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Evaluating and Modeling Traveler Response to Real-Time Information in the Pioneer Valley

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EVALUATING AND MODELING TRAVELER RESPONSE TO REAL-TIME INFORMATION IN THE PIONEER VALLEY

A Thesis Presented

By

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ABSTRACT

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MAY 2012

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This study used focus groups and surveys to provide a comprehensive evaluation of the Regional Traveler Information Center (RTIC) at UMass Amherst. The evaluation was completed by obtaining the awareness, usage, and perceived effectiveness of RTIC's information by residents in the Pioneer Valley. It was found that awareness of RTIC is limited due to its lack of advertisement. Usage is focused primarily on its webcams and advisory information. Surveys showed that participants perceive RTIC to be useful, even though they may never have seen the information before (the survey provided a chance for them to become familiar with the service). Revealed preference data were collected regarding the travelers' most memorable instances where real-time traffic information was provided. A binary logit model of a traveler's switch decision (route, departure time, mode, destination, trip cancellation, or combinations of them) with real-time traffic information was specified and estimated. It was found that travelers have an increasing tendency to switch away from the original option when the resulting delay caused by

congestion increases. Receiving congestion and crash information also provided a tendency to take an alternative travel method. It was found that males tend to switch more often than females, and young individuals switch less often.

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LIST OF ACRONYMS AND ABBREVIATIONS

RTIC	Regional Traveler Information Center
MassDOT	Massachusetts Department of Transportation
PVTA	Pioneer Valley Transit Authority
UMTC	UMass Transportation Center
GPS	Global Positioning System
HAR	Highway Advisory Radio
VMS	Variable Message Sign
RP	Revealed Preference
SP	Stated Preference
IRB	Institutional Review Board
RSO	Registered Student Organization
ITS	Intelligent Transportation Systems
PVPC	Pioneer Valley Planning Commission
FRCOG	Franklin Regional Council of Governments
OIT	Office of Information Technology

CHAPTER 1

INTRODUCTION

This introductory chapter will provide background information on the Regional Traveler Information Center and its website, discuss the research objectives of this study, and provide a brief literature review of previous studies within this realm. Following this introduction, each research task will be discussed.

1.1 Background and Motivations

The Regional Traveler Information Center (RTIC) is a joint venture of the University of Massachusetts (UMass) and the Massachusetts Department of Transportation (MassDOT) in collaboration with the Regional Planning Agencies and Transit Authorities of Western Massachusetts. RTIC is managed by the UMass Transportation Center (UMTC) with operational and facility support provided by UMass Transit Services. Established in 1999, RTIC currently provides a wide range of travel-related information for the I-91 Corridor and other areas in and around the Pioneer Valley by means of its website, www.MassTraveler.com (UMTC, 1999).

Throughout this thesis MassTraveler and RTIC will be used interchangeably. Generally speaking, MassTraveler will represent the webpage itself, whereas RTIC will represent the system as a whole.

MassTraveler functions like a traveler's home page for Western Massachusetts and the Five College area. The website provides a multitude of helpful webpage links to various travel agencies in the Northeast. A visitor to MassTraveler can be find and email their current state government representatives, check transit schedules, visit any New England state Department of Transportation website, visit a local University website, or even find out the latest shows at local venues. Alongside helpful webpage links, RTIC has a rather extensive amount of webcams located throughout the Pioneer Valley that transmit images of the Route 9 corridor, Hadley Center, Northampton Center, Amherst and UMass, and even as far north as Athol and Orange. The full map of available webcams and a preview image of a webcam location can be seen in Figure 1. Each webcam takes a still image every 15 seconds, 24/7. When viewed, a string of images are looped to show a clip of the roadway over a four minute period.

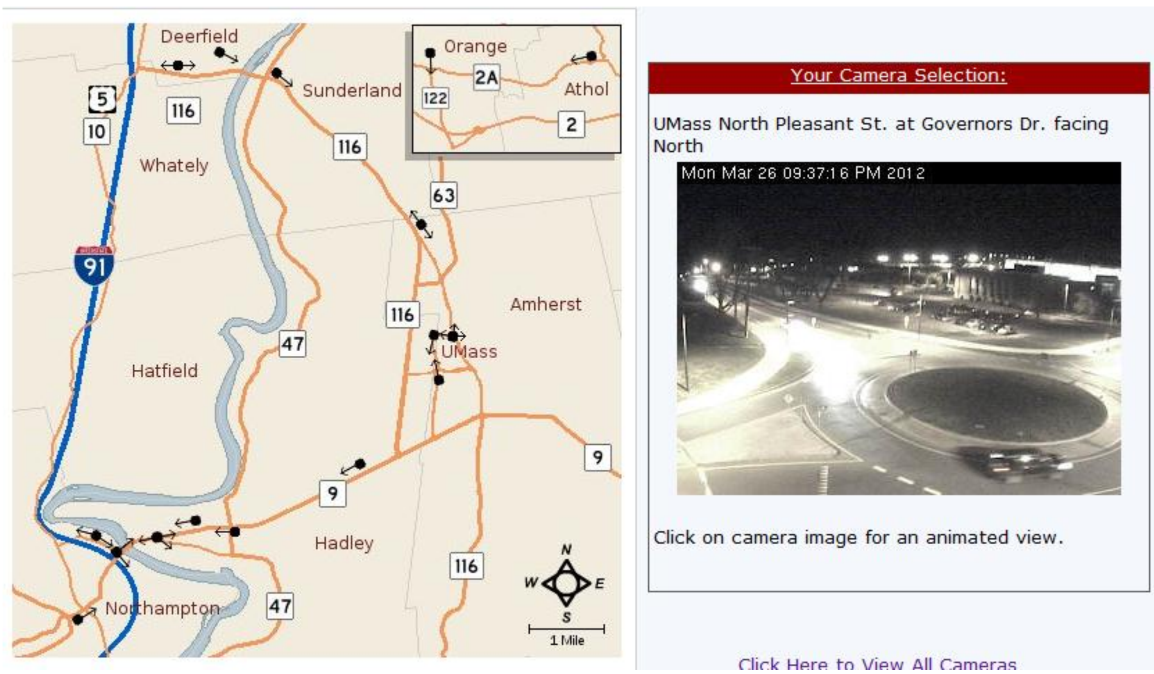

Figure 1: Webcam Map and Example Image (Source: MassTraveler)

Some of these cameras work very well, others are located in areas that are difficult to reach in winter months, causing them to remain offline until technicians can reach them. Other cameras are located on roadways that are not lit at night, which renders the camera image almost useless unless heavy traffic illuminates the picture. The amount of cameras that RTIC maintains is far less than some of the surrounding states' information systems and its sister to the east in the Boston Metropolitan area.

RTIC also operates four sensors located on Route 9 and Route 116. Each roadway contains a set of FastLane/EZPass readers which pick up passing tags as they drive by. Travel times are calculated by subtracting the time it takes one tag to pass the two poles. Knowing the distances between the readers, about 5.1 miles on Route 116 and 3.8 miles on Route 9, travel speeds can be calculated. RTIC has estimated the average time to cross the two readers. Utilizing the travel times accumulated over a given period, RTIC hosts a map that will show different colors on the stretches of roadway between the sensors based on road conditions, similar to the Google Traffic function that many travelers are used to. The website also displays this information in a small text block that provides the travel time and average travel speed. A preview of the map can be seen in Figure 2.

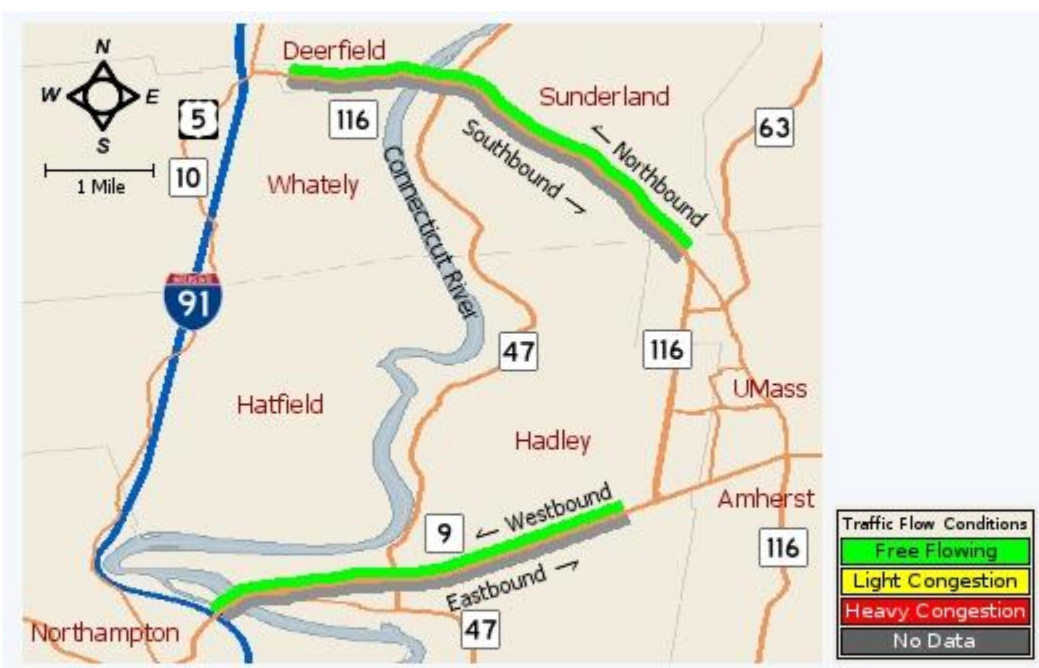

Figure 2: Preview of Travel Times Map (Source: MassTraveler)

Route 9 is also home to another method of obtaining travel speeds that dates back to RTIC's roots. One of RTIC's first investments was two cameras that matched license plate images between two points. Once verified, the timestamps of the images could be subtracted to obtain travel times. Instead of matching license plates, a stationary camera detects the presence of passing vehicles to determine travel speed. Both the time data, and camera feed is available to MassTraveler users.

The privacy of travelers is important to any travel information program that uses sensors and cameras. Though RTIC collects information on vehicles, it does not retain any information that may attribute to individuals. The reasoning for this is to remain neutral and abstain from being pulled into arguments in the courtroom.

Recently removed from RTIC was the bus tracking map. The Computer Science Department, working together with Transit Services, performed an experiment using Wi-Fi signals to track transit buses on campus. The “bus tracker” was linked to RTIC and the Transit Services website and may have been one of the most utilized functions for students and faculty alike. The tracker was removed in early 2011 as funding for the project was depleted. A previous screenshot of the bus tracker can be seen in Figure 3.

Figure 3: Bus Tracker Screenshot (Source: MassTraveler)

It is known that the Pioneer Valley Transit Authority (PVTA) is working on implementing its own bus tracking system as part of a new Intelligent Transportation System (ITS) overhaul, which should be implemented sometime in 2012. The extent of this bus tracker's functionality is unknown at this time.

MassTraveler also displays a Google Map locating all construction projects and roadway advisories known to MassDOT. This map uses traffic cone images to indicate areas of interest. Users can click on the traffic cone to get a basic description of the event, its time frame, and a visual depiction of the travel lanes and closed lanes. This map has undergone some criticism over the course of this study, which will be discussed in the following chapters.

One of the driving motivations for this study is the desire for more information in the area, in particular after several large storms have struck the area. The second half of 2011 brought a stretch of severe thunderstorms ripping through the Springfield area and the surrounding rural towns and demolishing a few neighborhoods. Following the tornado outcrop, which has not been seen in Massachusetts in decades, the area was hit by Hurricane Irene. The hurricane dropped extensive amounts of rain that caused severe flooding throughout the region, damaging roads and knocking out power. In October, a massive snow storm rolled through the region dumping several inches of snow. Because the trees had not yet shed their leaves, the weight of the snow and leaves combined caused tree limbs to topple, blocking roads and knocking out power for over a week in most places. The winter between 2011 and 2012 has hit close to record high temperatures. After the snow in October, almost none has fallen. As the area recovers from the impacts of the past year, more warning and information for the future is always helpful. Of course the weather related information here most greatly represents the dissemination of road closures and alternate detour routes.

More day to day information, regarding congestion and high travel times is becoming popular in many metropolitan areas. Information is starting to reach travelers much faster than it did in previous years. Smartphone technologies, from Apple, Google, and others, are advancing rapidly and feeding the hunger for information in our civilization today. Applications are being created for countless amounts of things, and travel applications are on the forefront including those that can determine transit arrival times and provide mobile views of area webcams. Many smartphones also allow the ability to provide similar information as a GPS navigator. Some new cars even have a GPS navigator embedded into the vehicle itself. GPS navigators are great solutions when travelers get lost in an unknown area. Outside of GPS, several advances have been made in traveler information including the national 511 program initiated by USDOT. The 511 program allows users in metropolitan areas to dial 511 on their phone and traverse through a series of menus to obtain various information regarding travel times or congestion of major roadways. In Massachusetts this is particularly useful for I-90, I-495, and I-93, which get particularly busy around the Boston area.

Instead of dialing a number, Highway Advisory Radio (HAR) has been used in several municipalities which broadcast advisories via an AM radio station. This is much easier to use as the driver tunes their radio and listens instead of having to dial through several menus. Another popular information source for arterials is the use of Variable Message Signs (VMS) which can display a wide assortment of text of messages to drivers regarding travel times or congestion due to construction or a crash.

As noted before, advances are being made towards providing transit riders with arrival and departure information. Probably the most innovative thing is the re-design of how users obtain this information. Most metro stations provide message boards similar to airline boards; however there have been prototypes made for bus stops as well. In research of this topic a very new-age bus stop (Figure 4) was found from MIT's SENSEable City Lab that incorporates several different technologies to help aid the transit rider in their travels.

Figure 4: MIT SENSEable City Lab Bus Stop (Source: Tuvie [http://bit.ly/l3SNSl])

The technology incorporates several screens that display arrival time of buses, waiting time, maps of routes, and weather information. The bus stop screens are interactive and can be manipulated via touch. Some of the screens allow for input of a destination and the screen will show directions on a map much like a GPS. From here, the user can manipulate alternatives to decide which method to take. Other screens serve as a digital message board that allows travelers to post up digital flyers, by drawing with fingers or uploading via mobile phone, for other travelers to scroll through.

