

THE IMPACT OF INCENTIVES ON MANAGED LANE TRAVEL

A Thesis

by

NAMOO ANDREW HAN

Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Chair of Committee,	Mark W. Burris
Committee Members,	Yunlong Zhang
	Timothy J. Lomax
Head of Department,	Robin Autenrieth

May 2016

Major Subject: Civil Engineering

Copyright 2016 Namoo Andrew Han

ABSTRACT

The use of managed lanes to control and maximize volume on freeways is increasing. One way of encouraging more managed lane use is through the implementation of incentives. In the Dallas-Fort Worth area, a managed lane was planned for opening on I-30 (Tom Landry freeway) and incentives were planned to be offered. Because the managed lanes were not yet open and the incentives were hypothetical, a stated preference survey was used to gauge the impact of the incentives on traveler behavior.

The stated preference survey was developed through the online application Limesurvey. The stated preference questions were designed using D_b-efficient and random adaptive designs. The incentives were chosen by looking at other programs around the country and through discussion with transportation experts. Once ready, the survey was administered online to travelers in the area and a total of 898 usable responses were gathered. From the responses, a mixed-logit model was developed to describe and predict traveler behavior. From the model, elasticities were calculated to predict the impact of the incentives on mode choice. Overall, the impact of incentives varied among specific incentives, with some having a modest effect while others were less impactful.

DEDICATION

To my parents, for giving me opportunities

ACKNOWLEDGEMENTS

First and foremost, I would like to thank my committee chair, Dr. Burris for providing me with the tools and help necessary to complete this research. I will be forever grateful for his patience during my time at A&M. I would also like to thank my other committee members, Dr. Zhang and Dr. Lomax. Despite their busy schedules, they agreed to be on my committee and provided valuable feedback.

I am also grateful to the Texas A&M Transportation Institute and North Central Texas Council of Government for assistance with administering the survey. Thanks are also in order to the FHWA value pricing pilot program. I would especially like to thank Nick Wood, Tina Geiselbrecht, Michelle Hoelscher, and Stephen Ranft for their help with developing and administering the survey. I am also grateful to all the Dallas-Fort Worth area travelers who took part in the survey and made this research possible. I would also like to thank the staff and other faculty in the Civil Department at Texas A&M for the wonderful education I received.

I am grateful for my classmates at Texas A&M and friends I made in College Station. Special thanks are in order for John and Kathy for being wonderful friends and helping me survive graduate school.

Finally, I would like to thank my parents and siblings. I am lucky to have parents who have done everything so that I could succeed and siblings who have supported me so much and provided someone to talk to at any hour of the day.

NOMENCLATURE

TxDOT	Texas Department of Transportation
TTI	Texas A&M Transportation Institute
NCTCOG	North Central Texas Council of Governments
FHWA	Federal Highway Administration
DART	Dallas Area Rapid Transit
NTTA	North Texas Tollway Authority
DFW	Dallas-Fort Worth
ML	Managed Lane
EL	Express Lane
HOV	High Occupancy Vehicle
SOV	Single Occupancy Vehicle
GPL	General Purpose Lane
MLDA	Managed Lane Drive Alone
MLCP	Managed Lane Carpool
SP	Stated Preference
SP1	Stated Preference Question 1
SP2	Stated Preference Question 2
SP3	Stated Preference Question 3
D_b -efficient	Bayesian D-efficient
RA	Random Adjusting

VTTS Value of Travel Time Savings

VOT Value of Time

TABLE OF CONTENTS

	Page
ABSTRACT	ii
DEDICATION	iii
ACKNOWLEDGEMENTS.....	iv
NOMENCLATURE	v
TABLE OF CONTENTS	vii
LIST OF FIGURES	ix
LIST OF TABLES.....	x
1. INTRODUCTION	1
1.1 Research Problem	4
1.2 Thesis Outline	5
2. LITERATURE REVIEW	6
2.1 Incentives	6
2.1.1 Research and Literature	6
2.1.2 Pilot Programs	8
2.1.3 Long-Term Programs.....	9
2.2 Value of Travel Time.....	11
2.3 Stated Preference Survey Design.....	13
3. RESEARCH OBJECTIVES	17
4. SURVEY DEVELOPMENT AND EXECUTION	19
4.1 Survey Overview	19
4.1.1 Recent Trip	19
4.1.2 Incentive Rating	24
4.1.3 Stated Preference Questions	25
4.1.4 Socio-economic/Demographics	28
4.1.5 Pilot Program	29

4.2 Incentive Development	30
4.3 Stated Preference Question Design	33
4.3.1 Travel Time/Trip Time of Day Factor/Toll Rate	34
4.3.2 Toll Rate	36
4.3.3 Stated Preference Design	38
4.3.3.1 Bayesian D_b -efficient Design	38
4.3.3.2 Random Adjusting Design	42
4.3.4 Incentive Design	43
4.4 Survey Administration	44
4.4.1 Advertising	44
4.4.2 Pilot Program	48
4.5 Summary	48
5. DATA ANALYSIS	49
5.1 Filtering	49
5.2 Preliminary Analysis	51
5.2.1 Socio-demographics	51
5.2.2 Recent Trip Characteristics	53
5.2.3 Basic Incentive Statistics	57
5.3 Model Development	66
5.3.1 Model 1	66
5.3.2 Model 2	73
5.3.3 D-eff vs RA Models	77
5.4 Elasticities	83
5.4.1 Manually Calculated Elasticities	83
6. CONCLUSION	93
6.1 Conclusions	93
6.2 Research Limitations	94
6.3 Recommendations for Future Research	95
REFERENCES	97
APPENDIX A	103
APPENDIX B	112
APPENDIX C	113
APPENDIX D	114
APPENDIX E	151

LIST OF FIGURES

	Page
Figure 1. Overview of Express Lanes in Dallas-Fort Worth	2
Figure 2. Most Recent Trip Characteristics	21
Figure 3. If ‘Driver’ of ‘Passenger Car/SUV/Pick-up Truck’ with ‘2+’ People was Chosen	23
Figure 4. Introduction of Managed Lanes and the Incentives	24
Figure 5. Stated Preference Question 2: If Recent Trip Characteristics were Provided...	27
Figure 6. Stated Preference Question 1: If Recent Trip Characteristics were not Provided	28
Figure 7. Example Online Advertisement	46
Figure 8. Cumulative Number of Responses by Day	47
Figure 9. Reported Trip Time	54
Figure 10. Extra Time to Pick Up Passenger	55

LIST OF TABLES

	Page
Table 1. List of Potential Incentives	30
Table 2. Speed Range Used for the Survey	35
Table 3. Speed and Travel Time Attribute Levels	35
Table 4. Time of Day Factors Based on Trip Start Time	36
Table 5. Toll and Fare Attribute Levels	37
Table 6. Overview of Attribute Levels and Priors	40
Table 7. D _b -Efficient Design Results	41
Table 8. Random Adjusting Design Initial Attributes	42
Table 9. Allowable Range of Random Adjusting Design Attributes	43
Table 10. Incentives Used and Their Levels	44
Table 11. Number of Referrals from Websites	46
Table 12. How Many Responses were Kept or Removed	51
Table 13. Socio-demographic Percentages	52
Table 14. Recent Trip Characteristics	56
Table 15. Incentive Rating	58
Table 16. Stated Preference Question Mode Choice	59
Table 17. Stated Preference Question Statistics	60
Table 18. Number of Respondents Who Chose the Same Mode Every Time	64
Table 19. Number of Respondents Who Switched Modes for an Incentive	65
Table 20. Average Value of Incentive Offered	66

Table 21. Model Incentive Values	67
Table 22. Model 1 Variables with Their Coefficients and P-values Along with the Model with Different Coefficients for the Incentives	69
Table 23. Model 2	74
Table 24. D-eff and RA Models	78
Table 25. Respondent 6's Values	84
Table 26. Elasticities of Incentives 1-5 and Percent Changes	89
Table 27. Incentives Ranked by Elasticity and %Change	92

1. INTRODUCTION

Currently, one of the biggest challenges in transportation is traffic on urban freeways. The growth of transportation infrastructure has not been able to keep pace with the increasing demand. One of the main reasons the supply has not kept up is because of the lack of funds to build new infrastructure. This has led to the increased use of managed lanes (MLs) to control and optimize freeway traffic. The definition of managed lanes differs but the Federal Highway Administration (FHWA) defines them as “highway facilities or a set of lanes where operational strategies are proactively implemented and managed in response to changing conditions.” (Federal Highway Administration [FHWA], 2013) Managed lanes offer planners and officials a way to manage traffic on freeways through various methods including pricing, access control, and vehicle eligibility (FHWA, 2013). They offer travelers an alternate path that will be less congested, but for a price. Some facilities require vehicles to have multiple occupants and are known as high-occupancy vehicle (HOV) lanes. These lanes can be further differentiated by occupancy required, some simply require 2 or more occupants while others may require 3+. Other facilities may also allow single occupancy vehicles (SOV) on the managed lane but charge a toll. Some facilities may have a fixed toll while others may adjust the price based on the time of day or level of congestion.

The area of study for this research was the I-30 Freeway MLs in between Fort Worth and Dallas, also referred to as the Tom Landry Freeway (see Figure 1). I-30 runs between downtown Fort Worth and downtown Dallas and the ML is highlighted in red.

The freeway section of note runs from Cooper Street in Arlington to SH 161 in Dallas County (Texas Department of Transportation [TxDOT], 2014). Before expansion, the section was a six-lane divided freeway with one concurrent HOV lane for each direction. After construction, there will be 10 general purpose lanes while the number of managed lanes varies. Part 1 has 1 reversible lane and is approximately 3 miles long, part 2 has 2 reversible lanes and is approximately 2.5 miles long, and Part 3 has 2 lanes (one for each direction) and is approximately 3 miles long. The freeway section is notable for being a major route between Fort Worth and Dallas, serving the cities of Grand Prairie and Arlington, and also being near both the Dallas Cowboys and Texas Rangers' stadiums.

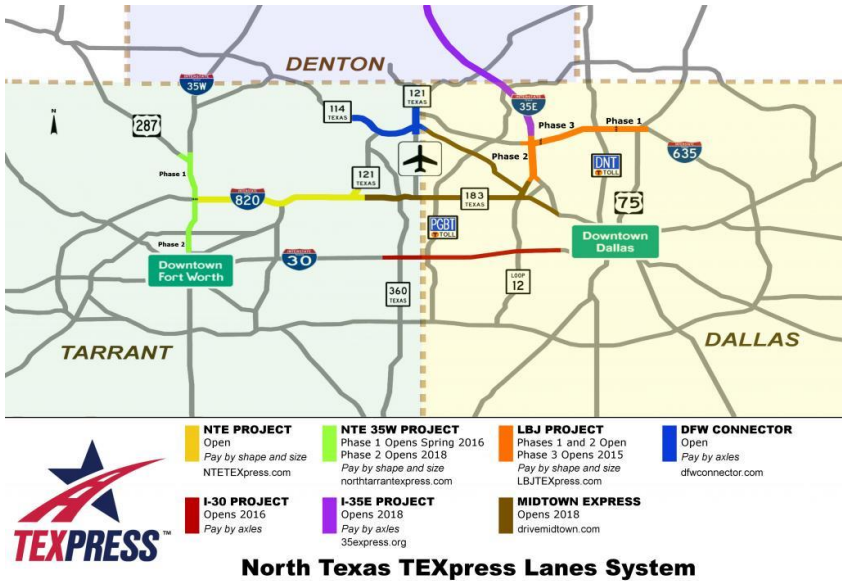


Figure 1. Overview of Express Lanes in Dallas-Fort Worth

Estimating how the public will react to new managed lanes is a challenge, especially when the public is not familiar with them. When first opened, managed lanes

can have a ramp-up period where traffic volume has not reached full potential. This period can last up to a few years before the managed lanes are fully used (Goodin et al. 2013). Although the main reasons travelers choose to use managed lanes are travel time savings or trip reliability, these savings may not be quickly realized. To combat the lower usage, incentives are being considered to encourage managed lane use.

There have been several incentive programs used around the world to encourage certain travel modes, generally carpooling or transit use. Two examples of carpool incentives were implemented in Atlanta and Washington DC. The Atlanta program, Cash for Commuters, hoped to reduce both congestion and improve air quality by offering \$3 per day for commuters who shifted from driving alone to alternate modes such as carpool, transit, telework, bicycle, or walk (Clean Air Campaign, 2009). The program hoped to introduce travelers to other modes of the travel that they would continue to use once the program ended. In DC metro area, the program 'Pool Reward\$' offered \$1 for every instance of carpooling (Rogers et al., 2009). Another incentive program was the Metro ExpressLanes which was used on the I-10 and I-110 freeways near Los Angeles (Metro ExpressLanes, 2014). This facility incentivized both carpooling and transit use through the use of loyalty programs. Carpoolers were given a chance to win monthly prizes for every instance of managed lane use. Transit use was encouraged by offering a \$5 toll credit when 32 one-way peak-hour trips were taken.

This research tests traveler's potential reaction to incentives for managed lane use through a stated preference survey. Notably, this research will include incentives not only for carpoolers and transit use, but also for SOVs who pay for the managed lane.

This research adds to the growing literature on estimating managed lane use which has traditionally focused on travel time savings. The research will hopefully help agencies examining the use of managed lanes.

1.1 Research Problem

The number of Managed lanes is expected to increase in the coming years, therefore it is important to understand the best practices for implementing them. The I-30 Managed lanes not only provide an opportunity to study how travelers rate incentives before the managed lanes are installed, but also how they react to the incentives once the managed lanes are operational. The usage and popularity of managed varies greatly from region to region or even from freeway to freeway within a region. I-95 and I-595 in south Florida both have congestion priced managed lanes but the popularity varies significantly. I-95 prices can reach \$10.95 due to traffic demand while I-595 has never increased beyond its minimum \$0.50. (Turnbell, 2015). The usual methods agencies have used to manage this demand have been to either adjust the price of the managed lane or to adjust the accessibility by restricting use to certain groups. However, other methods of controlling demand may be beneficial. One method of encouraging managed lane use is through the use of incentives. Incentives have been used in the past to encourage carpooling or transit use, but rarely have they been used for any managed lanes. Incentives will hopefully be another option available to agencies when planning managed lanes. This will hopefully help with planning and decision making for future managed lanes so they may provide the best transportation options to travelers.

This thesis examines the impact on mode choice by offering various incentives for utilizing the managed lanes. This thesis will test six different incentives which will be offered for either using the managed lane by carpooling, paying the toll, or using transit. These incentives were tested through the use of a stated preference survey, and the results were used to develop logistic mode choice models. The models provide an elasticity and help predict traveler behavior and mode choice shifts. The research will help planners understand how travelers will react when offered incentives for managed lane use.

1.2 Thesis Outline

The thesis is organized into the following sections. Section 2 reviews previous research done in the field of transportation incentives, value of travel time, and stated preference surveys. This section will help guide the optimal practices for designing, administering, and analyzing the survey. Section 3 states the objectives of this research. Section 4 includes the development and design of the complete survey. It describes the various sections of the survey and how the survey was created and administered. The section also goes into how the stated preference questions were designed including the travel time and toll levels and the incentive offered. Section 5 covers the analysis of the survey data and also the development of the mixed logit model. Finally, Section 6 has the conclusions made from the research, limitations of the research, and also recommendations for future research.

2. LITERATURE REVIEW

The goal of this research is to examine how incentives will affect the decision making of travelers on freeways with managed lanes. This section will examine previous research on the effect of incentives and also look at real-world applications of incentives. This section will also examine research done on a key aspect of traveler choice, the value of travel time savings. This section will then examine the development of managed lanes and also the best practices developed for stated preference design.

2.1 Incentives

In the world of transportation planning and management, incentives have generally been used to encourage modes of transportation or trip planning that have environmental or social benefits. For example, there have been programs that reward commuters for carpooling (Clean Air Campaign, 2009; Commuter Connections; Metro Expresslanes, 2014), using alternate modes of transportation (Clean Air Campaign, 2009), riding transit during peak hours (Metro Expresslanes, 2014), or driving during off-peak times (Merugu et al. in 2009). Other programs have rewarded employers for having higher vehicle occupancy or allowing telecommuting.

2.1.1 Research and Literature

If incentives are to be used, it is important to know which incentives would work best. One survey used to research incentives was conducted by Leblanc and Walker

(2012). They used a stated preference survey of San Francisco travelers. In this survey, participants were offered hypothetical incentives to change their commutes. Participants could either leave at a different time, take a different route, or take a different travel mode. They tested various incentives including cash, entry to a prize drawing, and credit towards various rewards such as gift cards or coffee. They found that Apple store credit and cash were the most effective and also noted that travelers were more sensitive to charges than rewards.

Incentives have been offered for transit use to increase ridership or shift travel start time. One such survey was conducted by Zhang et al. in 2014. They surveyed commuters on the Beijing Subway System and offered incentives to avoid the rush hour period. They found that discounted fares and restaurant related incentives had the most potential for reducing morning rush congestion. Another study looked to determine which incentives would increase ridership the most. Bianco (2000) assessed the effects of a plan to reduce single-occupancy vehicles by incentivizing transit use while also disincentivizing SOV use. This was done by offering discounted transit passes and by starting to charge for on-street parking. After a year, a survey of travelers in the area was conducted which found that SOV use decreased by 7%.

Most research on incentives have focused on one transportation mode. However, this research will examine transportation behavior and mode choice with incentives on multiple modes.

2.1.2 Pilot Programs

Most of the programs found have been conducted recently and therefore the research is also quite new and ongoing. One of the earliest programs was conducted in the Netherlands by Ettema et al. (2010) where they offered cash or credits to earn a smartphone if the traveler avoided travelling in the peak period by car. Travelers generally responded by traveling alone but before or after the peak period. They observed that after the end of the program, many travelers did not sustain the change and returned to the peak period.

Several other researchers have run programs to see the effectiveness of incentives (Ben-Elia 2011; Bliemer et al. 2010). Ben-Elia and Ettema used a 13-week pilot program to test how participants would adjust travel behavior if they were offered monetary or in-kind rewards for avoiding travel in the peak hour. To do this, the travelers could either change when they worked, switch travel modes, or telecommute. They found that in the short run, the monetary rewards and the Smartphone reward were especially effective in reducing rush-hour car commutes. Bliemer et al. examined three separate experiments conducted in the Netherlands and found that travelers were willing to change for monetary rewards. Both researchers expressed concern whether the change would be sustained after the end of the program. They also noted that mode choice is complex and dependent on many other factors such as location, education, attitudes, and information available.

2.1.3 Long-Term Programs

There have been some long-term programs that have offered incentives for changing travel behavior. Most have encouraged travel modes that benefit the environment or lowered the overall congestion. These programs encouraged people to use alternative modes rather than driving alone or to travel at a different time.

One such program was Cash for Commuters in Atlanta which offered commuters \$3 dollars for every day they used an alternative (bike, carpool, transit, vanpool, or walk) travel mode (Clean Air Campaign, 2009). Furthermore, The Center for Transportation and Environment (CTE) conducted several surveys after the participants had completed the program. The surveys were conducted anywhere from 3-21 months after completion (Georgia Department of Transportation, 2009). They found that participants generally kept up with the alternative modes. Around 70% of the participants continued to use the other modes after completion of the program. Another similar program, 'Pool Reward\$', in the DC metropolitan area encouraged vanpool and carpool usage by offering \$1 to new carpoolers every time they carpooled to work (Commuter Connections).

Other programs include the Dulles Greenway Cashback program, San Diego's iCommute prize drawing, and South Florida's 595 Express Bus. The Dulles Greenway Cashback program offers 5-15% cashback depending on how many trips were taken (with a minimum of 180 trips for a yearlong period) (Dulles Greenway, 2014). San Diego's iCommute program has a prize drawing every month for anyone who logged eight round-trip commutes by anything other than driving alone. The prize is separate

for every mode of transportation and has a value of \$100 (iCommute). Several agencies offer express buses from park and ride lots to central business districts. One example is the 595 Express Bus which offers a service to both downtown Fort Lauderdale and Miami (Florida Department of Transportation).

Another program that encouraged alternative modes is the Metro ExpressLanes on I-10 and I-110 in the LA area (Metro Expresslanes, 2014). These managed lanes had a carpool loyalty program as well as a transit rewards program. The carpool program offers a monthly prize drawing where carpools (identified by their FasTrak transponder) are entered every time they carpool. 3+ carpools are entered into a different drawing with larger prizes. Additionally, transit riders are also able to earn rewards by using transit during peak hours. For every 32 one-way trips taken, riders earned a \$5 toll credit that could be used on the Metro ExpressLanes. This transit incentive program, which was touted as the first of its kind in the country, was implemented alongside tolling policy forcing the peak hour minimum toll to be no less than 150% of the Metro transit fare (Higueros 2014). On average, 220 accounts enrolled in the program per month. On one of the transit lines, the Silver Line, ridership increased by 15% after the toll floor of 150% was put in place. A 2013 survey found that about a third of the new Silver Line riders were former commuters who drove alone on I-10 or I-110.

The area of study, Dallas-Fort Worth, has also implemented programs to encourage other modes of travel. NCTCOG's main program is Try Parking It which rewards users for carpooling, biking, or other modes. It also offers a vanpool or carpool matching program to help travelers find partners.

Overseas, a large scale program was conducted by Merugu et al. in Bangalore, India where they incentivized early commuting for employees of Infosys Technologies (Merugu et al. 2009). Employees were incentivized to avoid the peak and arrive earlier by offering entry into prize drawings. The program was able to roughly double the number of employees that arrived early.

This program was copied by Stanford University to reduce peak hour commutes by offering incentives to shift to non-peak hours or shift modes (Prabhakar 2014). They offered rewards such as Rose Bowl tickets through raffles and were able to reduce inbound peak hour commutes by 22.8% and outbound peak hour commutes by 14.7%. A survey was administered during the program asking if users shifted commute times. Out of the 1010 responses, 594 responded they did shift. However, many of those that did not shift were already traveling during the off-peak.

2.2 Value of Travel Time

There are many factors that influence a traveler's mode and route choice, with the value of travel time savings (VTTS) being one of the most important factors. Because of its significance in modeling and planning, there has been an abundance of research done on VTTS, also referred to as value of time (VOT), through various methods and at many different locations and situations. Early general work on the value of travel time was conducted by Becker (1965), Beesley (1965), and Oort (1969).

Research on the value of travel time savings on a ML is relatively new. Lam and Small (2001) studied data from SR-91 express lanes in Orange County, California to

developed models to obtain a VOT of \$22.87/hour. Brownstone et al (2003) used revealed preference data from the I-15 congestion pricing project in San Diego to estimate drivers' willingness to pay at \$30 per hour. They also found certain variables were predictors of express lane use. Another location that was studied was the I-85 Express Lanes in Atlanta, Georgia where Sheikh et al. (2014) found values of time that were similar to previous studies. They also found that drivers who infrequently used the express lanes had a higher value of travel time savings than those who frequently used them.

Burris and Xu (2006) looked at what the demand would be for single occupancy vehicle use on the HOV lane during the off-peak hours for a fee. They used a stated preference study and a discrete choice model to collect and analyze the data. They estimated the VTTS and the value of penalty for changing travel schedule (VPCS). The VPCS would show how willing travelers would be to change from traveling during peak hours to off-peak hours in order to utilize the HOV lane as a SOV. The models estimated a VTTS of around 45% the hourly wage rate and a VPCS of around 3% of the hourly wage rate.

Overviews of previous research and models on VTTS have also been done. Cherlow (1981) and Small (2012) reviewed various models and compared their accuracy and followed up with conclusions. Cherlow found that since different methods can have differing results even when used on the same data, it is important to take into consideration the context the VTTS was obtained.

Although finding the impact of incentives is the focus of this research, the methodology and modeling will also allow the calculation of the VTTS. This VTTS can then be compared to previous studies. Some of these studies have also examined incentives along with the value travel time savings. However, unlike this research, most had incentives for only one travel mode. One such study examined the impact of incentives on toll road use by trucks (Zhou et al. 2009). In this research, truckers were interviewed and surveyed to determine if and how they would utilize toll roads. They found that out of 20 incentives, off-peak discounts and a free trip after a number of paid trips were most likely to influence their choice. They also found the average value of travel time savings was \$44.20/hour.

2.3 Stated Preference Survey Design

A commonly used method for studying travel behavior and user choice, especially when dealing with scenarios that do not currently exist, is the stated preference survey. Because the managed lanes on I-30 have not opened, a stated preference survey is the best option for obtaining data on how travelers may utilize the new managed lanes. Stated preference surveys generally consist of multiple questions with each question offering two or more alternatives. Each alternative is differentiated from the other alternatives by a set of attributes, which also vary. The attribute levels used in a survey are selected by the researcher and can be determined using various design methods. The method of design influences the results and the statistical

significance of the mode choice model (Rose et al. 2008; Devarasetty et al. 2012; Bliemer and Rose 2010).

There are many different ways to design a stated preference survey. Methodologies have developed through the years. Bliemer and Rose reviewed previous stated preference surveys to see what design methodology was commonly used (Bliemer and Rose 2010). The various methods include Orthogonal, Random, D-efficient, and Adaptive. The majority of studies (40 out of 61) utilized an orthogonal design. They then designed an experiment to compare the different designs. They found that there were significant differences in the statistical results among the designs, and that the D-efficient design gave results closest to the empirical results. Similar results were obtained by Devarasetty et al. when they surveyed managed lane travelers and tested three stated preference designs (Devarasetty et al. 2012). The three designs were D_b -efficient, random attribute level generation, and adaptive random. They created models from results from each design and compared them with actual data from tolls and travel times on the freeway. They found that the D_b -efficient design generated results closest to the actual data. Therefore, for this study, D_b -efficient design was used for the stated preference survey. However, random adjusting was also used because it is especially useful for producing unbiased model parameters and upper and lower bounds for the value the traveler places on travel time savings (Richardson 2007). Furthermore, another design method provides the ability to compare with the D_b -efficient results.

