Evaluating the Financial Cost and Impact on Long-Term Pavement Performance of Expediting Michigan's Road Construction Work

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Abstract

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16. Abstract

The Michigan Department of Transportation (MDOT) has been using monetary incentive payments for many years to accelerate highway construction work, resulting in reduced delays to the traveling public. It was envisioned that incentive/disincentive (I/D) payments/penalties would capture the true cost (user delay savings vs. actual I/D dollars) and would have positive impacts on the long-term pavement performance by extending its expected life. Therefore, MDOT sponsored this research study to determine whether the I/D for expediting construction captures the true cost and identify its impacts on the long-term pavement performance for projects that have been expedited vs. conventional scheduling. The analyzed data statistically supports an improvement in the long term project performance for the incentive projects. Also, identified data suggests a trend that incentive clauses accelerate project schedules. Additionally, data analysis statistically supports the idea that incentive clauses increase project cost but further analysis finds that the avoided user delay was higher than the additional paid cost for some incentive clauses. The analysis results highlight the effectiveness of Accepted for Traffic and Interim Completion incentive/ Disincentive clauses; they also debate the effectiveness of the lane rental incentive/ disincentive clauses, in achieving their goal by accelerating project schedules and reducing user delay cost. Also, the report calls for little modification to the listed "Advantages and Disadvantages" and "Recommendations for Use" of each acceleration technique in the 2013 MDOT Innovative Construction Contracting document.

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Table of Contents

Contents

List of Tables

List of Figures

List of Acronyms and Abbreviations used in This Report

14-Sep	FHWA Special Experimental Project No. 14
AASHTO	American Association of State Highway and Transportation Officials
AFT	Accepted For Traffic Incentive/Disincentive
BCON	Bridge Construction
BMP	Beginning Mileage Post
BREC	Bridge Reconstruction
BREH	Bridge Rehabilitation
CO3	Construction Congestion Cost System
CPI	Cost Performance Index
CPM	Critical Path Method
DI	Distress Index
DOT	Department of Transportation
DTMB	Department of Technology Management and Budget
EMP	Ending Mileage Post
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
I/D	Incentive/Disincentive
JPCP	Jointed Plain Concrete Pavement
JRCP	Jointed Reinforced Concrete Pavement
MDOT	Michigan Department of Transportation
MISC	Miscellaneous
NCON	New Reconstruction
OQI	Office of Quality Initiatives
OTPI	Original Time Performance Index
PMAI	Maintenance
PMS	Pavement Management System
PTPI	Present Time Performance Index
RESU	Resurfacing
RREC	Reconstruction
RREH	Rehabilitation
RSL	Remaining Service Life
RUC	Road Users Costs
SFTY	Safety
SHA	State Highway Agencies
VE	Value Engineering

Executive Summary

The Michigan Department of Transportation (MDOT) has been using monetary incentive payments for many years to accelerate highway construction work, resulting in reduced delays to the traveling public. It was envisioned that incentive/disincentive (I/D) payments/penalties would capture the true cost (user delay savings vs. actual I/D dollars) and would have positive impacts on the long-term pavement performance by extending its expected life. However, these impacts have not been quantified nor qualified. Therefore, MDOT sponsored this research study to determine whether the I/D for expediting construction captures the true cost (user delay savings vs. actual I/D dollars), and identify its impacts on the long-term pavement performance for projects that have been expedited vs. conventional scheduling.

During the course of the study, the research team reviewed and synthesized the literature on Innovative Construction Contracting and its role in accelerating construction progress and reducing user delay. The literature supports the need for this study and highlights the lack of a process for reviewing the effectiveness of incentive/ disincentive clauses.

The research team navigated through multiple data sources to identify a list of all MDOT projects built via acceleration techniques using I/D methods mentioned in MDOT's Innovative Construction Contracting document. Additionally, a matching criteria was developed and used to identify a list of similar work type and vintage MDOT projects that were constructed under non I/D means.

Various hypotheses were proposed regarding the effect of different acceleration techniques on different project performances, including project schedule, cost, and long-term pavement performance. Different data analysis techniques were used to test these hypothesis and examine whether the additional project cost has captured the avoided user delay cost. Data analysis did not support the assertion that incentive clauses adversely impact long term project performance. To the contrary, the analyzed data statistically supported an improvement in the long term project performance for the incentive projects over their comparable non-incentive projects. Also, identified data suggests a trend that incentive clauses accelerate project schedules. A strong trend has been identified that the incentive projects' schedules were accelerated compared to their similar non-incentive projects. Additionally, data analysis statistically support the idea that incentive clauses increase project cost but further analysis finds that avoided user delay was higher than the additional paid cost for Accepted for Traffic and Interim Completion incentive/ disincentive clauses except for Lane Rental Incentive clauses.

The results confirm the effectiveness of Accepted for Traffic and Interim Completion incentive/ disincentive clauses, as well as open a debate on the effectiveness of the lane rental incentive/ disincentive clauses, in achieving their goal by accelerating project schedules and reducing the user delay cost. Also, this report calls for little modification to the listed "Advantages and Disadvantages" and "Recommendations for Use" of each acceleration technique in the 2013 MDOT Innovative Construction Contracting document.

The objectives of the study were satisfied and specific recommendations have been proposed:

- Maintain a database of current and previous approved special provisions, along with project performance indicators, to systematically measure the performance of I/D clauses and benchmark the effectiveness of any new project. This will allow MDOT to assess the value and practices of these incentives and will help in fulfilling the new incentive reporting requirement as required by the State of Michigan Act 200, Public Acts of 2012.
- Request both the construction engineer and the contractor receiving the incentive to submit a summary report providing lessons learned that can be implemented in future project designs and specifications.
- Examine the consistency of the currently developed procedure for calculating the incentive amount (especially for the lane rental incentive/disincentive) state-wide.

Chapter 1- Introduction

Problem Statement

Since transportation infrastructure in the United States has substantially deteriorated and is in emergent need of large-scale renewal, many State Highway Agencies (SHA) are now facing the dual challenge of repairing aging infrastructure systems while trying to minimize traffic inconvenience to the traveling public. In completing their projects, the Michigan Department of Transportation (MDOT) has considerable experience with the application of innovative construction contracting methods, including monetary incentive payments, which are targeted to accelerate construction progress and reduce user delay. However, little is known about their impact on various aspects of project performance such as project true cost (user delay savings vs. actual Incentive/Disincentive [I/D] dollars), and schedule, as well as their long-term impact on pavement performance vs. similar MDOT projects constructed under non-incentive methods. The purpose of this research project is to provide systematic studies on these strategies and proper analytical/assessment tools to allow MDOT to identify the most effective contractual method/tool for expediting construction projects and budget them accurately and realistically when they are considered for implementation.

Background

The United States transportation sector remains the most conservative segment of the construction industry. Projects are awarded to the lowest bidders. Recently, SHAs, including MDOT, have started to respond to limited budgetary needs and explore cost effective construction means. In the meanwhile, they have been pressured to reduce congestion and urban traffic disruptions by changing their focus from building new roads to maintaining and renewing the current network (Herbsman et al., 1995; MDOT, 1997). These improvement projects usually require high quality products that need to be completed in a timely manner to minimize the negative effects on the traveling public such as severe congestions or safety problems (Lee and Choi, 2006). To mitigate these problems, the Federal Highway Administration (FHWA) has recommended experimenting with innovative approaches that could lead to reduced construction time as well as diminish traffic disruption during construction (Herbsman and Glagola 1998).

Lee and Choi (2006) reported that traveling public and affected businesses are willing to pay higher construction prices when they anticipate a shortened project duration that mitigates their inconvenience. Jaraiedi et al. (1995) recommended offering contractors an incentive bonus for early completion that meets an accelerated schedule in exchange for the additional resources needed to accomplish the work faster. In 1990, FHWA Special Experimental Project No. 14 (SEP-14) Innovative Contracting, which was revised to Alternate Contracting in 2002, allowed agencies to use cost plus time bidding (A+B), Lane Rental, Design-Build contracting, and warranty clauses. No Excuse Incentives were allowed in 1996. Currently, the I/D contracting clauses are a common alternative strategy to motive contractors to finish projects early in order to meet the public's expectations.

Research Objectives

The objectives of this study are to:

1. Review, synthesize, and document the literature on Innovative Construction Contracting and its role in accelerating construction progress and reducing user delay.
2. Prepare a list of all MDOT projects built via acceleration techniques using I/D methods mentioned in the MDOT's Innovative Construction Contracting document.
3. Research and prepare a list of similar (work type and vintage) MDOT projects that were constructed under standard contract means.
4. Analyze all MDOT projects built via acceleration techniques to identify their impact on aspects of project performance such as project true cost, schedule, and their long-term impact on pavement performance vs. similar MDOT projects constructed under standard contract means.
5. Compare analysis results to the listed "Advantages and Disadvantages" and "Recommendations for Use" of each acceleration technique in the 2013 MDOT Innovative Construction Contracting document.

Statement of Hypotheses

A set of hypotheses was formulated for this research. The hypotheses were evaluated through statistical analysis techniques using SPSS® statistical program and they are discussed in Chapter 4. The discussion of results from such evaluations led to several findings and formed the basis for conclusions and recommendations provided in this study.

Chapter 2- Literature Review

A review of pertinent literature on the subject of Innovative Construction Contracting was conducted to gain insight into its role in accelerating construction progress and reducing user delay. The following six sections introduces various acceleration techniques, their role in accelerating construction progress and reducing user delay, their selection criteria, the determination of incentive amount and incentive time, and the different acceleration techniques used in Michigan.

Introduction

Innovative construction contracting is a well-known technique in accelerating construction progress and reducing user delay by minimizing the disruption of traffic flow in highway construction projects. Project planners have used these acceleration techniques as their management tools to achieve their objectives for a project. Motivated contractors accept the emphasized goals in the contract and try to achieve them in return for monetary incentives (Workman 1985). At the same time, a contractor is also subject to disincentives agreed upon with the agency, if the contractor fails to achieve those goals (Federal Highway Administration [FHWA] 1989).

Acceleration techniques may be grouped as follows: schedule-based incentives for early completion of work, cost-based incentives for reducing project cost, and performance-based incentives for improving project quality, safety, productivity, and so on. Among them, the incentive contract for early completion has been the most popular acceleration technique in highway construction projects because both the design and the implementation of schedule-based incentives are comparatively easy and inexpensive (Abu-Hijileh and Ibbs 1989). Cost-based incentives are designed to reduce project cost through financial ratios shared between the owners and contractors. One form of cost performance incentive is Value Engineering (VE). VE savings is usually split evenly between owners and contractors. State and federal transportation agencies have implemented the VE technique and reported surprisingly large monetary savings (FHWA 2003). Jaraiedi et al. (1995) stated that a performance-based incentive employs certain parameters of the contractors' project performance as a basis for the use of the incentive such as: safety, quality, responsiveness, and utilization of resources and craft labor productivity. In order to determine a contractor's incentive, the agency generally assigns a score based on the relative achievement of the performance standards (Stukhart 1984).

It should be noted that DOT and contractor perceptions of the acceleration technique objective could be misaligned. Arditi and Yasamis (1998) studied goal alignment between Illinois DOT engineers' perceptions and contractors' perceptions of I/D contract provisions using a survey conducted on a sample of I/D contract projects in Illinois highway construction. Resident engineers indicated that schedule was the most important objective. However, contractors indicated that cost was the most important target, as shown in Table 1.

Table 1: Ranking of Acceleration Technique Objectives (Source: Arditi and Yasamis 1998)

Superintendent's Objective	Ranking Score*	Resident Engineer's Objective	Ranking Score*
Cost	2.11	Schedule	2.14
Safety	2.44	Quality	2.36
Quality	2.67	Safety	3.07
Schedule	2.73	Cost	3.64
Management	4.33	Management	4.86
Technology	4.44	Technology	4.93

* The lower ranking score means more important objective.

Role of Acceleration Techniques in Accelerating Construction Progress and Reducing User Delay

Arditi et al. (1997) have reported that 28 highway construction projects in Illinois, from 1989-1993, have used time-based I/D provisions and were completed ahead of schedule. About 79% of the contractors for these projects received the maximum incentive payment, which represented an average of 4.71% of the contract amount.

In 1999, the Florida Department of Transportation (FDOT) Office of Quality Initiatives (OQI) published a report entitled *Alternative Contracting Program Preliminary Evaluation* for July 1, 1996 – June 30, 1999 (FDOT 1999). In this report, the OQI performed a cost analysis and a time analysis for 16 completed I/D projects. The report also summarized survey responses from two contractors, three consultants, and eight DOT project engineers. The survey on the impact of I/D contracts on project acceleration indicated that contractors thought that I/D contracts reduced project duration, while most consultants did not; the DOT respondents' opinions were divided on this topic. However, the majority of respondents indicated that contractors working on I/D projects were more willing to cooperate in project coordination.

In February 2000, MDOT completed an evaluation of the use of early completion clauses on 26 projects let and completed in 1998 and 1999 (AASHTO 2006). The average I/D pay amount for these 26 projects was $18,500 (about 1.5% of the contract amount) and the average project user delay savings was estimated at $610,500. Results of the evaluation indicated that 65% of the 26 projects were completed early, 12% were completed on time and 23% were completed late. MDOT found that the average completion time of pavement projects with early completion incentives was 19% less than similar projects without I/D provisions for early completion, although the contracts for the latter projects included an expedited schedule clause requiring the contractor to work a six calendar-day week. Special I/D provisions for ride quality were included in some MDOT project contracts.

In 2007, MDOT initiated and sponsored an exploratory study to search the MDOT data files and project records to identify data availability that are related to the I/D program and perform preliminary data assessment to determine whether or not the available data could support analyses of the costs and benefits of the MDOT I/D program (Baladi and Leveret, 2009). Because of the exploratory nature of the study, the original research plan was modified several times. It was concluded that the available data elements of the project files and records could be used to conduct the required analysis but low numbers of projects were identified.

Selection Criteria for Acceleration Techniques

FHWA (1989) recommended that acceleration techniques should be limited to the projects that severely disrupt highway traffic, significantly increase road user costs, and have a significant impact on adjacent neighborhoods or businesses, or close a gap, thereby providing a major improvement in the highway system. Several studies contain information on the selection criteria for determining whether or not to apply acceleration techniques (Christiansen, 1987; Plummer et al., 1992; Jaraiedi et al., 1995; NYSDOT, 1999; Livingston, 2002; Rister and Wang, 2004; Shr and Chen, 2004). In addition, Capuro and Seon (1996) developed project selection criteria for the South Dakota Department of Transportation as guidelines of time-based innovative contracting methods, A+B, I/D, and Lane Rental. The stepwise criteria for selecting innovative contracting are as follows:

1) Identify candidate projects for expedited completion and estimate road user cost (RUC),
2) Identify potential impacts,
3) Re-evaluate project, finalize RUC, estimate time, and choose a contract method, and
4) Develop special provisions.

Determination of Incentive Amount

Although there is no standard for setting incentive amounts, FHWA (1989) outlined the determination of the I/D amount as follows:

- The dollar amount must be of sufficient benefit to the contractor to encourage his/her interest, stimulate innovative ideas, and increase the profitability of meeting tight schedules so as to be effective and accomplish the objectives of I/D Provisions.
- If the incentive payment is not sufficient to cover the contractor's cost for the extra work, then there is little incentive to accelerate production, and the I/D provisions will not produce the intended results. (FHWA 1989)

According to the literature, most DOTs have developed their own procedures or methods to determine incentive and disincentive amounts based on the daily RUC. An array of computer applications is available for use in estimating road user delay cost such as CO3 (Carr 2000); RealCost (NJDOT 2001); Quickzone, QUEWZ, Alternat (FHWA 2006); HCS, MicroBENCOST (Gillespie 1998); FREWAY, QUADRO2, CARHOP, CORQ-CORCON, INTRAS, FREQ, and FRECON2 (Olguin et al. 1995). These I/D contracting clauses are usually attached to the typical low bid method. DOT pays an incentive fee if the work is completed ahead of schedule but assesses a disincentive fee if the work is completed beyond the expected completion date. Most DOTs set a cap for the total incentive fee as a certain percentage of the contract amount, a certain dollar amount, or a set number of days that will be paid (Sillars 2007). Most DOTs choose a cap of five percent of the total contract amount. The FHWA Technical Advisory does not recommend setting equal cap amounts for both the incentive and disincentive (FHWA 1989; Anderson and Russell 2001).

Determination of Incentive Time

FHWA (1989) and Gillespie (1998) emphasized that the determination of I/D time is one of the most important issues when developing an I/D project. According to FHWA (1989), most SHAs usually employ either past performance or a Critical Path Method (CPM) schedule in order to determine I/D time. A reasonable completion date must be set by answering the following question: To what extent and at what cost could a normal construction schedule be accelerated? It is important not to discourage the contractors by setting an impossible-to-meet completion date or to have them benefit with no extra efforts on the contractors' part.