Of course this bus stop, and several others like it, will likely not be fully implemented for quite some time, but it shows that it is possible. With time, and further research in this area, it is hoped that advances like these may be made possible for large metro areas and then eventually college campuses like MIT and UMass.

1.2 Research Objectives

The objective of this study is to comprehensively evaluate traveler information in the Pioneer Valley by collecting current and potential users' responses to the service from University members and affiliates. The primary source of traveler information in the Pioneer Valley is that provided by RTIC described above. Previous evaluations of MassTraveler have been primarily passive observation of website traffic. Observations of various website counters are effective in obtaining the number of page views, but they lack the ability to obtain actual opinions of users. In this study, to evaluate RTIC and the MassTraveler website, five attributes are important: awareness, usage, usefulness, benefits, and behavior. Attributes were obtained by holding three focus groups and distributing two web-based surveys over the course of one year. These methods collected useful feedback from participants regarding their experience using, or not using, traveler information in the area.

Completing an evaluation of RTIC as it stands will provide the UMass Transportation Center and MassDOT with valuable information to consider when determining the future of traveler information in the Valley. After 13 years of life, RTIC maintains a small assortment of information mediums including five sensors and several webcams. This study sets out to find which of these items are the most useful to travelers in the area and which items should be replaced or updated to meet new needs. Of course this all only matters if MassTraveler receives visitors every day. One of the major issues with the system is that it has not been heavily advertised in recent years. Although the website does not provide quite as much information as its sister in the Boston Metropolitan area or its cousins in New York and Vermont, it provides information nonetheless. Since its creation, the website's information has been used for various research projects at the University. An increase in users beyond those of graduate students and faculty alike will help boost popularity and provide additional feedback by means of its own "Comment and Questions" form. This study provides analysis to support a greater advertising effort to gain more viewers of the data. With more viewers may come more sponsors, and more sponsors bring more income for new technologies.

Ultimately, RTIC will become as up to date an informative as the system for the eastern half of the state, providing full information for the three major arterials this side of the Quabbin: Route 2, I-91, and I-90. Currently, I-91 is undergoing a brand new ITS project to provide VMS and webcams at several locations along the Interstate. These cameras will eventually be linked with MassDOT and hopefully be added to MassTravler. The results of this survey will show a growing need for RTIC and MassDOT to work together to build a better traveler information system that includes all areas of Western Massachusetts, and not just the Five College area.

An upgraded system benefits all parties; travelers receive more up to date information, UMass receives more data for research projects, and RTIC maintains an ability to fund purposeful information endeavors. This study examined a few potential benefits obtained by travelers who utilize travel information.

This study also uses the results of the distributed questionnaires to model traveler behavior in response to receiving traveler information. The model was created using questions designed to reveal specific attributes about a traveler's trip on a memorable day. Attributes were provided for a habitual travel pattern and a best alternative travel pattern. The attributes were then used to estimate a binary choice model. This model joins other revealed preference models in the study of traveler information.

1.3 Literature Overview

1.3.1 Revealed Preferences, Stated Preferences, and Travel Surveys

When modeling traveler behavior, two types of traveler information are obtained: Revealed Preferences (RP) and Stated Preferences (SP). Revealed Preferences are collected to predict travel behavior based on choices that can be observed in real life. Stated Preferences predict travel behavior by the use of hypothetical situations and specific questions to obtain preferences between situations. RP surveys have an advantage when collecting travel behavior data because the trip has already occurred (Bruun, 2007). This information can then be recorded via a diary, interview, or questionnaire. However, RP falls short when no there is no possibility for a participant to experience the proposed situation first hand. This is where SP questions come into play. SP questions allow investigators to carefully design a scenario that may not yet be implemented and receive user choice based on the created situations (Khattak *et al*, 1994; Bruun, 2007). A review of previous studies collecting RP and SP data for use of models is discussed below.

Khattak *et al* (1994) distributed mail-back questionnaires to travelers during peak period crossings of the Golden Gate Bridge. The surveys asked both RP and SP questions regarding the travelers' normal travel patterns and en-route response to unexpected congestion. Questions were tailored to find preferences of different styles of travel information. Analysis of RP questions found that most travelers would divert if the information was qualitative. Qualitative information was described as providing a description of the congestion. SP responses revealed most travelers would switch if the en-route information provided quantitative information for both the original route and the alternative route. Quantitative information was described as providing estimated travel times for each route. Even though the Golden Gate Bridge area has limited opportunity for route change, the study found that information could still bring about significant travel time savings if the switch was made early enough.

Polydoropoulou *et al* (1996) used both RP and SP survey questions to model traveler behavior for the Golden Gate Bridge. RP questions collected traveler responses to real life en-route awareness of congestion. SP questions collected user preference to hypothetical situations including the implementation of different styles of real-time traveler information. Travelers were asked to recall the most recent trip where they became aware of congestion via their own observation or by radio broadcast. They then described attributes of the trip including trip duration, weather, direction and expected delay. Hypothetical scenarios provided participants with a proposed VMS board that displayed four types of information: Qualitative, Quantitative, Prescriptive, and Predictive. For each case, participant route choice was recorded. Using both the RP and SP data, a choice model was constructed. The results of the model found that switching increases with the amount of prescriptive information being provided. They also found that the most significant increase occurred when predictive or quantitative information was provided for all alternative routes. Nonetheless, route switching increases with increase in detail of these messages (Polydoropoulou and Ben-Akiva 1996). A similar study completed a year prior found that drivers prefer descriptive messages instead of prescriptive. Although the combination of both types of messages is associated with the highest amount of route switching (Khattak *et al*, 1995).

Khattak *et al* (1998) obtained RP survey data by distributing mail-back surveys to both San Francisco and Chicago. Similar to this study, the surveys collected information regarding a memorable occurrence of travel delays. It was found that travel times, the availability of information via radio, and socioeconomic characteristics were key factors in decision between two alternatives.

One year later, Khattak *et al* (1999) continued their analysis by completing telephone surveys for the San Francisco Bay area. The RP surveys questioned travelers on their use of pre-trip information and how it affects their travel. The study found that commuters who had a previous experience with excessive delays during travel were more apt to alter their travel in response to pre-trip information.

Abdel-Aty *et al* (1999) collected SP data from two computer aided telephone surveys. Questions asked participants for route choice between two types of roadways. Participants stated preferences between a longer but reliable route and a shorter but uncertain route. A second survey was distributed to the same participants that asked for their reasoning for choosing between the two routes and a willingness to receive traveler information on such paths. A model was created combining these results to determine route choice between types of roadways and types of information associated with them. Results from the model shows that route choice is not based on travel time alone, but by the differences in reliability of travel times. Travelers were found to switch less when advised to take unfamiliar routes.

Dia (2002) distributed mail-back questionnaires to peak-period auto commuters in Brisbane, Australia. The questionnaires collected information regarding the travelers' response to traveler information on the specific traffic corridor. To analyze the primary factors responsible for travel switching, discrete choice models were estimated. In both cases of pre-trip and en-route information, it was found that the amount of switching varied with the content of the information.

Tsirimpa *et al* (2007) collected travel data from the Puget Sound Transportation Panel, a travel survey that has been distributed to about 2000 households in the Puget Sound area every two years since 1989. The survey collects data via a travel diary, where members of each household are asked to describe their travel habits over a period of days. Analysis of the data found that most travelers receive travel information from media sources like TV, radio, and phone. Another popular source of travel information was found to be the Internet. Two multinomial logit models were built and analyzed in this study regarding the data collected. The models found that travelers generally tend to stick to their habitual paths. However, depending on the context and language of the information, switches occur. The most frequent switches in travel behavior were found to be minor route switches, departure time switches, and major route switches.

Two years later, Tsirimpa *et al* (2009) continued research with data from Puget Sound Transportation Panel. This study used the survey data to examine the impact of traveler information on travel behavior. Multinomial logit models were estimated using Biogeme to examine whether the traveler would switch departure time, switch route, or maintain on the same schedule in response to the information. It was found that information obtained by the internet had a positive effect on switching departure time (Tsirimpa *et al*

2007; Tsirimpa *et al* 2009). Departure time switching is primary to receiving pre-trip information as the traveler has not already committed to traveling. The content of the information was also found to influence switching, noting that when information stated travel times or delays and increase in route switching was found.

1.3.2 Awareness and Usage of Advanced Traveler Information Systems (ATIS)

It has been found that travelers progress through stages when becoming users of ATIS (Polydoropoulou and Ben-Akiva, 1999). User progression follows the path of: awareness, consideration, choice, trial, and repeat. More clearly, the traveler must have some access to information, become aware that the information exists, try out the information, and then include the information as a full-time alternative (Goulias *et al* 2004). Two studies reviewed were found to analyze user awareness.

Goulias *et al* (2004) performed an analysis of the Puget Sound Transportation Panel and found that those who frequently ride transit are more likely to be aware of traveler information. This possibly has to do with the variability in transit headways and arrival/departure times, whereas personal vehicles can leave whenever they want. They also found that the older population was less likely to be aware of information. Those without children, or had children leaving their household, were also found to be less aware of traveler information. This is expected as the younger population, usually more familiar with technology, can spread their knowledge throughout the household. Also in adults, those employed in a professional field were more likely to be aware of traveler information than those in other fields.

Martin *et al* (2005) completed an analysis of Utah DOT's ATIS system. A short survey was distributed to obtain the travelers awareness and usage of each information source in the state. For each source; including advisory radio, 511, and various websites; an image was shown with associated questions asking if the traveler has ever seen the object and if the user has ever utilized the information it disseminates. Results of the questionnaire found that travelers were more aware of information sources en-route. They claimed this was due to visually seeing signs with information along the way rather than viewing the information prior to departing.

1.3.3 Usefulness and Benefits

Many studies have examined the benefits of real-time traveler information and have found that information greatly increases the feeling of comfort in travelers. Real-time traveler information has been found to greatly reduce anxiety in travelers, even if they don't actually change their travel behavior because of it (Khattak *et al* 1994, Khattak *et al* 1995).

Benefits vary between those of car trips and transit trips. In car trips, information relates to congestion of roadways. Modeling this assumes that drivers want to avoid congestion roadways to save time. It is known that wait time generally has a greater disutility than transit time. A study by Reed (1995) examined the effects of transit arrival time information on the burden of waiting. It was found that the burden of waiting decreases with certainty of remaining wait time. Knowledge of the remaining wait time allows the ability for transit riders to use their wait time more wisely.

In a case study using a segment of MBTA Red Line, Hickman *et al* (1995) found that the time saved when selecting between transit trips is not actually saved at all, and is instead spent waiting for the next transit vehicle to arrive. The implementation of arrival time information was found to allow riders to choose other activity while waiting for the transit vehicle. This type of information was also noted to allow riders to arrive to the terminal later than originally planned. A similar study found that real-time information even reduces passenger anxiety when waiting as uncertainty of arrival times is reduced (Labell *et al* 1992, Mishalani *et al* 2006). Variation of travel times and variability in schedule fluctuations reflects onto the perceived reliability of the transit services (Hickman *et al*, 1995). Likewise, it can be perceived that fluctuations in displayed information can have an effect on the perceived reliability of the information system.

Mishalani *et al* (2006) used personal interviews of transit riders waiting at bus stops to determine waiting time perceptions with real-time information. The study found that people feel more comfortable knowing transit will arrive even if the time is just spent sitting. Without knowing arrival time, passengers think transit will arrive much sooner than it actually does which can cause frustration.

Real-time traveler information also provides the user the knowledge needed to reorganize their destinations and trips. Travelers naturally incorporate “slack” into their schedules when traveling. This slack is a set amount of time added to the travel in case something happens, e.g. travel time variability. Real-time traveler information can help reduce the slack associated with travel by allowing travelers to use the slack time elsewhere, e.g. by going to the store. Thus, information allows the users to re-arrange their normal activities such that travel times are reduced, allowing for more activities to be added into the day

(Mahmassani and Chang, 1985, Mahmassani and Chang 1986, Polydoropoulou and Ben-Akiva 1999). Or, the traveler may decide to stay at one end of their trip longer, whether it be staying at home and watching the news or staying at work and getting some extra work done.

1.3.4 Survey and Incentives

To verify the use of incentives for the distributed surveys, four articles were reviewed. Overall, there was no significant change in the quality of the responses with or without an incentive, throughout all incentive types. Incentives studied were monetary and non-monetary. In all four of the articles selected, incentives raise the response rate of the survey. For the mail-out or telephone surveys, pre-paid incentives tended to provide higher response rates than promised incentives (Yu, 1983). With internet surveys cash incentives cannot be used and often times vouchers may serve as a substitute. An online voucher is something that entitles the participant to a specific amount of money somewhere, e.g. a gift certificate to Amazon.com or iTunes (Cobanoglu 2003, Goritz 2004, Deutskens 2004). Online money can be distributed through PayPal.com but is troublesome, studies have shown that participants prefer actual cash because online money is not physically seen or held (Goritz, 2004). Thus vouchers tend to be a legitimate substitute for online cash. Donations to charity in the participants name were also used as an incentive, but often times resulted in less of an increase in response rate.

The general comparison in then is between vouchers, or some non-monetary prize, and a raffle or lottery. Cobanoglu (2003) offered luggage tags as an incentive and compared the response to a raffle for a PDA. They found that combining the two provided the largest increase in response rate. When separating the two, it was found that the prize raffle had no significant difference in response rates than not offering any incentive. Thus, the best option in terms of price was to use a small uniform incentive such as a free key chain. The free key chain in combination with a prize draw for something larger was recommended but cautioned when trying to minimize funds.

Goritz (2004) compared Bonus Points to a monetary raffle and a monetary gift. Bonus Points were considered to be the immediate incentive to the survey. The study found that the Bonus Points provided a higher response rate than the monetary raffle, but did not differ from the monetary gift. They found that as the incentive increased in amount (number of BP’s, sum of money, or donation amount) the response rate increased, not surprisingly. However, one must make sure that the value of the incentive is not so large, that the participants will take the survey just to obtain the money or prize.

Here, two of the studies found that the guaranteed incentive draws the most responses. Deutskens (2004) compared incentives with differing length of survey, short vs. long. The incentives were a voucher (2€ and 5€), a lottery for a voucher (25€ and 50€), and a donation (up to 500€ if everyone participated) to one of three charities. The vouchers were to a CD and Book Store. The survey length varied from 15-30 minutes for the short version and 30-45 minutes for the long version. The lottery allowed five people to win a voucher of the specified denomination. They found that the vouchers and lotteries obtained higher response rates than the charity donation. Between the vouchers and the lotteries, the lotteries obtained higher response rates.