There has also been research done to determine the best practices for stated preference design dimensions. Designing a survey that is too complex or improperly

designing these dimensions can cause issues with the survey and result in unreliable data (Arentz et al. 2003). Therefore, optimal design methods must be used. Arentz et al. found that the number of attributes (three versus five) influenced the results. Individuals did not consistently value the attributes when there were more, which affected their decision making. Because of these results, we will limit the number of attributes to three: travel time, toll/fare, and incentive. They also tested other aspects such as response fatigue and addition of pictorial material. However, they found that these had no significant impact.

Similar work was conducted by Caussade et al. who explored the complexity of stated choice experiments in terms of design dimensions. These dimensions include the number of available alternatives, the number of attributes used to define the alternatives, and the number of levels for these attributes. They found that the most important design dimensions are the number of attributes and the number of alternatives. The number of attributes and the number of levels both negatively affected the ability to choose and resulted in a higher error variance, although the impact of the number of attributes was much greater. Furthermore, their results suggested that the optimal number of alternatives is four while the optimal number of choice situations is nine or ten. However, the number of choice situations was found to be much less important than the rest of the design dimensions (Caussade et al. 2005).

Another practice that has been developed for stated preference surveys is to relate the stated preference questions to the respondent's actual experiences. Known as a pivot survey, by asking about the respondent's former experience, a scenario can be

built that the respondent can more easily identify with and understand. The respondent will then provide a more accurate answer (Rose et al. 2008). Using the results from literature, we will properly design our stated preference survey to ensure statistically reliable data will be obtained.

3. RESEARCH OBJECTIVES

The research conducted has more than just academic significance. The implementation of managed lanes is increasing throughout the country and world. However, the ways managed lanes are being implemented by the different agencies varies. The volumes can be potentially adjusted by changing the toll, restricting certain vehicle types, or in this research's case, offering incentives for use. While incentives have been used in the past to encourage certain modes of transportation, for managed lanes this practice is more recent. This means that the best practices are not fully developed and research is needed in order to guide transportation officials in their decision making process.

The objectives of this research are as follows:

1. Develop an extensive list of potential incentives that can be used to encourage managed lane use. Narrow these into a select number that will be tested for effectiveness and potential use. Choose a range for each incentive to be tested.
2. Design a stated preference survey that will be administered to Dallas-Fort Worth travelers to gauge traveler interest in the incentives. The scenarios will mimic real choices to determine the effectiveness of the incentives.
3. Based on the survey data measure the effect of incentives on mode and route choice.

By achieving these objectives, this research will provide some background for officials looking to implement incentives on both new and existing managed lanes. This research will provide some recommendations for incentive use on managed lanes along with recommendations for future research.

4. SURVEY DEVELOPMENT AND EXECUTION

This section details the process of developing the many elements of the I-30 Express Lanes Survey. This includes how the incentives were chosen, the overall design of the online survey, the development of the stated preference questions including the necessary coding, and how the survey was administered. Much of the work for designing the survey was done through LimeSurvey, an online free open-source survey application that allows survey design and also hosted the data obtained through the survey. Execution and administration of the survey was assisted by the North Central Texas Council of Governments (NCTCOG) and the Texas A&M Transportation Institute (TTI) who helped develop the incentives, publicize the survey through advertisements and flyers to various media and websites, and offer a prize drawing to the respondents.

4.1 Survey Overview

This first section gives a quick overview of the parts of the online survey and explains how the survey flows and how it looked to the respondent. (See Appendix A for the survey instrument). The survey was divided up into four parts as discussed in the following sections.

4.1.1 Recent Trip

The first section of the survey asked the respondents basic travel questions to understand their typical travel characteristics. The answers to these questions could help

identify trends in the respondents travel and help create a model that could predict travel based on their trip characteristics. The answers to these questions would also create a starting point for the stated preference questions. The scenarios in the stated preference questions would draw on the trip characteristics of the respondent's most recent trip, or 'pivot' off these answers. This can help the respondent identify with the hypothetical situation and therefore result in a more accurate response (see Rose et al. 2008).

The section starts by asking how often he or she travels on the I-30 freeway with options ranging from 'Multiple times per day' to 'A few times per month'. A final option, 'I have not used I-30 in the past 6 months', was also available. If this was selected, the rest of this section of the survey, which was used to describe their most recent trip, disappeared and the respondent moved onto the Incentives page. If the respondent did indicate that he or she had traveled on I-30 in the past 6 months by choosing any of the other options, they were then asked to describe their most recent trip by answering the rest of the questions on the page. The respondent was then asked the following questions about their most recent trip (see Figure 2):

- Purpose of the most recent trip (options included commuting to work, recreation/leisure, school)
 - o Because both the Rangers and Cowboys stadium are on the stretch of I-30, 'Major sports game' was also an option
- What day of the week was this trip
- Time of day the trip started
- Zip codes of where the trip started and ended

- Time spent on I-30 (from when they entered the freeway to when they exited)
- Vehicle type used for the trip

I-30 Express Lanes Survey

0% 100%

1 of 2 questions

1 of 2 questions completed

How frequently do you travel on the I-30 (Tom Landry) Freeway? (This is the portion of I-30 between Dallas and Arlington)

Check at most 1 answers

Multiple times per day
(Commuting)

About once a day
(Commuting)

A few times per week
(Commuting; place of work (going to or from work); Shopping/Entertainment/Personal errands)

Once a week
(Commuting; Shopping/Entertainment/Personal errands)

A few times per month
(Commuting; place of work (going to or from work); Shopping/Entertainment/Personal errands)

I have not used I-30 in the past 6 months
(Commuting; place of work (going to or from work); Shopping/Entertainment/Personal errands)

? [Help](#)

What was the purpose of your most recent trip on I-30?

Choose one of the following answers

Commuting to or from my place of work (going to or from work)

Recreational/Social/Shopping/Entertainment/Personal errands

Major sports game (Rangers, Cowboys)

Work Related (other than to or from home to work)

To attend class at school or an educational institute

Other:

On what day of the week was your most recent trip?

Choose one of the following answers

Sunday

Monday

Tuesday

Wednesday

Thursday

Friday

Saturday

What time of day did that trip start?

Choose one of the following answers

Please choose... ▾

Where did you start and finish this trip?

In what zipcode did you start this trip?

In what zipcode did you finish this trip?

How long was your most recent trip on I-30?

(The amount of time from when you entered the freeway to when you exited the freeway)

minutes

Only numbers may be entered in this field

What kind of vehicle did you use for your most recent trip?

Choose one of the following answers

Passenger Car, SUV, or Pick-up Truck

Motorcycle

Bus

Other:

<< Previous Next >>

Copyright © 2014, Texas A&M Transportation Institute, The Texas A&M University System

Figure 2. Most Recent Trip Characteristics

The next set of questions were dependent on what type of vehicle was used by the respondent and related to the specific mode. If the respondent answered 'Motorcycle' or 'Other' there would be no further questions on the page. If the respondent indicated that their last trip was by bus, then they were asked how much they paid.

If the respondent instead answered that their last trip was by 'Passenger car, SUV, or Pick-up truck', they were asked how many people total were in the vehicle. If the occupancy was '1', there would be no further questions. However, if the occupancy was greater than '1' then questions would appear to ask if the respondent was either the driver or a passenger and what the relation is to the other occupant (Neighbor, child, Co-worker, adult family member, casual carpool, or other). Finally, if the respondent was the driver, a textbox would appear asking how much extra time it took to pick up the passenger(s) (see Figure 3).

What kind of vehicle did you use for your most recent trip?

Choose one of the following answers

- Passenger Car, SUV, or Pick-up Truck
- Motorcycle
- Bus
- Other:

How many people, including you, were in the passenger car / SUV / pick-up truck?

Choose one of the following answers

- 1
- 2
- 3
- 4
- 5+

Were you the driver or a passenger on this recent trip?

Choose one of the following answers

- Driver
- Passenger

How much extra time did it take to pick up and drop off the passenger(s)?

minutes

Only numbers may be entered in this field

Who did you travel with on this recent trip?

Check any that apply

- Neighbor
- Child
- Co-worker / person in the same, or nearby, office building
- Adult family member
- Another commuter in a casual carpool (also known as slugging or casual carpool)
- Other:

Figure 3. If 'Driver' of 'Passenger Car/SUV/Pick-up Truck' with '2+' People was Chosen

4.1.2 Incentive Rating

The next section introduces managed (express) lanes, the incentives, and the government agencies involved in operating the managed lanes. The page first describes managed lanes through text and a figure (see Figure 4) and provides an explanation of how express lanes operate and the benefits of implementing them. The page also presents the goals of the involved government agencies (NCTCOG and TxDOT) operating the I-30 corridor in relation to the survey.

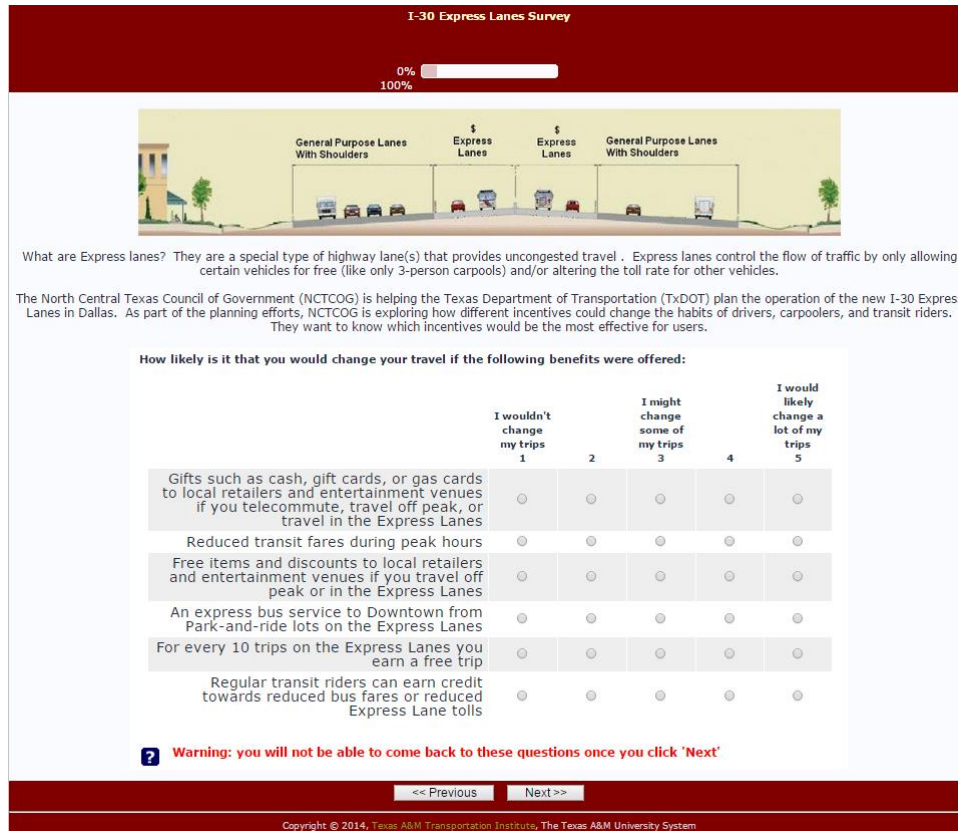


Figure 4. Introduction of Managed Lanes and the Incentives

The respondents were then presented with the six incentives. They were then asked to rate each incentive on a scale from 1 to 5, with 1 indicating that they wouldn't change their trips and 5 indicating they would change a lot of their trips (Figure 4). The order the incentives were presented in was randomized to ensure that the order would not affect how the respondent rated them.

4.1.3 Stated Preference Questions

The next section consisted of three stated preference (SP) questions. Each question was a separate scenario on I-30 with the hypothetical managed lane and the respondents were given four options (alternatives) (see Figure 5):

1. Travel on the General Purpose Lane (GPL)
2. Travel by Yourself on the Express Lane, or Managed Lane Drive Alone (MLDA)
3. Carpool on the Express Lane, or Managed Lane Carpool (MLCP)
4. Travel on the Express Lane (Transit).

Each option was presented with two attributes, travel time and toll. GPL was always free, MLDA and Transit always had a toll or fare, respectively, and MLCP was either free or had a toll of half the MLDA toll. The travel time for MLDA, MLCP, and Transit were all the same since they all traveled on the express lane while the travel time for GPL was always longer. However, footnotes were included to indicate that carpooling may require extra time to pick up passengers and transit may require waiting time.

The hypothetical situation was introduced in two different manners based on the responses given in the first section of the survey. If the respondent described what their most recent trip was like, these characteristics would be used to build the hypothetical situation. For example, if the respondent said their most recent trip was by passenger car at 11am on a Friday, the hypothetical situation would take place during that specific time. The stated preference question would then be introduced in the following manner: “You described your most recent trip on I-30 as occurring on a Monday at 11:30 AM in a passenger car, SUV, or pick-up truck. The reason for your trip was commuting to or from your place of work. If you had the options below for that trip during the mid-day, which option would you choose?” (see Figure 5)

If the respondent did not describe their most recent trip, the survey would develop a semi-random scenario and introduce the scenario with the following wording: “Consider you need to travel on I-30 on a Thursday at 8:00 AM in a passenger car, SUV, or pick-up truck. If you had the options below for that trip during the morning peak, which would you have chosen?” (see Figure 6).

Of the three stated preference questions, the first question did not have an incentive added to the scenario while the second and third were presented with an incentive. The incentive was randomly chosen from the six different incentives and was highlighted by a different color background.

You described your most recent trip on I-30 as occurring on a Monday at 11:30 AM in a passenger car, SUV, or pick-up truck. The reason for your trip was commuting to or from your place of work (going to or from work). If you had the options below for that trip during the mid-day, which would you have chosen?

Choose one of the following answers

<p>Travel on the General Purpose Lane</p> <p><input type="radio"/> Trip Time: 13 minutes No Toll</p>
<p>Travel by Yourself on the Express Lane</p> <p><input type="radio"/> Trip Time: 9 minutes Toll: \$1.00</p>
<p>Carpool on the Express Lane</p> <p><input type="radio"/> Trip Time: 9 minutes Toll: \$0.00</p> <p><small>*Please note that additional time may be needed to pick up passengers</small></p>
<p>Travel by Transit(Bus) on the Express Lane</p> <p><input type="radio"/> Trip Time: 9 minutes Fare: \$1</p> <p>Incentive: Express bus service from park-and-ride lots to Downtown</p> <p><small>*Please note that there may be additional time from waiting for the bus</small></p>

Figure 5. Stated Preference Question 2: If Recent Trip Characteristics were Provided

I-30 Express Lanes Survey

0% 100%

Each of the following questions will ask you to choose between four potential travel choices on I-30 in the Metroplex. Please select the travel mode that you would most likely choose if you were faced with these options on your recent trip.

Consider you need to travel on I-30 on a Thursday at 8:00 AM in a passenger car, SUV, or pick-up truck.
If you had the options below for that trip during the morning peak, which option would you choose?

Choose one of the following answers

<input type="radio"/>	Travel on the General Purpose Lane Trip Time: 22 minutes No Toll
<input type="radio"/>	Travel by Yourself on the Express Lane Trip Time: 13 minutes Toll: \$4.00
<input type="radio"/>	Carpool on the Express Lane Trip Time: 13 minutes Toll: \$0.00 <i>*Please note that additional time may be needed to pick up passengers</i>
<input type="radio"/>	Travel by Transit(Bus) on the Express Lane Trip Time: 13 minutes Fare: \$3.90 <i>*Please note that there may be additional time from waiting for the bus</i>

<< Previous Next >>

Figure 6. Stated Preference Question 1: If Recent Trip Characteristics were not Provided

4.1.4 Socio-economic/Demographics

The last set of survey questions asked about socio-economic and demographic characteristics of the respondent. Respondents were asked to give their gender, age group, race/ethnicity, education level, and household income. Age group was divided into 10 year intervals. For race/ethnicity, respondents were offered choices, but were also provided with a textbox for user-input. Education level ranged from ‘Less than High School’ to ‘Postgraduate College’. For household income, income ranges were provided along with an option to calculate based on hourly wage. Respondents could

also choose not to answer. The last section of this page offered a place for comments. Respondents could add any comments or suggestions related to the survey or to travel on I-30.

4.1.5 Pilot Program

After submitting the survey, respondents were then taken to the final page (See Appendix A). This page explained both the pilot program and the prize drawing to the respondent and provided links to three different surveys where they could enter the prize drawing, enroll in the pilot program, or both.

The prize drawing page explained the rules of the drawing such as who was eligible and how the drawing would be done. It also told the respondent the timeline for when the winner would be selected.

The Pilot Program page explained the goal and purpose of the pilot program. It is a program where I-30 travelers would be offered incentives similar to those introduced in the survey. At a later time, the participants would be given a follow-up survey asking about the program. The third page combined both the prize drawing and pilot program and explained them both.

All three surveys asked for the same information in order to enroll. Respondents were asked to provide their name, phone number, and email address in order to be contacted. This information was not used for anything else and was not linked to their main survey response.

4.2 Incentive Development

The first step for choosing the incentives was to develop a list of any incentives that could be tested or implemented. This was done by both looking at previously offered incentives in the area or incentives offered by other programs around the country and by discussion with transportation experts. The list was then expanded by determining innovative ways that these existing ideas could be enhanced or combined (see Table 1).

Table 1. List of Potential Incentives

Incentives	Comments
Earn cash, gift cards, gas cards, etc. for not traveling during the peak period or telecommuting	Previously offered through Try Parking It and North Texas Clean Air Coalition
Win airline tickets or apple iPad when alter your commute your name is put into a drawing to win prizes.	Previously offered through joint efforts between Try Parking It and North Texas Clean Air Coalition. - Ozone season promotion.
Win give away items including - Umbrella, Double Wall Cup, Drawstring Backpack, Mouse Pad, Pedometer, Lanyard when you alter your commute.	Previously implemented through Try Parking It
Discount for carpoolers during specified peak hours only	Regional Transportation Council Policy
Discount for registered RTC funded vanpools	Regional Transportation Council Policy

Table 1. Continued

Incentives	Comments
Vanpool subsidies	Previously sponsored by Regional Transportation Council through Dallas Area Rapid Transit, The T and Denton County Transportation Authority
Offer free or reduced fees for Emergency Ride Home Service for folks vanpooling and carpooling.	Previously sponsored by Regional Transportation Council through Dallas Area Rapid Transit, The T and Denton County Transportation Authority
Transit credits to be used for transit services or other transportation related expenses when you alter your commute.	
Offer parking price reductions for carpools	
On top of reduced rates for disadvantaged populations, offer payment alternatives to credit cards or tying to a checking account (possibly work with employers to automatically deduct from paycheck)	
Try to induce travel on Trinity Railway Express between Fort Worth and Dallas versus taking I-30 by offering a fare reduction on transit pass if ride between certain hours.	
Offer express bus service from I-30 park-n-ride lots to downtown Dallas.	
Employers or venues offer incentives to carpool or use alternative fuel vehicles for preferential parking.	

Table 1. Continued

Incentives	Comments
Allow users to earn points that could be redeemed for tickets to sporting events/concerts, parking at events, gift cards to retailers or restaurants, rental car vouchers, airline tickets, etc. Could be in the form of discounts/coupons or just free prizes.	
Credits or discounts for bicycling	
Credits or discounts for car sharing services, like Zip Car	
Offer real-time casual carpooling	Previously implemented through DFW Connect A Ride mobile website.
Offer ridesharing application	Previously implemented through Try Parking It
Wifi access would be available for free on all buses, trains, and light rail in the North Central Texas region.	
Earn credits while traveling during the off-peak period to travel for a reduced price during the peak period.	
Offer a commute coach. An individual that will meet with commuters on an individual basis to educate them on commuter options for their specific route and provide tailored incentives to change their behavior.	
Auto insurance discount due to using the safer, barrier separated lane, for many trips	

After creating a broad list of possible incentives, the next step was to narrow the list down through discussion and voting. The final incentives were chosen for both their potential impact on mode choice and potential for implementation. Some were good incentives that were used in other incentive programs and were likely to be implemented while others were requested specifically by the transportation agencies.

The final six incentives were the following:

1. For every 10 paid trips on the Express Lanes, you earn a free trip
2. Gifts such as cash, gift cards, or gas cards to local retailers and entertainment venues if you telecommute, travel off peak, or travel in the Express Lanes
3. Free items and discounts to local retailers and entertainment venues if you travel off peak or in the Express Lanes
4. Regular transit riders can earn credits towards reduced bus fares or reduced Express Lane tolls
5. Reduced transit fares during peak hours
6. An express bus service to Downtown from Park-and-ride lots on the Express Lanes

4.3 Stated Preference Question Design

The stated preference question section consisted of three questions, each with four hypothetical choices: GPL, MLDA, MLCP, and Transit. Each mode was presented with a travel time and cost. Traveling on the GPL would be free but have a longer travel time. The travel time on the other three modes would all be the same since they are all

on the managed lanes. Incentives would be only be offered on the second and third stated preference questions.

This section will describe how the stated preference questions were designed. It will describe how the attribute levels (travel time and toll rate) were chosen and it will also show all the factors that went into designing the stated preference scenarios.

4.3.1 Travel Time/Trip Time of Day Factor/Toll Rate

Travel time is one of the most important factors a traveler considers when choosing among different modes or routes, so it was important to display an accurate travel time in the scenarios. Several factors went into calculating the travel time:

$$TT = \frac{D * 60}{V/TDF} \quad (1)$$

Where: TT = total trip time (minutes)

D = trip distance (miles)

60 = Constant to convert miles/hour to miles/minute

V = speed (mph)

TDF = time of day factor

The distance was set to 10 miles for every trip as that was approximately the length of the MLs applicable to the study. The speed used for the scenarios was based on data obtained from detectors on the freeway and was set to a specific range. The speed range depended on whether they were traveling on the express lane or the general

purpose lane and is summarized in Table 2. The data used was obtained from DALTRANS detectors from two locations along I-30 and can be seen in Appendix B. This range was then used to develop levels of speeds (see Table 3). These speeds were then input into Equation 1 to get levels of travel times that could be used for the stated preference questions (Table 3).

Table 2. Speed Range Used for the Survey

Lane	Minimum speed (mph)	Maximum speed (mph)
General purpose lane	40	60
Express lane	55	75

Table 3. Speed and Travel Time Attribute Levels

Lane	Speed (mph)	Travel Time (minutes)
General Purpose Lane	60, 55, 50, 45, 40	10; 10.91; 12; 13.33; 15
Express Lane	75, 70, 65, 60, 55	8; 8.57; 9.23; 10; 10.91

The final factor in determining the travel time is the trip time of day as the period someone is traveling will greatly affect the total traffic and therefore the travel time. The time of day factor was dependent on the lane, GPL or ML, and the time period, morning shoulder, morning peak, mid-day, and so on (see Table 4). If the respondent provided the time their most recent trip started, that time period would be used. However, if the trip start time was not provided, the survey would default to either the AM or PM peak time of day (randomly choosing between the two). The time of day

factor could have little to no impact on the travel time or significantly increase the travel time (see Table 4).

Table 4. Time of Day Factors Based on Trip Start Time

Trip Start Time	Time of Day	Time of Day Factors	
		General Purpose Lane	Express Lane
6 AM to 7 AM	Morning Shoulder Period	1.4	1.1
7 AM to 9 AM	Morning Peak Period	1.8	1.2
9 AM to 10 AM	Morning Shoulder Period	1.4	1.1
10 AM to 4 PM	Mid-Day	1.0	1.0
4 PM to 5 PM	Evening Shoulder Period	1.4	1.1
5 PM to 7 PM	Evening Peak Period	1.8	1.2
7 PM to 8 PM	Evening Shoulder Period	1.4	1.1
8 PM to 6 AM	Night	1.0	1.0

For example, a trip during the morning peak could last 24 minutes if the managed lane was chosen, while the same trip would take 43 minutes on the general purpose lane. The second column in Table 4, Time of Day, shows the wording shown to the respondent to help describe the hypothetical scenario.

4.3.2 Toll Rate

The second attribute of each travel mode is the toll rate, which was based on rates from existing managed lanes and transit around the area. The toll rate was taken from the existing LBJ TEXpress Lanes, which is dynamically priced and dependent on

the level of demand. The toll typically ranges from 10-25 cents per mile during the off-peak hours and 45-75 cents per mile during the peak hours (LBJ TEXpress). Similarly, rates from the Dallas Area Rapid Transit were used to develop the fare range for transit use. As of 2015, the DART charged \$2.50 for a 2 hour pass that could be used on local lines, and \$5.00 for a 2 hour pass that could be used regionally. A local pass allowed riders to travel on all DART buses and trains while a regional pass allowed riders to also travel on all Fort Worth buses and transit. They also offered off-peak fares (9:30 AM to 2:30 PM) that cost \$1.75 for local trips and \$3.50 for regional trips (DART Fares). With these fares and toll rates, a range was developed for both (see Table 5).

Table 5. Toll and Fare Attribute Levels

Mode	Attribute	Levels
Managed Lane Drive Alone	Toll (cents/mile)	30, 35, 40, 45, 50
Managed Lane Carpool	Toll (cents/mile)	0, 0, 15, 25
Transit	Fare (dollars)	3.5; 4.0; 4.5; 5.0

The toll range for the express lanes also depended on what travel mode was used. Driving alone on the express lane would always incur a toll which ranged from 30 to 50 cents per mile. The toll rate for carpooling was set to be free 50% of the time, and half the toll rate the other 50% of the time (see Table 5). As for Transit, the trip was assumed to always be regional, and therefore the fare ranged from \$3.50 to \$5.00.

