of the flyover ramp provided an increase in safer operations and provides saving in estimated MAP of $225K; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
21	ATC 9: Use of uncoated weathering steel instead of painted structural steel	Y	Y	Y	Y	Y	N	The use of weathering steel which creates protective rust instead of structural steel which requires costly maintenance and upkeep of the paint provides savings in construction and O&M, this translates to an estimated $738K saving in MAP; but it is novel to InDOT.
22	ATC 14: Optimized tunnel cross section and utilities within it	Y	Y	Y	Y	Y	Y	The optimization of the tunnel cross section allowed the reduction of the width of the walkway, minimized the liner thickness, and improved the efficiency of the ventilation and fire suppression systems; all of this provided a potential discount of $620K in MAP.
23	ATC 15: Request for concessionaire to design shoulder pavement to its choice (accepted with conditions)	Y	N	N	N	N	N	The reduction of shoulder thickness is just a cost reduction; it is not a deviation in standard practice, does not provide a new PPS, and is not novel.

NTE								
#	Description	A	B	C	D	E	F	Meets Threshold
24	Extension of managed lanes south by 1.2 miles	Y	Y	Y	Y	N	N	The extension not previously considered as part of the project and not included in the at the time ongoing environmental impact statements studies allowed a deduction of $150 MM in government contribution after paying for itself and providing additional revenue to the SPV, by alleviating congestion in an important intersection which increased traffic considerably for the project; but the construction itself is not novel.
25	Rearrangement of I35W/I-820 interchange	Y	Y	N	Y	N	N	The rearrangement of the interchange provided enhanced mobility form the original design; but this is not a deviation in standard practice, does not provide a new PPS, and is not novel.
26	Revision of general purpose lanes and managed lanes vertical alignment configuration	Y	Y	N	Y	N	N	The at grade solution provided with this technical enhancement provided a cost improvement from the original design; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
27	Design bridge to use shorter span and reduce steel and concrete instead of using a longer span steel beams	Y	N	N	Y	N	N	The reduction in scope to design for shorter span concrete instead of longer span steel beams provided improvements in cost savings; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
28	Additional general purpose lanes	Y	Y	N	Y	N	N	Additional general purpose lanes improve the level of service; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
29	Conveyer system for reuse of pavement instead of trucks	Y	Y	Y	Y	Y	Y	The use of a conveyer system to transport recycled pavement from its source to its final placement place instead of having trucks hauling the material reduced costs and increased traffic safety by not having trucks in traffic. This type of construction method had not been previously seen by TxDOT personnel and was novel to them.
ERT								
#	Description	A	B	C	D	E	F	Meets Threshold
30	Use of jet-fans for ventilation system instead of transverse ventilation system	Y	Y	Y	Y	Y	Y	The longitudinal jet-fan system is a new technology not previously used by VDOT who is a substantial improvement over the transverse ventilation system used by VDOT.

31	Immersed concrete tunnel (box culvert) instead of steel tube encased in concrete tunnel	Y	Y	Y	Y	Y	Y	All tunnels in Virginia had previously been steel-shell tunnels; the immersed concrete tunnel brought new construction and design methods and processes in Virginia.
32	Tunnel cross section (box type)	Y	Y	Y	Y	Y	Y	Having a box type cross section instead of a circular cross section as previously used in Virginia allowed less excavation and allowed the selection for concrete over steel as the tunnel material.
33	Use of a deluge fire suppression system	Y	Y	Y	Y	Y	Y	The deluge fire suppression system is a new technology not previously used by VDOT; it increases substantially the safety of the users of the tunnel.
34	Use of weathering steel instead of painted structural steel (specified by owner after analysis of initial cost vs. long term investment)	Y	Y	Y	Y	Y	N	The use of weathering steel which creates protective rust instead of structural steel which requires costly maintenance and upkeep of the paint provides savings in construction and O&M; but it is novel to VDOT.
35	Replacement of stainless steel reinforcing for bridge decks for epoxy coated reinforcing steel	Y	N	N	N	N	N	The replacement of stainless reinforcing steel which provides a better solution and a longer life over epoxy coated reinforcing steel was a reduction in cost; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
					I4			
#	Description	A	B	C	D	E	F	Meets Threshold
36	ATC 4R2: Build 11 feet wide lanes on urban arterials instead of 12 feet as prescribed in specifications	Y	N	N	Y	N	N	A reduction in scope that will allow faster construction and construction savings estimated at $2.4 MM. This is allowed in AASHTO Greenbook and is not a deviation in standard practice, does not provide a new PPS, and is not novel.
37	ATC 6 R1: This ATC proposes to use recycled concrete aggregate (RCA) from the I4 project as aggregate for the base	Y	N	N	Y	N	N	Provides a potential $5.2 MM in savings by using RCA instead of new material. This cost reduction provides an improvement in construction cost. However, although a materials bulletin did not allow its use in projects with Federal aid, a new FDOT specification allowed its use, predicated in research performed at the University of Florida. It is not a deviation in standard practice, does not provide a new PPS, and is not novel.