A large recommendation from Cobanoglu (2004) was to be prompt when distributing the incentive such as to maintain their credibility. They also recommend allowing an equal chance for respondents to win the incentive and stating outright the deadlines and conditions involving the incentives. The final recommendation was to make the incentive something that will not bias the response answers. The example used was,

“For example, in a market research survey that investigates the most known shampoo, it is not a good idea to give out samples of a certain branded shampoo as an incentive as this may bias the survey results.” (Cobanoglu 2004)

No research was found that establishes a significant difference in the quality of the answers in the survey. This may be studied in the future. As of most studies, maximizing the response rate from surveys seems to be the big target as surveys generally don’t receive an incredibly fantastic response rate. The surveys found that when sending out email surveys, a significant amount of emails come back undeliverable due to changes in email addresses which decrease the sample size.

CHAPTER 2

FOCUS GROUPS

Focus groups provide a brainstorming environment that allows participants to bounce ideas off of each other, which can help stir up discussion. Interviews with a single person can end quicker than usual as that one person may not remember or may not be able to think of what they want to say. Having other people in the discussion may spark extra ideas into the discussion.

Three focus groups were held over a span of two months in the Higgins Room of Marston Hall at UMass Amherst. Each group lasted a duration of 90 minutes and participants were paid $25 cash for their time. This chapter will discuss those three focus groups.

2.1 Questionnaire Design

To begin the process of creating a focus group setting, questions were needed to help guide the discussion along a set agenda. This research focuses on three main aspects in the evaluation of RTIC and real-time traveler information: awareness, usage, and benefits. That being said, the three large questions in the focus group would then ask about the awareness, usage, and potential benefits from receiving such information in the Pioneer Valley. It was also found that it is generally good to include an entrance and/or exit survey for the group to allow a place for participants to collect their thoughts and write anything they may have forgotten to mention while in the group. Each of the surveys; entrance, exit, and focus group question agenda; went through several revision cycles to keep the question load short and the confusion to a minimum. The next few paragraphs will describe the general design of each questionnaire. Copies of each questionnaire can be seen in Appendix A.

The entrance questionnaire was used to get general demographic information from the participant while they waited for the rest of the group to arrive. Generally, these types of questions are recommended to be the last thing asked of a participant because some feel these types of questions are invasive. Demographic questions were chosen for the entrance questionnaire because they take no outside knowledge to complete. Without even knowing anything about traveler information, one can easily still answer their age and the number of years they have had their driver's license. The entrance questionnaire contained five questions that asked for the participants' age, gender, UMass affiliation (student, staff, faculty), primary mode of commute travel, and the number of years they have been licensed to drive. Every question required the participant to physically write in the response. Once this questionnaire was completed, the participant also read an Informed Consent form, per the requirements of the Institutional Review Board (IRB). The Informed Consent form explained the study, the process that was to take place, and the compensation each participant would receive. Once everyone arrived, completed the entrance questionnaire, read and signed the informed consent; the discussion started.

Focus groups were moderated with a PowerPoint presentation which contained seven main questions. First, RTIC was described, in moderate detail, for those who had never seen or used it. The participants were then asked what the most useful services offered by RTIC were. This question allowed discussion of the most useful items, the least useful items, and what could potentially be added to make RTIC better. The participants were then asked where major trouble spots are located. A trouble spot is considered any location that may be a burden to travel through. Typical burdens may be confusion due to lack of signage pertaining to detours, long travel times due to traffic congestion, or locations with high conflicts between modes. Participants continued discussing where they might get be confused when traveling, or where major problems may occur when traveling. Once the problem spots were identified, the participants were then asked how they would solve the problems via real-time traveler information, e.g. we could place a Variable Message Sign (VMS) at some location or send an alert to notify travelers of the disturbance. The next question in the series asked for the overall benefits of receiving information. Some potential benefits were described, and the participants were asked to build upon this list. The final questions of the discussion were in relation to the next tasks of the study, a full scale survey and eventually a full scale field study. The faculty/staff group completed a draft version of the full scale survey prior to the focus group and thus was asked more questions regarding the content and layout of the survey. The full-scale field study is outside the scope of this thesis and is the next step of this research.

Following the discussion, an exit questionnaire was given to each participant to fill out any last thoughts. The questionnaire also allowed the moderator to collect written responses to some of the questions that were asked during the discussion. The exit questionnaire was four questions long, and was short answer format. The first question asked if the participant had ever seen anyone using RTIC for their own navigational purposes. This was an important question because it allowed for the participant to provide a narrative of someone actually using and experiencing the RTIC system in the field. The majority of the questionnaire asked about the full scale field study that is still in the design phase at this time. In regards to the field study, the questionnaire asked for three things: a good time frame for the study, whether the participant would consider taking part in the study, and what characteristics of the study would influence people not to participate. After all questionnaires were completed, each participant was presented with compensation for their time, $25.00 cash.

2.2 Participants

Participants were recruited by email and by flyers that were tacked to various bulletin boards around campus. To build an email database, the investigators visited Campus Pulse to obtain email addresses for student group leaders. Campus Pulse is an online network, similar to Facebook, which lists every Registered Student Organization (RSO) and various bits of information about them. It was hoped that student group leaders could then forward the information on to their group members who might be interested. The investigators wanted active outgoing people to take part in the focus group such that discussion would be vibrant and provide lots of useful information. Unfortunately, the information provided on Campus Pulse is rather outdated and many of the email addresses listed no longer exist as students have graduated and passed the position on to new members. Only a few student groups responded to the emails that were sent out. The majority of the interest came in response to the flyer that was dispersed. The flyer was posted in several busy locations on campus including large lecture halls and common walkways/corridors. Areas close to bus stops were targeted, and areas with administrative offices were targeted. These areas were targeted with the assumption bus travelers might be aware of the Bus Tracker, and staff members might be aware of the roadway information. The overall hypothesis coming into the focus groups were that very few would be aware of the traveler information provided by RTIC, thus there also being a very low usage of RTIC. It was assumed that students would have a decently higher awareness of the bus tracker, due to its advertising efforts on the PVTA buses. Prior to attending, participants were asked several screening questions directly related to those asked in the focus group. Screening questions allowed the ability to cap the group attendance to those who would provide useful information. The questions also provided the investigators with a sneak preview of the participants' opinions and interests. The following paragraphs will describe the groups and their participant make up.

Group One consisted of five female students, three of which were undergraduate students and two were graduate students. The average age of the group was 22 years. Every group member typically walks, bikes, or takes the bus to school.

Group Two consisted of three male subjects, two of which were undergraduates and one was a visiting staff member. This group was planned to have male students, but a slight lack of interest was found amongst the male students that were invited. Many of the male students who responded could not make the time block, or did not qualify based on their screening questions. The two students selected had slightly less desirable screening responses, but they were given a chance nonetheless. To help make the group larger, the accompaniment of the visiting staff member was allowed on the assumption he represented the equivalent of a graduate student. The average age of the group was 31, which is skewed because the visiting staff member was over double the age of the students. The groups travel methods were split between walking and taking the bus.

Group Three consisted of two females and three males, all of whom were staff or faculty members. The average age of the group was 37 years. The travel methods of the group were primarily car and bus. In total, thirteen individuals attended the three groups.

2.3 Results

This section will discuss the results of each portion pertained to the focus groups. For a discussion of the Entrance Questionnaire results, please see section 2.2 Participants.

2.3.1 Screening Questions and Participant Quality

It was found that graduate students, faculty, and staff members provided the most useful information and were the most interested in the study. Undergraduate students were found to have little knowledge and experience with real-time traveler information. This is likely due to a lack of need for the information as an undergraduate who typically can walk to class from the dormitories. Most of the undergraduates, and some staff, used the discussion as an information session rather than a focus group. It seemed as if they just wanted to know what was offered, instead of having specific comments related to their use of information or desire for information. Having attendees like this was not a total loss however; once the participants became aware of information, they were more apt to suggest new ideas for types of information to provide.

Some participants, primarily from groups one and two, did not express any ideas. The investigators believe this is typically normal in every surveying situation. In experience as an undergraduate at this research institution, some professors encourage students to attend or participate in a graduate research study. For the participation, students can write a short report about the experience for extra credit. Because the focus group compensated participants, perhaps some of these participants just wanted to money without much effort put in. Unfortunately, this will happen even with pre-screening.

Those who expressed ideas and comments for the screening questions did so during the group as well. For them, the groups provided a place to be heard and a place for them to voice their opinions and complaints about the system. Even though the group was geared to traveler information, many comments were actually directed towards the PVTA and UMass Transit. It is thought that the participants viewed the focus groups as a good place to voice their concerns because RTIC itself is located in the same building as UMass Transit, and tends to work together with the bus system.

2.3.2 Awareness and Usage

After analyzing the screening questions and facilitating the three focus groups, it was found that roughly four individuals had actually used RTIC. Awareness of RTIC is somewhat a little skewed as the entry letter mentioned RTIC as part of the group's purpose. Five individuals claimed they were aware of RTIC's existence, the four who used the system and one Civil Engineering student who had heard of the website from one of the professors. All together about 38% of the participants were aware of RTIC before the group, and 30% had used RTIC before the group. Again, this wasn't at all a surprise to the investigators as RTIC has not been advertised, at least on campus, that heavily in the past couple of years. The website, MassTraveler, does get a pitch in most of the Transportation courses that are part of the Civil and Environmental Engineering program. One such course in particular is the Intelligent Transportation Systems (ITS) course instructed by Dr. Collura.

2.3.3 Discussion of RTIC Services

The best starting point was the bus tracker (Figure 5), as it was the most well-known and easiest to understand.

Figure 5: Bus Tracker Screenshot (Source: MassTraveler)

The largest problem found with the bus tracker was in the direction of bus travel. An easy solution to this is to put some kind of arrow on the bus blip showing its direction. Currently, the bus description tells where the bus is headed; however, experience has shown this is not always correct. This can be worked around, by watching the bus travel along the screen for a few page refreshes. However, this amount of time is enough to miss the bus. Perhaps all together we could replace the green blips with the number of the bus routes, e.g. 30, 31, 37. This way we would see a circle or square with the number traveling along the roadway, this circle or square could have an arrowhead to show direction. This removes the cluster of dots on the screen that all look identical. One great feature of the bus tracker is it allows for a user to pinpoint exactly where the bus blip should be on the map when they leave their office or home. Instead of watching the screen for several minutes, one staff member suggested adding a “ping” function that sends a “ping” to your mobile phone when the bus passes that particular location. Along with the buses, it would be interesting to have information on passenger numbers, or overload information. This could be added to the bus tracker, e.g. the number turns red when the bus driver flips the overload switch. This could also be sent as a message to a phone. Other additions to the bus tracker could be information of driver change times, as some drivers may be late for their change which causes the bus to sit and wait.

The biggest roadway issue was the Coolidge Bridge, which connects Hadley to Northampton across the Connecticut River (Figure 6).

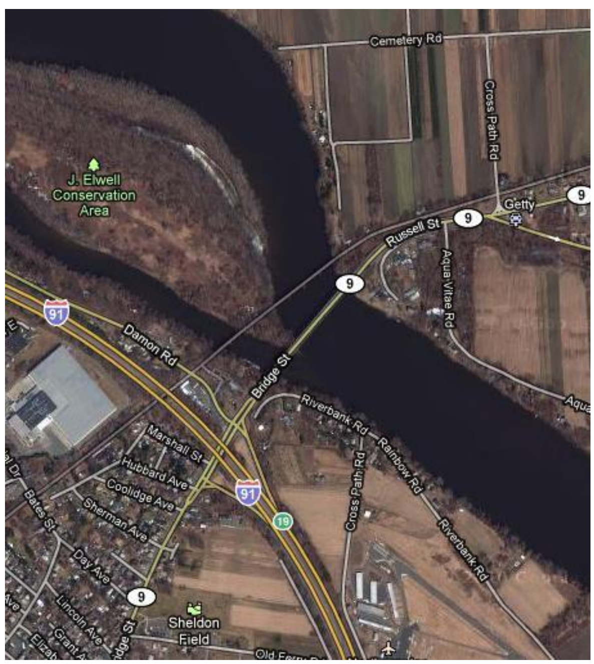

Figure 6: Coolidge Bridge Location (Source: Google Maps)

This bridge has been known to get very congested in the past, but with the new widening of the road deck congestion has alleviated somewhat. Many of the participants greatly enjoyed the webcam images (Figure 7) the most. They claimed that being able to see an actual image is much more satisfying than seeing a number or graph. Images don't lie, yet numbers can be misleading.

Figure 7: Example Webcam of I-91 and Route 9 Interchange (Source: RTIC)

The problem with the cameras is that they are not located in the best places; specifically there are none *on* the bridge. Figure 7 shows the only camera users can currently view to judge traffic on the bridge. The bridge causes problems with non-car travelers also as the two main buses to Northampton (B43 and M40) must travel that direction. The buses get stuck in that congestion during peak-hour and increase the travel time immensely (the B43 was mentioned extensively in the first two focus groups as well due to its irregularity). Coincidently, neither of these buses is included in the UMass bus tracker. This is because the PVTA is managed by three companies: UMass Transit, Valley Area Transit Company (VATCO), and Springfield Area Transit Company (SATCO). It so happens that, the B43 and the M40 are run by VATCO, and therefore is not part of the

UMass fleet to track. It is hoped that in the future all PVTA buses will have tracking capability.

All of the groups discussed the implementation of various message boards for bus stops. These could display or project arrival times or the next bus arriving/leaving at busy stops. Stops that may benefit from these signs were determined to be: Haigis Mall, Lederle Graduate Research Center, Fine Arts Center, and uptown Amherst. Message boards serve multiple purposes in different areas. For instance, a board uptown Amherst could display event going on in town and a board at UMass could display Mullins Center events or special UMass alerts.

Text messaging was discussed extensively as most people have phones that receive SMS. When asked about frequency, most people seemed distraught about receiving several messages frequently when a bus is arriving or departing. To solve this problem, staff members suggested creating a log in system for RTIC. This would allow users to personalize the RTIC page to their actual usage, allowing for an iGoogle sort of home page that allows users to drag around and place items like webcams images or travel time alerts on the page. The user would then be able to access a calendar and set when they would like to receive such messages and pings.