Acceleration Techniques Used in Michigan

In 2013, MDOT published a document containing fundamental information on various innovative construction contracting methods that could be used to enhance the implementation and delivery of MDOT construction projects. This *Innovative Construction Contracting Guide* (2010) defines these methods as follows:

- **Standard Incentive/Disincentive (I/D):** Incentive/Disincentive is a method used to motivate the contractor to complete work or open-to-traffic a portion of the work on or ahead of schedule by providing a bonus for early completion or open-to-traffic. It is also used as a penalty for late project completion or for lanes not open-to-traffic. The bonus or penalty is based on road user delay costs, but the bonus is limited to a maximum of 5% of the project costs. Progress clauses list any additional liquidated damages in conjunction with Section 108 of the 2012 Standard Specifications for Construction.
- **A+B Incentive/Disincentive:** A+B Bidding is a cost-plus-time bidding procedure that selects the low bidder based on a monetary combination of the contract bid items ("A" portion) and the time ("B" portion) needed to complete the project or a critical portion of the project. The rate of incentive/disincentive for the "B" portion is typically based on estimated road user delay costs.
- **No Excuse Incentive:** A No Excuse Incentive can reduce contract time by tying an incentive to the completion of specific construction activities by a set date, which may or may not be the contract completion date. The completion date(s) cannot be changed for any reason and a penalty is not applied, if the contractor fails to meet the completion date(s). The amount of incentive is based on estimated road user delay costs.

- **Accepted for Traffic Incentive/Disincentive (AFT):** The department will pay the contractor a lump sum incentive, if the work in the contract is accepted for traffic on or before the AFT incentive date(s). The contractor would be assessed a penalty if they failed to meet the AFT date(s). The rate of incentive/disincentive is based on estimated road user delay costs.
- **Lane Rental:** The contractor is charged a fee for occupying lanes or shoulders to complete contract work and can earn an incentive or disincentive based on the number of days they occupy the lane or shoulder versus the original Lane Rental lump sum bid. The hourly assessment is charged by the hour and is based on estimated road user delay cost.
- **Interim Completion Date Incentive/Disincentive**: Similar to the Standard Incentive/Disincentive, the contractor is paid an incentive for completing a specified amount of work on or before the interim completion date(s). A penalty is applied if the work is not completed by the interim completion date(s). The incentive/disincentive is typically based on the rate of liquidated damages specified in the MDOT Standard Specifications for Construction.

Chapter 3- Methodology

The purpose of this chapter is to illustrate the methodology utilized to collect project data and its classification in order to achieve the second and third objectives of the project. It also highlights the modification of the proposed research method to accommodate the project circumstances. Additionally, a reflection of the list of all MDOT projects built via acceleration techniques using I/D methods as well as the list of similar (work type and vintage) MDOT projects is presented. Finally, the data analysis method is discussed.

Task 1: Data Collection

The research team compiled a list of pavement projects that have used any of the accelerated contracting methods via “Field Manager” software and conversations with DOT personnel. After identifying these projects, the research team requested available project records and data files. Also, similar MDOT projects that were constructed under standard contract means in the work type and vintage were collected.

Modification of Task 1

Task 1 yielded a very small number of projects to add to the projects identified in a previous study (Baladi and Leveret 2009). The research team tried to identify additional projects through the Michigan FHWA office by obtaining their SEP14 project list for Michigan. It was found that the FHWA office maintains a list of only design-build projects prior to 2003 and that they do not have a record of any other types of projects that may have received SEP14 approval.

The research team worked with different personnel from MDOT’s Department of Technology Management and Budget (DTMB) to identify additional potential projects. The DTMB houses two databases for MDOT: Construction Database and Pre-construction Database. Neither of them has a column to represent the basis for accelerating contract payments directly. The team employed “fuzzy” search criteria for all possible combinations of the following key words: Standard Incentive/Disincentive, Permanent Pavement Markings, Hot Mix Asphalt, Portland Cement Concrete, A+B Incentive/Disincentive, No Excuse Incentive/Disincentive, Accepted for Traffic Incentive/Disincentive, Lane Rental, and Interim Completion Date Incentives. The search was set to report all possible columns found for every pay item such as Contract ID, Project, Project Item, Line No, Control Section, Route, Longitude of Midpoint, Latitude of Midpoint, Type of Work, Letting Date, Project Desc, Item Desc, Item Suppl Desc, and any other data such as planned quantities, actual quantities, planned cost, and actual cost, etc.

The research team manually filtered the query data and identified the pay item numbers associated with incentive pay items. A second search query was performed on the Construction Database and the Pre-construction Database to identify all projects that contained these pay items. Again, the search was set to report all possible columns found for every pay item. Both lists were merged and project data were filtered manually by the research team.

For every project identified, the construction contract inquiry page (http://mdotcf.state.mi.us/public/trnsport/) was used to identify the paid incentive and schedule and cost data of the project. Some schedule data for projects starting before 2003 were missing and the data were requested. Projectwise software was used to collect the project drawings, proposals, and any special provisions documents associated with the project. The Pavement Management System specialists were contacted to grant the research team access to the Pavement Management System (PMS) data files associated with the targeted projects. A historical and detailed distress data and distress index for each 0.1 mile of pavement were collected for years 1997 to 2011 and linked with the target projects using the control section, Beginning Mileage Post (BMP), and Ending Mileage Post (EMP). The data were used to determine the types of distress along the project, the distribution of Distress Index (DI), and the average DI for the entire project.

Task 2: Data Classification

Different project data lists were identified based on different attributes (such as project type, functional class, pavement type, and route) and assessed with different matching algorithms to create matching criteria for the projects in order to create an unbiased data sample which could be then utilized in the next step of the project, i.e. data analysis.

Three major matching criteria were identified for the classification procedure-

1. Route of the project: Freeway and Non-freeway,
2. Category of work: Resurfacing (RESU), Rehabilitation (RREH), Maintenance (PMAI), Bridge Reconstruction (BREC), Bridge Rehabilitation (BREH), Safety (SFTY), and Miscellaneous (MISC); and
3. Type of Material: Flexible, Composite, Jointed Plain Concrete Pavement (JPCP), and Jointed Reinforced Concrete Pavement (JRCP)

The outcome of this task is two project lists; a list of all MDOT projects built via acceleration techniques using I/D methods and a list of similar (work type and vintage) MDOT projects that were constructed without I/D methods.

Task 3: Data Analyses

In this task, the research team determined that the data obtained in tasks 1and 2 were sufficient to conduct further analysis. The acceptable matching lists (MDOT projects built via acceleration techniques matched with similar MDOT projects constructed under similar contract means but not using the acceleration technique) were analyzed to identify their impact on aspects of project performance. The following performance criteria were investigated.

Effect of acceleration techniques on project schedule

For each of the innovative acceleration techniques, two performance indices for each project on the matching list were determined based on original contract duration and present contract duration: Original Time Performance Index (OTPI) and Present Time Performance Index (PTPI), which included time extensions and supplemental agreement days. A statistical analysis was performed to examine where the actual contract duration was affected by the presence of different acceleration techniques and to determine whether certain acceleration techniques shortened the project duration below the levels observed in the conventional projects.

Effect of acceleration techniques on project cost

Similarly, a project Cost Performance Index (CPI) for each project on the matching list was determined based on original contract cost and the authorized contract cost, which included total work order amount, supplemental agreement amount, incentives paid, and other contract adjustments. Finally, a statistical analysis was performed to investigate: (1) How much project cost is affected by the presence of accelerating contracting techniques; (2) How much accelerating contracting techniques actually increase project cost; and, (3) Whether there is significant evidence to prove the research hypothesis that accelerating contracting techniques increase project costs significantly compared to conventionally contracted projects.

Cost and time-value savings (user delay cost savings)

The research team used the Construction Congestion Cost System (CO3) to estimate user delay cost. The additional cost increase for the acceleration technique was compared with the estimated user delay cost.

Effect of acceleration techniques on project long-term pavement performance

In this sub-task, the research team investigated aggregated project performance data to analyze an appropriate prediction model for pavement distress to estimate the Modified RSL for these projects. Statistical analysis was performed on each of the innovative acceleration techniques to determine whether or not the acceleration techniques significantly impact pavement performance (pavement life).

Task 4: Recommendations on Each Acceleration Technique

In this task, the quantitative results acquired from task 3 were used to quantitatively analyze the listed “Advantages and Disadvantages” and “Recommendations for Use” of each acceleration technique in the 2013 MDOT Innovative Construction Contracting document.

Chapter 4- Findings

The purpose of this chapter is to present a summary of the collected data, illustrate the method of data analysis employed, and present the results of the analysis.

Summary of Data

The aforementioned methodology was used to prepare a list of all MDOT projects built via acceleration techniques using I/D methods mentioned in the MDOT's Innovative Construction Contracting document as presented in Appendix 1. Table 2 presents a summary of the number of identified projects for each type of incentive.

Table 2: Data Collection Summary for Incentive Projects

	A+B	**Accepted for Traffic**	**Interim Completion**	**Lane Rental**	**No Excuse**	**Accelerated Schedules**	**Standard Incentives**
Bridge Construction (BCON)				1		Not Included	Not Included
Bridge Reconstruction (BREC)		1	1	12			
Bridge Rehabilitation (BREH)				4			
Miscellaneous (MISC)				5			
New Reconstruction (NCON)			1	3			
Maintenance (PMAI)		2	1	8			
Resurfacing (RESU)		1	7	14			
Reconstruction (RREC)	1	3		5			
Rehabilitation (RREH)		5	4	19	1		
Safety (SFTY)		3	2	5	1		
Total Number of Projects	**1**	**15**	**16**	**76**	**2**		

It should be noted that:

1. In most of the projects identified, each I/D technique was presented in any project concurrently with one or more types of the Standard Quality Incentive/Disincentive. This finding required the research team to change their classification method in order to achieve objective 3 of the project.

2. The collection of project distress data reduced the number of projects. The research team considered projects with at least 3 years of project distress data (increased distress over years) for the calculation of the Modified Remaining Service Life (RSL), and to estimate pavement performance in term of pavement life.
3. The list included no Accelerated Schedules techniques. The research team and project manager has attributed this to the timing of applying this incentive during design. This could be hardly identified in the project data collected; therefore, it was decided to exclude this acceleration technique from the project scope.
4. The list included a very small number of projects that utilized A+B Incentive/Disincentive and No Excuse Incentive/Disincentive. The research team repeated the search for these two techniques but was not able to identify any additional projects.

Table 3 illustrates the authorized contract amounts for the identified projects.

Table 3: The Authorized Contract Amounts for Incentive Projects

	A+B	**Accepted for Traffic**	**Interim Completion**	**Lane Rental**	**No Excuse**
1998	$19,351,482			$55,705,045	
1999			$8,970,860	$90,937,723	
2000				$236,928,448	
2001				$109,668,802	$27,279,743
2002				$171,411,133	
2003			$1,728,721	$60,429,980	
2004		$81,768,474	$2,349,126	$42,647,291	
2005		$111,894,865	$5,734,031	$126,184,813	$2,128,003
2006		$65,773,608		$58,626,666	
2007		$173,764,968	$13,236,925	$27,347,539	
2008		$6,405,881	$34,998,425	$105,707,836	
2009		$31,878,804		$53,529,608	
2010				$14,293,371	
2011			$20,296,685	$8,156,446	
2012		$2,730,094	$5,098,731	2685483.92	
Total	**$19,351,482**	**$474,216,694**	**$92,413,507**	**$1,164,260,188**	**$29,407,746**

Different non-incentive projects were identified based on different attributes (such as project type, functional class, pavement type, and route) and assessed with different matching algorithms to create matching criteria for these projects vs. the incentive projects in order to create an unbiased data sample which could be utilized for data analysis.

Three matching criteria were identified for the classification procedure:

1. Route of the project: Freeway and Non-freeway,
2. Category of the work: Resurfacing (RESU), Rehabilitation (RREH), Maintenance (PMAI), Bridge Reconstruction (BREC), Bridge Rehabilitation (BREH), Safety (SFTY), and Miscellaneous (MISC);
3. Type of Material: Flexible, Composite, Jointed Plain Concrete Pavement (JPCP), and Jointed Reinforced Concrete Pavement (JRCP); and
4. Matching projects should include the same type of Standard Quality Incentive/Disincentive.

Appendix 2 presents the matching list of the MDOT projects built via acceleration techniques with similar projects. It should be noted that in some cases multiple similar projects have been identified for non-incentive projects. Based on data availability, one similar project has been identified for the analysis at any instance.

Method of Analysis

Four different performance criteria were analyzed using statistical analyses; schedule, time, cost-time savings (user delays), and long-term performance.

Effect of acceleration techniques on project schedule

For each innovative acceleration technique, two performance indices for each project on the matching list were determined based on original contract duration and present contract duration: Original Time Performance Index (OTPI) and Present Time Performance Index (PTPI), which included time extensions and supplemental agreement days. These indices were calculated as:

OTPI = ((Actual Duration Used − Original Contract Duration)/ Original Contract Duration)

PTPI = ((Actual Duration Used − Present Contract Duration)/ Present Contract Duration)

Where

Actual Duration Used = Actual Work Completed - Actual Work Began
Original Contract Duration = Expected Completion Date per Progress Schedule - Start Date per Progress Schedule
Present Contract Duration = Current Completion Date - Actual Work Began

A negative value of *OTPI or* PTPI means time savings and a positive value means time overruns. The time performance indices for each project are calculated in Appendices 3 and 4 respectively. It was assumed that contractors' individual production performance and work experience were identical. Additionally, contractors' productivity during daytime and night times was assumed to be equivalent. Finally, it was assumed that these performance indicators follow a normal distribution.

It should be noted that Original Starting Date and Expected Finish Date were only available for projects after 2003. The research team and the project manager tried requesting this data but it was not accessible.

In addition to descriptive statistics, statistical analysis was performed to examine if the contract duration was affected by the presence of different acceleration techniques. The projects were grouped into two groups (i.e., MDOT projects built via acceleration techniques and similar MDOT projects that were constructed without the acceleration techniques). The Paired-Samples T-Test procedure was used to compare the means of the two groups and to test the effect of acceleration techniques on project time performance.

> ***Hypothesis 1: Acceleration Techniques and Project Duration Performance***
> **H_o:** The mean difference of the *OTPI or* PTPI between the paired observations (i.e., *OTPI or* PTPI for MDOT projects built via acceleration techniques and *OTPI or* PTPI for similar MDOT projects that were constructed without the acceleration techniques) is zero.
> **Ha:** The mean difference of the *OTPI or* PTPI between the paired observations (i.e., *OTPI or* PTPI for MDOT projects built via acceleration techniques and *OTPI or* PTPI for similar MDOT projects that were constructed without the acceleration techniques) is not zero.

SPSS was used to perform the Paired-Samples T-Test procedure using the two performance indices (OTPI and PTPI). The procedure was performed on the data as an aggregate group and then separately for each type of acceleration technique. When the number of data points was less than 30, boot strapping was performed to compensate for the sample size. No additional analysis was performed when the sample size was less than 5 paired projects.

Effect of acceleration techniques on project cost

Similarly, a project Cost Performance Index (CPI) for each project on the matching list was determined based on original contract cost and the authorized contract cost, which included total work order amount, supplemental agreement amount, incentives paid, and other contract adjustments. This index was calculated as:

$$CPI = ([\text{Authorized Contractor Cost} - \text{Original Contract Cost}] / \text{Original Contract Cost})$$

Where a negative value of CPI means cost savings and a positive value of CPI means cost overruns. For example, a value of CPI = -0.10 means project cost savings of 10%, while a value of CPI = 0.10 means a 10% cost overrun. Additionally, it was assumed that the cost performance index follows a normal distribution.

In addition to descriptive statistics, statistical analysis was performed to examine if the project cost is affected by the presence of accelerating contracting techniques and whether there is significant evidence to prove that accelerating contracting techniques increase project costs significantly compared to conventionally contracted projects. The Paired-Samples T-Test procedure was used to compare the means of the two groups and to test the effect of acceleration techniques on project time performance.

Hypothesis 2: Acceleration Techniques and Project Cost Performance

H0: The mean difference of the CPI between the paired observations (i.e., CPI for MDOT projects built via acceleration techniques and CPI for similar MDOT projects that were constructed without the acceleration techniques) is zero.

Ha: The mean difference of the CPI between the paired observations (i.e., CPI for MDOT projects built via acceleration techniques and CPI for similar MDOT projects that were constructed without the acceleration techniques) is not zero.

SPSS was used to perform the Paired-Samples T-Test procedure using CPI. The procedure was performed on the data as an aggregate group and then separately for each type of acceleration technique. When the numbers of data points were less than 30, boot strapping was performed to compensate for the sample size. No additional analysis was performed when the sample size was less than 5 paired projects.

Additionally, the actual increase in project costs were identified for every project built via acceleration techniques and descriptive statistics were performed to explore how much accelerating contracting techniques actually increased project costs.

Finally, a correlation analysis was performed between the Present Time Performance Index (PTPI) and Cost Performance Index (PCI) to explore the relationship between cost overruns and project schedule improvement.

Additional project cost and time-value savings

For every additional project cost identified (based on an acceleration technique and its project data accessible via Projectwise software), the Construction Congestion Cost System (CO3) (Carr 2000) was used to estimate the expected user delay cost, if this acceleration technique was not implemented. CO3 was selected because MDOT currently uses it to estimate user delay costs. The Expected Gain/Savings were materialized when the Expected User Delay is more than the Additional Project Cost based on the acceleration technique.

Because of the special nature of lane rental incentives and the complexity of materializing the lane rental incentive amounts, projects were evaluated based on the lane rental assessment rate. Expected Gain/ Savings were materialized when the lane rental assessment rate was greater than the calculated hourly user delay for the project.