4.3.3 Stated Preference Design

When designing a stated preference survey, it is important to properly design the attributes and their levels to ensure the best results. There are many methods to design a stated preference survey, including D-efficient, Adaptive Random, Orthogonal, and Random attribute level generation. For this study, two methods were used for designing the stated preference questions to allow for comparison. The first was Bayesian D-efficient design, which literature has shown to get results closest to revealed data. The second was Random Adjusting design which is useful for estimating the value of travel time (Richardson 2007). The two methods and how the stated preference questions were designed using each method will be discussed below.

4.3.3.1 Bayesian D_b-efficient Design

The first method used to generate the stated preference question's attributes was Bayesian D_b-efficient design. The reasons for using this method are set out in the literature review (Section 2.3). An efficient design estimates the attribute levels in a way that minimizes the standard error for the parameters and maximizes the t-statistic. The t-statistic indicates the difference between the chosen design and a design that has zero influence on the choices. The standard error is calculated from the asymptotic variance-covariance [AVC] matrix. A D-efficient design minimizes the D-error of the AVC matrix and the D-error is calculated by taking the determinant of the AVC matrix. Because it is a discrete choice model, the AVC matrix is equal to the inverse of the Fisher information matrix (equation 2).

$$AVC = -\frac{1}{N} \left[\frac{\partial^2 LL \beta}{\partial \beta \partial \beta'} \right]^{-1} \quad (2)$$

where: N = number of respondents

LL = log-likelihood function for the discrete choice model

B = vector of parameters used in the model

The Fisher information matrix contains a parameter vector which is unknown before conducting the survey and must be estimated from literature. For this survey, a Bayesian technique was used to estimate the prior parameters. In this method, a random distribution is used for the priors and the D_b -error is calculated by using equation 3.

$$D_b - error = \int_{\beta} detAVC(\tilde{\beta}|X)^{1/K} \phi(\tilde{\beta}|\theta) d\tilde{\beta} \quad (3)$$

where: $\phi(\tilde{\beta}|\theta)$ = joint distribution of the assumed parameter priors

θ = the corresponding parameters of the distribution

K = the number of parameters in the model

The integral is computationally difficult so it can be approximated by several different methods, including the use of Halton draws to simulate the distributions. This was the method used for this study. Once the Halton draws are completed, R independent draws are taken from each of the prior distributions of the K-parameters and the D_b -error is then calculated using equation 4:

$$\hat{D}_b - error = \sum_{r=1}^R detAVC(\tilde{\beta}^r|X)^{1/K} / R \quad (4)$$

where: $\tilde{\beta}^r = [\tilde{\beta}_1^1, \dots, \tilde{\beta}_k^r]$

R = the draw (1, 2, ..., R)

The priors for travel time, toll rate, and transit fare were assumed to have normal distribution with a non-zero mean. The means for the priors were obtained from a previous Transit to SOV study (Chum and Burris 2008). Along with the priors, the attribute levels for travel time, toll rates, and transit fare are also needed for the design. These attribute levels were determined as shown in Section 3.3.1 and 3.3.2. The attribute levels and the means and standard deviations used can be seen in Table 6.

Table 6. Overview of Attribute Levels and Priors

Attribute	Attribute Levels		Mean Value of Priors	Standard Deviation of Priors
Travel Time (minutes)	Express Lane	8; 8.57; 9.23; 10; 10.91	-0.33	0.32
	General Purpose	10; 10.91; 12; 13.33; 15		
Toll Rate (cents)	EL Drive Alone	30, 35, 40, 45, 50	-1.22	
	EL Carpool	0, 0, 15, 25		
	General Purpose	0		
Transit Fare (dollars)	Transit	3.5; 4; 4.5; 5		

Because the calculation of the D_0 -error is computationally difficult, N-gene software was used to calculate the error and design the survey (see Appendix C for the N-Gene code). Once the attribute levels and priors are inputted, a random parameter panel logit (rppanel) was specified for the discrete choice model and the priors were simulated using 400 Halton draws from the prior distribution. The Bayesian design obtained is shown in Table 7. The result shows 24 rows divided into 8 blocks of 3 rows

each. Every respondent would be given all choice sets from a randomly chosen block. The D_b -error for this design was 0.74. The smaller the D_b -error, the more efficient the design. The D_b -error is close to zero, which indicates an efficient design.

Table 7. D_b -Efficient Design Results

Mode	General Purpose Lane	Express Lane			
Block	Speed (mph)	Speed (mph)	Toll Rate (single occupant) (cents/mile)	Toll Rate (carpool) (cents/mile)	Transit Fare (dollars)
1	45	75	50	15	3.5
	50	70	35	15	4.5
	40	75	30	25	3.5
2	50	70	45	25	4.00
	50	60	50	0	5.00
	55	55	35	0	3.5
3	60	65	40	0	1.00
	55	65	40	0	5.00
	55	55	30	0	4.5
4	40	70	40	15	5.00
	45	65	30	0	5.00
	60	60	50	15	4.5
5	55	55	35	25	3.5
	45	65	40	0	4.5
	45	70	40	0	4.0
6	60	60	35	0	3.5
	60	60	50	25	5.00
	55	60	45	15	4.0
7	50	70	30	0	4.0
	40	75	45	0	5.00
	40	75	30	25	4.5
8	45	60	45	15	3.5
	50	65	45	25	4.00
	55	75	35	0	4.5

4.3.3.2 Random Adjusting Design

The other method used for generating the stated preference question attributes was Random Adaptive. In this method, the attributes for the first SP question are randomly created from a set initial range. This range is based on the same data used for the D-efficient attribute levels: LBJ TEXpress, freeway detector data, and DART fares (see Table 8). For travel time, this method was used for all three stated preference questions. For toll and fare, the attribute value was multiplied by a factor. This factor was based on which mode the respondent chose in the previous question. If the general purpose lane was chosen, the toll rate and transit fare were multiplied by a randomly generated factor between 0.35 and 0.7. If the Express Lane was instead chosen, the toll rate and fare was multiplied by a factor between 1.3 and 1.9. Constraints were included to ensure the toll would not be too high or too low (see Table 9).

Table 8. Random Adjusting Design Initial Attributes

Attribute	Lane	Range
Speed (mph)	Express Lane	55 + (0 to 20)
	General Purpose Lane	40 + (0 to 20)
Toll Rate (cents/mile)	Express Lane	30 + (0 to 20)
	General Purpose Lane	0
Transit Fare (dollars)	Express Lane	3.5 + (0 to 1.5)
	General Purpose Lane	N/A

Table 9. Allowable Range of Random Adjusting Design Attributes

Mode	Minimum	Maximum
Toll Rate (single occupancy) (cents/mile)	10	100
Toll Rate (carpool) (cents/mile)	0	50
Transit Fare (dollars)	1.00	10.00

4.3.4 Incentive Design

The focus of this research was to determine how travelers would be influenced by incentives for managed lane use and how their travel behavior would change. To do this, incentives were added to the managed lane travel modes for the second and third stated preference questions (see Section 3.2 for the methodology of incentive design). The six incentives used can be seen in Table 10. The incentive added to the stated preference question was chosen randomly from the 6 to ensure each incentive was tested equally. Furthermore, because every incentive except one had a numerical aspect, those incentives were tested by randomly choosing the value from a set range (see Table 10). The first three incentives were added to all three Express Lane modes while the last three applied only to Transit.

Table 10. Incentives Used and Their Levels

Incentive	Mode	Levels
Earn a free trip for every X paid trips on the Express Lanes	MLDA, MLCP	8, 9, 10, 11, 12
Earn gift cards worth \$5 for every X peak-hour trips saved by either telecommuting or by not traveling during the peak hours (7-9am or 4-6pm)	MLDA, MLCP, Transit	20, 25, 30, 35
X% discount offered through select businesses	MLDA, MLCP, Transit	5%, 10%, 15%, 20%, 25%
For every X trips taken by transit, \$5 in credits that can be used on the Express Lanes	Transit	20, 25, 30, 35
A transit fare discount of X%	Transit	10%, 20%, 30%
Express bus service from park-and-ride lots to downtown	Transit	N/A

4.4 Survey Administration

4.4.1 Advertising

To increase participation, the survey, along with a prize drawing for three random participants, was advertised to the general public through various means. Initially, the survey was administered starting on August 1st, 2014 and ran until September 15th, 2014. During this time, advertisements and press releases were sent out to various transportation agencies, relevant websites, and media outlets throughout the Dallas-Fort Worth metro area.

To encourage people to take the survey, prizes were offered to randomly chosen participants. Three participants were randomly drawn to win a \$250 dollar MasterCard

gift card. Participants could not be employees of any of the associated employers (TTI, NCTCOG) to be eligible.

Advertisements were purchased in the Dallas Morning News on two Fridays, September 5th and 12th. These ads were displayed in two sections, the main news section as well as the Neighbors section. Additionally, the survey was announced in newsletters of relevant transportation agencies such as NTTA and NCTCOG as well as local government websites near the Tom Landry freeway including Grand Prairie and Arlington. The survey was also promoted online through news sites such as opinionarlington.com and through social media sites Facebook and Twitter (see Figure 7). The last main advertisement focus was local transportation websites such as drivingnorthtexas.com which is an informational site run by the NTTA for driving on tollways and tryparkingit.com which is a program run by NCTCOG to encourage carpooling and alternate modes of transportation.

Limesurvey kept note of where the respondent was directed from and therefore we were able to see which advertisements were most effective at garnering responses (see Table 11).

Table 11. Number of Referrals from Websites

Referral Address	Referral Count
arlington-tx.gov	215
cbslocal.com	3
dallascitynewsroom.com	3
drivingnorthtexas.com	148
facebook.com	70
fwbusinesspress.com	5
gptx.org	38
nctcog.org	38
opinionarlington.com	5
reagan.com	2
texas.dotnewz.com	1
tryparkingit.com	2
twitter.com	13
uta.edu	3

The advertisement features a teal header with the text "Calling Users of I-30/Tom Landry Highway" in white. To the right of the header are three smiley face icons (sad, neutral, happy) and a graphic of a pencil with a checkmark. Below the header, the text reads: "3 randomly chosen survey respondents will win a \$250 gift card. Take our Traveler Survey to provide input on how to best manage I-30 between Dallas and Arlington at: www.i-30Survey.org". The URL is highlighted in a yellow box. Logos for the North Central Texas Council of Governments and the Texas A&M Transportation Institute are located in the bottom right corner.

Figure 7. Example Online Advertisement

At the end of the first time period, August 1st to September 15th, there was a total of 400 responses. At the end of this period, the prize drawing took place and rewarded three random respondents with \$250 MasterCard gift cards. However, this response total was deemed inadequate and the survey was kept open until November 30th to garner more responses. Additionally, a second strong push took place during the

second time period with advertisements and announcements. Although this second push did not include any sort of prize drawing, it was still able to get a significant number of responses (see Figure 8). The large jumps in responses usually were due to pushes by specific agencies or specific websites. For example, the large number of responses from November 13-20 were mostly from advertisements on the Arlington government website while the responses on August 28 were from drivingnorthtexas.com.

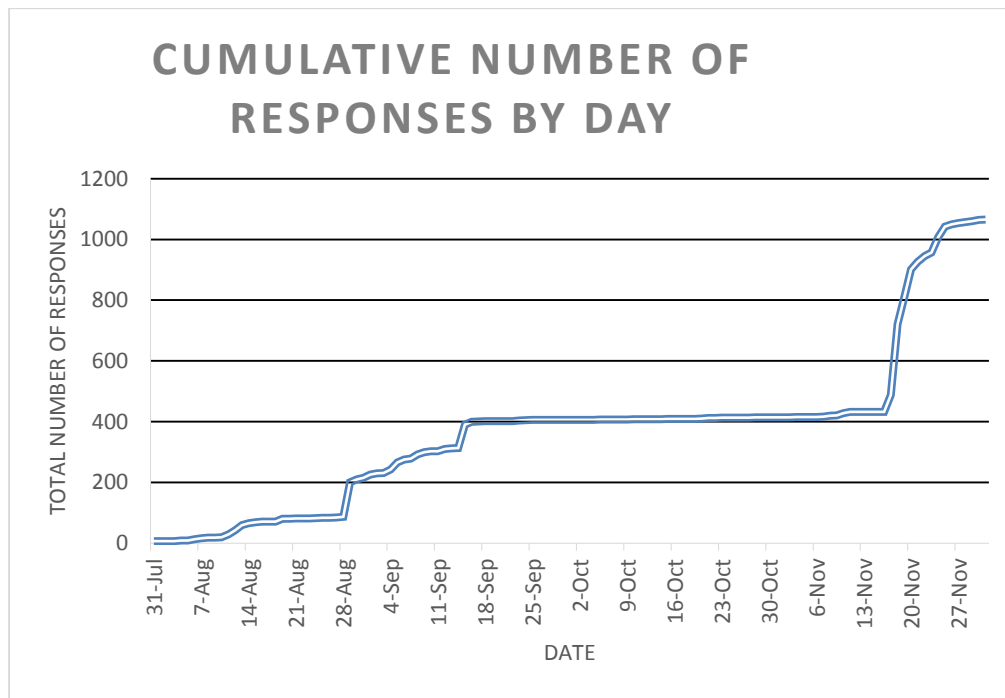


Figure 8. Cumulative Number of Responses by Day

The survey was developed and hosted on LimeSurvey. Limesurvey allowed for flexibility in creating the questions. While they offered basic survey question types such as drop down menus and checkboxes, they also allowed for code to be added to create the stated preference questions. Limesurvey also hosted the actual survey and stored the

data from the responses. However, to simplify the process for the survey takers, a simpler and more relevant url, i-30survey.org, was bought to redirect people to the survey hosted on the Limesurvey site.

4.4.2 Pilot Program

The goal of the survey was to gauge potential interest and quantify the effect of the incentives. Once the managed lanes are up and running, it is important to monitor how effective the implemented incentives. A pilot program will be used to see how travelers use the incentives once offered along with a follow-up survey at a later date.

4.5 Summary

The development of the survey consisted of many steps. First, with the help of TTI and NCTCOG, a list of incentives to test was developed. The general design of the survey was developed through the online software Limesurvey while the stated preference section was developed using the software N-Genie. The survey was then administered through Limesurvey and was advertised through various means such as newsletters and online ads. Ultimately, 1055 responses to the survey were received. The analysis of these responses is detailed in the following section.

5. DATA ANALYSIS

5.1 Filtering

Once the data was all collected, there was a total of 1055 responses. The first step in analyzing the data was to check the responses to filter out unusable data. This was done for two main reasons. First, because there was a prize incentive to encourage people to participate in the survey, there was a possibility that people would take the survey multiple times to increase their chances of winning. Second, some of the surveys were only partially completed and required extra examination to determine if the response was complete enough to be included in the analysis.

To determine if the response was legitimate and not an attempt to enter the prize drawing multiple times, the following criteria were used to determine if the response needed further scrutiny:

- Limesurvey recorded the IP address of the respondent. If the same IP address appeared, this could indicate if a respondent took the survey multiple times in a row.
 - o Most of the IP address repetitions appeared to be family members taking the survey from the same household or employees at the same company
 - o Other instances occurred when someone started the survey but quit partway through. They then started the survey again and completed the survey. It was very likely it was the same person as the answers to

previously completed questions matched the answers in the new survey.

The partial responses were removed.

- Limesurvey also recorded the start and end time of when the respondent participated. This could be used to see if anyone rushed through the survey just to enter the prize drawing.
 - o Any responses that took less than 3 minutes were further examined. If there was anything suspicious, they were removed. There were 173 survey responses that were under 3 minutes. Out of these, only 6 had suspicious answers. The 6 that were removed had completed the survey (meaning they clicked the 'Submit' button) but skipped most of the answers.
- Any responses with answers that seemed very unusual were also scrutinized
 - o One response had a 3 digit zip code which was flagged. The answers were not complete so that response was removed

Partial responses also required extra examination and thought. A set of rules were developed to sort the partial responses into either usable or unusable data. The following sorting criteria were made:

- If all but the demographics section was complete, including all 3 stated preference questions, the response was kept
- If all 3 stated preference questions were not completed, even if everything else was answered, the response was removed

After filtering out both suspect responses and partial responses, we were left with 898 responses out of 1055 total. Table 12 shows the breakdown of how many responses were kept or removed by response type.

Table 12. How Many Responses were Kept or Removed

	Total	Kept	Removed
Complete Responses	894	884	10
Partial Responses	161	14	147
Total Responses	1055	898	157

5.2 Preliminary Analysis

Once the data was filtered it was ready for analysis. The first type of analysis done was simple, preliminary analysis on socio-demographics, the respondent's recent trip, and basic incentive statistics.

5.2.1 Socio-demographics

The socio-demographic characteristics of the survey respondents can be seen in Table 13. A little over half of the respondents were male, and the majority (79%) were white/Caucasian. The age was distributed fairly evenly while the income was skewed towards the higher end (over 30% earned over \$100,000 per year or more).

These statistics were compared with socio-demographics of the Dallas-Fort Worth metropolitan area as well as the combined socio-demographics of Arlington and Grand Prairie (Table 13). There were several numbers that differed between the survey and census data. The populations that were over represented included those who were

white, college graduates, and those aged 55-64. Underrepresented groups included African Americans, Hispanic/Latino, those with less than high school or just a high school diploma, and those with an income less than \$50,000. The disparity is most likely due to the advertising targets as well as the online survey platform.

Table 13. Socio-demographic Percentages

Demographics	Percentage		
	Survey	DFW Metro	Arlington/Grand Prairie
Gender			
Male	51.4	49.3	49.0
Female	48.6	50.7	51.0
Age			
18-24	8.3	9.6	10.6
25-34	20.6	14.9	15.2
35-44	18.2	15	15.0
45-54	22.5	14.2	13.6
55-64	20.6	9.8	10.3
65+	10.0	8.9	7.4
Ethnicity			
White/Caucasian	79.4	50.2	55.8
Hispanic/Latino	8.5	27.5	35.1
African American	4.8	15.4	19.4
Asian American	2.1	5.9	6.7
Native American	1.2	0.6	0.8
Other	3.9	0.4	0.7
Education			
Less than High School	0.1	15.6	17.8
High School graduate	3.8	22.9	25.1
Some college or vocational school	21.6	22.0	24.0
College graduate	42.3	28.1	25.5
Post-graduate college	32.2	11.2	7.7
Household Income			

Table 13. Continued

Demographics	Percentage		
	Survey	DFW Metro	Arlington/Grand Prairie
Less than \$10,000	1.2	5.7	5.6
\$10,000 - \$14,999	0.8	4.3	4.5
\$15,000 - \$24,999	3.1	9.3	10.3
\$25,000 - \$34,999	6.0	9.9	10.9
\$35,000 - \$49,999	8.2	13.3	14.6
\$50,000 - \$74,999	19.2	18.2	19.7
\$75,000 - \$99,999	15.1	12.4	13.1
\$100,000 - \$199,999	25.3	20.9	18.6
\$200,000 or more	5.7	6.1	2.8
Prefer not to answer	15.4	-	-

5.2.2 Recent Trip Characteristics

The data on the respondent’s most recent trip is shown in Table 14. The most common answers to “How frequently do you travel on the I-30 (Tom Landry) Freeway?” were multiple times per day, few times per week, and few times per month, adding up to 83.9% of the responses. The other 16% of the responses were about once a day, once a week, or I have not used I-30 in the past 6 months. This shows that most travel on I-30 by respondents were round-trip travel since many people do not travel just once on the freeway. This matches up with the next question “What was the purpose of your most recent trip,” where the majority of travel was for work or social purposes. Only 2.5% of the trips were for major sports events. The trip day of the week was mostly evenly distributed with each day other than Sunday getting an average of 15.5% of the trips.

The average trip time was 31.8 minutes. The distribution of travel time are shown in Figure 9. The histogram shows there are several outliers with trip times

exceeding 90 minutes. The longest time someone reported was 6 hours. Many of these were suspect for various reasons. Some may have been caused by unusual traffic caused by an event (i.e. leaving a football game) or an accident. Others may have been the respondent misreading the question and recording how long they were on any part of I-30. In fact, based on the zip code, one of these long trips started in Arkansas. If trips 90 minutes or longer are removed, the adjusted average trip time becomes 29.6 minutes. The median time was 30 minutes before and after adjustment.

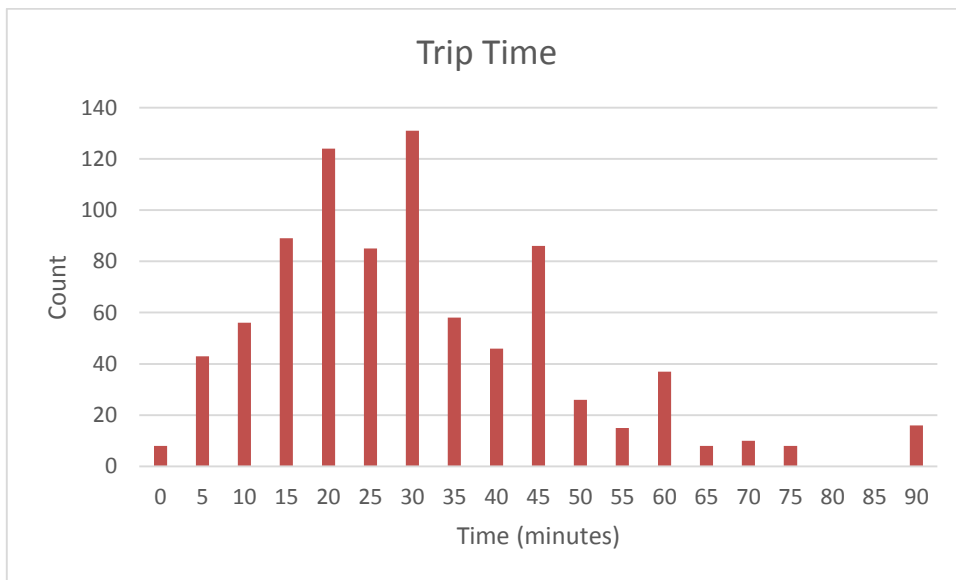


Figure 9. Reported Trip Time

Virtually everyone who took the survey traveled by passenger vehicle, SUV, or pick-up truck at 99.2% (see Table 14). The majority of respondents traveled alone (71.6%) or traveled with one other person (20.4%), and the rest traveled with 3 or more. The average occupancy of the vehicles was 1.40. Finally, if the respondent did travel

with someone else, it was usually a family member. Children were the extra passenger 17.5% of the time while adult family members were the extra passenger 55.3% of the time. We also asked how much extra time they spent picking up the passengers if they were the driver (Figure 10). The average was 3.95 minutes. However, if you only looked at the non-family member cases, this average jumped up to 11.1 minutes.

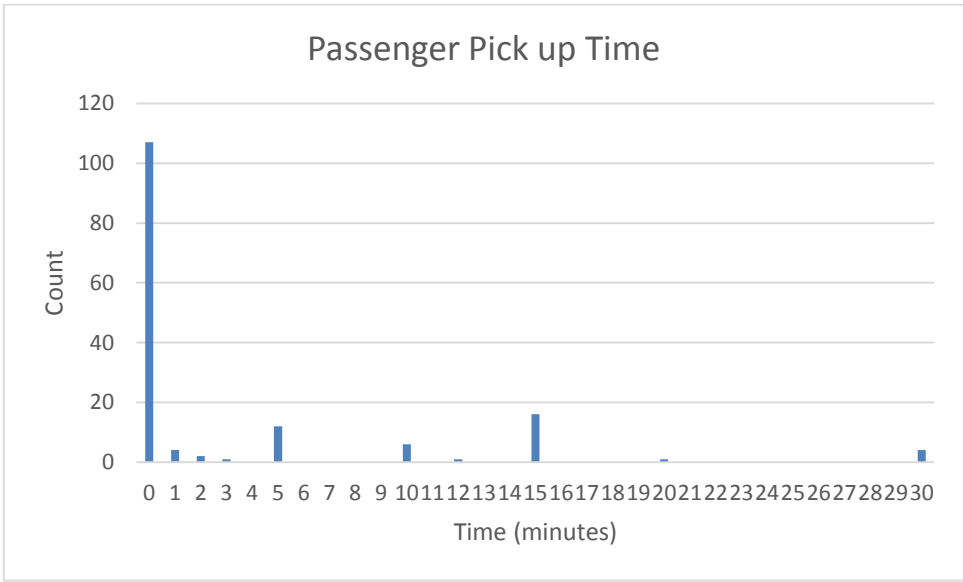


Figure 10. Extra Time to Pick Up Passenger

Table 14. Recent Trip Characteristics

Trip Characteristic	Percentage of Travelers
How Frequently do you travel on the I-30 (Tom Landry) Freeway?	
Multiple times per day	31.4
About once a day	6.8
A few times per week	22.5
Once a week	7.3
A few times per month	30.0
I have not used I-30 in the past 6 months	2.3
What was the purpose of your most recent trip on I-30?	
Commuting to or from work	40.3
Recreational/Social/Shopping	31.8
Major Sports game	2.5
Work Related (non-commuting)	15.4
Class or School	4.0
Other	6.1
On what day of the week was your most recent trip?	
Sunday	7.0
Monday	14.8
Tuesday	18.5
Wednesday	12.0
Thursday	16.2
Friday	16.6
Saturday	14.9
Average respondent trip time (minutes)	31.8
Adjusted average respondent trip time* (minutes)	29.6
% Passenger vehicle, SUV or Pick-up truck	99.2
How many people were in the vehicle?	
1	71.6
2	20.4
3	5.3
4	2.0
5+	0.7
Average Occupancy	1.40

Table 14. Continued

Trip Characteristic	Percentage of Travelers
Was the respondent the driver or passenger?	
Driver	73.1
Passenger	26.9
Average time to pick up passenger (minutes)	3.95
Adjusted Average time to pick up passenger** (minutes)	11.1
Passenger's relation to respondent	
Neighbor	2.9
Child	17.5
Co-worker	8.7
Adult family member	55.3
Commuter in a casual carpool	2.2
Other	13.5

*adjusted by removing any travel times over 90 minutes

** adjusted by removing all pick up times of 0 minutes

5.2.3 Basic Incentive Statistics

The goal of this research was to gauge traveler’s interest and reaction to potential incentives for managed lane use. To do this, two methods were used in the survey. First, the incentives were introduced and the respondents were asked to rate them (see Section 4.1.2). Then, stated preference questions were used which included incentives and responses to those questions were used to gauge interest in the incentives (see Section 4.1.3).