It was found overall that people enjoy information, even if they cannot actually utilize what it tells them. The groups claimed they feel less stressed when knowing what they might be getting into. When something does go awry, having information was claimed to reduce panic.

2.4 Summary

Three focus groups were held in the beginning stages of the project. Two groups contained students and one group contained faculty and staff. All participants were affiliates of the University of Massachusetts. The participants were obtained by distributing flyers to busy areas of campus, and sending out emails to leaders of RSO student groups. Participants were screened prior to attending by answering three sample questions that would be asked during the group. The second group was the smallest, and also had the least desirable screening responses. The group was held anyway to get opinion from male participants. Participants were required to sign consent forms and asked to answer two questionnaires. All questionnaires and consent forms that were distributed are attached in Appendix A.

Each group discussed RTIC and the information it provides. After the presentation of RTIC, three major questions were asked in order to reveal the participants' awareness and usage of this traveler information. Participants were also asked to recount any locations that may be a burden to travel. The group then brainstormed types of information that might alleviate this burden at each location. Troublesome locations were primarily the Coolidge Bridge, Route 9, I-91, and some areas around the campus. The most enjoyed information was found to be the Bus Tracker and the Webcams.

CHAPTER 3

PLANNING OFFICIAL DISCUSSIONS

Throughout the course of this research two presentations were given to regional planning agencies in the Pioneer Valley region. This chapter will describe the meetings, participants, questions, and comments.

3.1 Questionnaire and Participants

The first presentation was given to the Pioneer Valley Planning Commission (PVPC) in September 2011. The second presentation was given to the Franklin Regional Council of Governments (FRCOG) in February 2012. The presentations; led by Professor Emeritus Paul Shuldiner; provided a description of RTIC, a walkthrough of its services, and a small question and answer session. The questions were drawn from responses to the previous focus groups held on campus. The previous focus groups contained three major questions:

1. Are people aware of this kind of service?
2. What are some troublesome areas that may benefit from this kind of service?
3. What other types of information would be useful to you?

Attendees of each meeting ranged from Planning Board members to town representatives. Ideas and concerns varied between members due to their affiliation. Those involved with the counties as a whole seemed more concerned on the grand scheme of things; whereas those involved with individual towns seemed more concerned with the impact associated with their own town. The concerns of the two groups were very different from each other as well, even though the two areas are relatively close to each other.

3.2 Results

Results from the two meetings will be discussed separately in order to show comparisons. A discussion of both groups combined can be found in the section 3.3 Summary.

3.2.1 PVPC Meeting

The Pioneer Valley Planning Commission deals with Hampshire County and Hampden County. These counties include large cities and towns including Springfield, Northampton, and Amherst. The most heavily traveled routes in this general area are Interstate 91, Route 9, and several other interstates in the Springfield area. Interstate 91 and Route 9 have been undergoing a few large projects sponsored by MassDOT for some time. One of the largest projects involving both roadways is the I-91 – Route 9 Interchange in Northampton. The project is studying alternatives to alleviate congestion for the interchange, where the exit ramp for Exit 19 leads into a signalized intersection with the Coolidge Bridge; (For more information in the Interchange 19 project, please visit: www.interchange19.org). The Coolidge Bridge has been the major point of congestion for Route 9. In 2001, the Coolidge Bridge was renovated, adding a lane to the westbound side. Previously, the bridge had two eastbound lanes (heading towards Hadley) and one westbound lane (heading towards Northampton). During the PM peak, the bridge can cause back-ups over a mile and a half down Route 9 as people wait to cross the bridge into Northampton (Simons, 2000). The renovation has alleviated some of the congestion, allowing two lanes of traffic to cross into Northampton, but the light still causes problems.

As noted above, the Coolidge Bridge was the driving force that created RTIC. The reconstruction of the bridge clogged up traffic trying to get to Northampton. The information on Route 9 speed and travel time provided by RTIC helped drivers determine the feasibility of travel. The major hospital in the area, Cooley Dickinson Hospital, is located in Northampton. Anyone who needs major medical attention in Amherst or Hadley needs to cross the bridge to get to the hospital. If the bridge is clogged up, it could mean life or death for some patients. This is a very serious issue that needs to be dealt with, and the members of PVPC agree wholeheartedly.

Because many of the members of PVPC have been dealing with these situations for a while, the questions were geared heavily towards, "What do we do and how do we inform people?" When asked how many people were aware of RTIC and its information, eight people raised their hands. Considering at least four of these people have worked with RTIC in the past or present, this is an extremely low number which was expected. A major interest from several members was the presence of RTIC. Since RTIC is not advertised, at all really, not many people hear about or see it. Some suggestions included posting up banners on other websites, working with media such as radio or TV, and putting ads in newspapers. It was noted, however, that RTIC has worked with the Daily Hampshire Gazette in the past.

Different forms of information were discussed during the meeting, in regards to which types were found useful. It seemed members liked the webcams, which show images of Route 9 and some areas around the Valley. The concern with the webcams is generally that there aren't enough of them in useful areas. There is a strong desire for webcams and information on I-91, which is in the works. One member noted that the webcams are currently only capable of taking still images and then replaying those still images in a loop of four minutes. It would be intriguing to receive live continual feed from the cameras instead of snapshots. The reasoning here being that it could be possible for something small to happen within that interval of snapshots (15 seconds) that would not be easily decipherable by the still images. Others in the group showed some disdain for the cameras on the privacy side. As with any information, there will be complaints as to the privacy of travelers.

Other privacy concerns sprouted up with the Fast-Lane tag readers that determine travel time. It was strictly noted that RTIC does what it can to remove any information that may link to a specific person. The largest privacy complaints came regarding the license plate readers that were used in the beginning stages of RTIC. License plate cameras were stationed on Route 9, and video was captured such that a program could match license plate numbers in order to subtract travel time from two locations. This operation is rather tricky because it allows RTIC to "know" where a specific car is. Some other options for determining travel times are GPS devices. Smartphones now include GPS that can be used to track location and provide navigation advice like a Garmin or Tom Tom. One suggestion was to recruit volunteers to be probes for RTIC and use their GPS to track location and determine travel time on roadways in real time. It was noted that pilot studies using this sort of method have been sprouting up in some areas of the world. Currently MassDOT and RTIC are working to complete a project that uses Bluetooth sensors on I-91. These sensors can pick up Bluetooth signals transmitted from cell phones or even vehicles and can determine travel time by matching signals between sensors.

Another concern was how to get the information out there. MassDOT sponsors a telephone program in use throughout the country called 511, where any cell phone user can dial 511 on their phone to access a series of menus that provide information on specific roadways in their area. The problem noted with 511 is that it only provides information in your area and not in the area you'd like it. For example, if someone commutes from New Hampshire to Massachusetts every day and they call 511 before they leave, they receive information for New Hampshire and not Massachusetts. It has been found that 511 is rather inaccurate for the Western Mass area, sometimes not even listing delays that are well known to the public via the news. This is something that needs to be changed in the future. Reasoning for this problem is that MassDOT does not receive information on areas that can be confirmable. This is also the reason why their advisory map, which is embedded on RTIC, seems out of date or incomplete. Even if MassDOT receives information on closed roadways or construction projects, there is no efficient way to confirm all of the calls without actually driving to the scene. If the instances aren't confirmed and that information is broadcasted when there is no actual blockage, MassDOT and RTIC look untrustworthy. Public input on areas of heavy congestion or road closures could be collected nonetheless without actually confirming everything. It would be possible to open a phone line, where travelers could call in and report their findings in real time. Most news stations now allow this with the use of mobile smartphone applications. There is no stopping RTIC from traveling this route as well but it would require someone to screen calls for useful information. The website would then need a disclaimer noting that not all information is confirmed. Another suggestion was to have people report to the police, who would then be able to report to RTIC and MassDOT, however this would place a burden on the police as well. One very easy and cheap alternative is to open a social media account such as Twitter, which would allow users to tweet the account (@RTIC for instance) about incidents. The account could also follow organizations like MassDOT and various news agencies that post these kinds of notifications. At this point, you need to know your audience. Most of the concern in the area, at least based on the results of the surveys, comes from the older generation. Many of whom may not use Twitter.

The root cause of most problems in the area during the past two years has been weather. The Pioneer Valley has been hit with three major storms last year alone: Hurricane Irene, an unusual tornado outbreak, and an October snow storm. All of these storms caused road closures and even some to become completely washed out for months. Some of the hardest hit areas in Western Mass are the hill towns in the north and the west. The major roadway in these locations is MA Route 2 which runs east-west through the north portion of the state. For a multiple month period a segment of Route 2 was completely washed out and forced a large amount of traffic to be re-routed through surrounding towns. At the same time, segments of I-91 were also closed, forcing re-routed traffic to travel through the small residential streets of Greenfield, MA. With this in mind, the investigators also met with the Franklin Regional Council of Governments.

3.2.2 FRCOG Meeting

The Franklin Regional Council of Governments is a different form of planning committee than PVPC. The FRCOG meeting was primarily town planning representatives, with only a few members of FRCOG itself. It was interesting to be in a group with representatives from different types of towns in the area. Franklin County is large and primarily rural with Greenfield being one of the largest cities. One of FRCOG's priorities, at the moment, is the Scenic Byways program. The area receives heavy loads of traffic in the fall months as leaves start to change colors. The Mohawk Trail, a historic segment of

Route 2, runs right through Greenfield and includes several tourist spots up into the hill towns of Charlemont and Shelburne including the Bridge of Flowers and the Glacial Potholes. The members of the meeting expressed a great deal of concern in accommodating these new travelers along with their own residents.

Much of the concerns were not geared primarily towards congestion, as the area does not see much with exception of the tourist season. The second of two major Connecticut River crossings is located in Sunderland, which falls in Franklin County. Some members claimed that when the Coolidge Bridge backs up, there is a bit of an increase in volume traveling over the Sunderland Bridge. Though it is a bit out of the way from Route 9, drivers consider it a plausible alternative to sitting in traffic. The Sunderland Bridge is also very close to I-91, which can be an incentive as well due to the faster travel southbound once across the river.

It is not surprising that only two of the members had ever heard of RTIC before, and those two members had worked with RTIC previously. RTIC has virtually no presence in Franklin County with exception of two webcams in Athol and Orange. It did not seem as if the presence of RTIC was really needed for the area. Some expressed interest in webcams, and even travel time information for Route 2 and I-91, the two major roadways passing through. Outside of the two major roadways, there haven’t been too many issues in terms of congestion.

Detours, however, pose a giant problem in the area. Because most of the roads stretch through wooded areas and are not built for heavy loads, they become washed out or can become blocked by trees or debris, as seen during the previous storms. Information on roadway closures and detours would be heavily appreciated in this county. A discussion about how to collect this type of data led similar results to the PVPC meeting. Installing webcams and other sensors may be tricky for the area as data connection is not as far ahead as in the Amherst and Northampton areas. There are some cameras along Route 116 and two Fast-Lane readers along Route 116 to help provide information for UMass commuters. Likewise, an alternative to I-91 is Routes 5 and 10 which runs parallel to I-91 through Deerfield and Greenfield. Routes 5 and 10, part of the Scenic Byways, are home to several attractions such as Magic Wings and Yankee Candle's Flagship Store. When I-91 was shut down during Hurricane Irene's large rain storms, Routes 5 and 10 became a nightmare of traffic. Many members suggested a type of warning system to alert locals of incidents such that they can make arrangements to take alternate routes beyond those recommended by MassDOT.

Franklin County differs from their neighbors in terms of public transit as well. Where PVPC partners with the PVTA, FRCOG associates with the Franklin Regional Transit Authority (FRTA). The FRTA provides transit between Greenfield and many other rural towns stretching from Amherst to Worcester County (see www.frta.org). Items were discussed regarding the previous Bus Tracker provided for UMass Transit and the potential future with the PVTA. While FRTA is not exploring such items currently, it was considered a thought for the future. A bus tracker could be very useful in this area due to the rural roadways which can make travel in snowy conditions difficult and cause delays.

3.3 Summary

After visiting the two planning committees it was seen that PVPC seemed more focused on commuters and busy areas dealing with the Five Colleges and Springfield, hitting on the major corridors of I-91, I-90 (the Mass Pike), and Route 9. On the other side of the spectrum, FRCOG seemed focused on preserving its roadways, while catering to its own residents and tourists alike. One has found that Route 2 is a very nice and scenic alternative to the Mass Pike when traveling eastbound. I believe that Route 2 would be a very nice pilot area to provide traveler information, as well as adding information to I-91.

The two major pieces of interest are the two bridges crossing the Connecticut River. Both bridges receive significant traffic, with the Coolidge Bridge taking the brunt of most trips. More cameras were requested for both bridges. Each bridge does have a camera, but perhaps they don't provide the best angle. New methods of receiving the information were discussed in both meetings, including the adaptation of a potential smartphone application, and a better website layout. A site or application that combines weather information, travel information, and other breaking news of events at large venues would be ideal. Most of the participants were older individuals, who don't necessarily follow the current happenings at the University that may draw large crowds to I-91 or Route 9, such as University Move-In or Move-Out, graduation, or concerts. There was a discussion during both meetings regarding storms and evacuation congestion, as well as the aftermath of such storms and the roadway travel problems associated. Flooding and downed trees are not uncommon in Western Mass. Both groups seemed to have some awareness of the cameras located along the roadways, but were not aware as to who they belonged to. To raise awareness perhaps small signs could be posted on cameras noting the existence of MassTraveler. In other awareness studies, it has been found that the most recognized forms of travel information are those seen en-route, (Martin *et al*, 2005). RTIC currently does not provide any information en-route. MassDOT currently has several VMS boards installed on the two major interstates, I-91 and I-90. These message boards could be tied together with MassTraveler to help raise awareness also. Many group members were aware of the 511 program, but voiced concerns over the accuracy of the information portrayed by 511.