Effect of acceleration techniques on project long-term pavement performance

In order to investigate the effects of acceleration techniques on project long-term pavement performance, aggregate performance data were collectively investigated to identify the optimum curve that would represent the long-term performance of the collected data. Multiple regression analyses were performed on the averaged value of DI for each individual year. It was concluded that the 2nd degree polynomial curve provides the best fit for estimating the modified remaining service life of any given project. Figure 1 presents the correlated equation that yielded the highest R^2 for all incentive projects data.

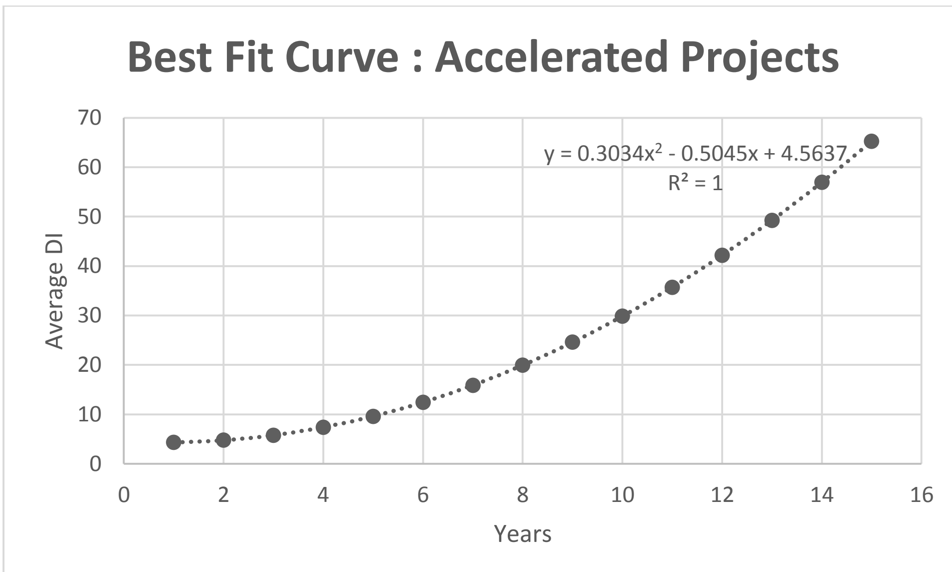

Figure 1: Polynomial Best Fit Curve for Accelerated Projects

Similar analysis was performed on the non-incentive projects data. The analysis yielded similar results for the non-incentive projects data. Figure 2 presents the correlated equation that yielded the highest R^2 for all non-incentive projects.

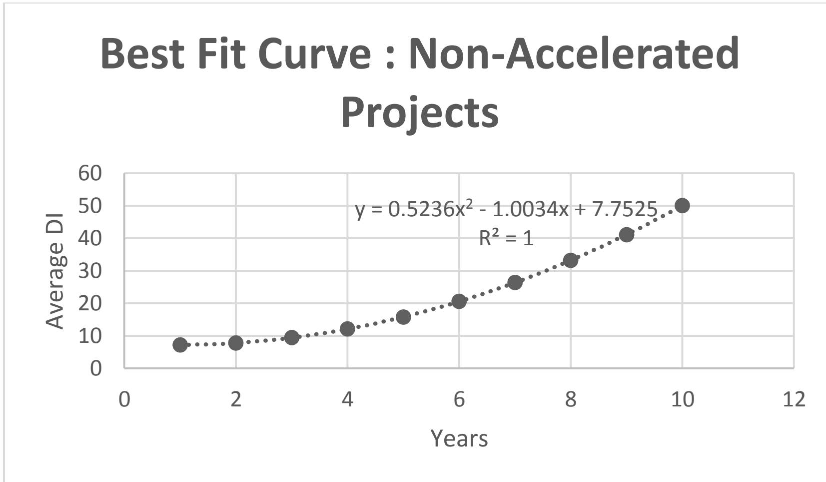

Figure 2: Polynomial Best Fit Curve for Non-Accelerated Projects

For each project in the different acceleration groups, the average DI data were calculated and the best fit curves between the average DI and time (T) in year were obtained using polynomial functions. The resulting correlation equations were used to estimate the modified remaining service life. This was accomplished by solving each equation for the time "T" for which the DI value equalled 50 distress points (the MDOT DI threshold value defining pavement life [PL]). Appendix 9 presents the average DI data for the projects with different acceleration groups and the calculations of the modified remaining service life respectively.

Statistical analysis was performed to examine if project long-term performance is affected by the presence of accelerating contracting techniques. The Paired-Samples T Test procedure was used to compare the means of the two groups and to test the effect of acceleration techniques on project long-term performance.

<u>Hypothesis 3: Acceleration Techniques and Long-Term Pavement Performance</u>

H0: The mean difference of the Modified Remaining Service Life (RSL) between the paired observations (i.e., RSL for MDOT projects built via acceleration techniques and RSL for similar MDOT projects that were constructed without the acceleration techniques) is zero.

Ha: The mean difference of the Modified Remaining Service Life (RSL) between the paired observations (i.e., RSL for MDOT projects built via acceleration techniques and RSL for similar MDOT projects that were constructed without the acceleration techniques) is not zero.

SPSS was used to perform the Paired-Samples T Test procedure using the modified RSL. The procedure was performed on the data as an aggregate group and then separately for each type of acceleration technique. When the numbers of data points were less than 30, boot strapping was performed to compensate for the sample size. No additional analysis was performed when the sample size was less than 5 paired projects.

Recommendations on each acceleration technique

The quantitative results acquired from task 3 were used to quantitatively analyze the listed "Advantages and Disadvantages" and "Recommendations for Use" of each acceleration technique in the 2013 MDOT Innovative Construction Contracting document.

Presentation of the Results

Effect of acceleration techniques on project schedule

Based on the *Present Time Performance Index (PTPI)*, 39 incentive projects were identified. Their project time and performance were found as follows:

- 37% of I/D projects were completed earlier than expected
- 51% were completed on time
- 12% were completed late

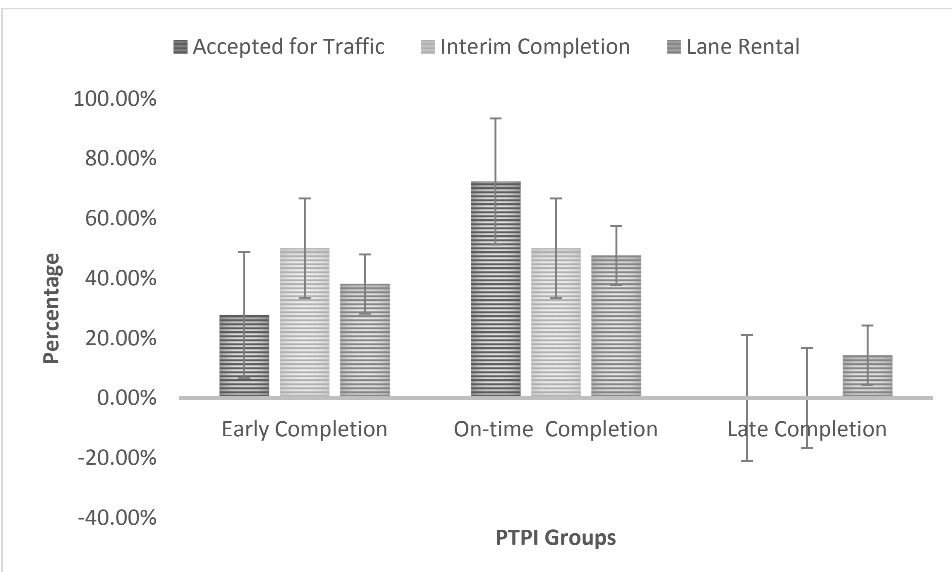

Figure 3: PTPI Data Summary for different types of Incentives

Figure 3 illustrates the project time performance for the different types of incentives. Accepted for traffic projects and interim completion incentive projects have shown great project control over the project duration completed on the expected time or earlier. Lane rental incentive project shows that 38.10% were completed ahead of schedule, 47.8% were completed on time, and 14.29% were completed late.

Figure 4 illustrates the PTPI vs. the paid incentive/disincentive. Most data identified for the incentive projects were located in the 3rd quadrant on the positive side of the time performance. The plotted data indicated, with few exceptions, that paying an incentive will assist the project in achieving its schedule goal or outperforming its project time target. Figure 5 and Figure 6 plot the frequencies of time performance index frequencies for incentive projects and non-incentive projects, respectively, vs. the normal distribution curve. Figure 7 plots the PTPI for each incentive project with the corresponding non-accelerated project. Most projects tend to have time savings when incentive clauses are included in the project.

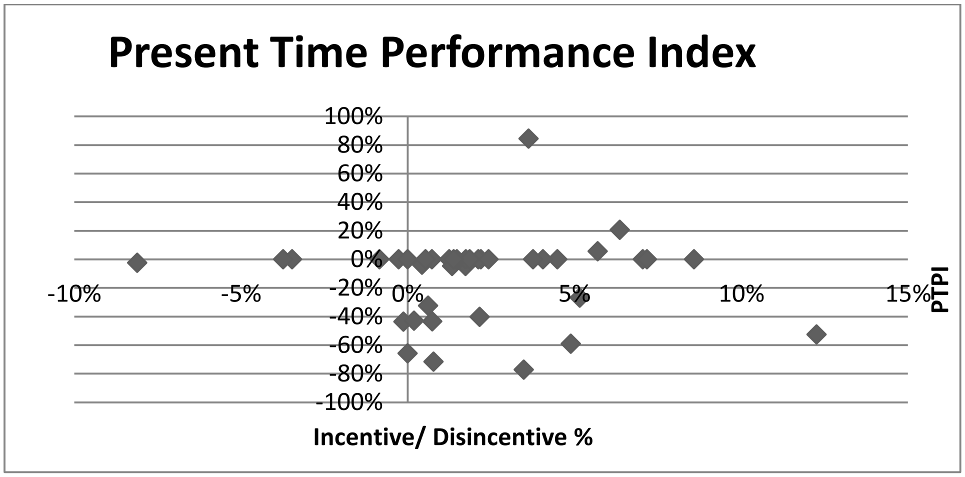

Figure 4: Time Performance Index vs. Paid Incentive/Disincentive Percentage

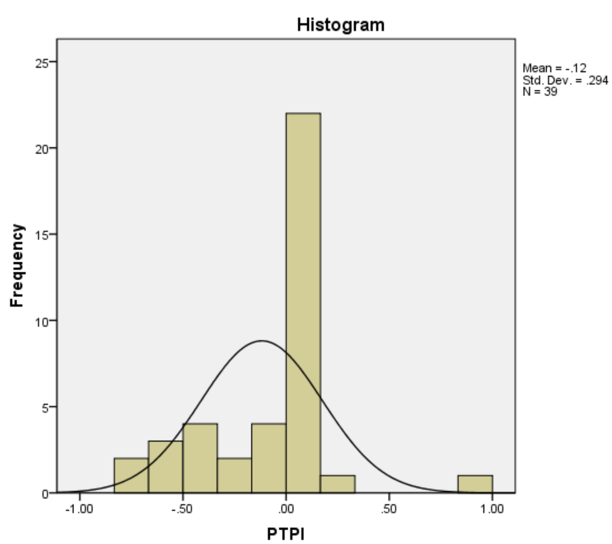

Figure 5: Frequencies of PTPI for Incentive Projects vs. Normal Distribution Curve

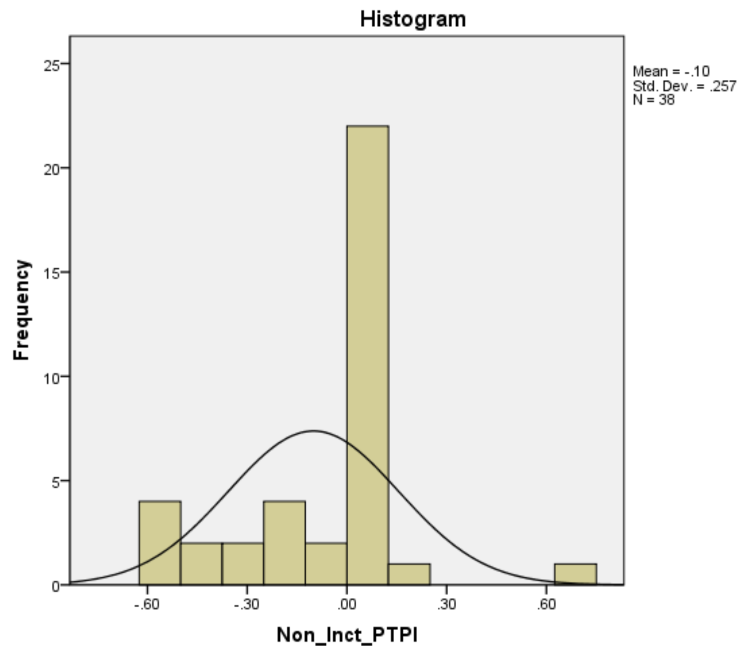

Figure 6: Frequencies of PTPI for Non-Incentive Projects vs. Normal Distribution Curve

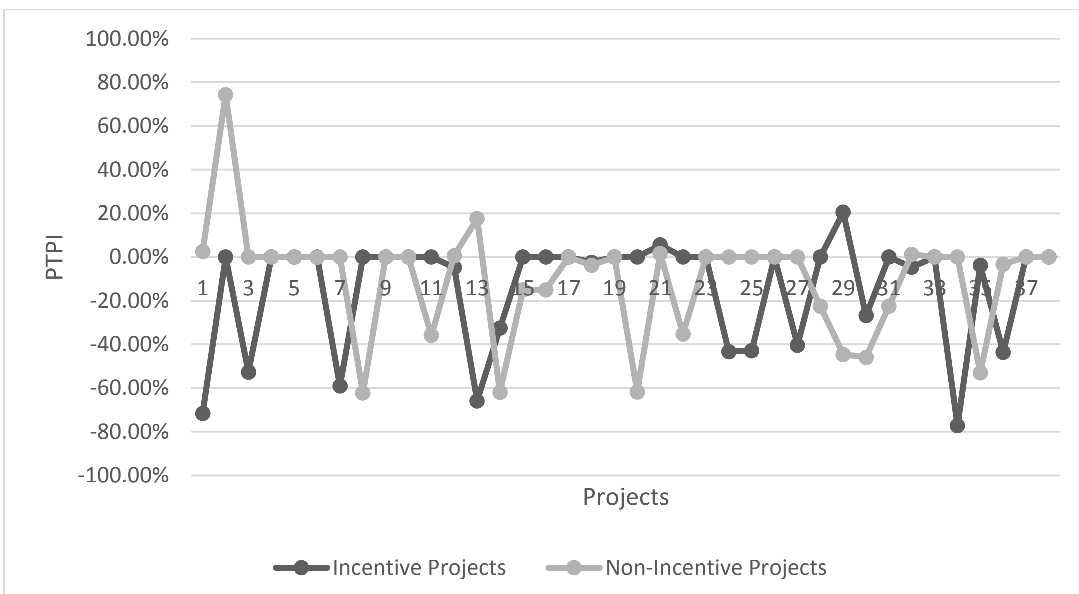

Figure 7: PTPI for Each Incentive Project with the Corresponding Non-Accelerated Project

In performing the paired samples t-tests and based on the OTPI, Table 4 illustrates the Paired Samples T-Test Results. There was no significant difference in the scores for incentive project group (M=0.39, SD=0.67) and non-incentive project group (M=0.19, SD=0.59) conditions; t (10) =0.69, p =0.51. There was no significant difference in the scores for Accepted for Traffic incentive project group (M=0.10, SD=0.19) and non-incentive project group (M=0.74, SD=0.67) conditions; t (3) =-1.78, p =0.173. Additionally, there was no significant difference in the scores for Lane Rental incentive project group (M=0.63, SD=0.86) and non-incentive project group (M=-0.07, SD=0.16) conditions; t (5) =1.04, p =0.096.

Table 4: The Paired Samples T-Test Results Based on OTPI

	M (Mean)	**SD (St. Dev.)**	**Sample Size**	**T**	**P**
Whole Groups Based on OTPI					
Incentive Group	0.39	0.67	10	0.69	0.51
Non-Incentive Group	0.19	0.59			
Accepted for Traffic Groups Based on OTPI					
Incentive Group	0.10	0.19	3	1.78	0.173
Non-Incentive Group	0.74	0.67			
Lane Rental Groups Based on OTPI					
Incentive Group	0.63	0.86	5	1.04	0.096
Non-Incentive Group	0.07	0.16			

Based on the PTPI, there was no significant difference in the scores for incentive project group (M=0.17, SD=1.60) and non-incentive project group (M=-0.10, SD=0.24) conditions; t (40) =1.08, p =0.29. For Accepted for Traffic, there was no significant difference in the scores for incentive project group (M=-0.11, SD=0.23) and non-incentive project group (M=-0.21, SD=0.33) conditions; t (10) =-0.71, p =0.50. For the Lane Rental incentive, there was no significant difference in the scores for incentive project group (M=0.44, SD=2.07) and non-incentive project group (M=-0.14, SD=0.22) conditions; t (22) =1.35, p =0.191. For the Interim Completion incentive, there was no significant difference in the scores for incentive project group (M=-0.21, SD=0.32) and non-incentive project group (M=-0.09, SD=0.22) conditions; t (5) =-0.66, p =0.54. Table 5 illustrates the Paired Samples T-Test Results.