Table 15 breaks down how respondents rated all the incentives on a scale from 1-5, with 1 indicating “I wouldn’t change my trips” and 5 indicating “I would likely change a lot of my trips.” Some of the key points from this data are that all the

incentives are not equal in rating or in usage. The carpool and drive alone incentives were rated better than the transit incentives. The only transit incentive to rate above a ‘2’ was “Reduced transit fares during peak hours.”

Table 15. Incentive Rating

Incentive:	Free Trip every 10 trips	Gifts such as cash and gift cards	Free items and discounts to local retailers and businesses	Credit for tolls and fares for transit use	Reduced Transit fare during Peak hours	Express Bus service to downtown
I wouldn't change - 1	133	123	132	190	151	206
2	19	29	37	27	34	25
I might change - 3	91	94	91	62	74	52
4	45	46	39	25	30	24
I would likely change - 5	48	41	33	28	44	28
Weighted Average	2.57	2.56	2.41	2.02	2.35	1.93

Table 16 shows the mode choice for each stated preference question. It is important to remember that incentives were not offered for stated preference question 1 (SP1). When the incentives were offered during the stated preference questions during stated preference question 2 and 3 (SP2 and SP3), the transit incentives were rarely chosen. When a transit incentive was offered, depending on the specific incentive, it was chosen less than 6% of the time.

However, the carpool and drive alone incentives were much more effective at getting people to change mode. These incentives were chosen around 25 to 35% of the

time they were offered. Furthermore, the mode choice from SP1 to SP2 to SP3 shows that people would change modes. The people who chose to drive for free on the general purpose lane went from 79% to 69% to 67%. This was due to both incentives being offered as well as changes in toll prices.

Table 16. Stated Preference Question Mode Choice

Travel Mode	SP1		SP2		SP3	
	Count	%	Count	%	Count	%
Travel on the General Purpose Lane	231	69.3	199	60.9	191	58.8
Travel Alone on the Managed Lane	52	15.6	56	17.1	71	21.8
Carpool on the Managed Lane	38	11.4	59	18.0	52	16.0
Travel by Transit	12	3.6	13	4.0	11	3.4

Table 17 summarizes the data from the stated preference questions. Unlike the previous tables, this table breaks down the responses based on what type of stated preference design was used, D-efficient (D-eff) vs Random Adjusting (RA) vs all responses.

For SP1, the differences in mode choice between the two designs are most likely due to the toll and transit fare. The carpool toll for RA was \$0.51/ mile while the rate was \$1.23/mile for D-eff. This is reflected in the carpool use with 8.9% for RA and 6.0% for D-eff. Similarly, transit use was slightly higher for D-eff (3.5% versus 2.6%) while the fare was slightly lower for D-eff (\$3.88 versus \$4.25).

For SP2 and SP3, mode percentages changed for two main reasons: incentives were introduced and the toll rate was adjusted in the RA design (see Section 4.3.3.2). Comparing the two designs, the effects can be seen. Respondents given both designs

chose GPL less and the express lanes more. However, there was a difference between the two designs.

Respondents who were given the D-eff design chose GPL less when incentives were offered, but the percentages did not change much from SP2 to SP3. The GPL percentage changed from 78.8% (SP1) to 71.7% (SP2) to 71.6% (SP3). This was most likely because the method of generation of travel time, toll, and incentives did not change from SP2 to SP3. The travel time and toll were preset by the D-efficient generation while the incentives offered were still random and the value of the incentive was chosen from the same range.

However for RA design, in addition to the incentives, the toll and fare were adjusted in between the stated preference questions. This led to much lower tolls and fares than compared to D-eff tolls and fares. Due to the lower tolls and fares, GPL was chosen even less than for D-eff: 79.0% (SP1) to 66.8% (SP2) to 62.0% (SP3).

Table 17. Stated Preference Question Statistics

Trip Characteristics	Percentage of Travelers		
	D-eff	RA	All
Stated Preference Question 1			
Average Travel Time (minutes)			
General Purpose Lane	16.2	17.4	16.9
Managed Lane	11.1	10.4	10.7
Average Toll/Fare (dollars)			
Managed Lane Drive Alone	4.03	4.01	4.02
Managed Lane Carpool	1.23	0.51	0.86
Managed Lane Transit	3.88	4.25	4.07
Mode Choice in SP1			
General Purpose Lane	78.8	79.0	78.8
Managed Lane Drive Alone	11.8	9.5	10.7

Table 17. Continued

Trip Characteristics	Percentage of Travelers		
	D-eff	RA	All
Managed Lane Car Pool	6.0	8.9	7.5
Transit	3.5	2.6	3.0
Stated Preference Question 2			
Average Travel Time (minutes)			
General Purpose Lane	17.7	17.6	17.6
Managed Lane	10.1	10.4	10.2
Average Toll/Fare (dollars)			
Managed Lane Drive Alone	4.16	2.71	3.42
Managed Lane Carpool	0.80	0.33	0.56
Managed Lane Transit	4.74	2.73	3.71
Incentives			
For every X trips, earn one free trip			
Number of times offered	75	73	148
% of the time chosen when offered	18.7	19.2	18.9
Average X	10.1	10.0	10.1
Average X when chosen	10.0	10.0	10.0
Average X when not chosen	10.1	10.0	10.1
Gifts such as cash or gift cards for every X trips			
Number of times offered	74	79	153
% of the time chosen when offered	24.3	25.3	24.8
Average X	27.3	27.1	27.2
Average X when chosen	26.4	28.5	27.5
Average X when not chosen	27.6	26.6	27.1
X% discount to local businesses			
Number of times offered	78	84	162
% of the time chosen when offered	21.8	39.3	30.9
Average X	15.4	15.4	15.4
Average X when chosen	18.2	14.8	16.0
Average X when not chosen	14.6	15.8	15.1
\$5 credit for every X trips taken by transit			
Number of times offered	55	65	121
% of the time chosen when offered	3.6	3.1	3.3
Average X	28.1	27.8	27.9
Average X when chosen	32.5	22.5	27.5
Average X when not chosen	28.0	28.0	27.9

Table 17. Continued

Trip Characteristics	Percentage of Travelers		
	D-eff	RA	All
Transit discount of X%			
Number of times offered	79	80	159
% of the time chosen when offered	7.6	2.5	5.0
Average X	19.4	19.6	19.5
Average X when chosen	18.3	20.0	18.8
Average X when not chosen	19.5	19.6	19.5
Express Bus Lanes			
Number of times offered	74	81	155
% of the time chosen when offered	5.4	3.7	4.5
Mode Choice in SP2			
General Purpose Lane	71.7	66.8	69.2
Managed Lane Drive Alone	11.6	16.9	14.3
Managed Lane Car Pool	12.5	13.0	12.8
Transit	4.2	3.3	3.7
State Preference Question 3			
Average Travel Time (minutes)			
General Purpose Lane	17.5	17.6	17.5
Managed Lane	10.3	10.4	10.4
Average Toll/Fare (dollars)			
Managed Lane Drive Alone	3.67	2.23	2.92
Managed Lane Carpool	1.04	0.25	0.64
Managed Lane Transit	4.10	2.02	3.03
Incentives			
For every X trips, earn one free trip			
Number of times offered	74	75	149
% of the time chosen when offered	16.2	35.0	25.5
Average X	10.1	9.9	10.0
Average X when chosen	9.8	9.8	9.8
Average X when not chosen	10.2	10.0	10.1
Gifts such as cash or gift cards for every X trips			
Number of times offered	78	70	148
% of the time chosen when offered	30.8	35.7	33.1
Average X	27.6	27.4	27.5
Average X when chosen	27.1	28.4	27.8
Average X when not chosen	27.9	26.9	27.4

Table 17. Continued

Trip Characteristics	Percentage of Travelers		
	D-eff	RA	All
X% discount to local businesses			
Number of times offered	65	97	162
% of the time chosen when offered	29.2	40.2	35.8
Average X	14.2	12.8	13.3
Average X when chosen	14.7	12.2	13.0
Average X when not chosen	13.9	13.2	13.5
\$5 credit for every X trips taken by transit			
Number of times offered	65	76	142
% of the time chosen when offered	3.1	3.9	3.5
Average X	28.2	26.9	27.5
Average X when chosen	27.5	30.0	29.0
Average X when not chosen	28.2	26.8	27.4
Transit discount of X%			
Number of times offered	73	81	154
% of the time chosen when offered	4.1	6.2	5.2
Average X	20.1	20.4	20.3
Average X when chosen	20.0	26.0	23.8
Average X when not chosen	20.1	20.0	20.1
Express Bus Lanes			
Number of times offered	80	63	143
% of the time chosen when offered	3.8	7.9	5.6
Mode Choice in SP3			
General Purpose Lane	71.6	62.0	66.7
Managed Lane Drive Alone	13.5	21.3	17.5
Managed Lane Car Pool	10.2	13.0	11.8
Transit	4.7	3.7	4.2

Many of the respondents chose to utilize the same mode for all three stated preference questions. Out of the 326 full survey responses, 186 chose the same mode every time. Out of these 186, most chose GPL every time, but there were some people who chose the other modes (see Table 18). There are various reasons why travelers choose to use the same mode. For some, it is a necessity. Some people may need the

car to be able to make stops along the way. For example, some may need to pick up children from school. Others may use public transportation because they are unable to afford a car. However, some people may use a mode due to convenience or travel time. These are the travelers that would be most likely to be persuaded by incentives.

Table 18. Number of Respondents Who Chose the Same Mode Every Time

Mode	Count
Travel on the General Purpose Lane	138
Travel by Yourself on the Managed Lane	19
Carpool on the Managed Lane	23
Travel by Transit	6

There were people who chose to switch modes during the stated preference questions. This could be for a number of reasons, including change in the fare/toll or a different incentive. Table 19 shows how many people switched modes on the stated preference questions and how many of those were for a specific incentive. Certain incentives were much more successful at convincing travelers to switch modes in the stated preference questions. The main incentive that stands out is incentive 3 “[5-25%] discount to local retailers and entertainment venues” which accounted for over a third of the switches that were due to an incentive. Conversely, all 3 transit incentives combined only accounted for 23 out of 153 changes. However, if this is instead compared to the total number of switches that resulted in transit use, the ratio changes to 23 out of 34. This shows that the incentive probably influenced the respondent’s choice to switch modes to transit.

Table 19. Number of Respondents Who Switched Modes for an Incentive

Incentive	SP1 to SP2	SP2 to SP3
Total number of switches	232	245
Total number of switches to the managed lane	169	148
Total number of switches to the managed lane, drive alone	85	96
Total number of switches to the managed lane, carpool	67	35
Total number of switches to transit on the managed lane	17	17
Total Number of Switches to the MLs for an incentive	75	78
Earn a free trip for every [8-12] trips	18	20
Earn gift cards worth \$5 to local retailers for every [20-35] peak hour trips avoided	19	19
[5-25%] discount to local retailers and entertainment venues	28	26
Transit Incentives		
For every [20-35] trips taken by transit, earn \$5 in credits for tolls and fares	2	4
A discount to the transit fare of [10-30%]	5	5
Express bus service from park-and-ride lots to Downtown	3	4

The incentives had a range of values that could be offered. For example, for incentive 1: Earn a free trip for every [8-12] trips. This was done so that the value the traveler places on the incentives could be further explored. However, as seen in Table 20, the value did not appear to make much a difference in whether or not the respondent chose it. In fact, sometimes the average value when not chosen was better than the average value when it was chosen. This is the case for two of the incentives: “Earn gift cards to local retailers worth \$5 for every [20-35] trips” and “A discount on the transit fare.”

Table 20. Average Value of Incentive Offered

Incentive	Range	Average when not chosen	Average when chosen	Overall
Earn a free trip for every [8-12] trips	[12, 11, 10, 9, 8] trips	10.07	10.0	10.05
Earn gift cards to local retailers worth \$5 for every [20-35] trips	[35, 30, 25, 20] trips	27.09	27.5	27.19
[5-25%] discount to local retailers and entertainment venues	[5, 10, 15, 20, 25]% discount	15.13	16.0	15.4
For every [20-35] trips taken by transit, earn \$5 in credits for tolls and fares	[35, 30, 25, 20] trips	27.9	27.5	27.89
A discount on the transit fare	[10, 20, 30]% discount	19.54	18.75	19.50
Express bus service from park-and-ride lots to downtown	-	-	-	-

5.3 Model Development

The basic analysis of the data provides some insight into the impact of the incentives. However, by modeling, a more complete picture can be obtained. One of the advantages of modeling is that we can use it to determine the impact of the incentives while controlling for variables that are more often used in mode choice analysis such as income level or toll.

5.3.1 Model 1

The base model consisted of travel time, toll, and the six incentives. However, before all the incentives could be used in the model, some of the values needed to be modified. This was because for three of the incentives (see Table 21 below), the

incentive was better when the value was lower. Therefore, the inverse of the incentive was used in the model (Equation 5).

$$I = \frac{1}{V} \quad (5)$$

where: I = inverse of the incentive

V = value of the incentive

The last incentive, Express bus service to downtown, did not have a value.

Therefore a dummy variable was used for this incentive.

Table 21. Model Incentive Values

Incentive Description	Model Variable
Earn a free trip for every [8, 9, 10, 11, or 12] paid trips taken on the Express Lanes	1/12, 1/11, 1/10, 1/9, 1/8
Earn gift cards worth \$5 for every [20, 25, 30, or 35] peak-hour trips saved by either telecommuting or by not traveling during the peak hours (7-9am or 4-6pm)	1/35, 1/30, 1/25, 1/20
[5%, 10%, 15%, 20%, or 25%] discount offered through select businesses	5, 10, 15, 20, 25
For every [20, 25, 30, 35] trips taken by transit, \$5 in credits that can be used on ELs	1/35, 1/30, 1/25, 1/20
A transit fare discount of [10%, 20%, or 30%]	10, 20, 30
Express bus service from park-and-ride lots to downtown	0, 1

A great deal of data were obtained in the survey on travelers and their trips.

Therefore, the first step was to determine which variables were significant and could be useful for the model. This was done by creating multiple models to test the various variables. Variables that were significant at a 95% level of confidence were kept.

Furthermore, variables with a level of significance between 95% and 80% were further tested in a new model to determine if they would improve the model. The best model based on the ρ^2 value, the percent of the mode choice correctly predicted, and the simplicity of the model. The final model developed and the variables chosen are shown below in Table 22. Travel time and toll formed the base equation and were included as part of all four modes. Because general purpose lane did not have any other variables, travel time and toll were its only variables. This first model forced the coefficients for the incentives to be the same for each mode determine an overall elasticity of that incentive.

Next, a model was estimated that allowed the coefficients of the incentives to vary by mode. The p-values and ρ^2 values were similar. However, to more easily calculate elasticities, the simpler model was used where the coefficients for the incentives were the same for every travel mode. Both models are shown below in Table 22.

Table 22. Model 1 Variables with Their Coefficients and P-values Along with the Model with Different Coefficients for the Incentives

Utility Function for Mode:	Variable Name	Description	Model 1		Different Coefficients	
			Coefficient	P-Value	Coefficient	P-Value
All Modes	TTIME	Travel time	-0.11	0.00	-0.11	0.00
	TOLL	Toll (for driving) or fare (for transit)	-0.09	0.01	-0.09	0.23
MLDA (Managed Lane Drive Alone)	ONE	The alternative specific coefficient	-2.34	0.00	-2.41	0.00
	SPORTS	The dummy variable used to describe if the respondent's trip purpose was to attend a major sporting event (Rangers or Cowboys)	0.86	0.00	0.95	0.00
	HISPANIC	The dummy variable used to describe if the respondent's ethnicity was Hispanic	0.52	0.00	0.56	0.00
	HINC	The dummy variable used to describe if the respondent's income was 100k or higher	0.46	0.00	0.48	0.00
	ONCEDAY	The dummy variable used to describe if the respondent's frequency of travel on I-30 was once a day	-1.17	0.00	-1.19	0.00

Table 22. Continued

Utility Function for Mode:	Variable Name	Description	Model 1		Different Coefficients	
			Coefficient	P-Value	Coefficient	P-Value
MLDA (Managed Lane Drive Alone)	INCINV1	The inverse of the value of incentive 1 in the stated preference question	3.01	0.05	4.3	0.01
	INCINV2	The inverse of the value of incentive 2 in the stated preference question	-0.61	0.88	2.8	0.55
	SPINC3	The value of incentive 3 in the stated preference question	0.01	0.18	0.01	0.32
MLCP (Managed Lane Carpool)	ONE	The alternative specific coefficient	-4.02	0.00	-3.84	0.00
	COMMUTE	The dummy variable used to describe if the respondent's trip purpose was commuting	-0.70	0.00	-0.6	0.00
	ASIAN	The dummy variable used to describe if the respondent's ethnicity was Asian	1.46	0.00	1.45	0.00
	HISPANIC	The dummy variable used to describe if the respondent's ethnicity was Hispanic	0.52	0.00	0.56	0.00
	LOWINC	The dummy variable used to describe if the respondent's income was 25k or less	1.01	0.00	0.95	0.00

Table 22. Continued

Utility Function for Mode:	Variable Name	Description	Model 1		Different Coefficients	
			Coefficient	P-Value	Coefficient	P-Value
MLCP (Managed Lane Carpool)	OCC	The number of vehicle occupants	0.90	0.00	0.58	0.00
	INCINV1	The inverse of the value of incentive 1 in the stated preference question	3.01	0.05	-2.32	0.48
	INCINV2	The inverse of the value of incentive 2 in the stated preference question	-0.61	0.88	-4.33	0.48
	SPINC3	The value of incentive 3 in the stated preference question	0.01	0.18	0.01	0.34
Transit	ONE	The alternative specific coefficient	-4.47	0.00	-4.5	0.00
	LMIDINC	The dummy variable used to describe if the respondent's income was between 25k and 50k	0.65	0.01	0.63	0.02
	AGE24	The dummy variable used to describe if the respondent's age was between 18 and 24	0.68	0.08	0.69	0.07
	AGE34	The dummy variable used to describe if the respondent's age was between 25 and 34	1.13	0.00	1.14	0.00

Table 22. Continued

Utility Function for Mode:	Variable Name	Description	Model 1		Different Coefficients	
			Coefficient	P-Value	Coefficient	P-Value
Transit	MALE	The dummy variable used to describe if the respondent was male	0.58	0.01	0.59	0.01
	INCINV4	The inverse of the value of incentive 4 in the stated preference question	-2.23	0.83	-2.33	0.82
	SPINC5	The value of incentive 5 in the stated preference question	0.02	0.08	0.02	0.08
	SPINC6	The dummy variable used to describe if incentive 6 was offered	0.30	0.37	0.3	0.37
Model 1	$\rho^2 = 0.433$		Log likelihood function = -2001.4		Chi-squared = 437.3	
	Adjusted $\rho^2 = 0.426$		Number of observations = 2691, skipped 147		VTTS = \$70.42/hour	
Different Coefficients	$\rho^2 = 0.438$		Log likelihood function = -1982.7		Chi-squared = 474.7	
	Adjusted $\rho^2 = 0.430$		Number of observations = 2691, skipped 147		VTTS = -\$76.01/hour	

Although all the incentives were included in the model, not all of them were statistically significant. Only incentive 1 (earn a free trip for every [8-12] paid trips), and incentive 5 (transit discount of [10-30%]) had p-values less than 0.1. However, it was necessary to include all the incentives in order to create a model where mode choice was influenced by each incentive. One of the stronger variables for predicting mode choice was the respondent's income. Respondents with high income (greater than 100k) were more likely to drive alone on the managed lane, respondents with low income (less than 25k) were more likely to carpool, and respondents with an income between 25k and 50k were more likely to utilize transit.

Incentive 2 (Earn gift cards worth \$5 for every [20-35] peak-hour trips saved by either telecommuting or by not traveling during the peak hours) and incentive 4 (\$5 credit for every [20-35] trips taken by transit) had p-values that were much worse than the other incentives. Incentive 2 had a p-value of 0.88 and incentive 4 had a p-value of 0.83. They also had negative coefficients implying that the incentive discouraged managed lane or transit use. Most likely, these incentives had little effect on mode choice and the travelers chose the mode due to other reasons such as travel time savings.

5.3.2 Model 2

A second model (see Table 23) was also created that did not take into account the value of the incentive. Instead, a dummy variable was used for each incentive. Because the value of the incentive did not seem to have a significant effect, this model may better predict model choice. All the other variables were kept the same as with model 1.

Table 23. Model 2

Utility Function for Mode:	Variable Name	Description	Coefficient	P-Value
All Modes	TTIME	Travel time	-0.10	0.00
	TOLL	Toll (for driving) or fare (for transit)	-0.09	0.02
MLDA (Managed Lane Drive Alone)	ONE	The alternative specific coefficient	-2.37	0.00
	SPORTS	The dummy variable used to describe if the respondent's trip purpose was to attend a major sporting event (Rangers or Cowboys)	0.86	0.01
	HISPANIC	The dummy variable used to describe if the respondent's ethnicity was Hispanic	0.53	0.00
	HINC	The dummy variable used to describe if the respondent's income was 100k or higher	0.46	0.00
	ONCEDAY	The dummy variable used to describe if the respondent's frequency of travel on I-30 was once a day	-1.16	0.00
	INCDUM1	The dummy variable used to describe if incentive 1 was offered	0.30	0.06
	INCDUM2	The dummy variable used to describe if incentive 2 was offered	0.03	0.87
	INCDUM3	The dummy variable used to describe if incentive 3 was offered	0.29	0.04

Table 23. Continued

Utility Function for Mode:	Variable Name	Description	Coefficient	P-Value
MLCP (Managed Lane Carpool)	ONE	The alternative specific coefficient	-4.05	0.00
	COMMUTE	The dummy variable used to describe if the respondent's trip purpose was commuting	-0.70	0.00
	ASIAN	The dummy variable used to describe if the respondent's ethnicity was Asian	1.46	0.00
	HISPANIC	The dummy variable used to describe if the respondent's ethnicity was Hispanic	0.53	0.00
	LOWINC	The dummy variable used to describe if the respondent's income was 25k or less	1.02	0.00
	OCC	The number of vehicle occupants	0.91	0.00
	INCDUM1	The dummy variable used to describe if incentive 1 was offered	0.30	0.06
	INCDUM2	The dummy variable used to describe if incentive 2 was offered	0.03	0.87
	INCDUM3	The dummy variable used to describe if incentive 3 was offered	0.29	0.04

Table 23. Continued

Utility Function for Mode:	Variable Name	Description	Coefficient	P-Value
Transit	ONE	The alternative specific coefficient	-4.50	0.00
	LMIDINC	The dummy variable used to describe if the respondent's income was between 25k and 50k	0.65	0.01
	AGE24	The dummy variable used to describe if the respondent's age was between 18 and 24	0.68	0.08
	AGE34	The dummy variable used to describe if the respondent's age was between 25 and 34	1.14	0.00
	MALE	The dummy variable used to describe if the respondent was male	0.58	0.01
	INCDUM4	The dummy variable used to describe if incentive 4 was offered	0.03	0.94
	INCDUM5	The dummy variable used to describe if incentive 5 was offered	0.49	0.11
	SPINC6	The dummy variable used to describe if incentive 6 was offered	0.31	0.36
$\rho^2 = 0.432$	Log likelihood function = -2000.9		Chi-squared = 438.3	
Adjusted $\rho^2 = 0.426$	Number of observations = 2691, skipped 147		VTTS = \$73.47/hour	

The incentives for driving alone or carpooling on the managed lane were more significant in this second model. The p-value for incentive 3 (5-25% discount to local retailers) improved from 0.21 to 0.04 while the p-value for incentive 2 (gifts such as cash or gift cards for every [20-35] trips) improved from 1.00 to 0.87. This is significant for incentive 3 since the p-value is now less than 0.05 and we can reject the null hypothesis.

The change in p-value for transit incentives weren't as successful. In fact, the two p-values increased slightly. However, the coefficient for incentive 4 (\$5 credit for every [20-35] trips taken by transit) changed from -2.4 to 0.03. This means that incentive 4 no longer removes travelers from transit and instead moves some travelers towards transit.

The models were also used to calculate a value of travel time savings. The value obtained from Model 1 was \$70.42/hour while the VTTS of Model 2 was \$73.47/hour. Although this value is higher than those reported in most literature, it is not uncommon for the VTTS on managed lanes to be higher than most scenarios. Typical values of time on freeways are around \$20/hour while values of time on managed lanes are \$51/hour (Patil 2011 and Devarasetty et al. 2012).

5.3.3 D-eff vs RA Models

Comparison of the two stated preference design types extended to modeling. Two models were created using data separated by whether the respondent was given the D-efficient design or the Random Adaptive design. The variables for both were kept the same as Model 1. The p-values and coefficients for both models are shown side by side in Table 24.