CHAPTER 4

POPUP SURVEY

When surfing the World Wide Web one often notices small little boxes asking for user survey information. Website user surveys obtain information about the page viewers to understand the characteristics of the audience. These surveys may ask questions regarding the viewers' desired webpage environment. Perhaps the user wants to see a different type of information than is already displayed on the webpage or maybe the user would like a better page layout. For this reason, a small popup was implemented on the RTIC webpage; www.masstraveler.com; that asked users to complete a short survey regarding their interests with the website. This chapter describes the popup, the survey, and some problems discovered.

4.1 Survey Design

The survey was designed to be short and simple in order to take minimal time for the website users to complete. Through examination of other website's user inquiry surveys it was found that the most effective surveys contain less than 10 questions and have only multiple choice answers, rather than open ended questions. This was considered in the design of the MassTraveler survey. The questions in this survey were chosen to obtain an accurate depiction of the MassTraveler user base. Prior to this questionnaire, RTIC performed analysis on website use by monitoring the most frequent page visits. Pages with the most visits were found to be Webcams and Travel Times.

This survey utilized questions from the full-scale survey which will be discussed in the next chapter. An extra question was added to this questionnaire regarding a potential future smartphone application. Drawing questions from the full-scale survey allows for comparison between the two surveys, e.g. could people utilize MassTraveler to aide in their trips instead of any other information they may already use? The survey asked the user to select: the information they were looking for, their perceived usefulness of the website, their desired smartphone operating system, age, gender, and zip code. The entire survey can be found in Appendix B.

As with all surveys, a consent form was created and attached via PDF to the survey. A web link provided access to the consent information that has been hosted on student Engineering Computer Services (ECS) web-space. The consent form described the usefulness of peoples' responses, information regarding the products derived from their responses, and information on who to contact about the study.

The entire survey itself was created using the Zoomerang survey creation and analysis website. The Zoomerang website allows one to create a series of questions of various styles and formats. The survey can then be distributed several ways: by email, URL hyperlink, webpage embedding, or by social media. This particular survey utilized the generated URL hyperlink to access the survey, which was added to the popup box that appeared on MassTraveler.com.

4.1.1 Popup Design

The actual popup feature of this survey was designed twice by Jamie Schleicher, the RTIC Technician. A redesign was issued after an unforeseen event caused users to become disgruntled. The original popup that was implemented appeared on the center of the page randomly when anyone visited MassTraveler.com (Figure 8). The popup had a percent chance of appearing when the user first accessed MassTraveler. Once the popup appeared and the user clicked on either link, a cookie would be attached in their browser and the popup would not appear again. In order to achieve a greater response, the popup was then set to 100% chance of appearing. Changing the appearance chance to 100% assumed that users were returning users, or those who had already visited the site before. Therefore, when someone entered the survey page they could fully answer the questions. It was also assumed that new users of the website would click the “No Thanks” button because they were not return users. It was found that the majority of people visiting the site chose to take the survey regardless of their usage status. This was likely due to the wording of the popup which only stated:

> In order to better serve travelers in Western Mass, Masstraveler.com would like to know a little about its users and how they feel the website can improve.
>
> Would you be willing to take a quick 2 minute survey?

Two links were listed below the text shown above. One link took the user to the questionnaire, and the other link removed the popup by refreshing the page with a cookie attached such that the popup would not return. At the end of the questionnaire a link was provided to take the user back to MassTraveler. The initial popup and questionnaire were launched in late August of 2011.

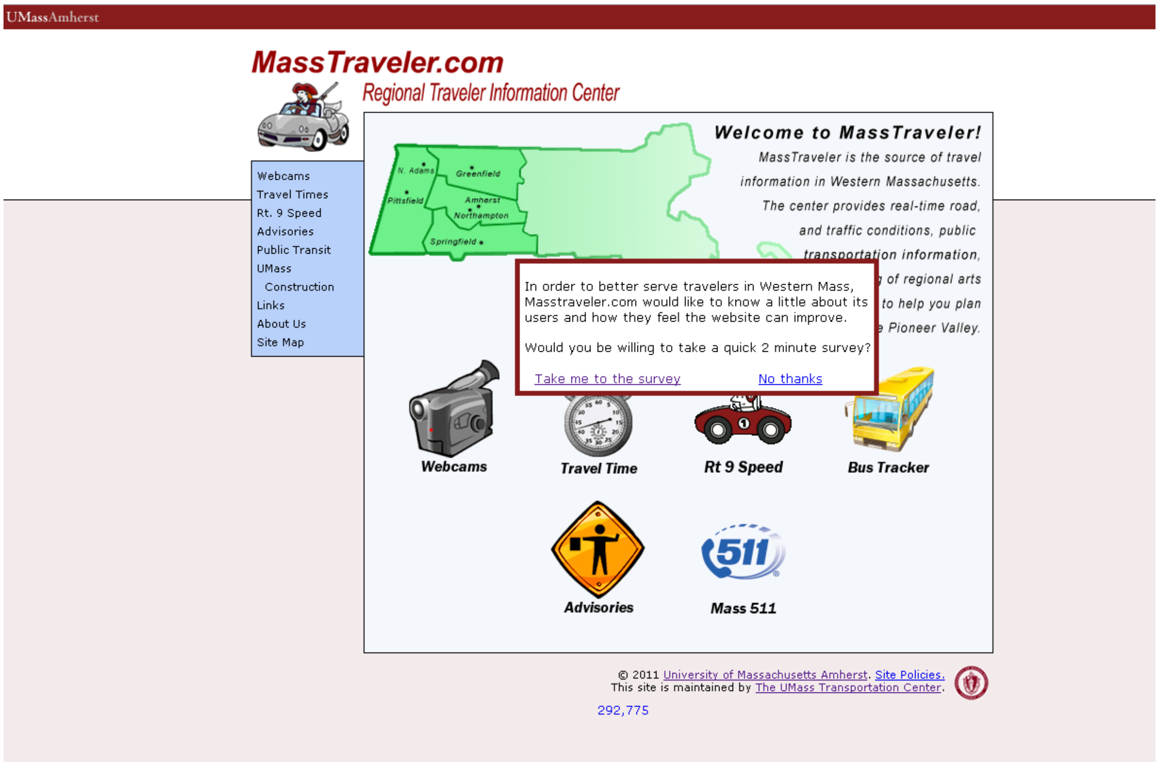

Figure 8: Preview of Initial Popup Placement

Throughout the period of initial launch it was found that the popup and survey combination greatly disgruntled website visitors who were looking for information. About 12% of responses complained of how they had no basis to describe their usage because they had not yet used the website, yet these were just the ones who made note of the fact. Again, it was unknown actually how many new users accessed the website on a weekly basis. The solution to this problem was to redesign the popup's location and behavior.

At this time, 2nd September 2011, the original popup was moved to the bottom left corner instead of front and center (Figure 9). The popup had a 100% chance of appearing, until the user selected a link to either take the questionnaire or to bypass the questionnaire. When the user visited the site, the popup would appear in the lower left corner and maintain that position for the entire visit to the website. The popup would scroll with the user and switch pages, within the MassTraveler domain, with the user. This allowed the user to visit the site without taking the survey and without clicking on "No Thanks" such that they could take the survey legitimately at a later time after viewing the pages and information offered.

Figure 9: Preview of Final Popup Placement

While analyzing the data for the originally implemented popup survey it was found that users became confused when answering one of the questions. One culprit was the question regarding smartphone applications. The question asked, “Would you use a MassTraveler App on your PDA or smartphone? If yes, please select your smartphone or PDA.” Here, several smartphone operating systems were listed along with an “other” category. About 22% of the responses in this question selected “other,” and added that they either did not have a smartphone or would not use an application. It was realized that a “none” value should be added to this question in order to keep things simple. To do this, the original survey was closed and a new cloned survey was launched with the launch of the new popup. Because the two surveys are independent, results were analyzed separately.

4.2 Results

The initial popup and questionnaire, launched in August, served as a semi-trial phase. Responses were monitored for the week following the launch by logging into the Zoomerang website, where responses could be viewed in real-time. It was found, as noted above, that many users were confused or frustrated as to why the popup appeared in front of the page itself blocking the view of the useful information. It was clear that the position needed to be changed if the popup was to appear for the entire visit of the site.

Within one week of the launch of the questionnaire New England was struck by Hurricane Irene. Because the storm biased most of the results from the first launch of the survey, this section will discuss results from the second launch of the survey. A discussion of the storm and its effects on the data is located in the next section.

It is important to note that throughout the course of the survey, not all participants answered every question. Each table lists the total number of responses collected for the question. The percentages in each table are the percent selected for the total amount of answers obtained per the specific question, not the percentage answered per the entire data set.

The first question of the popup survey asks the user what information they were searching for when they accessed the page. Consistent with the focus groups, the most frequently selected item was webcams. The second most popular information source was traffic and construction advisories. A summary of the results for this question can be seen in Table 1. It should be noted that each user could select multiple items on the list, thus the percentages won't add up to 100%. A total of 388 responses were collected out of 390 completions of the survey.

Table 1: Searched Information on MassTraveler

Service	Frequency	Percentage
Webpage Links	15	4%
Traffic/Construction Advisories	191	49%
Webcam Images	241	62%
Travel Times	103	27%
Travel Speeds	77	20%
Bus Tracker (defunct)	24	6%
Other, please specify	48	12%
Total Responses	**388**	

The most popular answer for those who selected "Other" was "road closures." Clearly here we can see that road closure information is the most valued type of information to display, more evidence of this will be discussed later. Some other responses for the "Other" category were: bus schedules, maps, weather information, and "I've never seen this before." After selecting what the user was looking for, they were asked how useful the website was for them. Table 2 displays a summary of the responses collected regarding perceived usefulness of the website. A total of 374 responses were collected out of 390 completions. It can be seen that the majority of users find the website Useful.

Table 2: Usefulness of MassTraveler

Ranking	Frequency	Percentage
Very Useful	110	29%
Useful	162	43%
Neutral	74	20%
Not Useful	16	4%
Very Not Useful	12	3%
Total	**374**	**100%**

This table is a very good indication of user satisfaction of the website as it stands now. This does not mean that the site can't be improved however. One relatively smart and easy improvement would increase the visibility of the website, that being a smartphone application. Applications allow someone to access information from a smartphone on the go in an easier less congested manner than viewing the page from a mobile browser. When asked the preferred operating system for a potential smartphone app responders chose iPhone. Table 3 shows a summary of the selected operating systems.

Table 3: Smartphone Operating Systems

Operating System	Frequency	Percentage
Android	60	17%
iPhone, iPod Touch, iPad	90	26%
Blackberry	18	5%
Palm (WebOS)	4	1%
Windows	24	7%
None	144	42%
Other, please specify	23	7%
Total Responses	**344**	

Users were able to select multiple operating systems if they preferred or had two different phones. Some users filled out the surveys with their spouse in mind also. Unsurprisingly the big two operating systems, Android and iOS, receive the most votes. Almost all of the "Other" responses were clarifying that they did not have a smartphone, even though the investigators had added a "None" option. This problem was found in the initial launch of the popup survey and continued throughout the second period of collection.

The next three questions obtain some demographic information regarding the users of MassTraveler. Characteristics obtained include gender, age, and zip code of the responder. The following three tables summarize the responses obtained.

It was found that most responders to the survey were male, Table 4, although not by much. A total of 383 people responded with their gender, 219 of them reporting male. This is interesting because the most frequent gender that responded to both the focus group studies and the full-scale survey were female. Although the three studies aren't comparable, it seems that males were more apt to access MassTraveler.

Table 4: Gender of Users

Gender	Frequency	Percentage
Male	219	57%
Female	164	43%
Total	383	100%

The average age of all of the responders was found to be around 50 years of age. A breakdown of the age groups is seen in Table 5. The most selected age group was found to be the 56 – 60 years of age group. Most of the survey's participation came from older individuals. Only about 5% of the responses came from "college aged" individuals, assuming "college aged" is 25 and below. This is unfortunate as it shows the undergraduate, and some graduate, population is relatively unaware of the website. The other possibility is that they are aware of the website, but they don't like taking surveys. A possible reason for the low usage by young persons is the lack of a need. Students generally don't have anywhere to travel that can't be navigated bus or walking, save for going home.

Table 5: Age Groups of Users

Age Group	Frequency	Percentage
<18	1	0%
18-20	2	1%
21-25	14	4%
26-30	11	3%
31-35	21	6%
36-40	14	4%
41-45	24	6%
46-50	57	15%
51-55	58	15%
56-60	78	21%
61-65	50	13%
66+	45	12%
Total	375	100%

The survey also collected users' zip codes of residence. This gives RTIC and the investigators a view of where the information is being searched from. A total of 371 responses were collected during the second launch of the survey. The most responses came from Amherst (15%), Northampton (13%), Hadley (3%), Sunderland (3%), Greenfield (3%), and the surrounding area. It was surprising to see so many zip codes from out of state, including as far as California. It seems that university alumni are using the site to keep an eye on the inner happenings of their alma mater. Many of these people from far away suggested more cameras throughout the busy areas of campus to view pedestrian traffic and changes to roadways as the university continually adds to its infrastructure repertoire. Just by looking at the most frequently answered zip codes it is easy to see the need for more information along the I-91 and Route 2 corridors. Currently most of the information is located throughout the Five College Area. Though this area makes for good testing and research projects, for the website to claim its status as a top traveler information provider it needs to branch out and cover more areas in Western Mass. This popup survey confirms many of the items discussed in the focus groups and the planning committee meetings discussed above. Like those meetings, this survey asked a follow up question as to what users would like to see added to the site. Many of the responses correlated directly with the zip code listed.

A total of 201 people left extra comments regarding RTIC and MassTraveler. The comment prompt asked, “What else would you like to see added to MassTraveler?” An analysis of these comments revealed 78 comments containing keywords relating to webcams. From the responses, many people wanted more of them in more useful places. Location suggestions were for cameras on I-91, Route 2, the Turnpike, Northampton, Springfield, Greenfield, and on Route 9. An unsurprising comment was the need for cameras to be moved to well-lit areas such that the image was useful the whole day instead of just during daylight. The solution to this would be to add lights to the cameras on Route 116, or to shift the cameras to locations that contain a street light. Many recommended the addition of live streaming capability instead of still image capture. Some benefits to live video instead of stills are discussed in the above sections. In particular, one user requested larger images for the cameras as she couldn’t see well.

Perhaps allowing the cameras to stream without actually having to open a new popup window might be helpful.