Table 5: The Paired Samples T-Test Results Based on PTPI

	M (Mean)	**SD (St. Dev.)**	**Sample Size**	**T**	**P**
Whole Groups Based on PTPI					
Incentive Group	0.17	1.60	40	1.08	0.29
Non-Incentive Group	0.10	0.24			
Accepted for Traffic Groups Based on PTPI					
Incentive Group	-0.11	0.23	10	-0.71	0.50
Non-Incentive Group	-0.21	0.33			
Lane Rental Groups Based on PTPI					
Incentive Group	0.44	2.07	22	1.35	0.191
Non-Incentive Group	-0.14	0.22			
Interim Completion Groups Based on PTPI					
Incentive Group	-0.21	0.32	5	-0.66	0.54
Non-Incentive Group	-0.09	0.22			

Although the collected data does not statistically support our hypothesis that projects with incentives would have better time performance than projects with no incentive, this could be attributed to the limited number of projects available for the analysis. The current descriptive statistics shows the trend that most projects tend to have time savings when incentive clauses are included in the project.

Effect of acceleration techniques on project cost

Based on the Cost Performance data, 53 incentive projects were identified. About 50% of the projects outperformed the expected cost performance and 50% underperformed when incentive clauses were included in the project. Figure 8 illustrates the project cost performance for the different types of incentives. It was found that most of the Accepted for Traffic incentive projects underperformed the expected cost. While the Interim Completion projects split equally, 50% of the projects outperformed expected cost performance and 50% underperformed. For the Lane Rental incentive projects, 64% of the projects outperformed the expected cost, and 36% underperformed cost expectations.

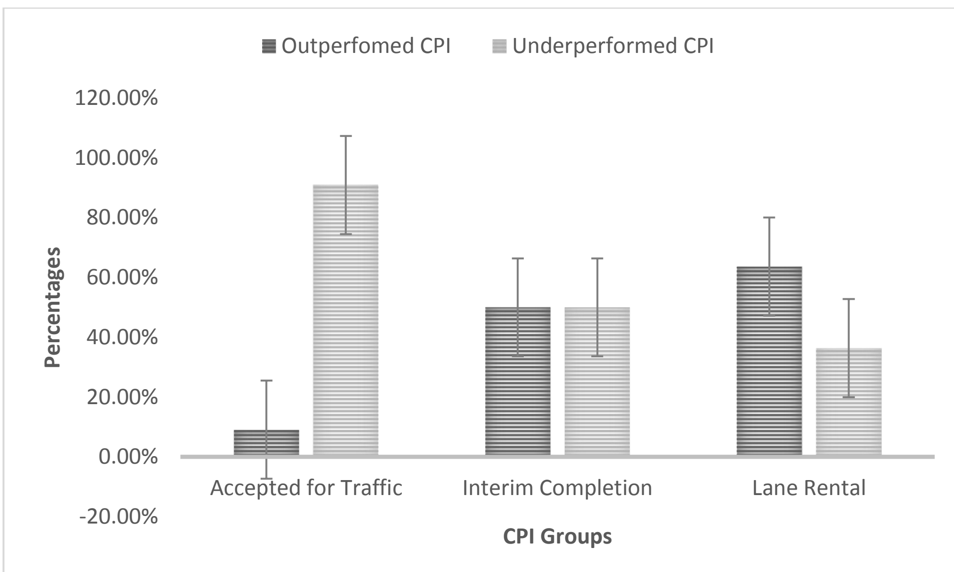

Figure 8: CPI Data Summary for different types of Incentives

Figure 9 illustrates the cost performance index vs. the paid incentive percentage. Unlike the trend shown in PTPI, the plotted CPI data is speared over the two quadrants with positive CPI and does not suggest any relation between the incentive paid and the project cost outcome. Figures 10 and 11 confirm the previous hypothesis’ suggestion by plotting the CPI frequencies for incentive projects and non-incentive projects, respectively, vs. the normal distribution curve. Figure 12 plots the CPI for each incentive project with the corresponding non-accelerated project.

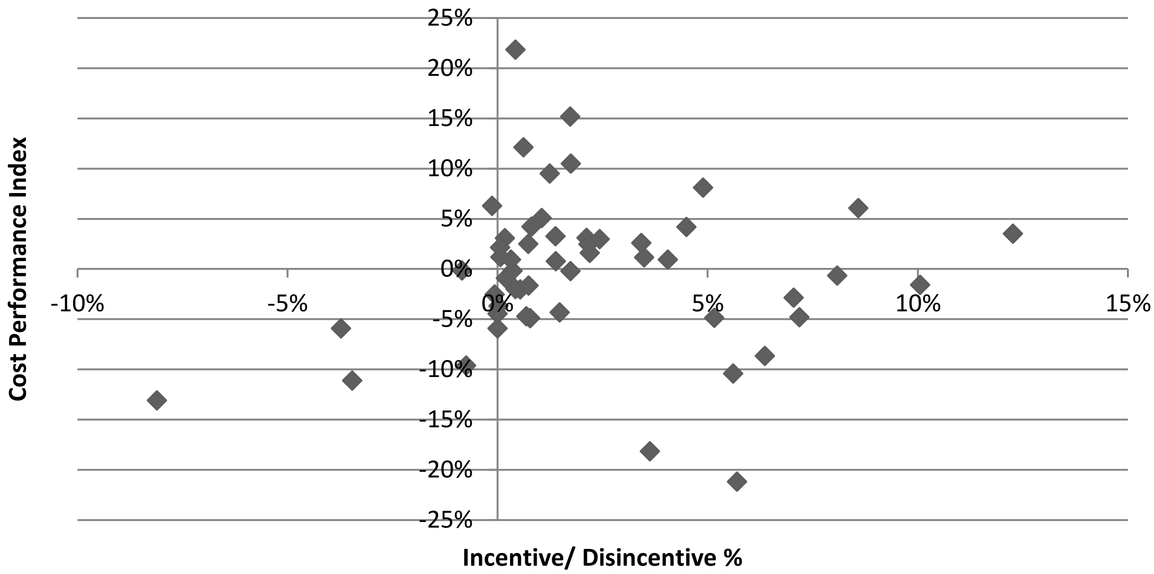

Figure 9: Cost Performance Index vs. Paid Incentive/ Disincentive Percentages

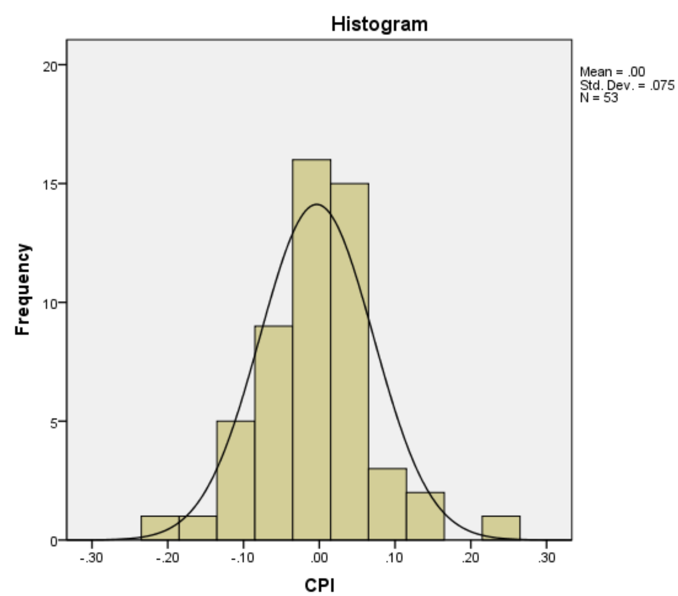

Figure 10: CPI Frequencies for Incentive Projects vs. Normal Distribution curve

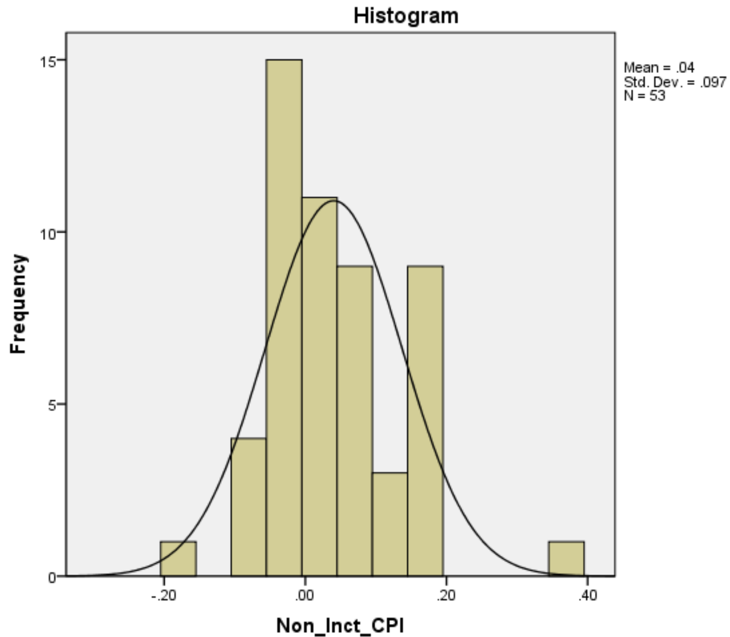

Figure 11: CPI Frequencies for Non-Incentive Projects vs. Normal Distribution curve

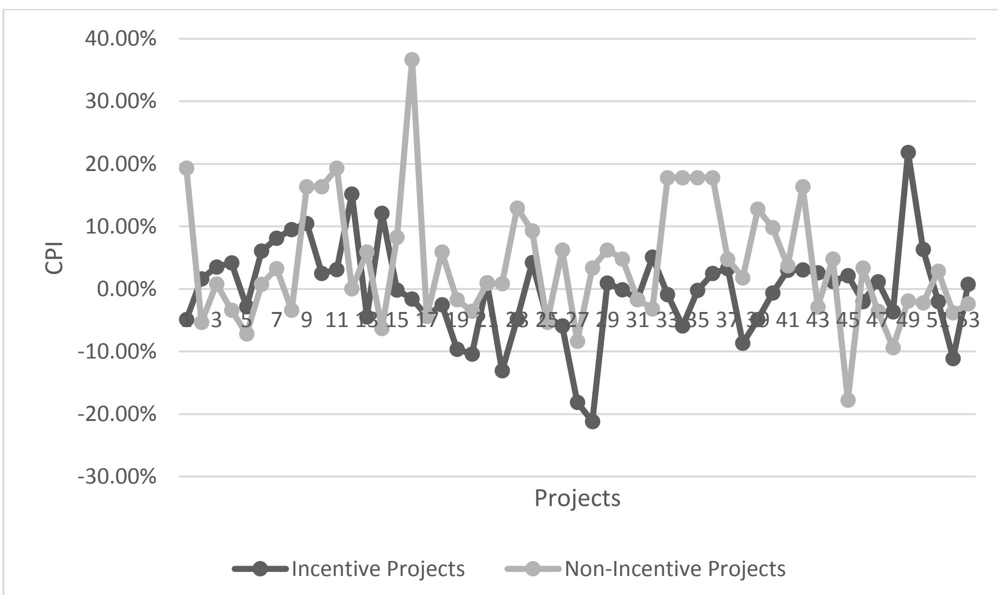

Figure 12: CPI for Each Incentive Project with the Corresponding Non-Accelerated Project

In performing the paired samples t-tests and based on the cost performance index, there was a significant difference in the scores for incentive project group (M=-0.03, SD=0.07) and non-incentive project group (M=0.04, SD=0.10) conditions; t (52) =-2.6, p =0.012. This indicates that the projects with incentives tend to have better cost control over similar projects with no incentive. This could be attributed to the additional staffing/requirements required for the projects with incentives. However, when breaking the groups into type of incentive, the difference was not statistically significant. This might be attributed to the smaller sample size number. There was no significant difference in the scores for Accepted for Traffic incentive project group (M=0.05, SD=0.05) and non-incentive project group (M=0.03, SD=0.09) conditions; t (10) =0.69, p =0.51. Additionally, there was no significant difference in the scores for Lane Rental incentive project group (M=0.06, SD=0.05) and non-incentive project group (M=0.03, SD=0.09) conditions; t (32) =1.24, p =0.23. Last, there was no significant difference in the scores for Interim Completion incentive project group (M=0.01, SD=0.10) and non-incentive project group (M=-0.02, SD=0.04) conditions; t (7) =0.99, p =0.36. Table 6 illustrates the Paired Samples T-Test Results.

Table 6: The Paired Samples T-Test Results Based on CPI

	M (Mean)	SD (St. Dev.)	Sample Size	T	P
Whole Groups Based on PTPI					
Incentive Group	-0.03	0.07	52	-2.6	0.012
Non-Incentive Group	0.04	0.10			
Accepted for Traffic Groups Based on PTPI					
Incentive Group	0.05	0.05	10	0.69	0.51
Non-Incentive Group	0.03	0.09			
Lane Rental Groups Based on PTPI					
Incentive Group	0.06	0.05	32	1.24	0.23
Non-Incentive Group	0.03	0.09			
Interim Completion Groups Based on PTPI					
Incentive Group	0.01	0.10	7	0.99	0.36
Non-Incentive Group	-0.02	0.04			

To evaluate the project cost increase due to incentive and to measure the control over this incentive, a comparative analysis was done between the maximum offered incentive and the actual paid incentive for each incentive type. Table 7 and Figure 13 present the results of this comparative analysis. Most of the accepted for traffic project paid incentive was almost the maximum offered incentive in the project. Better cost controls were established for interim completion and lane rental incentive projects.

Table 7: Average Maximum Offered Incentive versus the Average Paid Incentive for Each Type of Incentive

Type of Incentive/Distinctive	Average Maximum offered Incentive/Distinctive	Average Paid Incentive/Distinctive
Interim Completion	$109,286	$36,787
Accepted for Traffic	$736,923	$729,231
Lane Rental	$534,427	$269,536

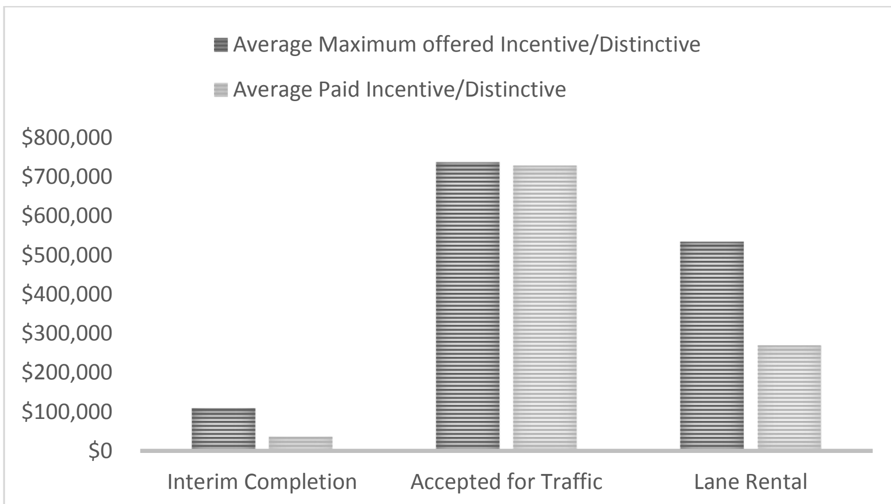

Figure 13: Average Maximum Offered Incentive versus the Average Paid Incentive for Each Type of Incentive

Finally, a series of linear, log and nonlinear regression models were run to establish a relationship between CPI and PTPI. Table 8 and Figure 14 illustrate the nonlinear model that resulted in the highest R^2.

Table 8: Variables of the Correlation between PTPI and CPI

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.462	.213	.161	.074

The independent variable is PTPI.

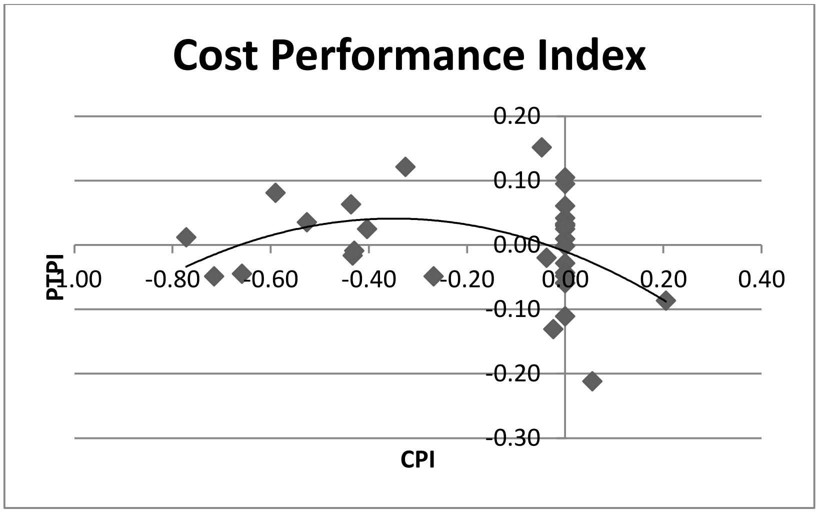

Figure 14: Correlation between PTPI and CPI

Table 9 summarizes the analysis of variance result. In this analysis, CPI was considered a dependent variable. The final model yielded an R^2 value of 0.213, indicating that the model has the ability to explain 21.3 percent variability in the data.