Table 24. D-eff and RA Models

Utility Function for Mode:	Variable Name	Description	D-eff		RA	
			Coefficient	P-Value	Coefficient	P-Value
All Modes	TTIME	Travel time	-0.10	0.00	-0.11	0.00
	TOLL	Toll (for driving) or fare (for transit)	-0.54	0.00	0.09	0.03
MLDA (Managed Lane Drive Alone)	ONE	The alternative specific coefficient	-0.77	0.27	-2.79	0.00
	SPORTS	The dummy variable used to describe if the respondent's trip purpose was to attend a major sporting event (Rangers or Cowboys)	0.50	0.31	1.03	0.01
	HISPANIC	The dummy variable used to describe if the respondent's ethnicity was Hispanic	0.93	0.00	0.10	0.66
	HINC	The dummy variable used to describe if the respondent's income was 100k or higher	0.70	0.00	0.26	0.13
	ONCEDAY	The dummy variable used to describe if the respondent's frequency of travel on I-30 was once a day	-1.47	0.00	-0.98	0.02
	INCINV1	The inverse of the value of incentive 1 in the stated preference question	2.46	0.31	4.82	0.02

Tale 24. Continued

Utility Function for Mode:	Variable Name	Description	D-eff		RA	
			Coefficient	P-Value	Coefficient	P-Value
MLDA (Managed Lane Drive Alone)	INCINV2	The inverse of the value of incentive 2 in the stated preference question	1.65	0.78	-0.72	0.90
	SPINC3	The value of incentive 3 in the stated preference question	0.00	0.75	0.02	0.07
MLCP (Managed Lane Carpool)	ONE	The alternative specific coefficient	-4.09	0.00	-3.86	0.00
	COMMUTE	The dummy variable used to describe if the respondent's trip purpose was commuting	-0.39	0.11	-1.02	0.00
	ASIAN	The dummy variable used to describe if the respondent's ethnicity was Asian	1.90	0.00	1.35	0.00
	HISPANIC	The dummy variable used to describe if the respondent's ethnicity was Hispanic	0.70	0.00	0.10	0.66
	LOWINC	The dummy variable used to describe if the respondent's income was 25k or less	1.07	0.00	0.85	0.01
	OCC	The number of vehicle occupants	1.10	0.00	0.82	0.00

Table 24. Continued

Utility Function for Mode:	Variable Name	Description	D-eff		RA	
			Coefficient	P-Value	Coefficient	P-Value
MLCP (Managed Lane Carpool)	INCINV1	The inverse of the value of incentive 1 in the stated preference question	2.46	0.31	4.82	0.02
	INCINV2	The inverse of the value of incentive 2 in the stated preference question	1.65	0.78	-0.72	0.90
	SPINC3	The value of incentive 3 in the stated preference question	0.00	0.75	0.02	0.07
Transit	ONE	The alternative specific coefficient	-2.31	0.00	-5.50	0.00
	LMIDINC	The dummy variable used to describe if the respondent's income was between 25k and 50k	0.23	0.53	1.04	0.01
	AGE24	The dummy variable used to describe if the respondent's age was between 18 and 24	1.14	0.01	-0.24	0.75
	AGE34	The dummy variable used to describe if the respondent's age was between 25 and 34	1.36	0.00	0.93	0.01
	MALE	The dummy variable used to describe if the respondent was male	0.24	0.43	0.98	0.01

Table 24. Continued

Utility Function for Mode:	Variable Name	Description	D-eff		RA	
			Coefficient	P-Value	Coefficient	P-Value
Transit	INCINV4	The inverse of the value of incentive 4 in the stated preference question	2.69	0.86	1.26	0.93
	SPINC5	The value of incentive 5 in the stated preference question	0.03	0.10	0.03	0.11
	SPINC6	The dummy variable used to describe if incentive 6 was offered	0.04	0.93	0.79	0.08
D-eff	$\rho^2 = 0.477$		Log likelihood function = -899.2		Chi-squared = 265.9	
	Adjusted $\rho^2 = 0.464$		Number of observations = 1305, skipped 64		VTTS = \$11.2/hour	
RA	$\rho^2 = 0.412$		Log likelihood function = -1061.7		Chi-squared = 242.0	
	Adjusted $\rho^2 = 0.400$		Number of observations = 1386, skipped 83		VTTS = -\$71.0/hour	

Overall, there are a few differences between the models. One interesting difference is that the coefficient for toll in the RA model is 0.09, while in all three other models, it is negative. Toll should generally be expected to have a negative coefficient since a higher cost should discourage that mode of transportation. The positive coefficient on toll may indicate that the toll did not affect mode choice and that mode choice is relatively rigid. As for the incentives, incentive 2 (gifts such as cash or gift cards for every [20-35] trips) again was not very impactful. Both models had values that were not statistically significant. The RA model did provide an improved p-value for both incentive 3 (5-25% discount to local retailers) and incentive 6 (Express bus service to downtown). In Model 1, the p-values were 0.18 and 0.37 respectively while in the D-eff model the p-values were 0.75 and 0.93. In the RA model, these values improved to 0.07 and 0.08 respectively.

Another difference between the models is the value of travel time savings calculated. The VTTS from the RA model (-\$71.0/hour) was negative while the VTTS from the D-eff model (\$11.2/hour) was positive. Neither were similar to the VTTS from the first 2 models (\$70.42/hour and \$73.47/hour). The VTTS from the D-eff model is most likely explained by how the attributes are set in the D-efficient design. In this design, the toll for driving alone on the managed lane ranged from 30 cents to 50 cents per mile. For the RA design, the range was 10 cents to 100 cents per mile.

5.4 Elasticities

The models were then used to develop elasticities of the incentives. Elasticities are useful for predicting how utilities and mode choice will change if the incentive values are adjusted. This is especially useful for the I-30 managed lanes since some managed lanes operate by adjusting values to reach desired speeds. First, the elasticities were then obtained from the Limdep output (see Table 25). Although the elasticities calculated by the software were reasonable, it was important to test them to ensure they were correct. Unfortunately, we were unable to replicate the Limdep results when tested. Therefore, elasticities needed to be manually calculated from the data. The following section describes the process of calculating the elasticities.

5.4.1 Manually Calculated Elasticities

This section details the steps taken to manually calculate the elasticities of the incentives based on the model. This was done by calculating the difference in utility for each respondent when changing the incentive value while holding all the other values constant. This utility would then be used to calculate the probabilities of each mode which would then allow the calculation of elasticities. For example, the elasticity of changing the value of Incentive 1 (earn a free trip for every [8-12] paid trips) from 12 paid trips to 11 paid trips could be calculated. This was completed for each change in incentive value. Afterwards, the same process was completed for each stated preference question for each respondent. Finally, all these elasticities were averaged to obtain a single elasticity.

To help explain the process, an example of these steps is shown below. This example will use data from Model 1, Respondent 6's answer to stated preference question 1 (see Table 25). Incentive 3 ([5-25%] discount offered through select businesses) will be used and the value will change from 10% to 15%.

Table 25. Respondent 6's Values

	Variable Name	Coefficient	Respondent 6 Value
Utility (General Purpose Lane [GPL])	TTIME	-0.108	27
	TOLL	-0.0917	0
Utility (Managed Lane Drive Alone [MLDA])	A_MLDA	-2.34	-2.34
	TTIME	-0.108	13
	TOLL	-0.0917	4.4
	SPORTS	0.862	0
	HISPANIC	0.517	0
	HINC	0.463	1
	ONCEDAY	-1.167	0
	INCINV1	3.008	-
	INCINV2	-0.611	-
	SPINC3	0.012	-
Utility (Managed Lane Carpool [MLCP])	A_MLCP	-4.023	-4.023
	TTIME	-0.108	13
	TOLL	-0.0917	1
	COMMUTE	-0.701	1
	ASIAN	1.459	0
	HISPANIC	0.517	0
	LOWINC	1.013	0
	DRIVER	0	0
	OCC	0.904	1
	INCINV1	3.008	-
	INCINV2	-0.611	-
	SPINC3	0.012	-
Utility (Transit)	A_Transit	-4.471	-4.471
	TTIME	-0.108	13

Table 25. Continued

	Variable Name	Coefficient	Respondent 6 Value
Utility (Transit)	TOLL	-0.0917	4.7
	LMIDINC	0.646	0
	AGE24	0.681	0
	AGE34	1.134	0
	MALE	0.577	1
	INCINV4	-2.228	-
	SPINC5	0.023	-
	SPINC6	0.297	-

The first step is to calculate the utilities of every mode if incentive 3 is offered at the two levels.

$$U(\text{GPL}) = (-0.108) * \text{TTIME} + (-0.0917) * \text{TOLL}$$

$$U(\text{MLDA}) = -2.34 + (-0.108) * \text{TTIME} + (-0.0917) * \text{TOLL} + 0.862 * \text{SPORTS} + 0.517 * \text{HISP} \\ + 0.463 * \text{HINC} + (-1.167) * \text{ONCEDAY} + 3.008 * \text{INCINV1} + (-0.611) * \text{INCINV2} + \\ 0.012 * \text{INCVAL3}$$

$$U(\text{MLCP}) = -4.023 + (-0.108) * \text{TTIME} + (-0.0917) * \text{TOLL} + (-0.701) * \text{COMMUTE} + \\ 1.459 * \text{ASIANAM} + 0.517 * \text{HISP} + 1.013 * \text{LOWINC} + 0.904 * \text{OCC} + \\ 3.008 * \text{INCINV1} + (-0.611) * \text{INCINV2} + 0.012 * \text{INCVAL3}$$

$$U(\text{Transit}) = -4.471 + (-0.108) * \text{TTIME} + (-0.0917) * \text{TOLL} + 0.646 * \text{LMIDINC} + \\ 0.681 * \text{AGE24} + 1.134 * \text{AGE34} + 0.577 * \text{MALE} + (-2.228) * \text{INCINV4} + \\ 0.023 * \text{INCVAL5} + 0.297 * \text{INCVAL6}$$

After plugging in the values for Respondent 6 (see Table 24), the following utilities were calculated.

MLDA Incentive 3 = 10%

$$U(\text{GPL}) = -2.916$$

$$U(\text{MLDA}) = -3.564$$

$$U(\text{MLCP}) = -5.316$$

$$U(\text{Transit}) = -5.729$$

MLDA Incentive 3 = 15%

$$U(\text{GPL}) = -2.916$$

$$U(\text{MLDA}) = -3.504$$

$$U(\text{MLCP}) = -5.316$$

$$U(\text{Transit}) = -5.729$$

With the utilities, the probabilities can now be calculated using Equation 6.

$$P(x_i) = \frac{e^{U(x_i)}}{\sum_{i=1}^4 e^{U(x_i)}} \quad (6)$$

MLDA Incentive 3 = 10%

$$P(\text{GPL}) = 59.75$$

$$P(\text{MLDA}) = 31.24$$

$$P(\text{MLCP}) = 5.42$$

$$P(\text{Transit}) = 3.59$$

MLDA Incentive 3 = 15%

$$P(\text{GPL}) = 58.62$$

$$P(\text{MLDA}) = 32.54$$

$$P(\text{MLCP}) = 5.32$$

$$P(\text{Transit}) = 3.52$$

The elasticity of demand (EoD) can then be calculated from the probabilities using Equation 7:

$$EoD = \frac{\%Change\ in\ Demand}{\%Change\ in\ Price} \quad (7)$$

For example, the elasticity of MLDA can be calculated by the following:

$$PEoD(MLDA_{10\% \text{ to } 15\%}) = \frac{\frac{Probability(MLDA_{15\%}) - Probability(MLDA_{10\%})}{15\% - 10\%}}{10\%}$$

$$PEoD(MLDA_{10\% \text{ to } 15\%}) = \frac{\frac{0.3254 - 0.3124}{0.3124}}{\frac{15\% - 10\%}{10\%}}$$

$$= \mathbf{0.0834}$$

Doing the same for the other modes, the following elasticities are calculated for

Respondent 6:

MLDA Incentive 3 = Respondent 6 10% to 15%

$$E(\text{GPL}) = -0.379$$

$$E(\text{MLDA}) = 0.0834$$

$$E(\text{MLCP}) = -0.379$$

$$E(\text{Transit}) = -0.379$$

In the same manner, the elasticities were calculated for every change in incentive value (10% to 15%, 15% to 20%, 20% to 25%). These elasticities are the averaged for each incentive to get a single elasticity per incentive.

MLDA Incentive 3 = Respondent 6

$$E(\text{GPL}) = -0.0352$$

$$E(\text{MLDA}) = 0.117$$

$$E(\text{MLCP}) = -0.0352$$

$$E(\text{Transit}) = -0.0352$$

Finally, the same is done for every respondent and everyone's elasticities are averaged:

MLDA Incentive 3 = All Respondents

$$E(\text{GPL}) = -0.0188$$

$$E(\text{MLDA}) = -0.0188$$

$$E(\text{MLCP}) = 0.135$$

$$E(\text{Transit}) = -0.0188$$

This was done for every incentive except for incentive 6 (Express bus service to downtown) since it didn't have an adjustable value. For incentive 6, a percent change was calculated instead. The calculated elasticities along with Limdep elasticities and Model 2's percentage change are shown in Table 26.

Table 26. Elasticities of Incentives 1-5 and Percent Changes

Incentive	Mode	Model 1: Limdep Elasticity	Model 1: Calculated Elasticity	Model 2: Percent Change
MLDA Inc1	GPL	-0.006	-0.050	-4.4
	MLDA	0.028	0.243	29.1
	MLCP	-0.006	-0.050	-4.4
	Transit	-0.006	-0.050	-4.4
MLCP Inc1	GPL	-0.002	-0.039	-3.5
	MLDA	-0.002	-0.039	-3.5
	MLCP	0.014	0.254	30.4
	Transit	-0.002	-0.039	-3.5
MLDA Inc2	GPL	0.000	0.003	-0.3
	MLDA	-0.002	-0.018	2.2
	MLCP	0.000	0.003	-0.3
	Transit	0.000	0.003	-0.3
MLCP Inc2	GPL	0.000	0.002	-0.3
	MLDA	0.000	0.002	-0.3
	MLCP	-0.002	-0.019	2.3
	Transit	0.000	0.002	-0.3
MLDA Inc3	GPL	-0.003	-0.024	-4.3
	MLDA	0.017	0.129	28.4
	MLCP	-0.003	-0.024	-4.3
	Transit	-0.003	-0.024	-4.3
MLCP Inc3	GPL	-0.003	-0.019	-3.4
	MLDA	-0.003	-0.019	-3.4
	MLCP	0.018	0.135	29.6
	Transit	-0.003	-0.019	-3.4
Transit Inc4	GPL	0.000	0.002	-0.1
	MLDA	0.000	0.002	-0.1
	MLCP	0.000	0.002	-0.1
	Transit	-0.008	-0.073	3.1
Transit Inc5	GPL	-0.003	-0.017	-1.9
	MLDA	-0.003	-0.017	-1.9
	MLCP	-0.003	-0.017	-1.9
	Transit	0.051	0.366	60.4
Transit Inc6 (%Change only)	GPL	-0.1	-1.1	-1.1
	MLDA	-0.1	-1.1	-1.1
	MLCP	-0.1	-1.1	-1.
	Transit	3.1	33.1	34.2

These elasticities can then be used to predict mode shifts due to changes in incentive values. By rearranging the variables from equation 7, the change in demand can be calculated from the elasticity and the change in price (see equation 8).

$$\% \text{ Change in Volume} = \frac{P_2 - P_1}{P_1} * EoD \quad (8)$$

where: P_2 = new incentive value

P_1 = previous incentive value

EoD = elasticity of demand

For example, if the value of incentive 3([5-25%] discount offered through select businesses) was increased from 15% to 20% for MLDA, which had an elasticity of 0.129, we would expect the demand to change as follows:

$$\% \text{ Change in Volume} = [(20 - 15)/15] * 0.129$$

$$\% \text{ Change in Volume} = 0.0143 \text{ or } 1.043\%$$

Similarly, GPL volume with its elasticity of -0.024 would decrease by $(1 + -0.024/[(20-15)/15])$, or -0.8%.

This method can be used to determine the change in volume due to an incentive change as long as the values stay within the tested range. If the value is outside of the test range, the results may not be accurate.

Looking at Table 25, certain incentives are more effective at changing travelers' mode than others. Incentive 1 and 3 were fairly impactful at getting travelers to pay to use the managed lane. They had elasticities of 0.243 and 0.129 respectively.

Conversely, incentive 2 was not effective at convincing mode shifts. This is consistent

with the p-values in Table 22. As for transit incentives, incentive 5 and 6 were effective while incentive 4 was ineffective. Incentive 5 had an elasticity of 0.366 while incentive 6 has a percentage change of 33.1. This percentage change can be compared to incentive 5's percentage change in Model 2. Although incentive 6's percentage change isn't as good as incentive 5's, the change is still substantial. However, it also important to recognize that this percentage change for transit use is based on a small initial number of riders and may decrease with transit travelers.

The incentive results of the modeling and elasticity calculations can be seen in Table 27 below. In this table, the incentives are ranked in order of greatest to least elasticity. Because there were 2 elasticities for the first 3 incentives (MLDA and MLCP), one was arbitrarily chosen. For the table, the MLCP elasticity was used. If the elasticity of MLDA was used, the values would have changed, but the order would have stayed the same. For incentive 4 and 5, the transit elasticity was used since it was the only focus of the incentive. As for incentive 6 (express bus service to downtown), since it did not have an elasticity it was ranked based on its percent change from Model 2 (33.1%). Incentive 5 (a transit fare discount of [10-30]%) had a percent change of 60.4% while incentive 1 (earn a free trip for every [8-12] paid trips on the Express Lanes) had a percent change of 30.4%. Therefore, incentive 6 was placed in between those two. Noticeably, the two incentives that required 20-35 trips to earn the reward were the only two incentives with negative elasticity. This is not especially surprising since the value obtained (\$5 dollar gift card or \$5 in credits) is fairly low compared to the required number of trips.

Table 27. Incentives Ranked by Elasticity and %Change

Rank	Incentive Description	Elasticity or %Change (with respect to MLCP and Transit)
1	(INC 5) A transit fare discount of [10%-30%]	0.366
2	(INC 6) Express bus service from park-and-ride lots to downtown	33.1%
3	(INC 1) Earn a free trip for every [8-12] paid trips on the Express Lanes	0.254
4	(INC 3) [5%-25%] discount offered through select businesses	0.135
5	(INC 2) Earn gift cards worth \$5 for every [20-35] peak-hour trips saved by either telecommuting or by not traveling during the peak hours (7-9am or 4-6pm)	-0.019
6	(INC 4) For every [20-35] trips taken by transit, \$5 in credits that can be used on the Express Lanes	-0.073

Overall, most of the incentives had an impact on the mode choice and it is important to note that the results from this survey do not mean that some incentives should not be considered. In other cities or with adjustments to the incentive, they could become more effective. Also, while the elasticities may seem small, leading to modest volume changes, the effects can still help tweak demand to maximize managed lane use.

6. CONCLUSION

The purpose of this research was to examine the potential impact of incentives on managed lane use. To do this, a stated preference survey was administered to travelers in the Dallas-Fort Worth area. The survey used both a Bayesian D-efficient and Random Adaptive designs. The stated preference questions were pivoted based on the respondent's most recent trip on the I-30 freeway. The survey was administered for several months with the help of the Texas A&M Transportation Institute and North Central Texas Council of Governments.

The results were then analyzed to gain an understanding of how travelers rated potential incentives and how the incentives would affect volumes on freeways with managed lanes. A mixed-logit model was developed to estimate these effects.

6.1 Conclusions

The effectiveness of the incentives on changing mode and lane varied based on which incentive was being tested. Overall, travelers were generally set in their specific mode choice (usually driving alone). Still, the incentives made an impact in the models and any bit of change can help maximize managed lane use. Some incentives such as incentive 3 ([5-25%] discount offered through select businesses) were relatively successful (higher elasticities), indicating that the incentives would move some travelers. Other incentives such as incentive 2 (Earn gift cards to local retailers worth \$5 for every [20-35] trips) were less impactful. However, this doesn't necessarily mean those

incentives will not work. Incentives put into practice may have a better impact, especially if the value of the incentive is increased. This is especially probable for two incentives, incentive 2 (earn gift cards worth \$5 for every [20-35] peak-hour trips saved) and incentive 4 (for every [20-35] trips taken by transit, \$5 in credits that can be used on the Express Lanes). If the reward was increased or perhaps changed to a lottery type of system, these incentives may prove more effective at shifting travel behavior.

The research was also able to determine a few other characteristics of travel from the data. The model developed calculated a value of travel time savings of \$70.42/hour, which is high for most freeways, but in line with managed lanes. Furthermore, the survey tested the difference between a D-eff design and a random adaptive design. Although previous research has shown advantages to each, our results were inconclusive. Further research with larger attribute ranges and more responses could potentially prove otherwise.

6.2 Research Limitations

Although this research was able to provide some insight into the use of incentives on managed lane travel, there were several limitations in the process that affected the study.

One of the biggest limitations was the hypothetical nature of the research. Although stated preference questions are often used for hypothetical scenarios, several aspects of the survey were not easily related to for some respondents. For example, a major focus of the survey was to gauge interest in transit incentives. However, many

travelers in the DFW area don't have access to transit. In fact, Arlington is known for being the largest city in the US without a comprehensive public transportation system.

The size and distribution of respondents could have also affected the results. Although the number of responses was adequate for analysis, more responses could have been beneficial. This is especially true since there were six incentives that had to be tested. The electronic nature of the survey and advertisements may have also affected the demographics of the respondents. Because the survey was online and most of the advertisements were through the internet, lower income travelers without internet access may be underrepresented by the results.

6.3 Recommendations for Future Research

Managed lanes are being considered as possible treatments in more corridors and their use is increasing around the country. Therefore, there are many opportunities for further studies. Because managed lanes are relatively new in the field of transportation, the best practices are still being developed, especially with respect to incentives.

As noted above, one of the biggest limitations was that this was a hypothetical scenario. Future research could include an after aspect where a survey is conducted after the incentives are implemented and travelers get a chance to actually earn them. These results could then be compared with stated preference data to form a better prediction model. Other research could test different incentives or use the same incentives but change the incentive value range. For example, incentive 1 (earn a free trip for every [8-12] paid trips) could be changed to reward a free trip for every [4-8] trips. This could

determine whether the incentive itself is not effective or the value of the incentive wasn't good enough. Other regions could also be surveyed. Areas with more transit use could be researched to see if transit incentives are more effective if respondents are more familiar with transit.

REFERENCES

- Arentze, T., Borgers, A., Timmermans, H., & DelMistro, R. (2003). Transport stated choice responses: effects of task complexity, presentation format and literacy. *Transportation Research Part E: Logistics and Transportation Review*, 39(3), 229-244.
- Becker, G. S. (1965). A Theory of the Allocation of Time. *The Economic Journal*, 493-517.
- Beesley, M. E. (1965). The value of time spent in travelling: some new evidence. *Economica*, 174-185.
- Ben-Elia, E., & Ettema, D. (2011). Rewarding rush-hour avoidance: A study of commuters' travel behavior. *Transportation Research Part A: Policy and Practice*, 45(7), 567-582.
- Bianco, M. (2000). Effective transportation demand management: Combining parking pricing, transit incentives, and transportation management in a commercial district of Portland, Oregon. *Transportation Research Record: Journal of the Transportation Research Board*, (1711), 46-54.
- Bliemer, M. C., Dicke-Ogenia, M., & Ettema, D. (2009). Rewarding for avoiding the peak period: A synthesis of three studies in The Netherlands. In *12th International Conference on Travel Behavior Research, Jaipur, India*.
- Bliemer, M. C., & Rose, J. M. (2011). Experimental design influences on stated choice outputs: an empirical study in air travel choice. *Transportation Research Part A: Policy and Practice*, 45(1), 63-79.

Brownstone, D., Ghosh, A., Golob, T. F., Kazimi, C., & Van Amelsfort, D. (2003).

Drivers' willingness-to-pay to reduce travel time: evidence from the San Diego I-15 congestion pricing project. *Transportation Research Part A: Policy and Practice*, 37(4), 373-387.

Burris, M., & Xu, L. (2006). Potential single-occupancy vehicle demand for high-occupancy vehicle lanes: Results from stated-preference survey of travelers in high-occupancy toll corridors. *Transportation Research Record: Journal of the Transportation Research Board*, (1960), 108-118.

Caussade, S., de Dios Ortúzar, J., Rizzi, L. I., & Hensher, D. A. (2005). Assessing the influence of design dimensions on stated choice experiment estimates. *Transportation research part B: Methodological*, 39(7), 621-640.

Cherlow, J. R. (1981). Measuring values of travel time savings. *Journal of Consumer Research*, 360-371.

Clean Air Campaign. (2009) Commuter Rewards: Cash for Commuters.

http://download.cleanaircampaign.org/var/cac/storage/pdf/CFC_09_FtBenning_010109.pdf, Retrieved September 13, 2015.

Commuter Connections. 'Poll Rewards for Carpools.

<http://www.commuterconnections.org/commuters/ridesharing/pool-rewards/pool-rewards-carpools/>, Retrieved September 16, 2015.

DART Fares. <https://www.dart.org/fares/fares.asp>, Accessed November 14, 2015.

- Devarasetty, P. C., Burris, M., & Shaw, W. D. (2012). The value of travel time and reliability-evidence from a stated preference survey and actual usage. *Transportation research part A: policy and practice*, 46(8), 1227-1240.
- Dulles Greenway (2014) VIP Program Overview. <http://www.dullesgreenway.com/vip-program>, Retrieved September 16, 2015.
- Ettema, D., Knockaert, J., & Verhoef, E. (2010). Using incentives as traffic management tool: empirical results of the " peak avoidance" experiment. *Transportation Letters*, 2(1), 39-51.
- Federal Highway Administration (FHWA). (2013) Managed Lanes: A Primer. http://ops.fhwa.dot.gov/publications/managelanes_primer/, Retrieved August 9, 2015.
- Florida Department of Transportation. 595 Express Bus Overview. <http://595express.info/expressbus.shtm>, Retrieved September 16, 2015.
- Georgia Department of Transportation (2009) Cash for Commuters: Survey Key Findings. <http://www.dot.ga.gov/DriveSmart/Travel/Documents/AirQuality/reports/2009-CashforCommutersSurvey.pdf>, Retrieved September 16, 2015.
- Goodin, G., Benz, R., Burris, M., Brewer, M., Wood, N., & Geiselbrecht, T. (2013). *Katy Freeway: An Evaluation of a Second-Generation Managed Lanes Project* (No. FHWA/TX-13/0-6688-1).