About 15 responses contained keywords relating to the bus tracker. The bus tracker, though very expensive, has proven to be a valuable asset to RTIC and the PVTA. Bus trackers work very well and provide riders with extra comfort when waiting at the bus stop. The PVTA has talked about the installment of a new tracker with the implementation of their new ITS systems. If the tracking system gets off the ground it would be worth their while to include RTIC as a possible host for the information. Finally, about 52 comments included keywords relating to weather, road closures, and advisories. One of the major recommendations was the incorporation of some form of weather information on the site. Two interesting additions could be a ticker that would scroll alerts on the front page along with other traffic advisories, or an interactive map that could be superimposed from Weather Channel onto the pre-existing advisory map. The advisory map also needs an overhaul. Surrounding states have much better maps that show clear and concise information in different forms on one common map. One in particular is discussed in the next section.

4.3 Problems and Discussions

Shortly after the popup was launched New England was hit by Hurricane Irene as it moved up the east coast. The severe storm system caused extreme flooding throughout the region for several days. Flooding caused major roadway and bridge damage on varying types of roads, completely washing out a segment of Route 2 for a multi-month period and closing down a segment of Interstate 91 for several days. The areas hardest hit were those in the northern part of the state and Vermont. Because the storm traveled northbound, heavy rains flooded rivers which carried high waters southbound. Thus, even when Massachusetts was out of the storm, heavy flood waters still raged. Rural roads were destroyed beyond immediate repair, causing many residents to become stuck. During, and immediately after, the storm an overwhelming amount of responses to the questionnaire poured in. The majority of these responses were searching for one type of information, "Road Closures." RTIC offers this information by means of the MassDOT advisory map that is embedded on the webpage. Generally the map does well with MassDOT affiliated construction projects, but fell short when travelers really needed road closure information. The map provided no information regarding roadway closures in Western Mass due to Hurricane Irene. After a few days some blips appeared on the map noting important road closures such as I-91 and Route 2; however the blips of information did not describe the distances of the closure or any detours that travelers should take. Many responses reported that surrounding states' traveler information websites performed miles better than that of RTIC/MassDOT. One that received many comments is that of Vermont who was struck very hard by heavy flooding, losing roads and bridges throughout the rural area. Vermont's map (located at www.511VT.com) showed a significant amount of road closings, including rural roadways and not just highways. The interactive map includes not just advisories but also shows locations of webcams and travel speed sensors. Everything is centralized on the front page. Observing comments and suggestions over the course of this study has shown a need for MassDOT or RTIC to update this system to match that of the surrounding New England states.

Due to the large influx of responses all searching for the same information that frankly wasn't there, the investigators decided stop collecting and bring the results to the attention of MassDOT who is responsible for the advisory map. A report was written up that describes the effect of Hurricane Irene on each of the questions asked for the popup survey. This report was given to MassDOT and RTIC, and was discussed greatly during the PVPC Meeting that is discussed in Chapter 3.

Prior to and during the storm 112 responses were collected. Only a few questions were considered biased by the storm. When asked what the responders were searching for, a strong edge was given to Advisories and Road Closures. Results of this question are seen in Table 6. Almost all of the “Other” comments here are requesting “Road Closures” or “Flooded Roads.” This adds about 35 extra responses to the Traffic/Construction Advisories column. At this point it was realized that including this data would potentially throw off the results and inaccurately portray the most frequently searched information. The primary reasoning for this was because most of these responses were from first time users of the website. To help remove responses from first time users the popup was moved to the lower left corner, see section 4.1.1 Popup Design.

Table 6: Searched Information on MassTraveler (Hurricane)

Service	Frequency	Percentage
Webpage Links	3	3%
Traffic/Construction Advisories	71	64%
Webcam Images	31	28%
Travel Times	18	16%
Travel Speeds	10	9%
Bus Tracker (defunct)	4	4%
Other, please specify	38	34%
Total Responses	**111**	

The second question that was found to be potentially biased was the second question, which asks for the usefulness of RTIC. Because most of the users were first time users they had no basis on ranking the website's usefulness. The majority of the answers here were found to be neutral. The responses can be seen in Table 7, with a large neutral response.

Table 7: Usefulness of MassTraveler (Hurricane)

Ranking	Frequency	Percentage
Very Useful	10	10%
Useful	33	34%
Neutral	44	46%
Not Useful	5	5%
Very Not Useful	4	4%
Total	**96**	**100%**

Restarting the survey would prove to remove most of the neutral responses. If the neutrals were thrown out of this table, the website is still considered pretty useful in most peoples' eyes. This is a good thing, and means the site is heading in a good direction. The rest of the questions and the analysis of the responses are discussed in the full report found in Appendix C.

CHAPTER 5

FULL-SCALE SURVEY

In September 2011 a web-based survey was distributed via Zoomerang (www.zoomerang.com) to a sample of University of Massachusetts affiliates via their email addresses. Participants were free to skip any questions they could not answer or did not want to answer. Upon completing the survey, participants were entered into a raffle for a $25 gift card to a vendor of their choice. In total, 329 responses were collected over a three month span. The following chapter will discuss the survey's design, implementation, and various results obtained.

5.1 Survey Design

The full-scale survey went through several stages of design and revisions before it was launched in September 2011. To start, Microsoft Word was used to create a list of questions and basic question format. Each version was then sent through a panel of reviewers from the UMass Transportation Center and MassDOT. Reviewers ranged from MassDOT project managers, professors, staff, and graduate assistants. After review of several iterations, the survey was then added to Zoomerang which altered much of the original format. Each online version was then reviewed by having a select few participants take the survey and then comment on their experience. This process allowed the investigators to correct any confusing wording and question format problems. After a final version was obtained, it was cleared through the Institutional Research Board (IRB). Clearance was needed as the target participant pool was primarily university affiliated.

The survey passed as it did not potentially damage subjects in any physical way, and was launched shortly thereafter.

Throughout the majority of the revisions, the survey contained six parts:

- Part I: Lifestyle and Travel
- Part II: Awareness and Usage of Regional Traveler Information Center
- Part III: Attitudes Towards Information Type
- Part IV: Most Memorable Use
- Part V: Demographics
- Part VI: Contact/Raffle

After reviewing the comments and answers of each participant it is easy to see which questions were effective and which were not. The next few sections will describe each part of the survey and how it was revised to achieve the final product that was distributed. An entire copy of the distributed survey is included in Appendix D.

5.1.1 Part I: Lifestyle and Travel

In order to provide a complete assessment of RTIC's potential user base, it was interesting to obtain some basic travel characteristics from the participants. The first section asked several questions regarding the number of usable vehicles each household has and the typical commute methods each participant uses. Knowing that each emailed recipient visits the university regularly, it was thought a commute trip end point would be UMass. At the first stages of design, several questions were proposed regarding this commute including parking lot location and availability of several travel alternatives. To help shorten the length of the survey the investigators focused on car availability in association with commute mode.

Tying the survey towards the use of information, four questions asked the participant about their availability to information providing sources and their usage of such sources to obtain travel information. To keep it simple, participants were asked if they had access to some popular electronic devices such as a GPS navigation device, smartphone, or internet connectivity. Once access was obtained, the investigators questioned if the participant used these devices to receive traveler information. Three more options were added here including radio, variable message signs and 511. These options were added after review of current information availability. Though these three aren't tailored directly to RTIC itself, traveler information was considered potentially easier to recognize from these sources. Likewise, the next question asked the participant to select how often they search for traveler information to aide in their travels. Options were worded in "times used per month." The initial wording provided options including, "Daily, Weekly, Monthly, Never." It was decided that this might include too much variability in the perceptions of participants. One person's definition of "weekly" might be different from that of the investigators. Options were then redesigned to involve numbers, which are easier to visualize. Connecting back to RTIC, the next question asked what types of information participants searched for. This question narrowed down selections to items specifically offered by RTIC with an option to describe an "other." Linking the responses with offered services provides RTIC with the most valued form of information it currently provides, even if the participants have never used RTIC before. Thus, RTIC can then tailor its website to focus on providing the information that participants may be venturing to other locations to find. Now that the participant has answered some basic questions regarding traveler information, they were then asked to describe their awareness of RTIC specifically.

5.1.2 Part II: Awareness and Usage of RTIC

This section remained virtually the same throughout all revisions, on the account of its pretty straightforward. Though the title describes the "Awareness and Usage," there was no question that specifically asked "Are you aware of RTIC's presence?" Not having this one question is seen to be one of the major problems with the results found. Most people had no idea that RTIC existed in the first place but had no place to note so. Alas, questions regarding the usage of each RTIC service, and perceived usefulness of each RTIC service were asked. Usage and usefulness were combined into two questions, when really it resembled 10 small questions; RTIC provides about five services at this time. To end the section, one question asked what potential benefits the participants might receive from obtaining/learning information during their travels. This question provided four suggested answers, "Reduce Anxiety, Avoid Delay, Allow Better Arrangement of Activity, and Ensure On-time Arrival." These options were thought to be the most plausible benefits taken from focus group responses. A final question allowed a place for participants to place extra comments about MassTraveler and RTIC. Most of the responses here are where participants noted they had never previously known about RTIC. After receiving a bit of information regarding RTIC use as it stands, the investigators wanted to give participants a place to voice their information desires.

5.1.3 Part III: Attitudes Towards Information Type

This section was really a continuation of the previous section, but was broken up to keep question pages short. In this section, a question was asked interest in several potential initiatives in new traveler information for the area. None of these options are currently being explored, to the knowledge of the investigators. Some of the initiatives were information on parking lot availability, bus overload, and personalized web page capability. Due to the University's large amount of construction of the past few years many of the parking lots have been removed for placement of new buildings. This diminishes the amount of premium parking availability; premium meaning close to the building of choice. Information showing parking lot capacity and availability might be helpful to some people who have other parking options. Those who bus to the University know the increase in enrolled students every year causes the buses to reach capacity much faster than in previous years. The University recently removed the requirement for sophomores to be housed in dormitories, likely in order to fit the large incoming freshmen classes every year. Not housing sophomores puts a strain on the surrounding apartment complexes as well as the bus system at peak hours. Those trying to reach campus in the morning peak often have to miss several bus cycles because the bus is "overloaded." Knowledge of the bus capacity and seat availability would be helpful to those who live mid-route and might not be able to get on the bus when it arrives. This would provide that person with the option to then walk, find a different bus route, or find another way to spend their waiting time. A personalized website was foreseen to be something similar to that of iGoogle, which allows its users to organize the webpage to their liking. Some traveler pages, including New York's, allows users to drag information blocks around the page and collapse information they don't need to see. The last question of the section asked participants to describe a troublesome area in their travels that might benefit from traveler information. This question was taken directly from the focus groups in order to obtain potential locations for RTIC expansion. This question was formatted as open ended; similar to that of the last question of the previous section. Open ended questions work well because it gives the participant the ability to write a short narrative; however they only seem to work well with short surveys.

Along with obtaining information regarding the awareness, usage, and usefulness of RTIC, the investigators planned to build a model around real-life travel situations. The next section was included for these modeling purposes.

5.1.4 Part IV: Most Memorable Use

The largest section of the survey was the section regarding traveler information usage during a trip. The primary purpose was to obtain preference travel data for which a model could be estimated to represent traveler behavior. Two types of travel data were desired, revealed preference and stated preference.

The investigators used focus group responses to research various locations around the Pioneer Valley, mainly the Five College area, which might fit as a hypothetical scenario location. Designing a hypothetical scenario location would allow the investigators to collect stated preference data for that individual. The scenario would ask participants which way they would travel provided a specific situation should occur in that location. After a significant amount of research and time spent on organizing a scenario location, the scenario section was removed from the survey design. It was found that the Five

College location does not contain very many locations that would serve as a good scenario. The final proposed scenario included the use of Route 9 heading towards Amherst, however after discussion with focus group participants it was realized that the congestion on Route 9 is caused by trying to cross the Coolidge Bridge into Northampton, the opposite direction. The only viable alternative to crossing the bridge toward Northampton is to cross the river via the Sunderland Bridge, several miles north. If one was to already be on the Coolidge Bridge, they couldn't turn around or alter their travel in any way. No scenario was found during the time of research that would work effectively for the survey. Without an effective scenario the stated preference portion was removed.

Instead, this survey collected revealed preferences from responders. This section of the survey collected information to emulate a study completed by Polydoropoulou *et al* (1996), which asked participants to recount the most recent time they became are of unexpected congestion along their route. Polydoropoulou *et al* (1996) modeled revealed preference data for the San Francisco Bay Area, much larger than the Pioneer Valley's Five College Area. This survey took the revealed preference questions further and asked participants to recount a previous time they utilized real-time traveler information during their travels. This section focused on receiving characteristics for the participants original or habitual travel patterns, as well as their best alternative travel patterns for a particular trip where information was used.

The section asked questions to obtain several alternative specific attributes used in the decision making process, including:

- Estimated Start Time of Trip
- Route
- Estimated Total Travel Time
- Estimated Travel Time Variability
- Estimated Number of Bus Transfers
- Estimated Bus Wait Time
- Number of Traffic Lights Passed

These attributes were considered to be the driving forces of the switch decision as higher travel times generally cause higher disutility. To determine a comparison between alternatives, the participant was to provide estimated travel time for three instances: the habitual travel pattern, the habitual travel patter after receiving information, and the alternative travel pattern. Comparing these three times provided a base for the model that will be discussed later. Several other attributes were also asked including origin/destination, departure time of the trip, weather at the time of the trip, time constraint on arrival time, and various questions regarding the information received and how it affected their decision.

Information sources and types could be selected similar to the questions in Part I and Part II. Participants were asked which travel pattern they chose, either to continue the way they were currently traveling or to switch to the best alternate travel pattern. As discussed later, this question represents the choice variable when modeling. Participants were also asked what their best alternative was, out of a list of six provided answers. The six possible alternatives were provided for the participant to select:

- Different Departure Time
- Different Route
- Different Mode
- Different Destination
- Add a Stop Along the Way
- Cancel the Trip

The question allowed participants to select multiple options, as well as "Other." For the area, these six were seen to be the most plausible in terms of travel choice. After selecting their alternative, the participant was asked to describe the alternative in their own words. To model effectively, all of this information would be needed for each individual's trip.