Table 9: Analysis of Variance of the Correlated Model

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	.044	2	.022	4.062	.027
Residual	.164	30	.005		
Total	.209	32			

The independent variable is PTPI.

Additional project cost and time-value savings

The Co3 calculations yielded following results for Interim Completion incentives, Accepted for Traffic incentives and Lane Rental incentives. Table 10 presents for every project the max offered incentives, the actual paid incentives and the calculated user delay avoided because of the Interim Completion incentive. As shown in Figure 15, with the exception of one project, all interim completion incentive projects yielded a user delay savings that exceeded the paid incentives. Figure 16 shows that these projects were completed on average of 10 days earlier than expected.

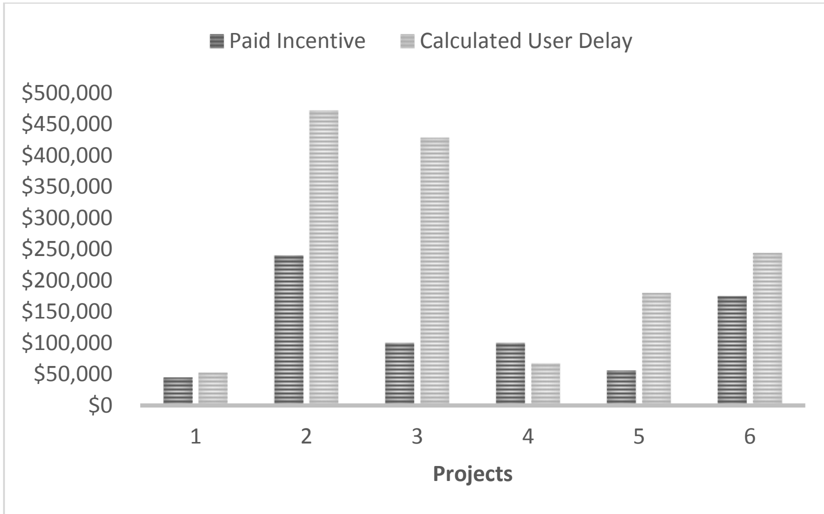

Figure 15 : Interim Completion Paid Incentives vs. Calculated User Delay Avoided

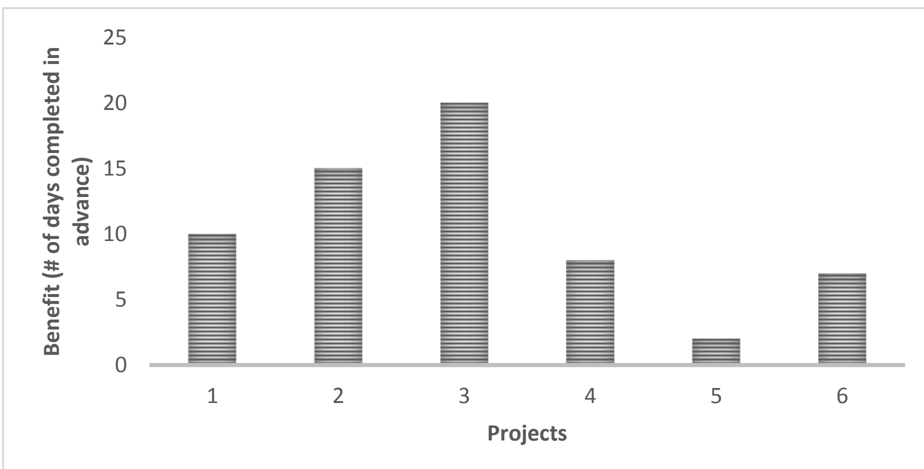

Figure 16: Benefit of Interim Completion Incentives (# of days completed in advance)

Table 10: Interim Completion Incentives vs. Calculated User Delay Avoided.

#	Contract No	Letting Year	Maximum Offered Incentive	Paid Incentive	Calculated User Delay	Benefit (# of days completed in advance)
1	25032-60481	2007	$45,000	$45,000	$52,492	10
2	38072-79005	2012	$240,000	$240,000	$471,968	15
3	39405_83201	2008	$100,000	$100,000	$428,364	20
4	65033-103442	2011	$100,000	$100,000	$67,524	8
5	38103-100001	2011	$150,000	$56,250	$180,100	2
6	46161-87522	2012	$250,000	$175,000	$243,873	7

Table 11 presents for every project the maximum offered incentive, the actual paid incentive and the calculated user delay avoided because of the Accepted for Traffic incentive. Figure 17 illustrates that 100% of the Accepted for Traffic incentive projects reviewed showed user delay savings that exceeded the paid incentives. Figure 18 shows that all projects were completed early with an average of 32 days early.

All projects have yielded a user delay savings that exceeded the paid incentives.

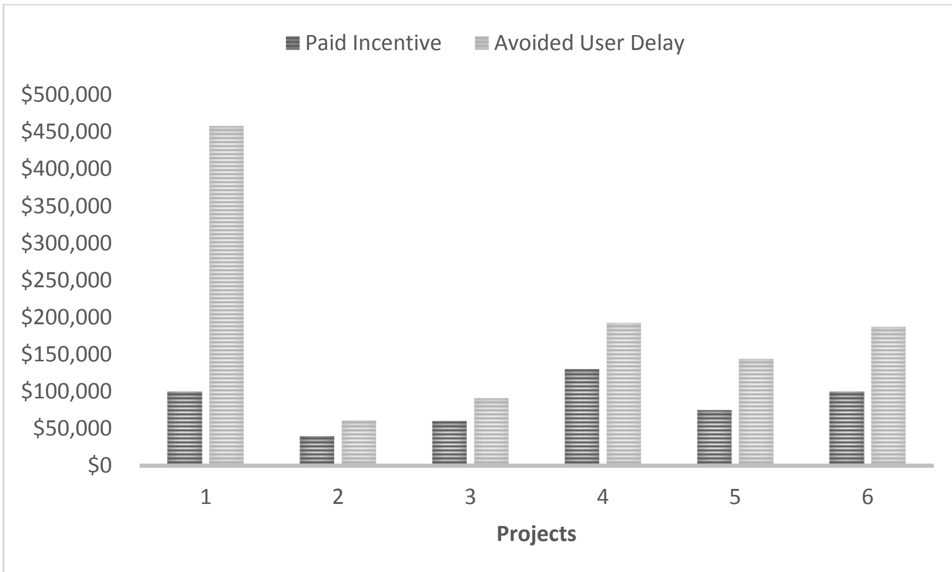

Figure 17: Accepted for Traffic Paid Incentives vs. Calculated User Delay Avoided

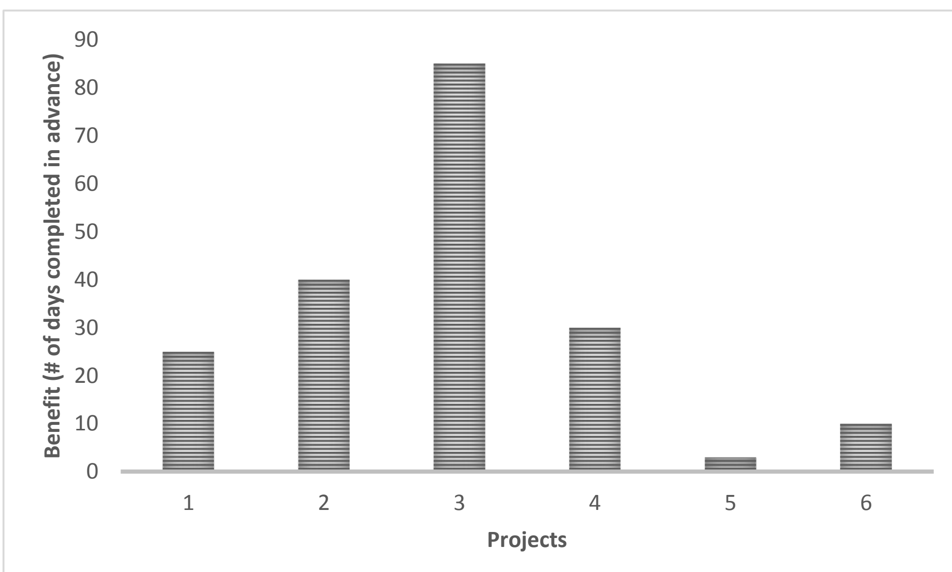

Figure 18: Benefit of Accepted for Traffic Incentives (# of days completed in advance)

Table 11: Accepted for Traffic Incentives vs. Calculated User Delay Avoided

#	Contract No	Letting Year	Maximum Offered Incentive	Paid Incentive	Calculated User Delay	Benefit (# of days completed in advance)
1	41025-82763	2008	$100,000	$100,000	$458,108	25
2	41051-90161(1)	2008	$40,000	$40,000	$60,860	40
3	41051-90161(2)	2008	$60,000	$60,000	$91,080	85
4	41062-75080	2008	$130,000	$130,000	$192,312	30
5	82195-79177	2006	$75,000	$75,000	$143,916	3
6	82194-110565	2012	$100,000	$100,000	$187,056	10

The project data analyses have highlighted the effectiveness of Accepted for Traffic and Interim Completion incentive/disincentive contracting methods. The paid incentives for the above two methods were easily justified by calculating the avoided user delay that could have been encountered if the incentive were not included. This was not the case for Lane Rental incentive.

Table 12 presents lane rental charge per hour and the hourly user delay rate for the lane rental incentive projects, as well as the maximum offered incentive and the paid incentive. It was found that in some projects the calculated user delay per hour is higher than what MDOT charges for lane rental assessment charge. To confirm these results, the calculations were reviewed with the MDOT pavement performance and selection engineer, as well as explored through a series of interviews with several regional project/construction engineers and the system operations engineer. It was found that MDOT does not have a standard process or guideline for developing lane rental incentive costs. Few interviewees mentioned using Co3 to calculate the expected user delay as a starting point but these numbers get adjusted by the project engineer later based on different factors such as the incentive not to exceed 5% of the allocated budget, what is left in the budget, which rates will motivate the contractor to open the road faster but not scare the contractor from bidding the job, etc.

Additionally, it should be noted that for all projects with lane rental charge lower than the calculated user delay, the actual paid incentives were substantially lower than the maximum offered incentive or a distinctive amount imposed on the contractor. This would questions the lane rental incentive/disincentive accelerating technique for these projects.

Table 12: Lane Rental Charge and the Hourly User Delay Rate for the Lane Rental Incentive Projects

#	Contract No.	Year	Maximum Incentive	Paid Incentive	Item	Lane Rental Charge per hr	User Delay Cost/ hr
1	25132-44785	2009	$100,000	$95,010	One lane I 475 N or S	$230	**$456**
					Detoured Nor S	$600	**$3,075**
2	34044-102316	2008	$100,000	$50,000	EB I 96	$750	$206
					WB I 96	$750	$461
					Saturdays	$750	$543
3	41024-75091	2007	$100,000	$97,675	One lane I-96	$700	$94
4	41131-79462	2008	$100,000	$0	one lane US 131	$1,000	**$9,273**
5	77011-75169	2007	$20,000	($6,420)	one lane M-19	$60	$14
6	77011-87392	2008	$50,000	($9,650)	one lane M-19	$100	**$972**
7	77023-51506	2007	$10,000	($225,650)	one lane I-69	$150	**$160**
					Entrance Ramp	$100	**$148**
					Exit Ramp	$100	**$285**
8	77024-74766	2008	$800,000	$260,222	One lane I-69	$412.53	$412.53
					Ramp Exit	$861.95/ $440.49	$861.95/ $440.49
					Ramp Ent.	$752.04/ $510.45	$752.04/ $510.45
9	77032-104088	2010	$80,000	$10,000	One Lane	$75	**$103**
					Two Lane	$200	$206
10	77052-81292	2007	$5,000	$4,300	one lane I-94 BL	$100	$111
					one lane M29	$100	$52
11	77052-89456	2007	$5,000	$5,000	One Lane	$100	$20
12	77111-100701	2008	$500,000	$388,740	One Lane I-94	$200	**$584**
13	77111-101386	2009	$20,000	$19,100	One Lane I-94	$200	$202
14	77111-76906	2008	$500,000	($946,920)	one lane I-69	$200	$160
					one lane Road	$100	$27
					Entrance Ramp	$100	**$148**
15	77111-78488	2008	$28,000	$28,000	EB I 96	$200	**$404**
					WB I 96	$200	**$550**
16	77111-80911	2009	$400,000	$399,318	One lane I-94	$559.57	$559.57
					Two lane	$526.20	$526.20
					Exit Ramp (A)	$805.28	$805.28
17	77111-89733	2007	$10,000	$5,000	One lane I-94	$150	**$614**

Effect of acceleration techniques on project long-term pavement performance

Although polynomial curves were used to calculate the DI progress for these projects, it should be advised that the actual project long term performance is different as the projects tend to deteriorate faster when they have higher DI values. Figures 1 and 2 illustrate the best fit curves for all incentive projects and non-incentive projects. It should be noted that the incentive projects took longer to reach Average DI of 50. The same results were obtained when the DI values were calculated for the 15 pair projects identified for the study analysis as illustrated in Figure 19. The incentive projects tend to deteriorate slower than the non-incentive projects for the identified pair-projects.

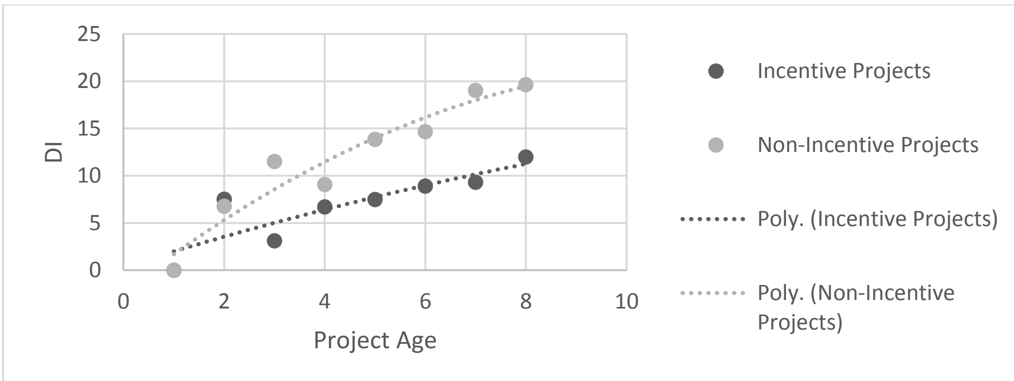

Figure 19: DI Progress for Incentive and non-Incentive Projects

Table 13 illustrates the Modified RSL right after construction in years for the incentive group projects and its paired non-incentive group. It should be noted that these numbers tends to be higher than usual as polynomial regression modeling was used to calculate these numbers. Actual projects tend to deteriorate faster as the project gets older. The DI performance data and calculations of Modified RSL are presented in Appendix 9.

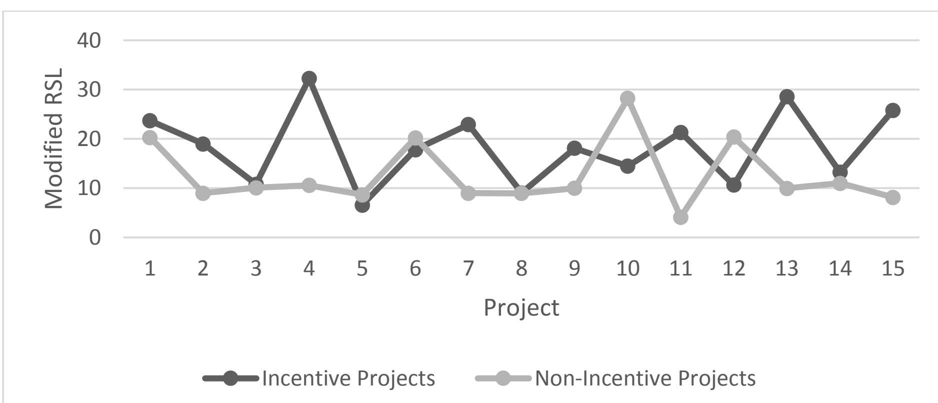

Figure 20: Modified RSL for Each Incentive Project with the Corresponding Non-Accelerated Project

Figure 20 plots the Modified RSL for each incentive project with the corresponding non-accelerated project. The plotted Modified RSL data also suggests a strong positive relation between the incentive paid and project long-term pavement performance.