- Higueros, E. (2014, October). *Metro ExpressLanes, Transit Rewards Program*.
PowerPoint presentation at the meeting of the Intelligent Transportation Society of California, Santa Clara, CA.
- iCommute. Prize List. <http://www.icommutesd.com/docs/default-source/prize/icommuter-monthly-prizes.pdf?sfvrsn=16>, Retrieved September 16, 2015.
- Lam, T. C., & Small, K. A. (2001). The value of time and reliability: measurement from a value pricing experiment. *Transportation Research Part E: Logistics and Transportation Review*, 37(2), 231-251.
- LBJ TEXpress. How pricing is determined: <http://www.lbjtexpress.com/using-lbjtexpress-lanes/pricing/how-pricing-is-determined>. Accessed on July 1, 2014.
- Leblanc, R., & Walker, J. L. (2013). Which Is the Biggest Carrot? Comparing Nontraditional Incentives for Demand Management. In *Transportation Research Board 92nd Annual Meeting* (No. 13-5039).
- Mazzotta, M. J., & Opaluch, J. J. (1995). Decision making when choices are complex: a test of Heiner's hypothesis. *Land Economics*, 500-515.
- Merugu, D., Prabhakar, B. S., & Rama, N. (2009). An incentive mechanism for decongesting the roads: A Pilot Program in Bangalore. In *Proc. of ACM NetEcon Workshop*.
- Metro ExpressLanes. (2014) How it works, <https://www.metroexpresslanes.net/en/about/howit.shtml>, Accessed September 13, 2015.

- Oort, C. J. (1969). The evaluation of travelling time. *Journal of Transport Economics and Policy*, 279-286.
- Patil, S., Burris, M., Shaw, W. D., & Concas, S. (2011). Variation in the value of travel time savings and its impact on the benefits of managed lanes. *Transportation Planning and Technology*, 34(6), 547-567.
- Prabhakar, B. (2014). Active Demand Management (Part 1) [Webinar]. In *Active Transportation and Demand Management Webinar Series*. Retrieved from https://www.nhi.fhwa.dot.gov/resources/docs/active_demand_mgmt_part1.pdf
- Richardson, A.J. (2007). Simulation study of estimation of individual specific values of time using an adaptive stated-preference survey. *Transportation Research Record*, 1804, 117-125.
- Rogers, J., Ramfos, N., and Sivasailam, D. (2009) Carpool Incentive Program Demonstration Project Study. *National Capital Region Transportation Planning Board Commuter Connections Program*. Retrieved from <http://www.mwcog.org/commuter2/pdf/Carpool%20Incentive%20Program%20Demonstration%20Final%20012709.pdf>
- Rose, J. M., Bliemer, M. C., Hensher, D. A., & Collins, A. T. (2008). Designing efficient stated choice experiments in the presence of reference alternatives. *Transportation Research Part B: Methodological*, 42(4), 395-406.
- Sheikh, A., Guin, A., & Guensler, R. (2014). Value of Travel Time Savings. *Transportation Research Record: Journal of the Transportation Research Board*, 2470(1), 161-168.

- Small, K. A. (2012). Valuation of travel time. *Economics of transportation*, 1(1), 2-14.
- Texas Department of Transportation (2014). Interstate Highway 30: TxDOT Project Tracker. <http://ftp.dot.state.tx.us/pub/txdot-info/ftw/overview.pdf>, Retrieved November 14, 2015.
- Turnbell, M. (2015, March 20). Drivers pay \$1 million to use I-595 express lanes. *Sun Sentinel*. Retrieved from <http://www.sun-sentinel.com/local/broward/fl-595-express-one-year-20150319-story.html>
- Zhang, Z., Fujii, H., & Managi, S. (2014). How does commuting behavior change due to incentives? An empirical study of the Beijing Subway System. *Transportation Research Part F: Traffic Psychology and Behaviour*, 24, 17-26.
- Zhou, L., Burris, M., Baker, R., & Geiselbrecht, T. (2009). Impact of Incentives on Toll Road Use by Trucks. *Transportation Research Record: Journal of the Transportation Research Board*, (2115), 84-93.

APPENDIX A

TRAVELER SURVEY INSTRUMENT



I-30 Express Lanes Survey

Thank you for taking the time to complete this survey! The Texas A&M Transportation Institute (TTI) and the North Central Texas Council of Governments (NCTCOG) are working on how to best manage the I-30 (Tom Landry) corridor. This survey will help us make these decisions. By taking this survey you help in achieving that goal. This survey should take approximately 10-15 minutes to complete. Any answers you provide will be kept anonymous. Thank you for your participation.

Sincerely,
Mark Burris, Ph.D.
mburris@tamu.edu

*This research has been reviewed by the Institutional Review Board at Texas A&M University.
TAMU IRB #2014-0074
Approved 03/11/2014
Expiration Date: 03/01/2015*

For research-related problems or questions regarding your rights as a research participant, please contact their office at (979) 458-4067 or irb@tamu.edu.

[Next >>](#)

Copyright © 2014, Texas A&M Transportation Institute, The Texas A&M University System

I-30 Express Lanes Survey



How frequently do you travel on the I-30 (Tom Landry) Freeway? (This is the portion of I-30 between Dallas and Arlington)

Check at most 1 answers

- Multiple times per day
- About once a day
- A few times per week
- Once a week
- A few times per month
- I have not used I-30 in the past 6 months

Other: _____

What was the purpose of your most recent trip on I-30?

Choose one of the following answers

- Commuting to or from my place of work (going to or from work)
- Recreational/Social/Shopping/Entertainment/Personal errands
- Major sports game (Rangers, Cowboys)
- Work Related (other than to or from home to work)
- To attend class at school or an educational institute
- Other: _____

On what day of the week was your most recent trip?

Choose one of the following answers

- Sunday
- Monday
- Tuesday
- Wednesday
- Thursday
- Friday
- Saturday

What time of day did that trip start?

Choose one of the following answers

Please choose... ▾

Where did you start and finish this trip?

In what zipcode did you start this trip?

In what zipcode did you finish this trip?

How long was your most recent trip on I-30?

(The amount of time from when you entered the freeway to when you exited the freeway)

minutes

Only numbers may be entered in this field

What kind of vehicle did you use for your most recent trip?

Choose one of the following answers

Passenger Car, SUV, or Pick-up Truck

Motorcycle

Bus

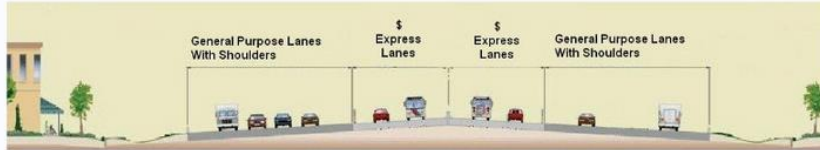
Other:

<< Previous

Next >>

Copyright © 2014, Texas A&M Transportation Institute, The Texas A&M University System

I-30 Express Lanes Survey



What are Express lanes? They are a special type of highway lane(s) that provides uncongested travel. Express lanes control the flow of traffic by only allowing certain vehicles for free (like only 3-person carpools) and/or altering the toll rate for other vehicles.

The North Central Texas Council of Government (NCTCOG) is helping the Texas Department of Transportation (TxDOT) plan the operation of the new I-30 Express Lanes in Dallas. As part of the planning efforts, NCTCOG is exploring how different incentives could change the habits of drivers, carpools, and transit riders. They want to know which incentives would be the most effective for users.

How likely is it that you would change your travel if the following benefits were offered:

	I wouldn't change my trips		I might change some of my trips		I would likely change a lot of my trips
	1	2	3	4	5
Gifts such as cash, gift cards, or gas cards to local retailers and entertainment venues if you telecommute, travel off peak, or travel in the Express Lanes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reduced transit fares during peak hours	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Free items and discounts to local retailers and entertainment venues if you travel off peak or in the Express Lanes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
An express bus service to Downtown from Park-and-ride lots on the Express Lanes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
For every 10 trips on the Express Lanes you earn a free trip	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Regular transit riders can earn credit towards reduced bus fares or reduced Express Lane tolls	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Warning: you will not be able to come back to these questions once you click 'Next'

<< Previous

Next >>

I-30 Express Lanes Survey



Each of the following questions will ask you to choose between four potential travel choices on I-30 in the Metroplex. Please select the travel mode that you would most likely choose if you were faced with these options on your recent trip.

Consider you need to travel on I-30 on a Thursday at 8:00 AM in a passenger car, SUV, or pick-up truck.

If you had the options below for that trip during the morning peak, which option would you choose?

Choose one of the following answers

Travel on the General Purpose Lane

- Trip Time: 22 minutes
No Toll

Travel by Yourself on the Express Lane

- Trip Time: 13 minutes
Toll: \$4.00

Carpool on the Express Lane

- Trip Time: 13 minutes
Toll: \$0.00

*Please note that additional time may be needed to pick up passengers

Travel by Transit(Bus) on the Express Lane

- Trip Time: 13 minutes
Fare: \$3.90

*Please note that there may be additional time from waiting for the bus

<< Previous Next >>

I-30 Express Lanes Survey



Please select the travel mode that you would most likely choose if you were faced with these options on your recent trip.

Consider you need to travel on I-30 on a Thursday at 8:00 AM in a passenger car, SUV, or pick-up truck.

If you had the options below for that trip during the morning peak, which would you have chosen?

Choose one of the following answers

Travel on the General Purpose Lane

- Trip Time: 22 minutes
No Toll

Travel by Yourself on the Express Lane

- Trip Time: 11 minutes
Toll: \$1.85

Carpool on the Express Lane

- Trip Time: 11 minutes
Toll: \$0.00

*Please note that additional time may be needed to pick up passengers

Travel by Transit(Bus) on the Express Lane

- Trip Time: 11 minutes
Fare: \$1.80

Incentive: Express bus service from park-and-ride lots to Downtown

*Please note that there may be additional time from waiting for the bus

Consider you need to travel on I-30 on a Thursday at 8:00 AM in a passenger car, SUV, or pick-up truck.

If you had the options below for that trip during the morning peak, which would you have chosen?

Choose one of the following answers

Travel on the General Purpose Lane

- Trip Time: 25 minutes
No Toll

Travel by Yourself on the Express Lane

- Trip Time: 13 minutes
Toll: \$1.15

Incentive: Earn gift cards to local retailers and entertainment venues worth \$5 for every 25 peak-hour (7-9am or 4-6pm) trips avoided by either telecommuting or by traveling during the off-peak

Carpool on the Express Lane

- Trip Time: 13 minutes
Toll: \$0.00

Incentive: Earn gift cards to local retailers and entertainment venues worth \$5 for every 25 peak-hour (7-9am or 4-6pm) trips avoided by either telecommuting or by traveling during the off-peak

*Please note that additional time may be needed to pick up passengers

Travel by Transit(Bus) on the Express Lane

- Trip Time: 13 minutes
Fare: \$1.10

Incentive: Earn gift cards to local retailers and entertainment venues worth \$5 for every 25 peak-hour (7-9am or 4-6pm) trips avoided by either telecommuting or by traveling during the off-peak

*Please note that there may be additional time from waiting for the bus

<< Previous

Next >>



Please state your gender.

Choose one of the following answers

- Male
- Female

Which of the following age categories best represents your age?

Choose one of the following answers

- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65 and over

What is your race/ethnicity?

Choose one of the following answers

- White/Caucasian
- Hispanic/Latino
- African American
- Asian American
- Native American
- Other:

What is your highest level of education?

Choose one of the following answers

- Less than high school
- High school graduate
- Some college or vocational school
- College graduate
- Postgraduate college

What is your annual HOUSEHOLD income?

Choose one of the following answers

- Less than \$10,000
- \$10,000 - \$14,999
- \$15,000 - \$24,999
- \$25,000 - \$34,999
- \$35,000 - \$49,999
- \$50,000 - \$74,999
- \$75,000 - \$99,999
- \$100,000 - \$199,999
- \$200,000 or more
- Prefer not to answer
- It is easier to note wages per hour (\$/hr)

Thank you for taking the time to fill out this survey. Your responses will be helpful as we work to improve travel in your area. If you have any comments or suggestions related to transportation on I-30, please type them below.

Please finish this survey by hitting "Submit" below. You will then be given instructions on how to enter the prize drawing for 1 of 3 MasterCard giftcards, enroll in the Pilot Program, or both.

<< Previous

Submit

APPENDIX B

I-30 SPEEDS

I-30 WEST (TOM LANDRY) AVERAGE SPEEDS (mph)

Date: 11/5/2013

source: DALTRANS - Detector Data Archive

Time Period	Belt Line Eastbound (3 lanes)	Belt Line Westbound (3 lanes)	Sylvan Eastbound (3 lanes)	Sylvan Westbound (3 lanes)
0:00-1:00	64	69	66	59
1:00-2:00	62	68	65	55
2:00-3:00	61	65	58	55
3:00-4:00	59	68	60	54
4:00-5:00	66	67	64	58
5:00-6:00	66	69	65	61
6:00-7:00	63	68	60	59
7:00-8:00	61	70	40	61
8:00-9:00	67	71	30	61
9:00-10:00	65	69	62	60
10:00-11:00	65	68	65	60
11:00-12:00	66	69	65	60
12:00-13:00	66	69	66	60
13:00-14:00	65	68	64	58
14:00-15:00	64	66	57	54
15:00-16:00	64	65	59	55
16:00-17:00	67	64	54	57
17:00-18:00	67	63	46	59
18:00-19:00	61	47	56	56
19:00-20:00	67	69	64	59
20:00-21:00	67	70	66	60
21:00-22:00	67	71	67	61
22:00-23:00	70	72	67	62
23:00-0:00	65	70	66	59

APPENDIX C

N-GENE CODE

?I-30 Express Lanes Survey

Design

;alts=gpl,elda,elcp,transit

;rows=24

;block=8

;eff=(rppanel,d)

;rep=1000

;rdraws=halton(400)

?ensures that the travel times for driving on the Express Lanes will always be the same regardless of mode choice

;cond:

if(elcp.ttlvl_e<>elda.ttlvl_e , elcp.ttlvl_e = elda.ttlvl_e)

,if(transit.ttlvl_e<>elda.ttlvl_e , transit.ttlvl_e = elda.ttlvl_e)

;model:

U(gpl)=tt[n,-.33,.32]*ttlvl_g[10,10.91,12,13.33,15]/

U(elda)=c2[-4.73] + tt*ttlvl_e[8,8.57,9.23,10,10.91] + toll[-1.22]*tlvl_d[.30,.35,.40,.45,.50]/

U(elcp)=c3[-3.66] + tt*ttlvl_e + toll*tlvl_c[0,0.0001,.15,.25]/

U(transit)=c4[-1.58] + tt*ttlvl_e + toll*tlvl_t[3.5,4,4.5,5]

\$

APPENDIX D

STATED PREFERENCE CODE

SP1 Code:

```
<SCRIPT language="JavaScript">
<!--hide from old browsers

//Set default question type to 0.
var questype = 0;

//Pull values from survey for presentation in SP questions.
var dayofweek = "{INSERTANS:76992X255X7293}" //take value from question group
1, question 3
    if (dayofweek == "")
        { //User did not select the day of the week. Generate a weekday
randomly.
        var questype = 1;
        var random4 = (Math.floor(Math.random()*5))+1;
        switch (random4)
        {
            case 1:
                var dayofweek = "Monday";
                break;
            case 2:
                var dayofweek = "Tuesday";
                break;
            case 3:
                var dayofweek = "Wednesday";
                break;
            case 4:
                var dayofweek = "Thursday";
                break;
            case 5:
                var dayofweek = "Friday";
                break;
        }
    }
document.getElementById('answer76992X257X728628').value = dayofweek;

//sets the type of vehicle taken
```

```

var vehicle = "{INSERTANS:76992X255X7295}"; //G1Q5
  if (vehicle == "")
  {
    //User did not select a vehicle.
    var vehicle = ""
    document.getElementById('answer76992X257X728629').value = "";
  }
  else
    { //User specified vehicle, convert to: 'in a passenger car, SUV, or pick-up
truck/motorcycle/bus'
    var vehicle = vehicle.toLowerCase();
    var vehicle = vehicle.replace("suv","SUV");
    var vehicle = " in a " + vehicle;
    document.getElementById('answer76992X257X728629').value = vehicle;
  }

//sets the trip purpose
var trippurpose = "{INSERTANS:76992X255X7292}" //G1Q2
  if (trippurpose == "")
  {
    //User did not select a trip purpose.
    var trippurpose = "";
    document.getElementById('answer76992X257X728633').value = "";
  }
  else
    {
      //User specified trip purpose, convert to: 'the reason for your trip
was _____'
      var trippurpose = trippurpose.toLowerCase();
      var trippurpose = trippurpose.replace("my","your");
      var trippurpose = " The reason for your trip was " + trippurpose + ".";
      document.getElementById('answer76992X257X728633').value =
trippurpose;
    }

// Determine the time of day - influences the toll rate and travel speeds
//Timeofday variable: 1 refers to peak, 2 to shoulder, and 3 for off-peak
var TripTime = "{INSERTANS:76992X255X7294}"; //G1Q4
if (TripTime == "")
  {
    //User did not provide response. Force in to AM or PM peak.
    var questype = 1;
    var TimeOfDay = 1;
    var random1 = Math.floor(Math.random()*100); //0-99
    if (random1 < 50) //force into AM peak

```

```

        {
            var TripTime = "8:00 AM";

document.getElementById('answer76992X257X728627').value = "8:00 AM";

document.getElementById('answer76992X257X72861').value = TimeOfDay;

document.getElementById('answer76992X257X72862').value = "morning peak";
        }
        else //force into PM peak
        {
            var TripTime = "5:00 PM";

document.getElementById('answer76992X257X728627').value = "5:00 PM";

document.getElementById('answer76992X257X72861').value = TimeOfDay;

document.getElementById('answer76992X257X72862').value = "afternoon
peak" ;
        }
    }
    else if (TripTime == "12 midnight")
    {
        //this is done because the answers for midnight and noon are not
in the same format as the others; 12 midnight vs 12:00 AM
        var TimeOfDay = 3;
document.getElementById('answer76992X257X72861').value =
TimeOfDay ;
document.getElementById('answer76992X257X72862').value = "night
time" ;
    }
    else if (TripTime == "12 noon")
    {
        var TimeOfDay = 3;
document.getElementById('answer76992X257X72861').value =
TimeOfDay;
document.getElementById('answer76992X257X72862').value = "mid-
day" ;
    }
    else
    {
        //create an hours after midnight (HAM) variable. Takes what is
given, ex. 4:30 PM, and divides into 4, 30, and PM

```

```

var x = TripTime.split(" ");
var y = x[0].split(":");
var hours = Number(y[0]);

if (x[1] == "AM")
    {
    var HAM = hours;
    }
else
    {
    var HAM = hours + 12;
    }

if (HAM < 6 || HAM >= 19)
    {
    var TimeOfDay = 3 ;
    var PeriodOfDay = "night time";
    }
else if (HAM >= 10 && HAM < 15)
    {
    var TimeOfDay = 3 ;
    var PeriodOfDay = "mid-day";
    }
else if (HAM >= 6 && HAM < 7 || HAM >= 9 && HAM < 10)
    {
    var TimeOfDay = 2 ;
    var PeriodOfDay = "morning";
    }
else if (HAM >= 15 && HAM < 16 || HAM >= 18 && HAM < 19)
    {
    var TimeOfDay = 2 ;
    var PeriodOfDay = "afternoon";
    }
else if (HAM >= 7 && HAM < 9)
    {
    var TimeOfDay = 1 ;
    var PeriodOfDay = "morning peak";
    }
else if (HAM >= 16 && HAM < 18)
    {
    var TimeOfDay = 1 ;

```



```

        var PeriodOfDay = "afternoon peak";
    }
    document.getElementById('answer76992X257X72861').value =
TimeOfDay ;
    document.getElementById('answer76992X257X72862').value =
PeriodOfDay ;
    }

// Find TT peak factors(TravTime) for non-toll (NTR) and toll roads (TR)
if (TimeOfDay == 1)
    { //assigns value of PeakFactor for peak travel
        var PeakFactorNTR = 1.8 ;
        var PeakFactorTR = 1.2 ;
    }
else if (TimeOfDay == 2)
    { //assigns value of PeakFactor for shoulder travel
        var PeakFactorNTR = 1.4 ;
        var PeakFactorTR = 1.1 ;
    }
else if (TimeOfDay == 3)
    { //assigns value of PeakFactor for off-peak travel
        var PeakFactorNTR = 1.0 ;
        var PeakFactorTR = 1.0 ;
    }
document.getElementById('answer76992X257X72863').value = PeakFactorTR ;
document.getElementById('answer76992X257X72864').value = PeakFactorNTR ;

// Create variables pos1 (lat & long) and pos2 (lat & long) based on user input.
// Not used in I-30 Managed Lanes Survey.

var pos1 = 0;
var pos2 = 0;
var pos1Lat = 0;
var pos1Long = 0;
var pos2Lat = 0;
var pos2Long = 0;

// Create a variable for the trip distance.
var TripDist = 10

```

```

document.getElementById('answer76992X257X72865').value = pos1Lat ;
document.getElementById('answer76992X257X72866').value = pos1Long ;
document.getElementById('answer76992X257X72867').value = pos2Lat ;
document.getElementById('answer76992X257X72868').value = pos2Long ;
document.getElementById('answer76992X257X72869').value = TripDist ;

// Determine if pictures will be included in questions; not used in I-30 survey

var random2 = 100 //random number equation was removed to ensure there won't be a
picture
if (random2 < 50)
    { // picture
    document.getElementById('answer76992X257X728610').value = 1 ;
    var tablewidth = 750;
    }
else
    { // no picture
    document.getElementById('answer76992X257X728610').value = 2 ;
    var tablewidth = 600;
    }
document.getElementById('answer76992X257X728630').value = tablewidth;

//Write question text to output. Will depend on if the user answered all the questions in
Group 1
if (questype == 0)
    {
    document.getElementById('answer76992X257X728635').value = "You
described your most recent trip on I-30 as occurring on a " + dayofweek + " at " +
TripTime + vehicle + "." + trippurpose ;
    }
else
    {
    document.getElementById('answer76992X257X728635').value = "Consider you
need to travel on I-30 on a " + dayofweek + " at " + TripTime + vehicle + "." +
trippurpose ;
    }

// How will survey attributes be selected.
var random3=Math.floor(Math.random()*100);
if (random3 < 50)

```

```

    {      // Method 1 - D-Efficient; these numbers are obtained from the program
Ngene
    //Transit fares are based on DART and The T regional fares

    document.getElementById('answer76992X257X728611').value = 1;
    var Block = Math.floor(Math.random()*8)+1; // Random integer from 1 to 8;
carries over to SP2
    document.getElementById('answer76992X257X728612').value = Block;

    switch (Block) //randomly chooses a case that will have different speeds, toll rate,
and variability
    {
    case 1:
        var SpeedTR = 75; //speed on Express Lanes
        var SpeedNTR = 45; //speed on General purpose lanes
        var TollRate = 50 ; //toll rate in cents per mile
        var TollRateCP = 15;
        var TransitFare = 3.50;
        var VarFactorTR = 5/100 ; //variability in express lane travel time;
not used in I-30 survey
        var VarFactorNTR = 5/100 ; //variability in general purpose lane
travel time; not used in I-30 survey
        break;

    case 2:
        var SpeedTR = 70;
        var SpeedNTR = 50;
        var TollRate = 45 ;
        var TollRateCP = 25;
        var TransitFare = 4.00;
        var VarFactorTR = 10/100 ;
        var VarFactorNTR = 5/100 ;
        break;

    case 3:
        var SpeedTR = 65;
        var SpeedNTR = 60;
        var TollRate = 40 ;
        var TollRateCP = 0;
        var TransitFare = 4.00;
        var VarFactorTR = 10/100 ;

```

```

        var VarFactorNTR = 15/100 ;
break;

case 4:
    var SpeedTR = 40;
    var SpeedNTR = 70;
    var TollRate = 40 ;
    var TollRateCP = 15;
    var TransitFare = 5.00;
    var VarFactorTR = 10/100 ;
    var VarFactorNTR = 5/100 ;
break;
case 5:
    var SpeedTR = 55;
    var SpeedNTR = 55;
    var TollRate = 35 ;
    var TollRateCP = 25;
    var TransitFare = 3.50;
    var VarFactorTR = 0/100 ;
    var VarFactorNTR = 5/100 ;
break;

case 6:
    var SpeedTR = 60;
    var SpeedNTR = 60;
    var TollRate = 35 ;
    var TollRateCP = 0;
    var TransitFare = 3.50;
    var VarFactorTR = 0/100 ;
    var VarFactorNTR = 10/100 ;
break;

case 7:
    var SpeedTR = 70;
    var SpeedNTR = 50;
    var TollRate = 30 ;
    var TollRateCP = 0;
    var TransitFare = 4.00;
    var VarFactorTR = 5/100 ;
    var VarFactorNTR = 5/100 ;
break;