Wording this section was difficult. At the start, the survey was written in Microsoft Word as if it would be mailed or taken paper style. This allowed the questions to be worded a bit differently than using the Zoomerang interface. Several iterations of question layout were examined, including how to order the questions for each alternative. At the start, it was determined the participant would list attributes for three best alternatives to their habitual travel pattern. This proved to be much longer than desired even with the use of skip wording. Skip wording is a function that allows the participant to skip questions with selected answers to a target question. It was found the easiest way to receive answers to the attributes desired was to ask individual questions in the order listed above, separated by a series of questions describing the information they received and their decision. This design allowed for a narrative style flow that followed the format of, "I usually travel this way, but I found out this information that allowed me to travel this way instead." An initial design format was to organize this information in a concise table seen in Figure 10.

EXAMPLE:						
Alternative	*Note: Only list the most traveled roadway or route for each alternative.*			Estimated Travel Time (Minutes)	Travel Time Variability (+/- Minutes)	Typical Roadway Congestion *Please Rank A-F: A=Empty Road; F=Traffic Jam*
	Roadway (car, bike)	Bus	Road Name or Route Number			
1	□	X	Route 31	20	10	A
2	X	□	Rt. 116/North Pleasant	10	5	A
3	X	□	Rt. 116/Mass Ave.	15	10	C
4	□	□				
5	□	□				

Figure 10: Example Proposed Table of Responses

Unfortunately; Zoomerang does not allow the addition of these types of tables. The solution was to individually ask the questions, which increased the question length and may have confused several participants throughout the course of this survey.

In total this section was 25 questions of varying styles: multiple choice, fill in, and open ended. The varying styles proved to be a problem in the data analysis and modeling portion that will be discussed later. Fill in questions were used to obtain travel times and variability times. Open ended questions were used to obtain narratives for route and information description. Multiple choice questions were used for selection of information type, weather type, and bus information. The final two sections asked participants to provide some basic demographic and contact information.

5.1.5 Part V: Demographics and Part VI: Contact/Raffle

Part V included six questions regarding demographic information of the participant. Participants could skip any questions they felt necessary. Basic demographic questions were searched via the use of Google. Because demographics can be a sensitive area, questions were sampled from various other internet surveys and Zoomerang's help tutorials. The questions asked included age, gender, ethnicity, UMass affiliation, zip code, and income.

Finally, one small follow up section was added such that the participant could enter a raffle. The raffle was used as an incentive to participation in the survey. Participants were to choose one of five vendors for which the investigators would purchase a $25 gift card to, should they be selected. One winner was selected for every 50 participants. Winners were selected randomly with the use of Excel's random number generator. Random observations were pulled. If the observation included a complete survey and included contact information, they were selected and received a gift card. If the observation did not include a complete survey or contact information, another random number was pulled. Gift cards were sent through email with the e-Gift Card function through the vendor of their choice.

5.2 Implementation and Participants

Unlike the popup survey discussed above, this survey was distributed primarily by email to members of the University. Several other distribution options were explored as Zoomerang allows surveys to be distributed by a few different methods. It was found that using emails would be the most selective method. Unfortunately, mailing several thousand emails at the same time causes some problems. Initially, the survey was planned to be mass emailed via UMass Office of Information Technology (OIT). This would provide the "umass.edu" email tag to make the email seem more official. However, OIT regulates mass email lists and the amount of inbox space that is provided. Research found that OIT only allows faculty members to create mass email lists for course purposes. An alternative option to using OIT was to create a third party email account, such as Yahoo or Google. The investigators created a Gmail account[1] to house all email conversations regarding the project. This email address was then going to create a large Address Book and send one email to everyone in that address book. It turns out; Gmail does not allow this due to its spam regulations. Gmail regulates a maximum of 200 emails per day, and also recognizes when users are sending the same email to multiple people. This email can then become flagged as spam. The final solution was to let Zoomerang send the emails. Zoomerang provides a distribution option that allows for a large address book to be pasted into a field. The website then asks for your invitation email text and any other branding. Once sent, Zoomerang sends all of the emails at once as bulk (low priority) email. Low priority mail often gets sorted out from most inboxes at this point. For those emails that did make it through to the inbox, there needed to be a way for the person to remove themselves from the email list. An opt-out section was added to the end of the invitation that provided a link for recipients to click that would remove them from the distribution list. Reminders were sent the same way, except a short section of text was added before the original invitation noting that it was a reminder. Reminders were not sent to anyone manually removed for the list, or anyone who followed the opt-out procedure.

After the period of return started to slow, another distribution option was explored. The investigators created a Facebook event page that included the same text as the invitation email, and the generated hyperlink to the survey. Once the event was launched, all friends of the investigators were invited to take part in the survey. Over a span of two weeks, about 20 more responses were collected.

[1] This email account was also used in the recruitment of focus group participants, as it was listed on the recruitment flyer.

The survey was sent to undergraduates, graduates, staff, and faculty members. Students were sampled from the University of Massachusetts Student Directory 2009-2010. About four names per column, which equals about sixteen names per page, were selected. Each selected name was then entered into the UMass People Finder, located on the UMass website (www.umass.edu). People Finder provides information about the entered name, including university affiliated email address. Just over 2,000 students were sampled from the Student Directory out of roughly 20,000 students enrolled in the University. Some issues were found by using this method. The primary cause of the problems was due to the out datedness of the Student Directory. The University ceased printing the paper directory after 2010, which led to the use of the 2009-2010 Directory. Being an old directory, several names that were pulled came up non-existent in People Finder due to graduation. One quicker method of entering names was to select one last name and take several subjects with that same last name. This however led to the careless selection of some Staff and Faculty members as People Finder does not discriminate the affiliation of the listings. These were caught by examining the Faculty and Staff database in relation to the Student Database.

The Faculty and Staff database was obtained from Human Resources. After a period of several months, the University complied with our request and allowed the use of a database that contained every registered staff and faculty member of the university, their zip code of residence, and their email address. A total of just over 6,000 staff and faculty members were utilized from this database. One issue was found with this database, that being it included several undergraduates and graduate students who were employed as UMass Staff members. It was assumed that the two databases did not overlap in this aspect. The survey asked questions regarding perceptions and use of real-time traveler information. Understanding that mostly commuters would use this type of information rather than students in dormitories, the survey answers were thought to be heavily depended on those responses from staff and faculty. In this respect it was decided to use the entire list of staff and faculty members instead of just a sample.

About 8079 emails were sent at the start of distribution. Two reminder emails were sent; the first reminder was sent in late September, the second reminder was sent in early October. The survey received 307 responses in two months of activity. Including Facebook responses, a total of 328 completions were received. For the purpose of statistics only the responses from the emails will be discussed here.

The goal was to receive between 5 and 10 percent responses. This survey received about 4% response. One of the big setbacks was the lack of emails that actually made it to the subjects. Many of the invitations bounced back due to "Out of the Office" notifications. A total of 6,726 invitations were soft bounced throughout all three invitations. A Soft Bounce is when an email is delivered to the recipient, accepted by their mail server, but bounces back before it actually reaches the recipient's inbox (QuinStreet Inc., 2010). This leaves a total of 27% of responses left that were not soft bounced. Several emails were also hard bounced. A Hard Bounce is when an email is delivered to the recipient's mail server but is not accepted and is immediately bounced back to the sender (QuinStreet Inc., 2010). A total of 63 invitations, about 0.77% of total responses, were hard bounced. Therefor a total of 26% (about 2100) of the total emails actually made it to the participants' inboxes. If the new population size is then 2100 participants, a total of 307 responses yields a 14% return rate. A summary of the responses collected is discussed in the next section.

5.3 Summary Statistics

This section will describe some basic summary statistics of the results to each questions asked in the survey. Each part of the survey will be discussed independently, so as to maintain organization. Part IV of the survey asks questions regarding the participant's "Most Memorable Use." This section was used for creating the choice model; however the data needed to be cleaned in order for the model to be estimated. The cleaning process and some summary statistics of the data after the cleaning process will be described in the next chapter.

Similar with that of the popup survey, not all questions were answered by every participant. Each table listed below contains the total amount of responses collected for the question. The percentages are calculated by analyzing the number of selections for each answer divided by the number of completions for the specific question.

5.3.1 Part I: Lifestyle and Travel

As discussed above, this section collected information regarding participants' travel habits and availability to potential information providing sources. Of the 328 responses collected, it was found that most households have two vehicles available, Table 8. The average between all responses comes out to about two vehicles as well.

Table 8: Available Vehicles per Household

Vehicles	Frequency	Percentage
0	7	2%
1	86	26%
2	165	50%
3	46	14%
>3	24	7%
Total	328	100%
Average	*2*	

When analyzing commute mode, 72% of responded with driving alone, Table 9. Considering that most participants were staff and faculty members, this result is not surprising. Most staff and faculty members commute from varying distances, some as close as Amherst and others as far as Springfield or even Boston. A total of 21 people selected "Other." The responses written by those who selected "Other" described multiple modes of transit, as if the participant had multiple choices that varied depending on the day or certain situations. The question itself only allowed for the selection of one answer and some wanted to select two or three. Thus the majority of the descriptions contained combinations of bus, drive alone, bike, and carpool. Taking the free bus system was found to be the second most popular, followed by carpooling and then non-motorized methods. Throughout the analysis of the different comment questions asked in the survey, it was found that biking is a viable option for most local people, even in the winter time.

Table 9: Typical Commute Modes

Commute Mode	Frequency	Percentage
Drive alone	235	72%
Bus	24	7%
Bike	11	3%
Walk	12	4%
Carpool as Passenger	8	2%
Carpool as Driver	15	5%
Other	21	6%
Total	326	100%

Comparing the responses with that of vehicle ownership, only 7 people claimed they had zero vehicles. This means that even though vehicles are plenty available, around 50 participants choose to take non-motorized or public transit instead of their personal vehicle. It should be noted however, when describing the number of available vehicles in the previous question some people may have listed their bicycle as an available "vehicle" even though it is not motorized.

Only 205 participants responded to the third question regarding information source availability, seen in Table 10. This question allowed participants to select as many sources as they had available to them. The option to choose "Other" was allowed to see if any other interesting media might be available for future information dissemination. Unfortunately, the majority of the responses to "Other" were not a useful medium to broadcast real-time information. An overwhelming 98% of the participants listed "Internet" as an available source to receive information. Considering this survey was taken via the internet, this number should be 100%, but perhaps some don't have internet at home but they do at work. Other available resources were social media, with 70% of responses, and text messaging. Social media seems to be ever expanding during this generation, and can be a great way to distribute travel information. GPS navigation devices were also prominent, but these may be becoming less popular as many smartphones have applications that can provide similar capability.

Table 10: Availability to Information Sources

Information Source	Frequency	Percentage
GPS Navigation Device	186	58%
Web-enabled Smartphone	130	40%
(SMS) Text Messaging	208	65%
Facebook/Twitter	224	70%
Internet	315	98%
Other, please specify	14	4%
Total Observations	**205**	

After receiving which items participants had access to in their homes or offices, participants were asked to select which items they actually searched for information with. This question removed Internet as an option and added three new sources including radio, variable message signs, and telephone. These sources generally provide en-route information and are located along the roadway in sign form. For example, one highway may contain a road sign that says, "Turn to AM 1380 for Roadway Information," or perhaps a sign that says, "Dial 511 on your Mobile Phone for Roadway Information." These types of information sources may be more well-known because they are put in front of drivers' eyes. Again, only 205 participants responded to this question. Table 11 shows a large percentage of responses including radio as a search method. Radio based traffic information has declined in recent years, mainly being broadcasted during the morning and afternoon peak hours. These results may also have a correlation with the age of the participants that responded, as it was though the younger population may be more in tune with smartphones and new technology while the older population remains true to their background with radio and signage. Thirty five participants responded with “Other” comments. Many of these discussed the use of television, similar to radio, to receive information. Some other participants discussed the use of co-workers or spouses to obtain information. The participants described situations where one co-worker might travel a bit early and then report the areas of high congestion or vehicle crashes such that the rest of the staff did not travel the same way.

Table 11: Use of Information Sources to Receive Travel Information

Information Source	Frequency	Percentage
GPS Navigation Device	52	25%
Web-enabled Smartphone	63	31%
(SMS) Text Messaging	17	8%
Facebook/Twitter	11	5%
Radio	105	51%
Roadside Variable Message Signs	87	42%
Telephone (e.g. 511)	26	13%
Other, please specify	35	17%
Total Observations	**205**	

The participants were also asked how often they search for information using the sources they reported. A summary of responses is listed in Table 12.

Table 12: Frequency of Information Usage

Number of Times Searched / Month	Frequency	Percentage
Never	145	45%
1 ~ 5	144	45%
6 ~ 10	18	6%
11 ~ 20	6	2%
21 ~ 30	10	3%
Total	323	100%

Of the 323 total responses, about 90% of them selected less than 5 times per month. Several reasons may describe this. Perhaps the travel times in this area don't vary enough to make information worthwhile, or perhaps the information just does not exist in the eyes of the participants so they couldn't use it even if they wanted to. This study shows evidence for both cases including a low awareness of information availability and a low availability of alternate routes (when considering the Coolidge Bridge). The investigators did note a number of comments where participants noted they wanted to select an area between 1-5 times per month and never. Not having an available selection for this caused participants to pick either the upper or lower bound.

Table 13 shows a general summary of the types of information that participants have searched for during their travels. These information types mirror that of RTIC, such that this thesis can then provide RTIC with types of information that should be highlighted. Of the 242 responses to this question, 68% searched for congestion on roadways. RTIC offers a few different methods of disseminating this information for Route 9; including a display of travel speeds, travel times, and an advisory map showing construction projects. Similar to this, the next two most popular types were travel times and construction alerts. Those who chose "Other" discussed a need for weather related information and bus related information, similar to that found in the popup survey.

Table 13: General Information Types Searched For

Information Type	Frequency	Percentage
Travel times for specific roadways	101	42%
Congestion on specific roadways	165	68%
Webcams for specific roadways and intersections	58	24%
Bus locations or bus arrival times	76	31%
Traffic accident alerts	78	32%
Construction alerts	101	42%
Other, please specify	19	8%
Total Observations	**242**	

5.3.2 Part II: Awareness and Usage of RTIC

This section asked a few questions regarding the usage of RTIC information similar to that above. Each participant was asked the estimated number of times per month they access the MassTraveler web pages for information. A summary of the results is listed in Table 14.