Table 13: Modified Remaining Service Life for Incentive Projects vs. Non-Incentive Projects

No	**Contract ID**	**RSL* (Yrs)**	**Incentive**	**Contract ID**	**RSL* (Yrs)**
1	41043-45783	23.7	Interim Completion	41043-45786	20.3
2	61153-45782	18.98	Interim Completion	61151-45809	9
3	62031-32352	10.82	Interim Completion	62031-32342	10.12
4	82123-52803	32.26	Accepted for Traffic	41026-53377	10.58
5	03112-48577	6.6	Lane Rental	83031-80235	8.67
6	06111-55125	17.84	Lane Rental	65041-45865	20.22
7	26011-43817	22.93	Lane Rental	26011-45415	9.01
8	39014-38097	9.06	Lane Rental	41131-44778	8.96
9	39022-45837	18.12	Lane Rental	11017-106483	10
10	41131-53766	14.5	Lane Rental	39051-49430	28.25
11	50111-43941	21.32	Lane Rental	39041-90224	4.14**
12	63071-49287	10.67	Lane Rental	79031-45850	20.4
13	82024-82589	28.61	Lane Rental	11013-51197	9.99
14	82112-48379	13.26	Lane Rental	82111-75706	11
15	63052-50291	25.8	Lane Rental	82053-45693	8.17

* It should be noted that the Modified RSL numbers tends to be higher than usual as the projects deteriorate faster later in their life
**This is an actual number as the project reached DI of 58.22 in Year 5

In performing the paired samples t-tests for the expected Modified RSL performance index, there was a significant difference in the scores for incentive project group (M=18.30, SD=7.53) and non-incentive project group (M=12.59, SD=6.50) conditions; t (15) =-2.067, p =0.05. However, there was no significant difference in the scores for Lane Rental incentive project group (M=17.16, SD=7.07) and non-incentive project group (M=12.62, SD=7.16) conditions; t (11) = 1.327, p =0.214. Table 14 illustrates the Paired Samples T-Test Results.

Table 14: The Paired Samples T-Test Results Based on Modified RSL

	M (Mean)	SD (St. Dev.)	Sample Size	T	P
Whole Groups Based on Modified RSL					
Incentive Group	18.30	7.53	15	-2.067	0.05
Non-Incentive Group	12.59	6.5			
Lane Rental Groups Based on Modified RSL					
Incentive Group	17.16	7.07	11	1.327	0.214
Non-Incentive Group	12.62	7.16			

Recommendations on each acceleration technique

Based on the limited results provided in task 3, the results support a few of the listed "Advantages and Disadvantages" and "Recommendations for Use" of each acceleration technique in the 2013 MDOT Innovative Construction Contracting document. Tables 15, 16, and 17 illustrate all the "Advantages and Disadvantages" and "Recommendations for Use" for Interim Completion Date Incentives, Accepted for Traffic Incentives, and Lane Rental incentives, respectively, along with a supporting statement, if the data analysis support this statement.

Table 15: Recommendations on Interim Completion Date Incentives

Item	Supporting statement
Advantages- Interim Completion Date Incentives	
Earlier completion or open-to-traffic date for critical phases of a project	Table 10 supports the second half of the statement "Open-to- traffic for…" (Appendix 4 partially supports the first half of this statement)
Minimizes impacts to motorists and/or community	Because of the earlier completion, the user delay cost was less (Table 10)
Reduces road user delay costs	Table 10 supports this statement
Better scheduling by contractors for construction activities	Appendix 4 partially supports this statement
Disadvantages - Interim Completion Date Incentives	
Increased project costs may require additional funding	Table 10 supports this statement. MDOT had to pay additional incentive cost that was not considered in the comparable non-incentive projects.
Potential for increased bid costs	Table 10 supports this statement. Contractors will increase bid in case they feel that they cannot meet the required interim completion date.
Potential for increased costs for construction oversight	The project did not consider this factor

Due to cap on the maximum amount, the incentive may be less than road user delay costs	Table 10 supports this statement. How is that a Disadvantage? This should be moved to Advantages
Recommendations for Use- Preferred Candidates:	
Projects with critical completion dates	Project proposal supports this statement
Projects with significant road user delay costs and/or community and local business impacts	Table10 supports this statement
Recommendations for Use- Undesirable Candidates:	
Projects with open-to-traffic constraints, such as weekends to accommodate seasonal peak volumes or extended periods for special events, which significantly limit the amount of work hours or days per week	Almost all projects provided, the incentives were provided to avoid seasonal peak volumes (such as 4th of July or Labor Day weekend).
Projects with third party coordination concerns, such as utility relocations	The project did not consider this factor

Table 16: Recommendations on Accepted for Traffic Incentive/Disincentive

Item	Supporting statement
Advantages- Accepted for Traffic incentive/Disincentive	
Earlier open-to-traffic dates and contract completion	Table 11 supports the first half of the statement and Appendix 4 partially supports the second half of the statement.
Minimizes impacts to motorists and/or community	Because of the earlier completion, the user delay was less (Table 8)
Reduces road user delay costs	Table 11 supports this statement
Better scheduling by contractors for construction activities	Appendix 4 supports this statement
Disadvantages - Accepted for Traffic incentive/Disincentive	
Increased project costs may require additional funding	Table 11 supports this statement. MDOT had to pay additional incentive cost that was not considered in the comparable non-incentive projects.
Potential for increased bid costs	Table 11 supports this statement. Contractors will increase bids in case they feel that they cannot meet the required Interim completion date.
Potential for increased costs for construction oversight	The project did not consider this factor
Due to cap on the maximum amount, the incentive may be less than road user delay costs	Table 11 supports this statement.
Recommendations for Use- Preferred Candidates:	

Projects with critical open-to-traffic dates	Project proposal supports this statement
Projects with significant road user delay costs and/or community and local business impacts	Table 11 supports this statement
Recommendations for Use- Undesirable Candidates:	
Projects with third party coordination concerns, such as utility relocations	The project did not consider this factor

Table 17: Recommendations on Lane Rental Incentive

Item	Supporting statement
Advantages- Lane Rental Incentive	
Earlier contract completion or open-to-traffic date	Neither data in Table 13 nor Appendix 4 supports this statement. Table 13 indicates that in most projects, the contractor was paid less than the full incentive amount. This means that road lanes were closed more than expected and Appendix 4 shows in the following graph that the non-incentive projects show better performance in earlier contract completion compared with the lane rental incentive projects.
Minimizes impacts to motorists and/or community	Conceptually, the numbers do not support this statement
Better scheduling by contractors for construction activities	Appendix 4 does not support this statement. Appendix 4 indicates that non-incentive projects have a better performance in earlier contract completion compared with lane rental incentive projects.
Disincentives for exceeding the estimated lane rental amounts.	Table 13 supports this statement. Lane rental charges (disincentives) were assessed when the lanes were closed more than expected.
Disadvantages - Lane Rental Incentive	
Increased project costs may require additional funding	Although this statement could be supported conceptually, Table 13 indicated that for most projects identified, contractors were assessed disincentives more than expected when the incentive was calculated.
Potential for increased bid costs	Table 12 supports this statement. Contractors will increase bids in case they feel that they cannot meet the required lane rental charges.
Potential for increased costs for construction oversight	The special provision template supports this statement. The construction engineer and the contractors must meet biweekly to agree on the lane rental assessed hours.
Tracking of lane rental charges	The special provision template supports this statement. The construction engineer and the contractors have to

	meet biweekly to agree on the lane rental assessed hours.
Recommendations for Use- Preferred Candidates:	
Projects with critical completion dates	The proposal justification for lane rental supports this statement.
Projects with significant road user delay costs and/or community and local business impacts	The proposal justification for lane rental supports this statement.
Recommendations for Use- Undesirable Candidates:	
Projects with open-to-traffic constraints, such as weekends to accommodate seasonal peak volumes or extended periods for special events, which significantly limit the amount of work hours or days per week	The project did not consider this factor.
Projects with third party coordination concerns, such as utility relocations	The project did not consider this factor.

Chapter 5- Conclusions

Conclusions from the Study

The research team provides the following conclusions from the study

1. The literature supports the need for this study and highlights the lack of a process for reviewing the effectiveness of incentive/ disincentive clauses.
2. Data was scarce and fragmented. The team spent considerable time identifying the required projects, locating their records and connecting these records with long-term performance data.
3. Limited data was identified and used to carry the analysis.
4. Data analysis did not support the notion that incentive clauses adversely impact long term project performance. The analyzed data statistically supports an improvement in the long term project performance for the incentive projects over their comparable non-incentive projects.
5. Identified data suggest a trend that incentive clauses accelerate project schedules. A strong trend has been identified that the incentive projects schedules were accelerated compared to their similar non-incentive projects.
6. Data analysis statistically supports the assertion that incentive clauses increase project cost but further analysis finds that the avoided user delay was higher than the additional paid cost for Accepted for Traffic and Interim Completion incentive/ disincentive clauses but not for Lane Rental incentive clauses.
7. The analysis results highlight the effectiveness of Accepted for Traffic and Interim Completion incentive/ Disincentive clauses in achieving their goals by accelerating project schedules and reducing user delay cost.
8. The analysis results debate the effectiveness of the Lane Rental incentive/ disincentive clause in achieving their goals and calls for an in-depth future study to investigate this issue.
9. The results call for little modification to the listed “Advantages and Disadvantages” and “Recommendations for Use” of each acceleration technique in the 2013 MDOT Innovative Construction Contracting document.
    a. For interim completion date incentives, remove “Projects with open-to-traffic constraints, such as weekends to accommodate seasonal peak volumes or extended

periods for special events, which significantly limit the amount of work hours or days per week" from Recommendations for Use-Undesirable Candidates list.

b. For the lane rental incentive, remove "Earlier contract completion or open-to-traffic date" and "Better scheduling by contractors for construction activities" from "Advantages" list of Recommendations for Further Research.

Recommendations for Further Research

1. Initiate a research study to develop a state-wide guidebook and best management practices for estimating the amount of incentive/ disincentive clauses. The study should include a national survey of the current practices of states that are known to sponsor more I/D clauses in their contracts (such as Florida, South Carolina, and Ohio).

Recommendations for Implementation

The following recommendations are provided for implementation by MDOT.

1. Maintain a database of current and previous approved special provisions along with project performance indicators to systematically measure the performance of I/D clauses and benchmark the effectiveness of any new project. This will allow MDOT to assess the value and practices of these incentives and will help in fulfilling the new incentive reporting requirement as required by the State of Michigan Act 200, Public Acts of 2012.
2. Request that both the construction engineer and the contractor receiving the incentive submit a summary report providing lessons learned that can be implemented in future project designs and specifications.
3. Examine the consistency of the currently developed procedures for calculating the incentive amount (especially for the lane rental incentive/disincentive) state-wide.

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Appendix 1: List of MDOT Projects Built Via Acceleration Techniques Using I/D Methods Mentioned in the MDOT Innovative Construction Contracting Document

No	Contract ID	Letting Year	Route	Work Type
A+B Incentive/Disincentive				
1	09034-46575-2	2001	I-75	RREC
No Excuse Incentive/Disincentive				
1	38111-43497	2001	US-127	RREH
2	39405-76303	2005		SFTY
Accepted for Traffic I/D				
1	41025-82763	2008	M-44, M-37, I-96	PMAI
2	41027-51883	2009	I-196	RREH
3	41029-45086	2006	I-196	PMAI
4	41051-90161	2008	M-37	SFTY
5	41062-75080	2008	M11	RREC
6	63022-76051	2005	I-96	SFTY
7	63081-45715	2006	M-10	RREH
8	63101-54301	2006	I-696	RREC
9	82022-45684	2004	I-94	RREH
10	82053-58175	2006	US-24	RESU
11	82123-45199	2005	I-96	RREH
	82123-45199	2005	I-96	RREH
12	82123-52803	2005	I-96	RREH
13	82194-110565	2012	I-75	SFTY
14	82194-37795	2007	I-75 I-96 I-94	RREC
15	82195-79177	2006	I-75	BREC
Lane Rental				
1	03112-48577	2002	US-131	RESU
2	06111-55125	2005	I-75	RESU
3	18024-75774	2004	US-10	RESU
4	25032-100664	2010	I-75	PMAI
5	25132-44785	2009	I-475	RREC
6	26011-43817	2001	M18/M61	RREH
7	34043-87157	2011	I-96	PMAI
8	34044-102316	2008	I-96	SFTY
9	34044-109045	2012	I-96	PMAI
10	39014-38097	1999	US-131	RESU
11	39014-50799-2	2001	US-131	PMAI
12	39022-45837	2000	I-94	RESU

No	Contract ID	Letting Year	Route	Work Type
Lane Rental (Cont.)				
13	39024-46457	2001	I-94	RESU
14	41024-45271	2005	I-96	NCON
15	41024-75091	2007	I-96	BREC
16	41027-54148-2	2005	I-196	BREC
17	41064-33333	2000	M-6;US-131	NCON
18	41131-45125	1999	US-131/US-131BR	SFTY
19	41131-45811	2005	US-131 SB	RREC
20	41131-51903	2004	US-131	PMAI
21	41131-53766	2004	US-131/M-11	BREC
22	41131-79462	2008	US-131	MISC
23	50111-43941	2002	I-94	BREH
24	54022-73737	2011	M-20	BCON
25	61072-38184	1999	US-31	RREH
26	63071-49287	2000	M-15	RESU
27	63174-107677	2009	I-75	BREC
28	63174-50290	2005	I-75	RESU
29	70025-33330	2001	M-6; I-196	NCON
30	70063-50804	2003	I-96	RREH
31	76023-57078	2006	I-69	RESU
32	77011-75169	2007	M-19	BREC
33	77011-87392	2008	M-19	RREC
34	77023-51506	2007	I-69	RREH
35	77023-79725	2007	I-69	PMAI
36	77024-74766	2008	I-69	RREH
37	77032-104088	2010	I-94BL	MISC
38	77032-55660	2005	I-94BL	RESU
39	77041-55661	2008	M-19	RESU
40	77052-81292	2007	I-94BL and M-29	SFTY
41	77052-89456	2007	M-29	SFTY
42	77111-100701	2008	I-94	RREH
43	77111-101386	2009	I-94	MISC
44	77111-45758	2006	I-94 I-94BL	RREH
45	77111-76906	2008	I-94	RREH
46	77111-78488	2008	I-94	MISC
47	77111-80911	2009	I-94	RREH
48	77111-88128	2007	I-94	RREC
49	77111-89733	2007	I-94	MISC

No	Contract ID	Letting Year	Route	Work Type
		Lane Rental (Cont.)		
50	80024-53350	2006	I-94	RREH
51	81063-59277	2005	I-94	RREC
52	82022-34014	2003	I-94	BREC
53	82022-48345	2002	I-94	BREC
54	82023-51493-2	2004	I-94	BREC
55	82023-52802	2003	I-94	RESU
56	82024-48607	2002	I-94	RESU
57	82024-82589	2007	I-94	BREH
58	82025-46982	2000	I-94	RESU
59	82025-72419	2003	I-94	BREC
60	82052-45694	2003	US-24	RREH
61	82101-45707	2000	OLD M-14	RREH
62	82101-49401	2002	Old M-14	RREH
63	82112-48379	2000	M-10	BREC
64	82122-38079	2001	I-96/M-14/I-275	RREH
65	82123-53387	2000	I-96	BREC
66	82125-45752	1998	I-275/I-96	RREH
67	82191-45196	2000	I-75	BREH
68	82192-45702	2001	M-39	RREH
69	82192-52861	2000	M-39	BREH
70	82194-45699	2002	I-75	RREH
71	82195-53891	2000	I-75 TO I-375 RAMP	RREH
72	82251-45183	2001	I-375	PMAI
73	82251-77658	2003	I-75/I-94	PMAI
74	63052-50291	2005	US 24	RREH
75	82024-43927	1999	I-94	BREC
76	25061-40906	1999	M-121	SFTY
		Interim Completion		
1	25032-60481	2007	I-75	RESU
2	38072-79005	2012	M-50/US-127	BREC
3	39405-83201	2008	I-94	RREH
4	41043-45783	1999	M-21	RESU
5	53555-46157	1999		RESU
6	54022-45832	2007	M-20	RREH
7	56044-60433	2008	US10	RESU
8	61153-45782	1999	US-31 BR	RESU
9	62031-32352	1999	M-37	RESU

No	Contract ID	Letting Year	Route	Work Type
Interim Completion (Cont.)				
10	65033-103442	2011	I-75 Boulevard	RREH
11	84916-87518	2007	VARIES	PMAI
12	38103-100001	2011	I-94	NCON
13	81406-56839	2005		RREH
14	81406-75300	2003		RESU
15	39405-56213	2004		SFTY
16	70081-48248	1999	M-104	SFTY

Appendix 2: List of MDOT Projects Built via Acceleration Techniques vs. Similar MDOT Projects Constructed without Acceleration Techniques

No	Type	Contract I/D	Lettin g	Material	Common Route	Contract I/D	Letting
A+B Incentive/Disincentive							
1	RREC	09034-46575-2	2001		I-75	25032-45899	2002
No Excuse Incentive/Disincentive							
1	RREH	38111-43497	2001	US-127	No Match		
2	SFTY	39405-76303	2005		No Match		
Accepted for Traffic I/D							
1	PMAI	41025-82763	2008		M-37	No Match	
	PMAI	41025-82763	2008		M-44	No Match	
	PMAI	41025-82763	2008		I-96	No Match	
2	RREH	41027-51883	2009		I-196	70023-60422	2006
3	PMAI	41029-45086	2006		I-196	80013-60471	2006
4	SFTY	41051-90161	2008	Concrete	M-37	No Match	
5	RREC	41062-75080	2008	Concrete	M-11	No Match	
6	SFTY	63022-76051	2005	Concrete	I-96	41025-72022	2003
						47065-82603	2005
						47065-53312	2001
7	RREH	63081-45715	2006		M-10	82112-45681	2006
						82111-47085	2001
8	RREC	63101-54301	2006		I-696	No Match	
9	RREH	82022-45684	2004		I-94	82022-34014	2003
						63103-34121	1999
10	RESU	82053-58175	2006		US-24	82053-45692	2000
						63052-47041	2002
11	RREH	82123-45199	2005		I-96	82122-45705	2003
						82123-45199	2005
12	RREH	82123-52803	2005		I-96	82122-45705	2003
	RESU	82123-52803	2005		I-96	41026-53377	20006
						82122-45705	2003
13	SFTY	82194-110565	2012		I-75	No Match	
14	RREC	82194-37795	2007	Concrete	I-75	09034-46575-2	2001
						25032-45899	2002
						09034-84072	2008
						73171-75246	2006