```

```

    case 8:
        var SpeedTR = 60;
        var SpeedNTR = 45;
        var TollRate = 45 ;
        var TollRateCP = 15;
        var TransitFare = 3.50;
        var VarFactorTR = 10/100 ;
        var VarFactorNTR = 5/100 ;
    break;

    default:
        alert ("Default");
    }

// sets the maximum and minimum for travel time; not used in I-30 Survey
    var TravTimeTR = Math.round((TripDist * 60) / (SpeedTR / PeakFactorTR));
    if (TravTimeTR > 60)
        {
            var TravTimeTR = 60;
        }
    var TravTimeNTR = Math.round((TripDist * 60) / (SpeedNTR /
PeakFactorNTR));
    if (TravTimeNTR > 60)
        {
            var TravTimeNTR = 60;
        }

    var TotToll = (Math.round((TollRate * TripDist)/5)/20).toFixed(2) ;
    var TotTollCP = (Math.round((TollRateCP * TripDist)/5)/20).toFixed(2) ;
    var TravTimeVarTR = Math.round(VarFactorTR*PeakFactorTR*TravTimeTR) ;
//not used in I-30 survey
    var TravTimeVarNTR =
Math.round(VarFactorNTR*PeakFactorNTR*TravTimeNTR) ;
    var MinTravTimeTR = TravTimeTR - TravTimeVarTR ;
    var MaxTravTimeTR = TravTimeTR + TravTimeVarTR ;
    var MinTravTimeNTR = TravTimeNTR - TravTimeVarNTR ;
    var MaxTravTimeNTR = TravTimeNTR + TravTimeVarNTR ;
    var MinSpeedTR = (TripDist/MaxTravTimeTR)*60 ;
    var MaxSpeedTR = (TripDist/MinTravTimeTR)*60 ;
    if (MaxSpeedTR > 85)

```

```

        {
            var MaxSpeedTR = 85 ;
            var MinTravTimeTR = (TripDist/MaxSpeedTR)*60 ;
        }
    var MinSpeedNTR = (TripDist/MaxTravTimeNTR)*60 ;
    var MaxSpeedNTR = (TripDist/MinTravTimeNTR)*60 ;
        if (MaxSpeedNTR > 75)
            {
                var MaxSpeedNTR = 75 ;
                var MinTravTimeNTR = (TripDist/MaxSpeedNTR)*60 ;
            }
    }
else
    {
        // Method 2 - adaptive random
        document.getElementById('answer76992X257X728611').value = 2;
        var SpeedTR = 55 + Math.floor(Math.random()*21); //55-75 mph, based on
        freeway data and previous surveys
        var SpeedNTR = 40 + Math.floor(Math.random()*21); //40-60 mph, based on
        freeway data
        var TravTimeTR = Math.round((TripDist * 60) / (SpeedTR / PeakFactorTR));
        if (TravTimeTR > 60)
            {
                var TravTimeTR = 60;
            }
        var TravTimeNTR = Math.round((TripDist * 60) / (SpeedNTR /
        PeakFactorNTR));
        if (TravTimeNTR > 60)
            {
                var TravTimeNTR = 60;
            }
        var TollRate = 30 + (Math.floor(Math.random()*21)) ; //30-50 cents per mile.
        based on LBJ express lane rates
        var TotToll = (Math.round((TollRate * TripDist)/5)/20).toFixed(2) ;

        var random6 = Math.random(); //half the time the carpool will be free
        if (random6 < 0.5 )
            {
                var TollRateCP = 0;
            }
        else

```

```

        {
            var TollRateCP = 10 + Math.floor(Math.random()*16); //10-25
cents per mile
        }
        var TotTollCP = (Math.round((TollRateCP*TripDist)/5)/20).toFixed(2) ;

        var TransitFare = (3.5 + Math.floor(Math.random()*16)/10).toFixed(2); //3.5-5
dollars, based on DART and The T Regional fares

//travel time variability not used for I-30 survey
var VarFactorTR = (Math.floor(Math.random()*11))/100 ;
var VarFactorNTR = (5 + Math.floor(Math.random()*11))/100 ;
var TravTimeVarTR = Math.round(VarFactorTR*PeakFactorTR*TravTimeTR) ;
var TravTimeVarNTR =
Math.round(VarFactorNTR*PeakFactorNTR*TravTimeNTR) ;
var MinTravTimeTR = TravTimeTR - TravTimeVarTR ;
var MaxTravTimeTR = TravTimeTR + TravTimeVarTR ;
var MinTravTimeNTR = TravTimeNTR - TravTimeVarNTR ;
var MaxTravTimeNTR = TravTimeNTR + TravTimeVarNTR ;
var MinSpeedTR = (TripDist/MaxTravTimeTR)*60 ;
var MaxSpeedTR = (TripDist/MinTravTimeTR)*60 ;
    if (MaxSpeedTR > 85)
        {
            var MaxSpeedTR = 85 ;
            var MinTravTimeTR = (TripDist/MaxSpeedTR)*60 ;
        }
var MinSpeedNTR = (TripDist/MaxTravTimeNTR)*60 ;
var MaxSpeedNTR = (TripDist/MinTravTimeNTR)*60 ;
    if (MaxSpeedNTR > 75)
        {
            var MaxSpeedNTR = 75 ;
            var MinTravTimeNTR = (TripDist/MaxSpeedNTR)*60 ;
        }
    }

//determine travel time and speed for carpool lane
var SpeedCP = SpeedTR;
var TravTimeCP = TravTimeTR;

```

```

//determine which pictures will be displayed. Pictures are not used in I-30 survey
if (SpeedTR >= 65)
    { //Light traffic
      var picturerefTR = 1;
    }
else if (SpeedTR < 65 && SpeedTR > 50 )
    { //Medium heavy traffic
      var picturerefTR = 2;
    }
else
    { //Heavy traffic
      var picturerefTR = 3;
    }

if (SpeedNTR >= 65)
    { //Light traffic
      var picturerefNTR = 1;
    }
else if (SpeedNTR < 65 && SpeedNTR > 50 )
    { //Medium heavy traffic
      var picturerefNTR = 2;
    }
else
    { //Heavy traffic
      var picturerefNTR = 3;
    }

//determine the incentive chosen for the question
var random5 = (Math.floor(Math.random()*6))+1; //random number (1-6)
switch (random5)
    {
    case 1:
        var incentive = Math.floor(Math.random()*5)+8
        incentive = "Earn a free trip for every " + incentive + " paid trips
taken on the Express Lanes";
        document.getElementById('answer76992X257X728638').value =
"none" ;

```



```

        document.getElementById('answer76992X257X728639').value =
"none";
        document.getElementById('answer76992X257X728640').value =
"none" ;
        document.getElementById('answer76992X257X728641').value =
"none" ;

        break;

    case 2:
        var incentive = 5;
        var incentivecase = (Math.floor(Math.random()*5)+1)*20;
        incentive = "Earn gift cards worth $" + incentive + " for every " +
incentivecase + " peak-hour trip saved by either telecommuting or by not traveling
during peak hours (7-9am or 4-6pm)";
        document.getElementById('answer76992X257X728638').value =
"none" ;
        document.getElementById('answer76992X257X728639').value =
"none";
        document.getElementById('answer76992X257X728640').value =
"none";
        document.getElementById('answer76992X257X728641').value =
"none" ;
        break;

    case 3:
        var incentive = (Math.floor(Math.random()*5)+1)*5;
        incentive = incentive + "% discount offered through select
businesses";
        document.getElementById('answer76992X257X728638').value =
"none" ;
        document.getElementById('answer76992X257X728639').value =
"none";
        document.getElementById('answer76992X257X728640').value =
"none";
        document.getElementById('answer76992X257X728641').value =
"none" ;
        break;

    case 4:
        var incentive = 5;

```

```

        var incentivecase = (Math.floor(Math.random()*5)+1)*20;
        var incentive = "For every " + incentivecase + " trips taken by
transit, $" + incentive + " in credits that can be used on the Express Lanes";
        document.getElementById('answer76992X257X728638').value =
"none" ;
        document.getElementById('answer76992X257X728639').value =
"none" ;
        document.getElementById('answer76992X257X728640').value =
"none" ;
        document.getElementById('answer76992X257X728641').value =
"none";
        break;

    case 5: //A discount of 'incentive' lowering the fare to 'newfare'
        var incentive = (Math.floor(Math.random()*3)+1)*10;
        var newfare = (TransitFare * (1-(incentive/100))).toFixed(2);
        incentive = "A discount of " + incentive + " lowering the fare to "
+ newfare;
        document.getElementById('answer76992X257X728638').value =
"none" ;
        document.getElementById('answer76992X257X728639').value =
"none" ;
        document.getElementById('answer76992X257X728640').value =
"none" ;
        document.getElementById('answer76992X257X728641').value =
"none";
        break;

    case 6:
        var incentive = "Express bus service from park-and-ride lots to
Downtown";
        document.getElementById('answer76992X257X728638').value =
"none" ;
        document.getElementById('answer76992X257X728639').value =
"none";
        document.getElementById('answer76992X257X728640').value =
"none";
        document.getElementById('answer76992X257X728641').value =
"none" ;
        break;
    }

```

```
document.getElementById('answer76992X257X728613').value = SpeedTR ;
document.getElementById('answer76992X257X728614').value = SpeedNTR ;
document.getElementById('answer76992X257X728615').value = TravTimeTR ;
document.getElementById('answer76992X257X728616').value = TravTimeNTR ;
document.getElementById('answer76992X257X728617').value = TollRate ;
document.getElementById('answer76992X257X728618').value = TotToll ;
document.getElementById('answer76992X257X728619').value = VarFactorTR ;
document.getElementById('answer76992X257X728620').value = VarFactorNTR ;
document.getElementById('answer76992X257X728621').value = TravTimeVarTR ;
document.getElementById('answer76992X257X728622').value = TravTimeVarNTR ;
document.getElementById('answer76992X257X728623').value = MaxTravTimeTR ;
document.getElementById('answer76992X257X728624').value = MinTravTimeTR ;
document.getElementById('answer76992X257X728625').value = MaxTravTimeNTR ;
document.getElementById('answer76992X257X728626').value = MinTravTimeNTR ;
document.getElementById('answer76992X257X728631').value = picturerefTR ;
document.getElementById('answer76992X257X728632').value = picturerefNTR ;
document.getElementById('answer76992X257X728636').value = TransitFare ;
document.getElementById('answer76992X257X728637').value = incentive ;
```

```
document.getElementById('answer76992X257X728642').value = TollRateCP;
document.getElementById('answer76992X257X728643').value = TotTollCP;
```

//hides all the answers on the screen

```
document.getElementById('answer76992X257X72861').style.display='none' ;
document.getElementById('answer76992X257X72862').style.display='none' ;
document.getElementById('answer76992X257X72863').style.display='none' ;
document.getElementById('answer76992X257X72864').style.display='none' ;
document.getElementById('answer76992X257X72865').style.display='none' ;
document.getElementById('answer76992X257X72866').style.display='none' ;
document.getElementById('answer76992X257X72867').style.display='none' ;
document.getElementById('answer76992X257X72868').style.display='none' ;
document.getElementById('answer76992X257X72869').style.display='none' ;
document.getElementById('answer76992X257X728610').style.display='none' ;
document.getElementById('answer76992X257X728611').style.display='none' ;
document.getElementById('answer76992X257X728612').style.display='none' ;
document.getElementById('answer76992X257X728613').style.display='none' ;
document.getElementById('answer76992X257X728614').style.display='none' ;
```

```
document.getElementById('answer76992X257X728615').style.display='none' ;
document.getElementById('answer76992X257X728616').style.display='none' ;
document.getElementById('answer76992X257X728617').style.display='none' ;
document.getElementById('answer76992X257X728618').style.display='none' ;
document.getElementById('answer76992X257X728619').style.display='none' ;
document.getElementById('answer76992X257X728620').style.display='none' ;
document.getElementById('answer76992X257X728621').style.display='none' ;
document.getElementById('answer76992X257X728622').style.display='none' ;
document.getElementById('answer76992X257X728623').style.display='none' ;
document.getElementById('answer76992X257X728624').style.display='none' ;
document.getElementById('answer76992X257X728625').style.display='none' ;
document.getElementById('answer76992X257X728626').style.display='none' ;
document.getElementById('answer76992X257X728627').style.display='none' ;
document.getElementById('answer76992X257X728628').style.display='none' ;
document.getElementById('answer76992X257X728629').style.display='none' ;
document.getElementById('answer76992X257X728630').style.display='none' ;
document.getElementById('answer76992X257X728631').style.display='none' ;
document.getElementById('answer76992X257X728632').style.display='none' ;
document.getElementById('answer76992X257X728633').style.display='none' ;
document.getElementById('answer76992X257X728634').style.display='none' ;
document.getElementById('answer76992X257X728635').style.display='none' ;
document.getElementById('answer76992X257X728636').style.display='none' ;
document.getElementById('answer76992X257X728637').style.display='none' ;
document.getElementById('answer76992X257X728638').style.display='none' ;
document.getElementById('answer76992X257X728639').style.display='none' ;
document.getElementById('answer76992X257X728640').style.display='none' ;
document.getElementById('answer76992X257X728641').style.display='none' ;
document.getElementById('answer76992X257X728642').style.display='none' ;
document.getElementById('answer76992X257X728643').style.display='none' ;
```

```
function validation()
{
document.limesurvey.move.value = 'movenext';
document.limesurvey.submit();
}
setTimeout( 'validation()', 250); //takes the user past the page without needing to hit the
'next' button

//end hiding code-->
</script>
```

SP2 Code:

```
<SCRIPT language="JavaScript">
<!--hide from old browsers

// Get values from question set 1
document.getElementById('answer76992X261X73062').value =
"{INSERTANS:76992X257X72862}";
    // TimeOfDay (description)

document.getElementById('answer76992X261X730610').value =
"{INSERTANS:76992X257X728610}";
    // Pictures (y=1, n=2)

document.getElementById('answer76992X261X730611').value =
"{INSERTANS:76992X257X728611}";
    // Attribute selection (d-eff=1, RA=2)

document.getElementById('answer76992X261X730612').value =
"{INSERTANS:76992X257X728612}";
    // D-eff Case No. (1 through 8)

// Variables
    var TimeOfDay = Number("{INSERTANS:76992X257X72861}");
    var PeakFactorTR = Number("{INSERTANS:76992X257X72863}");
    var PeakFactorNTR = Number("{INSERTANS:76992X257X72864}");
    var TripDist = Number("{INSERTANS:76992X257X72869}");
    var Block = Number("{INSERTANS:76992X257X728612}");
    var TollRate1 = Number("{INSERTANS:76992X257X728617}");
    var TollRateCP1 = Number("{INSERTANS:76992X257X728642}");
    var TransitFare1 = Number("{INSERTANS:76992X257X728636}");

//Set Tolls and Travel Times
if (" {INSERTANS:76992X257X728611}" == 1)
    { //D-Efficient
    switch (Block)
        {
        case 1:
            var SpeedTR2 = 70;
            var SpeedNTR2 = 50;
            var TollRate2 = 35 ;
```

```

        var TollRateCP2 = 15;
        var TransitFare2 = 4.50;
break;

case 2:
    var SpeedTR2 = 60;
    var SpeedNTR2 = 50;
    var TollRate2 = 50 ;
    var TollRateCP2 = 0;
    var TransitFare2 = 5.00;
break;

case 3:
    var SpeedTR2 = 65;
    var SpeedNTR2 = 55;
    var TollRate2 = 40 ;
    var TollRateCP2 = 0;
    var TransitFare2 = 5.00;
break;

case 4:
        var SpeedTR2 = 65;
    var SpeedNTR2 = 45;
    var TollRate2 = 30 ;
    var TollRateCP2 = 0;
    var TransitFare2 = 5.00;
break;

case 5:
    var SpeedTR2 = 65;
    var SpeedNTR2 = 45;
    var TollRate2 = 40 ;
    var TollRateCP2 = 0;
    var TransitFare2 = 4.50;
break;

case 6:
    var SpeedTR2 = 60;
    var SpeedNTR2 = 60;
    var TollRate2 = 50 ;
    var TollRateCP2 = 25;

```

```

        var TransitFare2 = 5.00;
    break;

    case 7:
        var SpeedTR2 = 75;
        var SpeedNTR2 = 40;
        var TollRate2 = 45 ;
        var TollRateCP2 = 0;
        var TransitFare2 = 5.00;
    break;

    case 8:
        var SpeedTR2 = 65;
        var SpeedNTR2 = 50;
        var TollRate2 = 45 ;
        var TollRateCP2 = 25;
        var TransitFare2 = 4.00;
    break;

    default:
        alert ("Default");
    }
    var TravTimeTR2 = Math.round((TripDist * 60) / (SpeedTR2 / PeakFactorTR));
    if (TravTimeTR2 > 60)
    {
        var TravTimeTR2 = 60;
    }
    var TravTimeNTR2 = Math.round((TripDist * 60) / (SpeedNTR2 /
PeakFactorNTR));
    if (TravTimeNTR2 > 60)
    {
        var TravTimeNTR2 = 60;
    }
    var TotToll2 = (Math.round((TollRate2 * TripDist)/5)/20).toFixed(2) ;
    var TotTollCP2 = (Math.round((TollRateCP2 * TripDist)/5)/20).toFixed(2) ;
    TransitFare2 = (TransitFare2).toFixed(2);
}

else if ("{INSERTANS:76992X257X728611}" == 2) // smart adjusting
{
    var SP1Ans = "{INSERTANS:76992X396X10268}";

```

```

        var SP1AnsA = SP1Ans.search("General"); // finds out if general purpose lane
option was selected
        var SP1AnsB = SP1Ans.search("Express"); // finds out if express lane option was
selected
        var SP1AnsC = SP1Ans.search("Carpool"); // finds out if carpool option was
selected
        var SP1AnsD = SP1Ans.search("Transit"); // finds out if transit option was
selected

        if (SP1AnsA > 0 || SP1Ans == "")
        {
            var randomnumberTfact = (35+Math.round(Math.random()*35))/100;
            var TollRate2 = TollRate1*randomnumberTfact ;
            var TollRateCP2 = TollRateCP1*randomnumberTfact ;
            var TransitFare2 =
(Math.round((TransitFare1*randomnumberTfact*100)/5)/20).toFixed(2) ;

            document.getElementById('answer76992X261X730627').value = "GPL "
;
        }

        if (SP1AnsB > 0)
        {
            var randomnumberTfact = (130+Math.round(Math.random()*60))/100;
            var TollRate2 = TollRate1*randomnumberTfact ;
            var TollRateCP2 = TollRateCP1;
            var TransitFare2 = (TransitFare1).toFixed(2);

            document.getElementById('answer76992X261X730627').value =
"MLDA" ;
        }

        if (SP1AnsC > 0)
        {
            var randomnumberTfact = (130+Math.round(Math.random()*60))/100;
            var TollRate2 = TollRate1;
            var TollRateCP2 = TollRateCP1*randomnumberTfact ;
            var TransitFare2 = (TransitFare1).toFixed(2);

            document.getElementById('answer76992X261X730627').value =
"MLCP" ;

```



```

    }

    if (SP1AnsD > 0)
    {
        var randomnumberTfact = (130+Math.round(Math.random()*60))/100;
        var TollRate2 = TollRate1;
        var TollRateCP2 = TollRateCP1 ;
        var TransitFare2 =
(Math.round((TransitFare1*randomnumberTfact*100)/5)/20).toFixed(2);

        document.getElementById('answer76992X261X730627').value =
"Transit" ;
    }

    if (TollRate2 > 100)
    {
        var TollRate2 = 100;
    }
    else if (TollRate2 < 10)
    {
        var TollRate2 = 10;
    }

    if (TollRateCP2 > 50)
    {
        TollRateCP2 = 50;
    }

    if (TransitFare2 >10)
    {
        TransitFare2 = 10.00;
    }
    else if (TransitFare2 < 1)
    {
        TransitFare2 = 1.00;
    }

    var SpeedTR2 = 55 + Math.floor(Math.random()*21);
    var SpeedNTR2 = 40 + Math.floor(Math.random()*21);
    var TravTimeTR2 = Math.round((TripDist * 60) / (SpeedTR2 / PeakFactorTR));
        if (TravTimeTR2 > 60)

```

```

        {
            var TravTimeTR2 = 60;
        }
    var TravTimeNTR2 = Math.round((TripDist * 60) / (SpeedNTR2 /
PeakFactorNTR));
    if (TravTimeNTR2 > 60)
        {
            var TravTimeNTR2 = 60;
        }

    var TotToll2 = (Math.round((TollRate2 * TripDist)/5)/20).toFixed(2) ;
    var TotTollCP2 = (Math.round((TollRateCP2*TripDist)/5)/20).toFixed(2);
    }

//determine the incentive chosen for the question
    var random5 = (Math.floor(Math.random()*6))+1; //random number (1-6)
    switch (random5)
        {
            case 1: //Earn a free trip for every [8,9,10,11,12] paid trips taken on the
Express Lanes
                var incentive = Math.floor(Math.random()*5)+8
                incentive = "Incentive: Earn a free trip for every " + incentive + "
paid trips taken on the Express Lanes";
                var gpl incentive = "" ;
                var mldaincentive = incentive ;
                if (TollRateCP2 == 0)
                    {
                var mlcpincentive = "" ;
                }
                else
                    {
                var mlcpincentive = incentive ;
                }
                var transitincentive = "" ;
                break;

            case 2:
                var incentive = 5; //Earn gift cards to local retailers and
entertainment venues worth $5 for every [20,25,30,35] peak-hour (7-9am or 4-6pm)

```

```

//trips avoided by either
telecommuting or by traveling during the off-peak
    var incentivecase = (Math.floor(Math.random()*4))*5+20;
    incentive = "Incentive: Earn gift cards to local retailers and
entertainment venues worth $" + incentive + " for every " + incentivecase + " peak-hour
(7-9am or 4-6pm) trips avoided by either telecommuting or by traveling during the off-
peak";

    var gpl incentive = "" ;
    var mldaincentive = incentive ;
    var mlcpincentive = incentive ;
    var transitincentive = incentive ;
break;

case 3: //[5,10,15,20,25% discount] to local retailers and entertainment
venues
    var incentive = (Math.floor(Math.random()*5)+1)*5;
    incentive = "Incentive: " + incentive + "% discount to local
retailers and entertainment venues";

    var gpl incentive = "" ;
    var mldaincentive = incentive ;
    var mlcpincentive = incentive ;
    var transitincentive = incentive ;
break;

case 4:
    var incentive = 5; //For every [20,25,30,35] trips taken by transit,
earn $5 in credits that can be used on the Express Lane tolls or transit fare
    var incentivecase = (Math.floor(Math.random()*4))*5+20;
    var incentive = "For every " + incentivecase + " trips taken by
transit, earn $" + incentive + " in credits that can be used on the Express Lane tolls or
transit fare";

    var gpl incentive = "" ;
    var mldaincentive = "" ;
    var mlcpincentive = "" ;
    var transitincentive = incentive ;
break;

case 5: //A discount of [10,20,30%] on the transit fare

```

```

        var incentive = (Math.floor(Math.random()*3)+1)*10;
//[10,20,30%]
        var newfare = (Math.round((100*TransitFare2 * (1-
incentive/100))/5)/20).toFixed(2);
        incentive = "Incentive: A discount of " + incentive + "%, lowering
the fare to $" + newfare;

        var gpl incentive = "" ;
        var mldaincentive = "" ;
        var mlcpincentive = "" ;
        var transitincentive = incentive ;
    break;

    case 6:
        var incentive = "Incentive: Express bus service from park-and-ride
lots to Downtown";
        var gpl incentive = "" ;
        var mldaincentive = "" ;
        var mlcpincentive = "" ;
        var transitincentive = incentive ;
    break;
}
document.getElementById('answer76992X261X730632').value = gpl incentive ;
document.getElementById('answer76992X261X730633').value = mldaincentive ;
document.getElementById('answer76992X261X730634').value = mlcpincentive ;
document.getElementById('answer76992X261X730635').value = transitincentive ;

//sets background color for incentives
    if (gpl incentive == "")
        {
            var gplbackground = "FFFFFF"
        }
    else
        {
            var gplbackground = "FFFF99"
        }

    if (mldaincentive == "")
        {
            var mldabackground = "FFFFFF"
        }

```

```

else
  {
    var mldabackground = "FFFF99"
  }

if (mlcpincentive == "")
  {
    var mlcpbackground = "FFFFFF"
  }
else
  {
    var mlcpbackground = "FFFF99"
  }

if (transitincentive == "")
  {
    var transitbackground = "FFFFFF"
  }
else
  {
    var transitbackground = "FFFF99"
  }

```

```

document.getElementById('answer76992X261X730637').value = gplbackground ;
document.getElementById('answer76992X261X730638').value = mldabackground ;
document.getElementById('answer76992X261X730639').value = mlcpbackground;
document.getElementById('answer76992X261X730640').value = transitbackground ;

```

```

document.getElementById('answer76992X261X730613').value = SpeedTR2 ;
document.getElementById('answer76992X261X730614').value = SpeedNTR2 ;
document.getElementById('answer76992X261X730615').value = TravTimeTR2 ;
document.getElementById('answer76992X261X730616').value = TravTimeNTR2 ;
document.getElementById('answer76992X261X730617').value = TollRate2 ;
document.getElementById('answer76992X261X730618').value = TotToll2 ;
//document.getElementById('answer76992X261X730619').value = VarFactorTR2 ;
//document.getElementById('answer76992X261X730620').value = VarFactorNTR2 ;
//document.getElementById('answer76992X261X730621').value = TravTimeVarTR2 ;
//document.getElementById('answer76992X261X730622').value = TravTimeVarNTR2 ;
//document.getElementById('answer76992X261X730623').value = MaxTravTimeTR2 ;
//document.getElementById('answer76992X261X730624').value = MinTravTimeTR2 ;