38	ATC 7 R2: This ATC proposed the use of precast edge girders that incorporate a curb along the external edge of the girder that eliminates the need for overhang falsework in the bridge deck	Y	Y	Y	Y	Y	Y	FDOT specifications considered typical girders and did not consider the deck form curb. The use of this modified precast beam was previously used by the proponent in projects in North Carolina, but not used before in Florida and is expected to provide $450K in schedule savings and $140K in construction. It also provides increased safety by reducing the need for forming the overhang.
39	ATC 14: Use maturity meters to test concrete compressive strength instead of waiting 14 days for testing representative cylinders	Y	Y	Y	Y	Y	Y	While ASTM 1074 was adopted by ASTM in 1987, it is not adopted by FDOT; their standards require that test cylinders be performed or that 14 have passed in order to open a segment to traffic. This complies with all elements of the rubric.
40	ATC 15*: Wymore-Riddle overpass reconfiguration	Y	Y	N	Y	N	N	The rearrangement of the interchange provided enhanced mobility form the original design; but this is not a deviation in standard practice, does not provide a new PPS, and is not novel.
41	ATC 19*: Michigan-Kaley interchange realignment	Y	Y	N	Y	N	N	The rearrangement of the interchange provided enhanced mobility form the original design; but this is not a deviation in standard practice, does not provide a new PPS, and is not novel.
42	ATC 20 R2*: I-4/SR 408 direct connection proposal	Y	Y	N	Y	N	N	Providing a direct connection alleviates traffic; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
43	ATC 21: Use reclaimed limerock aggregate for new aggregate base	Y	N	N	Y	N	N	Provides an improvement in estimated costs of $3.7MM by utilizing reclaimed limerock from the existence base instead of new material, but this is not a deviation in standard practice, does not provide a new PPS, and is not novel.
44	ATC 24*: Redesign Formosa Curve to comply with stopping sight distance	Y	N	N	N	N	N	Provides a typical section instead of a wide section to comply with stopping sight distance due to the elimination of a toll gantry in the final RFP. This is not a deviation in standard practice, does not provide a new PPS, and is not novel.
45	ATC 26 R1*: Provide an optimization to the fly-under ramp at Orange Blossom Trail (OBT)	Y	Y	N	Y	N	N	The optimization of the interchange provided enhanced mobility form the original design; but this is not a deviation in standard practice, does not provide a new PPS, and is not novel.
46	ATC 27*: Kirkman Road pedestrian bridge	Y	Y	N	Y	N	N	The construction of a new pedestrian bridge not previously considered in the RFP increases safety; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.

47	ATC 28: recently installed pipes to remain	Y	N	N	Y	N	N	The reduction of scope of allowing the recently installed pipes to remain instead of installing new ones provides cost savings; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
48	ATC 29 R2*: This ATC provided additional auxiliary lane – EB I-4 Princeton to Fairbanks to improve capacity	Y	Y	N	Y	N	N	This ATC added $1.23 MM of additional scope in the project improving the level of service. However, the construction of new general purpose lanes does not deviate from current practice, provide a new PPS, or is novel.
49	ATC 30 R1*: This ATC provided additional auxiliary lane – WB I-4 Maitland to Lee to improve capacity and reduce weaving distance between ramps	Y	Y	N	Y	N	N	This ATC added $1.28 MM of additional scope in the project improving the level of service and increasing the weaving distance between two ramps; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
50	ATC 31*: Elimination of median rail corridor	Y	N	N	Y	N	N	Eliminates the rail corridor depicted in the design plans but eliminated from the RFP, it provides an estimated $8.7MM in savings, but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
51	ATC 32: Use of high definition CCTV instead of analog as required in the RFP	Y	Y	Y	Y	Y	N	Provides an improved technology over the required in the RFP and not currently used by FDOT; however it is used by other agencies in Florida.
52	ATC 34*: This ATC provided additional auxiliary lane – WB I-4 OBT to Conroy to improve capacity	Y	Y	N	Y	N	N	This ATC added $2.18 MM of additional scope in the project improving the level of service which includes the widening of an overpass bridge; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
53	ATC 36: This ATC proposes to increase the floor plan of the toll equipment buildings to allow space to house the ITS equipment in a separate room, instead of building two separate structures	Y	N	N	N	N	N	This ATC provides a trivial reduction in scope. That does not deviate in standard practice, does not provide a new PPS, and is not novel.
54	ATC 38 R1*: This ATC provides additional auxiliary lane – EB I-4 Colonial To Princeton to improve capacity and improves an exit that used to overflow with traffic previously	Y	Y	N	Y	N	N	This ATC added $1.91 MM of additional scope in the project improving the level of service and includes improvements to an exit to alleviate traffic overflow; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
55	ATC 39 R1*: Division-Kaley intersection improvements	Y	Y	N	Y	N	N	The improvements of the interchange provided enhanced mobility form the original design; but this is not a deviation in standard practice, does not provide a new PPS, and is not novel.

56	ATC 41 R1 Option 2*: Maitland Summit Boulevard grade separation and geometric realignment to convert to a tight urban diamond interchange	Y	Y	N	Y	N	N	This ATC added $9 MM of additional scope in the project improving the level of service and reducing traffic overflow; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
57	ATC 42*: Garland Avenue alignment modification	Y	Y	N	Y	N	N	The refinement of the original design provided a potential saving of $3.8MM; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
58	ATC 43*: Lee Road Lane revision	Y	Y	N	Y	N	N	Provides improvements to the capacity of Lee Road, but this is not a deviation in standard practice, does not provide a new PPS, and is not novel.
59	ATC 45: This ATC proposed to utilize the same back-up generators at toll gantries for ITS and toll equipment	Y	N	N	Y	N	N	This ATC eliminated the purchase of separate power generators for tolling equipment and ITS equipment by upsizing the generators and using one for both equipment's. This constitutes a reduction in scope that provided an improvement in cost of $346K; but it is not a deviation in standard practice, does not provide a new PPS, and is not novel.
60	ATC 49 Option 1*: SR408 WB reconfiguration	Y	Y	N	Y	N	N	The reconfiguration of the interchange provides enhanced mobility form the original design and created an estimated $28 MM in savings; but this is not a deviation in standard practice, does not provide a new PPS, and is not novel.