	RREC	82194-37795	2007	Concrete	I-94	80024-83935	2007
15	BREC	82195-79177	2006		I-75	82191-51518	2002
Lane Rental							
1	RESU	03112-48577	2002	Flexible	US-131	11017-106483	2005
						28091-37848	1998
						40011-37958	1999
						41131-44778	2001
						54012-88885	2012
						54014-75064	2004
						67015-56736	2005
						67017-50699	2004
						78031-32379	2000
						83031-80235	2006
2	RESU	06111-55125	2005	Flexible	I-75	65041-45865	2000
3	RESU	18024-75774	2004	Concrete	US-10	No Match	
4	PMAI	25032-100664	2010		I-75	09035-104965	2010
5	RREC	25132-44785	2009		I-475	No Match	
6	RREH	26011-43817	2001	Flexible	M-18	26011-45415	1999
						26011-45410	1998
	RREH	26011-43817	2001	Flexible	M-61		
7	PMAI	34043-87157	2011	Concrete	I- 96	34043-79371	2005
8	SFTY	34044-102316	2008		I-96	No Match	
9	PMAI	34044-109045	2012		I- 96	No Match	
						34043-79371	2005
10	RESU	39014-38097	1999	Flexible	US-131	41131-44778	2001
11	PMAI	39014-50799-2	2001	Flexible	US-131		
12	RESU	39022-45837	2000	Flexible	I-94	11017-106483	2005
13	RESU	39024-46457	2001	Flexible	I-94	50111-105851	1999
14	NCON	41024-45271	2005		I-96	No Match	
15	BREC	41024-75091	2007		I-96	63022-55798	2003
16	BREC	41027-54148-2	2005		I-196	11111-50793	2005
						41027-51881	2006
						80012-89684	2010
17	NCON	41064-33333	2000		US-131	No Match	
18	SFTY	41131-45125	1999		US-131/US-131BR	No Match	
19	RREC	41131-45811	2005		US-131	No Match	
20	PMAI	41131-51903	2004		US-131	54013-79078	2006

21	BREC	41131-53766	2004		US-131	39014-81325	2003
						41131-87156	2011
						03112-47648	2000
					US-131	39051-49430	2000
22	MISC	41131-79462	2008		US-131	No Match	
23	BREH	50111-43941	2002	Flexible	I-94	39041-90224	2003
24	BCON	54022-73737	2011		M-20	No Match	
25	RREH	61072-38184	1999		US-31	11056-50757	2005
26	RESU	63071-49287	2000	Flexible	M-15	25091-45841	1999
						09071-33925	1998
						79031-45850	2000
27	BREC	63174-107677	2009		I-75		
28	RESU	63174-50290	2005	Flexible	I-75	63173-51472	2003
29	NCON	70025-33330	2001		M-6; I-196	No Match	
30	RREH	70063-50804	2003		I-96	23152-45640	2001
						82122-45705	2003
31	RESU	76023-57078	2006	Flexible	I-69	No Match	RESU
32	BREC	77011-75169	2007		M-19	77011-60338	2005
33	RREC	77011-87392	2008		M-19	No Match	
34	RREH	77023-51506	2007		I-69	No Match	
35	PMAI	77023-79725	2007		I-69	No Match	
36	RREH	77024-74766	2008	Concrete	I-69	12033-49921	2001
37	MISC	77032-104088	2010	Concrete	I-94	No Match	
38	RESU	77032-55660	2005	Flexible	I-94		
39	RESU	77041-55661	2008	Flexible	M-19	50091-45731	2000
						74031-45847	2000
40	SFTY	77052-81292	2007		I-94	No Match	SFTY
41	SFTY	77052-89456	2007		M-29	No Match	
42	RREH	77111-100701	2008		I-94	No Match	
43	MISC	77111-101386	2009		I-94	No Match	
44	RREH	77111-45758	2006		I-94 I-94BL	82022-45686	2004
45	RREH	77111-76906	2008		I-94	82022-45686	2004
46	MISC	77111-78488	2008		I-94	No Match	
47	RREH	77111-80911	2009		I-94	82022-45686	2004
48	RREC	77111-88128	2007		I-94	No Match	
49	MISC	77111-89733	2007		I-94	No Match	
50	RREH	80024-53350	2006		I-94	82022-45686	2004
51	RREC	81063-59277	2005		I-94	No Match	

52	BREC	82022-34014	2003		I-94	77111-51508	2003
						11015-50795	
						11015-50782	2004
53	BREC	82022-48345	2002		I-94	No Match	
54	BREC	82023-51493-2	2004		I-94	No Match	
55	RESU	82023-52802	2003	Flexible	I-94	No Match	
56	RESU	82024-48607	2002	Flexible	I-94	11016-46460	2001
57	BREH	82024-82589	2007		I-94	11013-51197	2002
58	RESU	82025-46982	2000		I-94	13121-45999	2000
						77032-47050	2001
						81063-38034	1999
59	BREC	82025-72419	2003		I-94	77111-51508	2003
						77111-51507	2003
						11015-50782	2004
60	RREH	82052-45694	2003	Flexible	US-24	No Match	RREH
61	RREH	82101-45707	2000		OLD M-14	No Match	
62	RREH	82101-49401	2002		OLD M-14	No Match	
63	BREC	82112-48379	2000		M-10	82112-89273	2009
64	RREH	82122-38079	2001		I-96/M-14/I-275	82122-45705	2003
65	BREC	82123-53387	2000		I-96	47064-78200	2008
66	RREH	82125-45752	1998		I-275/I-96	No Match	
67	BREH	82191-45196	2000		I-75	No Match	
68	RREH	82192-45702	2001		M-39	82193-76902	2004
69	BREH	82192-52861	2000		M-39	No Match	
70	RREH	82194-45699	2002		I-75	82052-47061	2001
71	RREH	82195-53891	2000		I-375	No Match	
72	PMAI	82251-45183	2001		I-375	No Match	
73	PMAI	82251-77658	2003		I-75/I-94	No Match	
74	RREH	63052-50291	2005		US 24	63031-45714	2000
						82053-45693	2002
75	BREC	82024-43927	1999		I-94	77111-51508	2003
76	SFTY	25061-40906	1999		M-121	No Match	
Interim completion							
1	RESU	25032-60481	2007	Flexible	I-75	09111-60467	2005

	RESU				I-75	49026-84211	2009
	RESU				I-75	20052-48557	
	RESU				I-75	49025-45609	2003
	RESU				I-75	63173-51472	2003
	RESU				I-75	25031-45446	2000
2	BREC	38072-79005	2012	Flexible	M-50/US-127		2012
3	RREH	39405-83201	2008	Flexible	I-94	50111-105851	2009
4	RESU	41043-45783	1999	Flexible	M-21	41043-45786	
	RESU				M-21	34061-60415	2004
	RESU				M-21	25081-48543	2004
	RESU				M-21	25081-73150	2003
5	RESU	53555-46157	1999	Flexible			
6	RREH	54022-45832	2007	Flexible	M-20	62015-53767	2003
	RREH				M-20	62015-56914	2004
	RREH				M-20	62015-60572	2005
7	RESU	56044-60433	2008	Concrete	US10	56051-45789	1999
	RESU				US10	53022-45162	1998
	RESU				US10	67022-44987	2001
8	RESU	61153-45782	1999	Flexible	US-31 BR	61151-45809	2002
	RESU				US-31 BR	15012-48535	2002
	RESU				US-31 BR	53034-45826	2000
	RESU				US-31 BR	10032-44113	1999
	RESU				US-31 BR	10032-45121	2000
	RESU				US-31 BR	64012-45805	2000
	RESU				US-31 BR	28012-45834	2001
	RESU				US-31 BR	61073-30127	2000
9	RESU	62031-32352	1999	Flexible	M-37	62031-32342	2003
	RESU				M-37	62032-45802	2002
	RESU				M-37	13011-38086	2001
					M-37	43012-79565	2006
10	RREH	65033-103442	2011	Flexible	I-75 Boulevard	17034-53932-2	2001
11	PMAI	84916-87518	2007	Flexible	I-94		
12	NCON	38103-100001	2011		I-94		
13	RREH	81406-56839	2005				
14	RESU	81406-75300	2003				
15	SFTY	39405-56213	2004				
16	SFTY	70081-48248	1999	Flexible	M-104		

Appendix 3: Original Time Performance Index

Incentive Type	Incentive Contract I/D	OTPI	Non-Incentive Contract I/D	OTPI
Accepted for Traffic	41027-51883	0.00%	70023-60422	80.73%
Accepted for Traffic	41029-45086	38.28%	80013-60471	57.95%
Accepted for Traffic	63022-76051	0.00%	47065-82603	-2.56%
Accepted for Traffic	63081-45715	-3.72%	82112-45681	241.40%
Accepted for Traffic	82123-45199	126.90%	82123-45199	126.90%
Accepted for Traffic	82123-52803	75.17%	41026-53377	108.49%
Accepted for Traffic	82194-37795	2.23%	09034-84072	159.28%
Lane Rental	34043-87157	152.55%	34043-79371	-15.00%
Lane Rental	34044-109045	0.00%	34043-79371	-15.00%
Lane Rental	41027-54148-2	97.80%	11111-50793	-0.49%
Lane Rental	41131-51903	165.28%	54013-79078	4.41%
Lane Rental	41131-53766	-22.27%	39014-81325	-30.38%
Lane Rental	77011-75169	-14.74%	77011-60338	14.06%
Interim Completion	25032-60481	14.43%	09111-60467	-41.61%

Appendix 4: Present Time Performance Index

Incentive Type	Incentive Contract I/D	PTPI	Non-Incentive Contract I/D	PTPI
A+B Incentive/ Distinctive	09034-46575-2	-71.57%	25032-45899	2.59%
Accepted for Traffic	41027-51883	0.00%	70023-60422	74.34%
Accepted for Traffic	41029-45086	-52.67%	80013-60471	0.00%
Accepted for Traffic	41062-75080	0.00%	41063-74453-2	0.00%
Accepted for Traffic	63022-76051	0.00%	47065-82603	0.00%
Accepted for Traffic	63081-45715	0.00%	82112-45681	-0.10%
Accepted for Traffic	82022-45684	-59.05%	82022-34014	0.00%
Accepted for Traffic	82053-58175	0.00%	82053-45692	-62.20%
Accepted for Traffic	82123-45199	0.00%	82123-45199	0.00%
Accepted for Traffic	82123-52803	0.00%	41026-53377	0.00%
Accepted for Traffic	82194-37795	0.00%	09034-84072	-35.91%
Accepted for Traffic	82195-79177	-4.76%	82191-51518	0.65%
Lane Rental	03112-48577	-65.87%	28091-37848	17.57%
Lane Rental	06111-55125	-32.55%	65041-45865	-61.95%
Lane Rental	34043-87157	0.00%	34043-79371	-15.00%
Lane Rental	34044-109045	0.00%	34043-79371	-15.00%
Lane Rental	41024-75091	0.00%	63022-55798	0.00%
Lane Rental	41027-54148-2	-2.44%	11111-50793	-3.82%
Lane Rental	41131-51903	0.00%	54013-79078	0.00%
Lane Rental	50111-43941	210.18%	39041-90224	0.00%
Lane Rental	61072-38184	0.00%	11056-50757	-61.75%
Lane Rental	63071-49287	5.53%	25091-45841	1.67%
Lane Rental	63174-50290	0.00%	63173-51472	-35.31%
Lane Rental	70063-50804	961.40%	23152-45640	-11.45%
Lane Rental	77011-75169	0.00%	77011-60338	0.00%
Lane Rental	77024-74766	-43.32%	12033-49921	0.00%
Lane Rental	77111-45758	-42.97%	82022-45686	0.00%
Lane Rental	77111-76906	0.00%	82022-45686	0.00%
Lane Rental	80024-53350	-40.38%	82022-45686	0.00%
Lane Rental	82022-34014	0.00%	11015-50782	-22.47%
Lane Rental	82024-48607	20.54%	11016-46460	-44.59%
Lane Rental	82024-82589	-26.80%	11013-51197	-45.92%
Lane Rental	82025-72419	0.00%	11015-50782	-22.47%
Lane Rental	63052-50291	84.30%	63031-45714	0.53%
Lane Rental	82024-43927	-4.67%	77111-51508	1.27%

Interim Completion	25032-60481	0.00%	09111-60467	0.00%
Interim Completion	39405-83201	-77.24%	50111-105851	0.00%
Interim Completion	54022-45832	-3.79%	62015-60572	-52.95%
Interim Completion	56044-60433	-43.67%	56051-45789	-3.33%
Interim Completion	61153-45782	0.00%	61151-45809	0.00%
Interim Completion	62031-32352	0.00%	62031-32342	0.00%

Appendix 5: Present Time Performance Index for Incentive Projects and the Paid Incentives

Incentive Type	Incentive Contract I/D	PTPI	Letting Year	Route	Type	Authorized Contract Amount	Incentive	Incentive %
A+B Incentive/ Distinctive	09034-46575-2	-71.57%	2001	I-75	RREC	$19,351,482	$150,000	0.78%
Accepted for Traffic	82022-45684	-59.05%	2004	I-94	RREH	$81,768,474	$4,000,000	4.89%
Accepted for Traffic	41029-45086	-52.67%	2006	I-196	PMAI	$1,631,086	$200,000	12.26%
Accepted for Traffic	82195-79177	-4.76%	2006	I-75	BREC	$4,331,253	$75,000	1.73%
Accepted for Traffic	41027-51883	0.00%	2009	I-196	RREH	$31,878,804	$700,000	2.20%
Accepted for Traffic	41062-75080	0.00%	2008	M11	RREC	$2,895,502	$130,000	4.49%
Accepted for Traffic	63022-76051	0.00%	2005	I-96	SFTY	$709,340	$50,000	7.05%
Accepted for Traffic	63081-45715	0.00%	2006	M-10	RREH	$27,956,395	$2,400,000	8.58%
Accepted for Traffic	82053-58175	0.00%	2006	US-24	RESU	$16,099,727	$200,000	1.24%
Accepted for Traffic	82123-45199	0.00%	2005	I-96	RREH	$28,652,579	$500,000	1.75%
Accepted for Traffic	82123-52803	0.00%	2005	I-96	RREH	$82,532,946	$600,000	0.73%
Accepted for Traffic	82194-37795	0.00%	2007	Multiple	RREC	$173,764,968	$3,675,000	2.11%
Interim Completion	39405-83201	-77.24%	2008	I-94	RREH	$2,868,784	$100,000	3.49%
Interim Completion	56044-60433	-43.67%	2008	US10	RESU	$32,129,641	($41,132)	-0.13%
Interim Completion	54022-45832	-3.79%	2007	M-20	RREH	$4,699,233	$20,000	0.43%
Interim Completion	25032-60481	0.00%	2007	I-75	RESU	$8,345,520	$45,000	0.54%
Interim Completion	61153-45782	0.00%	1999	US-31 BR	RESU	$1,921,195	($5,200)	-0.27%

Interim Completion	62031-32352	0.00%	1999	M-37	RESU	$1,790,570	($62,000)	-3.46%
Lane Rental	03112-48577	-65.87%	2002	US-131	RESU	$6,071,832	($12)	0.00%
Lane Rental	77024-74766	-43.32%	2008	I-69	RREH	$35,348,348	$260,222	0.74%
Lane Rental	77111-45758	-42.97%	2006	I-94BL	RREH	$25,906,027	$50,000	0.19%
Lane Rental	80024-53350	-40.38%	2006	I-94	RREH	$16,173,424	$349,495	2.16%
Lane Rental	06111-55125	-32.55%	2005	I-75	RESU	$32,615,930	$200,000	0.61%
Lane Rental	82024-82589	-26.80%	2007	I-94	BREH	$7,755,114	$400,000	5.16%
Lane Rental	82024-43927	-4.67%	1999	I-94	BREC	$57,620,339	$765,000	1.33%
Lane Rental	41027-54148-2	-2.44%	2005	I-196	BREC	$3,443,756	($279,200)	-8.11%
Lane Rental	34043-87157	0.00%	2011	I-96	PMAI	$1,064,896	$15,750	1.48%
Lane Rental	34044-109045	0.00%	2012	I-96	PMAI	$2,685,484	$50,000	1.86%
Lane Rental	41024-75091	0.00%	2007	I-96	BREC	$2,409,374	$97,675	4.05%
Lane Rental	41131-51903	0.00%	2004	US-131	PMAI	$4,178,770	$300,000	7.18%
Lane Rental	61072-38184	0.00%	1999	US-31	RREH	$12,847,099	$0	0.00%
Lane Rental	63174-50290	0.00%	2005	I-75	RESU	$8,860,899	$333,500	3.76%
Lane Rental	77011-75169	0.00%	2007	M-19	BREC	$755,423	($6,420)	-0.85%
Lane Rental	77111-76906	0.00%	2008	I-94	RREH	$25,388,933	($946,920)	-3.73%
Lane Rental	82022-34014	0.00%	2003	I-94	BREC	$14,490,204	$200,000	1.38%
Lane Rental	82025-72419	0.00%	2003	I-94	BREC	$4,006,695	$97,250	2.43%
Lane Rental	63071-49287	5.53%	2000	M-15	RESU	$5,545,924	$315,778	5.69%
Lane Rental	82024-48607	20.54%	2002	I-94	RESU	$20,611,173	$1,311,000	6.36%
Lane Rental	63052-50291	84.30%	2005	US 24	RREH	$13,788,041	$500,000	3.63%