```

```
//document.getElementById('answer76992X261X730625').value = MaxTravTimeNTR2
;
//document.getElementById('answer76992X261X730626').value = MinTravTimeNTR2
;
//document.getElementById('answer76992X261X730628').value = picturerefTR2 ;
//document.getElementById('answer76992X261X730629').value = picturerefNTR2 ;
document.getElementById('answer76992X261X730630').value = TotTollCP2 ;
document.getElementById('answer76992X261X730631').value = TransitFare2 ;
document.getElementById('answer76992X261X730636').value = TollRateCP2 ;
```

```
document.getElementById('answer76992X261X73061').style.display='none' ;
document.getElementById('answer76992X261X73062').style.display='none' ;
document.getElementById('answer76992X261X73063').style.display='none' ;
document.getElementById('answer76992X261X73064').style.display='none' ;
document.getElementById('answer76992X261X73065').style.display='none' ;
document.getElementById('answer76992X261X73066').style.display='none' ;
document.getElementById('answer76992X261X73067').style.display='none' ;
document.getElementById('answer76992X261X73068').style.display='none' ;
document.getElementById('answer76992X261X73069').style.display='none' ;
document.getElementById('answer76992X261X730610').style.display='none' ;
document.getElementById('answer76992X261X730611').style.display='none' ;
document.getElementById('answer76992X261X730612').style.display='none' ;
document.getElementById('answer76992X261X730613').style.display='none' ;
document.getElementById('answer76992X261X730614').style.display='none' ;
document.getElementById('answer76992X261X730615').style.display='none' ;
document.getElementById('answer76992X261X730616').style.display='none' ;
document.getElementById('answer76992X261X730617').style.display='none' ;
document.getElementById('answer76992X261X730618').style.display='none' ;
document.getElementById('answer76992X261X730619').style.display='none' ;
document.getElementById('answer76992X261X730620').style.display='none' ;
document.getElementById('answer76992X261X730621').style.display='none' ;
document.getElementById('answer76992X261X730622').style.display='none' ;
document.getElementById('answer76992X261X730623').style.display='none' ;
document.getElementById('answer76992X261X730624').style.display='none' ;
document.getElementById('answer76992X261X730625').style.display='none' ;
document.getElementById('answer76992X261X730626').style.display='none' ;
document.getElementById('answer76992X261X730627').style.display='none' ;
document.getElementById('answer76992X261X730628').style.display='none' ;
document.getElementById('answer76992X261X730629').style.display='none' ;
document.getElementById('answer76992X261X730630').style.display='none' ;
document.getElementById('answer76992X261X730631').style.display='none' ;
```

```

document.getElementById('answer76992X261X730632').style.display='none' ;
document.getElementById('answer76992X261X730633').style.display='none' ;
document.getElementById('answer76992X261X730634').style.display='none' ;
document.getElementById('answer76992X261X730635').style.display='none' ;
document.getElementById('answer76992X261X730636').style.display='none' ;
document.getElementById('answer76992X261X730637').style.display='none' ;
document.getElementById('answer76992X261X730638').style.display='none' ;
document.getElementById('answer76992X261X730639').style.display='none' ;
document.getElementById('answer76992X261X730640').style.display='none' ;

```

```

function validation()
{
    document.limesurvey.move.value = 'movenext';
    document.limesurvey.submit();
}
setTimeout( 'validation()', 250);

```

```

// end hiding code -->
</script>

```

SP3 Code:

```

<SCRIPT language="JavaScript">
<!--hide from old browsers

// Get values from question set 1
    document.getElementById('answer76992X263X73072').value =
"{INSERTANS:76992X257X72862}" ; // TimeOfDay (description)

    document.getElementById('answer76992X263X730710').value =
"{INSERTANS:76992X257X728610}" ; // Pictures (y=1, n=2)

    document.getElementById('answer76992X263X730711').value =
"{INSERTANS:76992X257X728611}" ; // Attribute selection (d-eff=1, RA=2)

    document.getElementById('answer76992X263X730712').value =
"{INSERTANS:76992X257X728612}" ; // D-eff Case No. (1 through 8)

// Variables
    var TimeOfDay = Number("{INSERTANS:76992X257X72861}");

```

```

var PeakFactorTR = Number("{INSERTANS:76992X257X72863}");
var PeakFactorNTR = Number("{INSERTANS:76992X257X72864}");
var TripDist = Number("{INSERTANS:76992X257X72869}");
var Block = Number("{INSERTANS:76992X257X728612}");
var TollRate2 = Number("{INSERTANS:76992X261X730617}");
var TollRateCP2 = Number("{INSERTANS:76992X261X730636}");
var TransitFare2 = Number("{INSERTANS:76992X261X730631}");

```

```
//Set Tolls and Travel Times
```

```
if (" {INSERTANS:76992X257X728611}" == 1)
```

```
{ //D-Efficient
```

```
switch (Block)
```

```
{
```

```
case 1:
```

```
var SpeedTR3 = 75;
```

```
var SpeedNTR3 = 40;
```

```
var TollRate3 = 30 ;
```

```
var TollRateCP3 = 25;
```

```
var TransitFare3 = 3.50;
```

```
break;
```

```
case 2:
```

```
var SpeedTR3 = 55;
```

```
var SpeedNTR3 = 55;
```

```
var TollRate3 = 35 ;
```

```
var TollRateCP3 = 0;
```

```
var TransitFare3 = 3.50;
```

```
break;
```

```
case 3:
```

```
var SpeedTR3 = 55;
```

```
var SpeedNTR3 = 55;
```

```
var TollRate3 = 30 ;
```

```
var TollRateCP3 = 0;
```

```
var TransitFare3 = 4.50;
```

```
break;
```

```
case 4:
```

```
var SpeedTR3 = 60;
```

```
var SpeedNTR3 = 60;
```



```
        var TollRate3 = 50 ;
        var TollRateCP3 = 15;
        var TransitFare3 = 4.50;

    break;

    case 5:
        var SpeedTR3 = 70;
        var SpeedNTR3 = 45;
        var TollRate3 = 40 ;
        var TollRateCP3 = 0;
        var TransitFare3 = 4.00;
    break;

    case 6:
        var SpeedTR3 = 60;
        var SpeedNTR3 = 55;
        var TollRate3 = 45 ;
        var TollRateCP3 = 15;
        var TransitFare3 = 4.00;
    break;

    case 7:
        var SpeedTR3 = 75;
        var SpeedNTR3 = 40;
        var TollRate3 = 30 ;
        var TollRateCP3 = 25;
        var TransitFare3 = 4.50;
    break;

    case 8:
        var SpeedTR3 = 75;
        var SpeedNTR3 = 55;
        var TollRate3 = 35 ;
        var TollRateCP3 = 0;
        var TransitFare3 = 4.50;
    break;

    default:
        alert ("Default");
    }
```

```

var TravTimeTR3 = Math.round((TripDist * 60) / (SpeedTR3 / PeakFactorTR));
    if (TravTimeTR3 > 60)
        {
            var TravTimeTR3 = 60;
        }
    var TravTimeNTR3 = Math.round((TripDist * 60) / (SpeedNTR3 /
PeakFactorNTR));
    if (TravTimeNTR3 > 60)
        {
            var TravTimeNTR3 = 60;
        }
    var TotToll3 = (Math.round((TollRate3 * TripDist)/5)/20).toFixed(2) ;
    var TotTollCP3 = (Math.round((TollRateCP3 *
TripDist)/5)/20).toFixed(2) ;
    }

    else if ("{"INSERTANS:76992X257X728611}" == 2) // smart adjusting
        {
            var SP2Ans = "{"INSERTANS:76992X262X7308}";
            var SP2AnsA = SP2Ans.search("General"); // finds out if general
purpose lane option was selected
            var SP2AnsB = SP2Ans.search("Express"); // finds out if express lane
option was selected
            var SP2AnsC = SP2Ans.search("Carpool"); // finds out if carpool option
was selected
            var SP2AnsD = SP2Ans.search("Transit"); // finds out if transit option
was selected

            if (SP2AnsA > 0 || SP2Ans == "")
                {
                    var randomnumberTfact = (35+Math.round(Math.random()*35))/100;
                    var TollRate3 = TollRate2*randomnumberTfact ;
                    var TollRateCP3 = TollRateCP2*randomnumberTfact ;
                    var TransitFare3 =
(Math.round((TransitFare2*randomnumberTfact*100)/5)/20).toFixed(2) ;
                    document.getElementById('answer76992X263X730727').value = "GPL "
;
                }
            if (SP2AnsB > 0)
                {

```

```

        var randomNumberTfact = (130+Math.round(Math.random()*60))/100;
        var TollRate3 = TollRate2*randomNumberTfact ;
        var TollRateCP3 = TollRateCP2;
        var TransitFare3 = (TransitFare2).toFixed(2);
        document.getElementById('answer76992X263X730727').value =
"MLDA" ;
    }
    if (SP2AnsC > 0)
    {
        var randomNumberTfact = (130+Math.round(Math.random()*60))/100;
        var TollRate3 = TollRate2;
        var TollRateCP3 = TollRateCP2*randomNumberTfact ;
        var TransitFare3 = (TransitFare2).toFixed(2);
        document.getElementById('answer76992X263X730727').value =
"MLCP" ;
    }
    if (SP2AnsD > 0)
    {
        var randomNumberTfact = (130+Math.round(Math.random()*60))/100;
        var TollRate3 = TollRate2;
        var TollRateCP3 = TollRateCP2 ;
        var TransitFare3 =
(Math.round((TransitFare2*randomNumberTfact*100)/5)/20).toFixed(2);
        document.getElementById('answer76992X263X730727').value =
"Transit" ;
    }

    if (TollRate3 > 100)
    {
        TollRate3 = 100;
    }
    else if (TollRate3 < 10)
    {
        TollRate3 = 10;
    }

    if (TollRateCP3 > 50)
    {
        TollRateCP3 = 50;
    }

```

```

    if (TransitFare3 > 10)
        {
        TransitFare3 = 10.00;
        }
    else if (TransitFare3 < 1)
        {
        TransitFare3 = 1.00;
        }

var SpeedTR3 = 55 + Math.floor(Math.random()*21);
var SpeedNTR3 = 40 + Math.floor(Math.random()*21);
var TravTimeTR3 = Math.round((TripDist * 60) / (SpeedTR3 / PeakFactorTR));
    if (TravTimeTR3 > 60)
        {
        var TravTimeTR3 = 60;
        }
var TravTimeNTR3 = Math.round((TripDist * 60) / (SpeedNTR3 /
PeakFactorNTR));
    if (TravTimeNTR3 > 60)
        {
        var TravTimeNTR3 = 60;
        }
var TotToll3 = (Math.round((TollRate3 * TripDist)/5)/20).toFixed(2) ;
var TotTollCP3 = (Math.round((TollRateCP3*TripDist)/5)/20).toFixed(2);
}

//determine the incentive chosen for the question; same numbers set-up as from SP2
code
var random5 = (Math.floor(Math.random()*6))+1; //random number (1-6)
switch (random5)
    {
    case 1:
        var incentive = Math.floor(Math.random()*5)+8 //[8,9,10,11,12]
        incentive = "Incentive: Earn a free trip for every " + incentive + "
paid trips taken on the Express Lanes";
        var gplincentive = "" ;
        var mldaincentive = incentive ;
        if (TollRateCP3 == 0) //the incentive is only given if carpoolers
have to pay a toll
            {
            var mlcpincentive = "" ;

```

```

    }
    else
        {
var mlcpincentive = incentive ;
        }
    var transitincentive = "" ;
break;

case 2:
    var incentive = 5;
    var incentivecase = (Math.floor(Math.random()*4))*5+20;
//[20,25,30,35]
    incentive = "Incentive: Earn gift cards to local retailers and
entertainment venues worth $" + incentive + " for every " + incentivecase + " peak-hour
(7-9am or 4-6pm) trips avoided by either telecommuting or by traveling during the off-
peak";
    var gplincentive = "" ;
    var mldaincentive = incentive ;
    var mlcpincentive = incentive ;
    var transitincentive = incentive ;
break;

case 3:
    var incentive = (Math.floor(Math.random()*5)+1)*5;
//[5,10,15,20,25% discount]
    incentive = "Incentive: " + incentive + "% discount to local
retailers and entertainment venues";
    var gplincentive = "" ;
    var mldaincentive = incentive ;
    var mlcpincentive = incentive ;
    var transitincentive = incentive ;
break;

case 4:
    var incentive = 5;
    var incentivecase = (Math.floor(Math.random()*4))*5+20;
//[20,25,30,35]
    var incentive = "Incentive: For every " + incentivecase + " trips
taken by transit, earn $" + incentive + " in credits that can be used on the Express Lane
tolls or transit fare";
    var gplincentive = "" ;

```

```

        var mldaincentive = "" ;
        var mlcpincentive = "" ;
        var transitincentive = incentive ;
    break;

    case 5: //A discount of 'incentive' lowering the fare to 'newfare'
        var incentive = (Math.floor(Math.random()*3)+1)*10;
//[10,20,30%]
        var newfare = (Math.round((100*TransitFare3 * (1-
incentive/100))/5)/20).toFixed(2);
        incentive = "Incentive: A discount of " + incentive + "%, lowering
the fare to $" + newfare;
        var gplinentive = "" ;
        var mldaincentive = "" ;
        var mlcpincentive = "" ;
        var transitincentive = incentive ;
    break;

    case 6:
        var incentive = "Incentive: Express bus service from park-and-ride
lots to Downtown";
        var gplinentive = "" ;
        var mldaincentive = "" ;
        var mlcpincentive = "" ;
        var transitincentive = incentive ;
    break;
}

```

```

document.getElementById('answer76992X263X730732').value = gplinentive ;
document.getElementById('answer76992X263X730733').value = mldaincentive ;
document.getElementById('answer76992X263X730734').value = mlcpincentive ;
document.getElementById('answer76992X263X730735').value = transitincentive ;

```

```

//sets background color; FFFFFFFF = white background; FFFF99 = light yellow
background

```

```

    if (gplinentive == "")
    {
        var gplbackground = "FFFFFFF"
    }
    else
    {

```

```

var gplbackground = "FFFF99"
}

if (mldaincentive == "")
    {
var mldabackground = "FFFFFF"
}
else
    {
var mldabackground = "FFFF99"
}

if (mlcpincentive == "")
    {
var mlcpbackground = "FFFFFF"
}
else
    {
var mlcpbackground = "FFFF99"
}

if (transitincentive == "")
    {
var transitbackground = "FFFFFF"
}
else
    {
var transitbackground = "FFFF99"
}

document.getElementById('answer76992X263X730737').value = gplbackground ;
document.getElementById('answer76992X263X730738').value = mldabackground ;
document.getElementById('answer76992X263X730739').value = mlcpbackground;
document.getElementById('answer76992X263X730740').value = transitbackground ;

document.getElementById('answer76992X263X730713').value = SpeedTR3 ;
document.getElementById('answer76992X263X730714').value = SpeedNTR3 ;
document.getElementById('answer76992X263X730715').value = TravTimeTR3 ;
document.getElementById('answer76992X263X730716').value = TravTimeNTR3 ;
document.getElementById('answer76992X263X730717').value = TollRate3 ;
document.getElementById('answer76992X263X730718').value = TotToll3 ;

```

```
//document.getElementById('answer76992X263X730719').value = VarFactorTR3 ; Not
used in this survey
//document.getElementById('answer76992X263X730720').value = VarFactorNTR3 ;
//document.getElementById('answer76992X263X730721').value = TravTimeVarTR3 ;
//document.getElementById('answer76992X263X730722').value = TravTimeVarNTR3 ;
//document.getElementById('answer76992X263X730723').value = MaxTravTimeTR3 ;
//document.getElementById('answer76992X263X730724').value = MinTravTimeTR3 ;
//document.getElementById('answer76992X263X730725').value = MaxTravTimeNTR3
;
//document.getElementById('answer76992X263X730726').value = MinTravTimeNTR3
;
//document.getElementById('answer76992X263X730728').value = picturerefTR3 ;
//document.getElementById('answer76992X263X730729').value = picturerefNTR3 ;
document.getElementById('answer76992X263X730730').value = TotTollCP3 ;
document.getElementById('answer76992X263X730731').value = TransitFare3 ;
document.getElementById('answer76992X263X730736').value = TollRateCP3 ;
```

```
document.getElementById('answer76992X263X73071').style.display='none' ;
document.getElementById('answer76992X263X73072').style.display='none' ;
document.getElementById('answer76992X263X73073').style.display='none' ;
document.getElementById('answer76992X263X73074').style.display='none' ;
document.getElementById('answer76992X263X73075').style.display='none' ;
document.getElementById('answer76992X263X73076').style.display='none' ;
document.getElementById('answer76992X263X73077').style.display='none' ;
document.getElementById('answer76992X263X73078').style.display='none' ;
document.getElementById('answer76992X263X73079').style.display='none' ;
document.getElementById('answer76992X263X730710').style.display='none' ;
document.getElementById('answer76992X263X730711').style.display='none' ;
document.getElementById('answer76992X263X730712').style.display='none' ;
document.getElementById('answer76992X263X730713').style.display='none' ;
document.getElementById('answer76992X263X730714').style.display='none' ;
document.getElementById('answer76992X263X730715').style.display='none' ;
document.getElementById('answer76992X263X730716').style.display='none' ;
document.getElementById('answer76992X263X730717').style.display='none' ;
document.getElementById('answer76992X263X730718').style.display='none' ;
document.getElementById('answer76992X263X730719').style.display='none' ;
document.getElementById('answer76992X263X730720').style.display='none' ;
document.getElementById('answer76992X263X730721').style.display='none' ;
document.getElementById('answer76992X263X730722').style.display='none' ;
document.getElementById('answer76992X263X730723').style.display='none' ;
document.getElementById('answer76992X263X730724').style.display='none' ;
```



```
document.getElementById('answer76992X263X730725').style.display='none' ;
document.getElementById('answer76992X263X730726').style.display='none' ;
document.getElementById('answer76992X263X730727').style.display='none' ;
document.getElementById('answer76992X263X730728').style.display='none' ;
document.getElementById('answer76992X263X730729').style.display='none' ;
document.getElementById('answer76992X263X730730').style.display='none' ;
document.getElementById('answer76992X263X730731').style.display='none' ;
document.getElementById('answer76992X263X730732').style.display='none' ;
document.getElementById('answer76992X263X730733').style.display='none' ;
document.getElementById('answer76992X263X730734').style.display='none' ;
document.getElementById('answer76992X263X730735').style.display='none' ;
document.getElementById('answer76992X263X730736').style.display='none' ;
document.getElementById('answer76992X263X730737').style.display='none' ;
document.getElementById('answer76992X263X730738').style.display='none' ;
document.getElementById('answer76992X263X730739').style.display='none' ;
document.getElementById('answer76992X263X730740').style.display='none' ;
```

```
function validation()
{
    document.limesurvey.move.value = 'movenext';
    document.limesurvey.submit();
}
setTimeout( 'validation()', 250);
```

```
// end hiding code -->
</script>
```

APPENDIX E

NLOGIT CODE

?Model 1 - simple model to start

? A = sov gpl, B = sov el, C = cp el, D = transit

? INC1 = Earn a free trip for every 8, 9, 10, 11, or 12 paid trips taken on the Express Lanes

? INC2 = Earn gift cards worth \$5 for every 20, 25, 30, or 35 peak-hour trips saved by either telecommuting or by not traveling during the peak hours (7-9am or 4-6pm)

? INC3 = 5%, 10%, 15%, 20%, or 25% discount offered through select businesses

? INC4 = For every 20, 25, 30, or 35 trips taken by transit, \$5 in credits that can be used on the Express Lanes

? INC5 = A transit fare discount of 10%, 20%, or 30%

? INC6 = Express bus service from park-and-ride lots to downtown

sample; all\$

create; if (GENDER=2) MALE=1; (else) MALE=0\$

create; if (EDUC=1) LESSTHAN=1; (else) LESSTHAN=0\$

create; if (EDUC=2) HIGHSCHL=1; (else) HIGHSCHL=0\$

create; if (EDUC=3) SOMECOL=1; (else) SOMECOL=0\$

create; if (EDUC=4) COLLEGE=1; (else) COLLEGE=0\$

create; if (RACE=1) AFRAM=1; (else) AFRAM=0\$

create; if (RACE=2) ASIANAM=1; (else) ASIANAM=0\$

create; if (RACE=3) HISP=1; (else) HISP=0\$

create; if (RACE=4) NATIVEAM=1; (else) NATIVEAM=0\$

create; if (RACE=5) WHITE=1; (else) WHITE=0\$

create; if (DRIVER=1) DR=1; (else) DR=0\$

create; if (TRIPFREQ=1) MULTIDAY=1; (else) MULTIDAY=0\$

create; if (TRIPFREQ=2) ONCEDAY=1; (else) ONCEDAY=0\$

create; if (TRIPFREQ=3) FEWWEEK=1; (else) FEWWEEK=0\$

create; if (TRIPFREQ=4) ONCEWEEK=1; (else) ONCEWEEK=0\$

create; if (TRIPFREQ=5) FEWMONTH=1; (else) FEWMONTH=0\$

create; if (TRIPPURP=1) COMMUTE=1; (else) COMMUTE=0\$

create; if (TRIPPURP=2) REC=1; (else) REC=0\$

create; if (TRIPPURP=3) SPORTS=1; (else) SPORTS=0\$

create; if (TRIPPURP=4) NOTCOM=1; (else) NOTCOM=0\$

create; if (TRIPPURP=5) CLASS=1; (else) CLASS=0\$

create; if (AGEGROUP=1) AGE24=1; (else) AGE24=0\$
create; if (AGEGROUP=2) AGE34=1; (else) AGE34=0\$
create; if (AGEGROUP=3) AGE44=1; (else) AGE44=0\$
create; if (AGEGROUP=4) AGE54=1; (else) AGE54=0\$
create; if (AGEGROUP=5) AGE64=1; (else) AGE64=0\$
create; if (AGEGROUP=6) AGE65UP=1; (else) AGE65UP=0\$

create; if (AGEGROUP=1|AGEGROUP=2) LOWAGE=1; (else) LOWAGE=0\$
create; if (AGEGROUP=3|AGEGROUP=4) MEDAGE=1; (else) MEDAGE=0\$
create; if (AGEGROUP=5|AGEGROUP=6) HIAGE=1; (else) HIAGE=0\$

create; if (HHINC=1|HHINC=2|HHINC=3) LOWINC=1; (else) LOWINC=0\$
create; if (HHINC=4|HHINC=5) LMIDINC=1; (else) LMIDINC=0\$
create; if (HHINC=6|HHINC=7) HMDINC=1; (else) HMDINC=0\$
create; if (HHINC=8|HHINC=9) HINC=1; (else) HINC=0\$

create; if (PERIOD=1|PERIOD=5) PEAK=1; (else) PEAK=0\$
create; if (PERIOD=2|PERIOD=4) SHOULDER=1; (else) SHOULDER=0\$
create; if (PERIOD=3) MIDDAY=1; (else) MIDDAY=0\$
create; if (PERIOD=6) NIGHT=1; (else) NIGHT=0\$

create; if (INC=1) SPINC1=1; (else) SPINC1=0\$
create; if (INC=2) SPINC2=1; (else) SPINC2=0\$
create; if (INC=3) SPINC3=1; (else) SPINC3=0\$
create; if (INC=4) SPINC4=1; (else) SPINC4=0\$
create; if (INC=5) SPINC5=1; (else) SPINC5=0\$
create; if (INC=6) SPINC6=1; (else) SPINC6=0\$

create; if (INCVAL1=0) INCINV1=0; (else) INCINV1 = 1/INCVAL1\$
create; if (INCVAL2=0) INCINV2=0; (else) INCINV2 = 1/INCVAL2\$
create; if (INCVAL4=0) INCINV4=0; (else) INCINV4 = 1/INCVAL4\$

? Get LLc

NLOGIT; Lhs=DECISION,NALTS,MODE;
Choices = DA-GPL,DA-EL,CP-EL, TRAN;
Model:U(DA-GPL)= 0/
U(DA-EL)= ASC_DAEL/
U(CP-EL) = ASC_CPEL/
U(TRAN) = ASC_TRAN\$

calc;list;LLc=LogL-kreg\$

?sp incentives without initial (1/0) set. Works the same. This is the one to use.

NLOGIT ;Lhs=DECISION,NALTS,MODE;

Effects:

INCINV1(*)/INCINV2(*)/INCVAL3(*)/INCINV4(*)/INCVAL5(*)/INCVAL6(*);

Choices = A,B,C,D;

Model:U(A)=c_time*TTIME+c_toll*TOLL/

**U(B)=A_B+c_time*TTIME+c_toll*TOLL+c_sports*SPORTS+c_hisp*HISP
+c_hinc*HINC+c_onceday*ONCEDAY+c_spinc1*INCINV1+c_spinc2*INCINV2+
c_spinc3*INCVAL3/**

**U(C)=A_C+c_time*TTIME+c_toll*TOLL+c_commute*COMMUTE+c_as*
ASIANAM+c_hisp*HISP+c_lowinc*LOWINC+c_driver*DR+c_occ*OCC+c_spinc
1*INCINV1+c_spinc2*INCINV2+c_spinc3*INCVAL3/**

**U(D)=A_D+c_time*TTIME+c_toll*TOLL+c_lmidinc*L MIDINC+c_age24*
AGE24+c_age34*AGE34+c_male*MALE+c_spinc4*INCINV4+c_spinc5*INCVAL
5+c_spinc6*INCVAL6;
check data;**

list

crosstab\$

calc;list;VTTS=(b(1)/b(2))*60 \$

calc;LL0=nreg*log(1/4)\$

calc;list;r2=1-((LOGL)/LL0)\$

calc;list;r2adj=1-((LOGL-kreg)/LL0)\$

?sp incentives without value (only 1/0)

NLOGIT ;Lhs=DECISION,NALTS,MODE;

Choices = A,B,C,D;

Model:U(A)=c_time*TTIME+c_toll*TOLL/

**U(B)=A_B+c_time*TTIME+c_toll*TOLL+c_spinc1*SPINC1+c_spinc2*SPI
NC2+c_spinc3*SPINC3/**

**U(C)=A_C+c_time*TTIME+c_toll*TOLL+c_spinc1*SPINC1+c_spinc2*SPI
NC2+c_spinc3*SPINC3/**

**U(D)=A_D+c_time*TTIME+c_toll*TOLL+c_spinc4*SPINC4+c_spinc5*SPI
NC5+c_spinc6*SPINC6;
check data;**