Appendix 6: Cost Performance Index

Incentive Type	Incentive Contract I/D	CPI	Non-Incentive Contract I/D	CPI
A+B Incentive/ Distinctive	09034-46575-2	-4.89%	25032-45899	19.31%
Accepted for Traffic	41027-51883	1.62%	70023-60422	-5.36%
Accepted for Traffic	41029-45086	3.52%	80013-60471	0.83%
Accepted for Traffic	41062-75080	4.18%	41063-74453-2	-3.41%
Accepted for Traffic	63022-76051	-2.84%	41025-72022	-7.19%
Accepted for Traffic	63081-45715	6.06%	82112-45681	0.77%
Accepted for Traffic	82022-45684	8.10%	82022-34014	3.27%
Accepted for Traffic	82053-58175	9.51%	82053-45692	-3.40%
Accepted for Traffic	82123-45199	10.49%	82122-45705	16.36%
Accepted for Traffic	82123-52803	2.49%	82122-45705	16.36%
Accepted for Traffic	82194-37795	3.11%	25032-45899	19.31%
Accepted for Traffic	82195-79177	15.18%	82191-51518	0.02%
Lane Rental	03112-48577	-4.45%	41131-44778	5.92%
Lane Rental	06111-55125	12.12%	65041-45865	-6.32%
Lane Rental	25032-100664	-0.18%	09035-104965	8.29%
Lane Rental	26011-43817	-1.59%	26011-45415	36.68%
Lane Rental	34043-87157	-4.32%	34043-79371	-4.37%
Lane Rental	39014-38097	-2.52%	41131-44778	5.92%
Lane Rental	39022-45837	-9.62%	11017-106483	-1.71%
Lane Rental	39024-46457	-10.41%	50111-105851	-3.55%
Lane Rental	41024-75091	0.95%	63022-55798	0.89%
Lane Rental	41027-54148-2	-13.08%	11111-50793	0.84%
Lane Rental	41131-51903	-4.81%	54013-79078	12.94%
Lane Rental	41131-53766	4.21%	39014-81325	9.28%
Lane Rental	50111-43941	-4.71%	39041-90224	-5.32%
Lane Rental	61072-38184	-5.92%	11056-50757	6.22%
Lane Rental	63071-49287	-18.14%	25091-45841	-8.33%
Lane Rental	63174-50290	-21.18%	63173-51472	3.38%
Lane Rental	70063-50804	0.95%	23152-45640	6.24%
Lane Rental	77011-75169	-0.13%	77011-60338	4.82%
Lane Rental	77024-74766	-1.65%	12033-49921	-1.69%
Lane Rental	77041-55661	5.08%	50091-45731	-3.18%
Lane Rental	77111-45758	-0.90%	82022-45686	17.80%

Lane Rental	77111-76906	-5.90%	82022-45686	17.80%
Lane Rental	77111-80911	-0.20%	82022-45686	17.80%
Lane Rental	80024-53350	2.47%	82022-45686	17.80%
Lane Rental	82022-34014	3.27%	11015-50795	4.77%
Lane Rental	82024-48607	-8.67%	11016-46460	1.80%
Lane Rental	82024-82589	-4.85%	11013-51197	12.77%
Lane Rental	82025-46982	-0.64%	13121-45999	9.80%
Lane Rental	82025-72419	2.98%	77111-51507	3.70%
Lane Rental	82122-38079	3.07%	82122-45705	16.36%
Lane Rental	82123-53387	2.60%	47064-78200	-2.87%
Lane Rental	82192-45702	1.21%	82193-76902	4.82%
Lane Rental	82194-45699	2.16%	82052-47061	-17.78%
Interim Completion	25032-60481	-2.01%	63173-51472	3.38%
Interim Completion	39405-83201	1.17%	50111-105851	-3.55%
Interim Completion	41043-45783	-3.67%	41043-45786	-9.36%
Interim Completion	54022-45832	21.84%	62015-60572	-1.89%
Interim Completion	56044-60433	6.31%	67022-44987	-2.22%
Interim Completion	61153-45782	-1.99%	15012-48535	2.85%
Interim Completion	62031-32352	-11.10%	62031-32342	-3.80%
Interim Completion	65033-103442	0.77%	17034-53932-2	-2.39%

Appendix 7: Cost Performance Index for Incentive Projects and the Paid Incentives

Incentive Type	Incentive Contract I/D	CPI	Letting Year	Route	Type	Authorized Contract Amount	Incentive	Incentive %
A+B Incentive/ Distinctive	09034-46575-2	-4.89%	2001	I-75	RREC	$19,351,482	$150,000	0.78%
Accepted for Traffic	41027-51883	1.62%	2009	I-196	RREH	$31,878,804	$700,000	2.20%
Accepted for Traffic	41029-45086	3.52%	2006	I-196	PMAI	$1,631,086	$200,000	12.26%
Accepted for Traffic	41062-75080	4.18%	2008	M11	RREC	$2,895,502	$130,000	4.49%
Accepted for Traffic	63022-76051	-2.84%	2005	I-96	SFTY	$709,340	$50,000	7.05%
Accepted for Traffic	63081-45715	6.06%	2006	M-10	RREH	$27,956,395	$2,400,000	8.58%
Accepted for Traffic	82022-45684	8.10%	2004	I-94	RREH	$81,768,474	$4,000,000	4.89%
Accepted for Traffic	82053-58175	9.51%	2006	US-24	RESU	$16,099,727	$200,000	1.24%
Accepted for Traffic	82123-45199	10.49%	2005	I-96	RREH	$28,652,579	$500,000	1.75%
Accepted for Traffic	82123-52803	2.49%	2005	I-96	RREH	$82,532,946	$600,000	0.73%
Accepted for Traffic	82194-37795	3.11%	2007	Multiple	RREC	$173,764,968	$3,675,000	2.11%
Accepted for Traffic	82195-79177	15.18%	2006	I-75	BREC	$4,331,253	$75,000	1.73%
Interim Completion	25032-60481	-2.01%	2007	I-75	RESU	$8,345,520	$45,000	0.54%
Interim Completion	39405-83201	1.17%	2008	I-94	RREH	$2,868,784	$100,000	3.49%
Interim Completion	41043-45783	-3.67%	1999	M-21	RESU	$4,937,849	$950	0.02%
Interim Completion	54022-45832	21.84%	2007	M-20	RREH	$4,699,233	$20,000	0.43%
Interim Completion	56044-60433	6.31%	2008	US10	RESU	$32,129,641	($41,132)	-0.13%
Interim Completion	61153-45782	-1.99%	2007	M-20	RREH	$4,699,233	$20,000	0.43%

Interim Completion	62031-32352	-11.10%	1999	M-37	RESU	$1,790,570	($62,000)	-3.46%
Interim Completion	65033-103442	0.77%	2011	I-75 Boulevard	RREH	$7,224,670	$100,000	1.38%
Lane Rental	03112-48577	-4.45%	2002	US-131	RESU	$6,071,832	($12)	0.00%
Lane Rental	06111-55125	12.12%	2005	I-75	RESU	$32,615,930	$200,000	0.61%
Lane Rental	25032-100664	-0.18%	2010	I-75	PMAI	$10,714,471	$38,155	0.36%
Lane Rental	26011-43817	-1.59%	2001	M18/M61	RREH	$4,475,341	$450,000	10.06%
Lane Rental	34043-87157	-4.32%	2011	I-96	PMAI	$1,064,896	$15,750	1.48%
Lane Rental	39014-38097	-2.52%	1999	US-131	RESU	$5,429,208	($4,000)	-0.07%
Lane Rental	39022-45837	-9.62%	2000	I-94	RESU	$4,266,756	($32,000)	-0.75%
Lane Rental	39024-46457	-10.41%	2001	I-94	RESU	$3,939,016	$220,800	5.61%
Lane Rental	41024-75091	0.95%	2007	I-96	BREC	$2,409,374	$97,675	4.05%
Lane Rental	41027-54148-2	-13.08%	2005	I-196	BREC	$3,443,756	($279,200)	-8.11%
Lane Rental	41131-51903	-4.81%	2004	US-131	PMAI	$4,178,770	$300,000	7.18%
Lane Rental	41131-53766	4.21%	2004	US-131/M-11	BREC	$6,195,691	$50,000	0.81%
Lane Rental	50111-43941	-4.71%	2002	I-94	BREH	$43,806,921	$300,000	0.68%
Lane Rental	61072-38184	-5.92%	1999	US-31	RREH	$12,847,099	$0	0.00%
Lane Rental	63071-49287	-18.14%	2005	US 24	RREH	$13,788,041	$500,000	3.63%
Lane Rental	63174-50290	-21.18%	2000	M-15	RESU	$5,545,924	$315,778	5.69%
Lane Rental	70063-50804	0.95%	2003	I-96	RREH	$19,739,241	$63,000	0.32%
Lane Rental	77011-75169	-0.13%	2007	M-19	BREC	$755,423	($6,420)	-0.85%
Lane Rental	77024-74766	-1.65%	2008	I-69	RREH	$35,348,348	$260,222	0.74%
Lane Rental	77041-55661	5.08%	2008	M-19	RESU	$9,526,207	$100,000	1.05%

Lane Rental	77111-45758	-0.90%	2006	I-94BL	RREH	$25,906,027	$50,000	0.19%
Lane Rental	77111-76906	-5.90%	2008	I-94	RREH	$25,388,933	($946,920)	-3.73%
Lane Rental	77111-80911	-0.20%	2009	I-94	RREH	$23,036,598	$399,318	1.73%
Lane Rental	80024-53350	2.47%	2006	I-94	RREH	$16,173,424	$349,495	2.16%
Lane Rental	82022-34014	3.27%	2003	I-94	BREC	$14,490,204	$200,000	1.38%
Lane Rental	82024-48607	-8.67%	2002	I-94	RESU	$20,611,173	$1,311,000	6.36%
Lane Rental	82024-82589	-4.85%	2007	I-94	BREH	$7,755,114	$400,000	5.16%
Lane Rental	82025-46982	-0.64%	2000	I-94	RESU	$40,672,181	$3,287,500	8.08%
Lane Rental	82025-72419	2.98%	2003	I-94	BREC	$4,006,695	$97,250	2.43%
Lane Rental	82122-38079	3.07%	2001	I-96/M-14/I-275	RREH	$46,094,595	$81,200	0.18%
Lane Rental	82123-53387	2.60%	2000	I-96	BREC	$2,048,601	$70,000	3.42%
Lane Rental	82192-45702	1.21%	2001	M-39	RREH	$32,041,475	$21,000	0.07%
Lane Rental	82194-45699	2.16%	2002	I-75	RREH	$84,340,400	$50,250	0.06%

Appendix 8: Present Time Performance Index, Cost Performance Index and the Paid Incentives Percentage

No	Incentive Type	Incentive Contract I/D	Incentive %	PTPI	CPI
1	A+B Incentive/ Distinctive	09034-46575-2	0.78%	-71.57%	-4.89%
3	Accepted for Traffic	41029-45086	12.26%	-52.67%	3.52%
5	Accepted for Traffic	41062-75080	4.49%	0.00%	4.18%
6	Accepted for Traffic	63022-76051	7.05%	0.00%	-2.84%
7	Accepted for Traffic	63081-45715	8.58%	0.00%	6.06%
9	Accepted for Traffic	82022-45684	4.89%	-59.05%	8.10%
10	Accepted for Traffic	82053-58175	1.24%	0.00%	9.51%
11	Accepted for Traffic	82123-45199	1.75%	0.00%	10.49%
12	Accepted for Traffic	82123-52803	0.73%	0.00%	2.49%
14	Accepted for Traffic	82194-37795	2.11%	0.00%	3.11%
15	Accepted for Traffic	82195-79177	1.73%	-4.76%	15.18%
3	Interim Completion	39405-83201	3.49%	-77.24%	1.17%
7	Interim Completion	56044-60433	-0.13%	-43.67%	6.31%
8	Interim Completion	61153-45782	0.43%	-3.79%	-1.99%
9	Interim Completion	62031-32352	-3.46%	0.00%	-11.10%
1	Lane Rental	03112-48577	0.00%	-65.87%	-4.45%
2	Lane Rental	06111-55125	0.61%	-32.55%	12.12%
7	Lane Rental	34043-87157	1.48%	0.00%	-4.32%
15	Lane Rental	41024-75091	4.05%	0.00%	0.95%
16	Lane Rental	41027-54148-2	-8.11%	-2.44%	-13.08%
20	Lane Rental	41131-51903	7.18%	0.00%	-4.81%
25	Lane Rental	61072-38184	0.00%	0.00%	-5.92%
26	Lane Rental	63071-49287	3.63%	84.30%	-18.14%
28	Lane Rental	63174-50290	5.69%	5.53%	-21.18%
32	Lane Rental	77011-75169	-0.85%	0.00%	-0.13%
36	Lane Rental	77024-74766	0.74%	-43.32%	-1.65%
44	Lane Rental	77111-45758	0.19%	-42.97%	-0.90%

45	Lane Rental	77111-76906	-3.73%	0.00%	-5.90%
50	Lane Rental	80024-53350	2.16%	-40.38%	2.47%
52	Lane Rental	82022-34014	1.38%	0.00%	3.27%
56	Lane Rental	82024-48607	6.36%	20.54%	-8.67%
57	Lane Rental	82024-82589	5.16%	-26.80%	-4.85%
59	Lane Rental	82025-72419	2.43%	0.00%	2.98%

Appendix 9: Modified Remaining Service Life (RSL) Calculations

No		Contract ID	Modified_RSL	Equation	Route	Contract ID	Modified_RSL	Equation
Interim Completion Incetive/ Disincentive								
2	RESU	41043-45783	23.7	DI= 0.0986x2 - 0.254x + 0.6394	M-21	41043-45786	20.3	DI = 0.1312x2 - 0.285x + 1.7137
3	RESU	61153-45782	18.98	DI =0.1836x2 - 1.2287x + 7.193	US-31	61151-45809	9	DI = 0.928x2 - 3.5188x + 6.4542
4	RESU	62031-32352	10.82	DI = 1.0125x2 - 7.9407x + 17.457	M-37	62031-32342	10.12	DI = 0.5535x2 - 0.756x + 0.9425
		Accepted for Traffic Incentive/ Disincentive						
1	RREH	82123-52803	32.26	DI = = 0.0571x2 - 0.3063x + 0.451	I-96	41026-53377	10.58	DI == 0.676x2 - 2.684x + 2.721
		lane Rental Incentive/ Disincentive						
1	RESU	03112-48577	6.6	DI= 1.177x2 - 1.161x + 6.38	US-131	83031-80235	8.67	DI = = 0.9394x2 - 2.7991x + 3.6208
2	RESU	06111-55125	17.84	DI =0.1315x2 + 0.4557x	I-75	65041-45865	20.22	DI = 0.1063x2 + 0.237x + 1.7717
3	RREH	26011-43817	22.93	DI = 0.1044x2 - 0.2775x + 1.4781	M-18	26011-45415	9.01	DI= 0.9125x2 - 2.9x + 1.9875
4	RESU	39014-38097	9.06	DI = 0.8463x2 - 1.2x + 4.6838	US- 131	41131-44778	8.96	DI = 0.4163x2 + 2.0375x + 1.72
5	RESU	39022-45837	18.12	DI = 0.0533x2 + 1.8081x - 0.2805	I- 94	11017-106483	10	DI = 0.25x2 + 0.845x + 16.61
6	BREC	41131-53766	14.5	DI = 0.1375x2 + 1.492x - 0.6455	US-131	39051-49430	28.25	DI = 0.1584x2 - 0.671x + 0.0059
7	BREH	50111-43941	21.32	DI = 0.1163x2 - 0.17x + 0.7338	US-131	39041-90224	4.14	DI = 1.05x2 + 0.03x + 31.82
8	RESU	63071-49287	10.67	DI = = 0.3467x2 + 1.0223x - 0.4163	M-15	79031-45850	20.4	DI = 0.1678x2 - 1.2173x + 5.0032
9	BREH	82024-82589	28.61	DI = 0.05x2 + 0.06x + 7.37	I-94	11013-51197	9.99	DI = 0.25x2 + 0.845x + 16.61
10	BREC	82112-48379	13.26	DI = 0.1713x2 + 0.02x + 19.599	I-94	82111-75706	11	DI = 0.4531x2 - 1.1315x + 7.6479
11	RREH	63052-50291	25.8	DI = 0.065x2 + 0.112x + 3.812	US-24	82053-45693	8.17	DI = 0.862x2 - 3.0831x + 17.659