Table 14: Usage of RTIC in Times per Month

Top number is the count of respondents selecting the option. Bottom % is percent of the total respondents selecting the option.	Number of Times Accessed / Month				
	Never	**1 ~ 5**	**6 ~ 10**	**11 ~ 20**	**21 ~ 30**
Bus Tracker (defunct)	283	20	6	4	3
	90%	6%	2%	1%	1%
Route 9 and/or Route 116 travel times	250	57	10	2	3
	78%	18%	3%	1%	1%
Webcams	240	68	6	3	4
	75%	21%	2%	1%	1%
Construction Alerts	258	52	6	2	4
	80%	16%	2%	1%	1%
Route 9 Travel Speeds	267	38	5	5	2
	84%	12%	2%	2%	1%

This table shows an overwhelming bias towards "Never" which represents the large sample of people who are either unaware of MassTraveler, or do not see a need for the website. This question began with a short description of MassTraveler and a basic description of each of the services listed. At this point, participants were no longer "unaware" of RTIC but may have never known about it before. For those who had used the webpage in the past, usage is limited to once per month or once per week. Webcams were seen to have the most users, which is consistent with previous MassTraveler studies.

Participants were also asked to rank the usefulness of each MassTraveler page on a scale. The results are summarized in Table 15.

Table 15: Usefulness of MassTraveler

Top number is the count of respondents selecting the option. Bottom % is percent of the total respondents selecting the option.	Perceived Usefulness					
	Not Very Useful	**Not Useful**	**Undecided**	**Useful**	**Very Useful**	**Never used it**
Bus Tracker (defunct)	20	6	17	27	29	216
	6%	2%	5%	9%	9%	69%
Route 9 and/or Route 116 travel times	13	7	26	63	21	190
	4%	2%	8%	20%	7%	59%
Webcams	19	10	38	42	26	185
	6%	3%	12%	13%	8%	58%
Construction Alerts	11	7	29	57	23	193
	3%	2%	9%	18%	7%	60%
Route 9 Travel Speeds	15	4	33	47	15	201
	5%	1%	10%	15%	5%	64%

Following the previous question, this table leans heavily to the "Never Used It" side. Over half of the participants claimed they had never used any of the items discussed, prior to or after they were discussed in the survey. Many more may have never used the page prior to the survey, but visited the site and made educated judgment while answering the survey. Most find the website and its information useful or very useful. These results show RTIC two things, one being that the program needs to be advertised and presented more and two being the program is currently providing useful information for the area.

Some potential benefits to receiving information were proposed to participants, who then selected statements they agreed with. Table 16 shows a summary of responses for this question. A total of 244 participants provided answers. Participants were recommended to select as many as they saw true and to add any other benefits that might be obtained by receiving travel information. It can be seen that information provides the ability to avoid delays when traveling. Closely related, the other two popular answers were better arrangement of activity and ensuring on-time arrival. None of the comments listed in "Other" provided any other benefits.

Table 16: Benefits of Receiving Traveler Information

Potential Benefits	Frequency	Percentage
Avoid Delay	165	68%
Reduce Anxiety	103	42%
Allow better arrangement of activities	124	51%
Ensure on-time arrival	121	50%
Other, please specify	28	11%
Total Observations	**244**	

The final question in this section asked participants to discuss any other comments they had in regards to MassTraveler and RTIC. Three comments stood out among the 100 responses. The most popular comment stated that participants were not aware the website existed and that this information was available. Others showed a desire for this information to be made more public, as in displayed on other webpages that receive more traffic or by displaying advertisements on other webpages and media. The third popular comment was to bring the previous bus tracker back. The bus tracker provided bus location information for the UMass Transit free-fare bus fleet. The bus tracker program's funding contract expired in 2011 and has been removed from the website. The PVTA has been working on another version of a bus tracker, and it is hoped to be launched soon.

5.3.3 Part III: Attitudes Towards Information Type

This section asked participants to rank their desire for new types of information. A summary of the responses can be seen in Table 17.

Table 17: Interest in New Information Types

	Stated Interest					
Top number is the count of respondents selecting the option. Bottom % is percent of the total respondents selecting the option.	Absolutely Not Interested	Not Interested	Neutral	Interested	Absolutely Interested	N/A
Bus Overload	63	25	68	41	32	71
	21%	8%	23%	14%	11%	24%
Severe Traffic Congestion or Crashes	19	7	24	95	149	24
	6%	2%	8%	30%	47%	8%
Desired Parking Lot is Full	44	14	69	69	61	47
	14%	5%	23%	23%	20%	15%
Guidance on Alternatives in the Event of a Problem	17	12	35	119	107	23
	5%	4%	11%	38%	34%	7%
Personalized Webpage, with selected services specific to your travel patterns	50	24	71	60	63	35
	17%	8%	23%	20%	21%	12%

It can be seen that information regarding bus overload received less interest than any of the other forms of information. This is likely because of the majority of car commuters in the participant population. Bus overload information would be more useful to students who would be commuting without parking permits. Most participants were more interested in severe traffic congestion and guidance on alternatives. These are already displayed to some extent with the current system. It seems that the basic information displaying what's wrong and how the traveler needs to travel to avoid the incident is the most valuable information, without all of the bells and whistles. The personalized webpage received some interest, but will take some time before RTIC displays enough information to make that initiative worthwhile.

Participants were also asked where specific troublesome locations exist in the area that could be helped with the installation of information. About 160 participants responded with varying locations, similar to those discussed previously. Troublesome locations included stretches of I-91, Route 9, Route 116, North Pleasant Street (which runs through campus), and the Coolidge Bridge. Some bus travelers discussed issues regarding Route 31, which travels from Sunderland to South Amherst, and the Blue 43 which travels from Amherst College to Smith College via UMass and the Hampshire Mall. In particular, the Route 31 bus tends to fill up in the mornings causing overloads for those trying to reach class on time. The Blue 43, which is run by the PVTA not UMass Transit, often gets caught up in Route 9 traffic causing it to arrive late. Sometimes the bus even arrives early, causing riders to miss the bus before they even get to the bus stop. A tracking application will solve bus rider's problems. To take the application a step farther, having the application display some form of icon or notification showing the bus is full would also help during peak hours.

5.3.4 Part V: Demographics

The following tables will summarize the demographic information collected regarding the participants of the survey.

A total of 320 participants selected a gender that most represents themselves. This survey found two thirds of the participants to be female and one third of the participants to be male, as in Table 18.

Table 18: Gender of Participants

Gender	Frequency	Percentage
Male	121	38%
Female	199	62%
Total	320	100%

Participant age was collected by selecting the age group in which the participant belonged. It was found that the general age of the participant population was middle to upper aged. A total of 22 participants were found to be 25 and below, the general age of college students. The average age group of participants was found to be between 41 and 45 years of age.

Table 19: Age Groups of Participants

Age Group	Frequency	Percentage
<18	0	0%
18-20	0	0%
21-25	22	7%
26-30	25	8%
31-35	16	5%
36-40	24	8%
41-45	38	12%
46-50	44	14%
51-55	54	17%
56-60	56	18%
61-65	24	8%
65+	13	4%
Total	316	100%

It can be seen that most of the participants were faculty and staff members of the university, with some alumni responses collected from the deployment using Facebook.

This is confirmed in Table 20. Answers contained as “Other” ranged from alumni to medical and emergency personnel who were not sure if they were considered staff.

Table 20: UMass Affiliation of Participants

UMass Affiliation	Frequency	Percentage
Student	20	6%
Staff	187	59%
Faculty	95	30%
Other, please specify	17	5%
Total	319	100%

A summary of participant ethnicity is summarized in Table 21. The majority of the participants considered themselves to be “white,” although it was realized after collection of the survey that there was no location to denote “Latino or Hispanic.” Those who may have fit into these categories are thought to have either not answered, or selected something else that best fits them.

Table 21: Participant Ethnicity

Ethnicity	Frequency	Percentage
American Indian or Alaska Native	4	1%
Asian	15	5%
Black or African American	6	2%
Native Hawaiian or Other Pacific Islander	0	0%
White	282	92%
Total	307	100%

Participants were asked to select the income group to which they most represented. Income brackets were created in $10,000 per year increments. There seemed to be an even spread among income brackets toward the upper side of the scale, Table 22. About 18 participants of 236 listed themselves as below $30,000 per year.

Table 22: Participant Income Brackets

Income Group	Frequency	Percentage
<$10,000	2	1%
$10,000-$29,999	16	7%
$30,000-$49,999	39	17%
$50,000-$69,999	46	19%
$70,000-$99,999	43	18%
$100,000-$125,000	47	20%
>$125,000	43	18%
Total	236	100%

Participants were finally asked to list their zip code of residence. Analyzing the zip codes allows RTIC to tailor its system to meet both the desires of its users, but also the specific areas where the most users currently live and travel. A total of 307 participants listed their zip code of residence. Table 23 provides a segment of towns with the most participants. The full table can be seen in Appendix D. The participant population represented a total of 57 towns in Massachusetts, Connecticut, Rhode Island, Vermont, and New Jersey. Most of the surveys were completed by Amherst residents, followed by Northampton, Belchertown, and Greenfield. These results are very similar to that of the popup survey results which listed the same towns. It may be worth effort in providing more information along roadways in these areas.

Table 23: Participant Towns of Residence (partial)

Responses	Town
91	Amherst
36	Northampton
21	Belchertown
17	Greenfield
13	Leverett
12	Hadley
11	Sunderland
10	South Hadley
7	Easthampton
6	Shutesbury
5	Granby
5	Holyoke

Throughout the course of the survey process some interesting comments and problems arose. The following section will discuss these issues in detail.

5.4 Discussions

This section will discuss some issues that were uncovered throughout the process of distributing, collecting and analyzing this survey. Most of the issues were found by reading comments submitted by participants, voicing their opinions and suggestions.

Some comments were returned to the designated email address shortly after the launch of the survey. Participants noted one issue with the Zoomerang email system, its way of coding the email text. Zoomerang codes its email text via HTML, which many email clients can decode and display as text formatting. It was discovered by several disgruntled staff and faculty members, mostly faculty, that their email clients could not decode the HTML and the message appeared as a jumbled block of code and text. The email was still legible provided one read around the bits of HTML coding, but this proved to be too much of a hassle for some. Other faculty members expressed some concern over the return email address. The investigators designated the Gmail account as the return address instead of a UMass affiliated address. This caused some faculty and staff to feel a little caution when answering the survey. The return address is what appears in the "Sent From" box; some claimed they would feel more comfortable if the email was sent from a "umass.edu" address to seem more official. The reasoning for using the Gmail account was simply because Gmail can collect more mail than an OIT account. It was expected that many emails would have delivery errors that send an error email back to the return address as the University cycles through students and staff frequently. If the survey was sent using a UMass email address, perhaps more emails would have made it to more of the intended inboxes.

Some other comments were received via email, sent directly to the investigators. These comments came from participants who seemed to be confused as to their validity when taking the survey. Comments came from a number of participants who reached the first page of the survey and opted out because they "Don't ride the bus," even though the survey did not specifically target bus riders. The only logical explanation for this is due to the image of a PVTA bus that appears on the front page of the survey. Regardless, these participants felt the need to explain themselves to the investigators, and sent an email with some reasoning. A return email was sent back to these participants explaining the purpose of the study and answered some of the questions asked. No emails were ever returned back after the replies.

More emails were returned from pre-generated "Out of the Office" notifications than any other response from participants. It was discerning to think that so many individuals were all “Out of the Office” at the same time, even after two reminder emails. Although, the initial launch of the survey was sent at the very start of the Fall Semester. Perhaps most of the participants had not yet returned from summer vacation yet.

Some issues appeared when analyzing the responses to questions within the survey. It was found that wording for select questions could have been made easier to understand. As noted above, the survey population was very diverse. The questions were worded in attempts to provide as much information as possible regarding the desired responses, and to also minimize the reading load required of the participants. Because the survey was rather lengthy, the investigators wanted to keep directions simple and straightforward by explaining most of the background information in the recruitment email. It is thought that some may have skipped reading the background information that was written, and then became confused when completing the survey.

The first two questions were filled out correctly by almost every participant as they requested very basic travel information similar to many other surveys, including number of vehicles and commute mode. The survey received several responses from people who wanted to include “too much” information, often including multiple different scenarios of answers. In particular during the commute mode question participants were intended to select one option, yet some noted multiple by the use of the “Other” category. Multiple responses were found to be entered for different reasons as well. Some participants entered two scenarios of answers when possible, representing different situations of their own travel. For example one response was for peak travel and another off peak travel. Other participants noted two responses in order to account for their significant other.

There was some confusion regarding whether or not the participant was supposed to answer regarding just themselves or their whole household.

The questions regarding information accessibility and usage can only be taken somewhat seriously. This study has shown that there is a lacking knowledge of the awareness of traveler information in the Pioneer Valley, save for that of radio and television news coverage. These answers may be skewed as the recruitment email discussed RTIC and its existence. Where some may not have known about the system prior to taking the survey, they had since been exposed to it during the survey. Likewise, the survey describes each information item provided by RTIC and then asked participants to rank them on different scales. These can also be skewed based on previous knowledge and usage. Even though the participant was able to select “Never” or “N/A,” some may have taken a guess and selected an answer. It is not uncommon for some participants to answer questions regarding preference to new products with answers they envision the investigators desire. Some participants may have purposely selected Useful or Very Interested just to please the investigators, which could potentially bias the results (Schofer *et al*, 1993). Though this may have occurred in this data set, it is assumed that the effect would not vary the conclusions found.

Methods to correct these issues in the future would be to create a condensed version of this survey that only asks a few questions, similar to that completed by Martin *et al* (2005). In the Utah DOT survey, brief questions were asked that included an image of each information system and three questions asking the participant if they’d ever seen the object during their travel, if they were aware of what it provided, and if they had ever used its information. A redesign of this survey should ask participants if they are aware that RTIC exists, without providing any descriptions of what RTIC actually is. Then they should be asked how useful they feel RTIC is as a whole. Finally they should be asked to describe their favorite and least favorite aspect of RTIC. It is thought that this small survey would obtain the same responses needed, without the bulk of the rest of the questions.

Perhaps utilizing an alternate distribution method may have gained more valuable responses. In the past, the use of telephone surveys and interviews have been used to collect revealed and stated preference information (Schofer *et al*, 1993; Abdel-Aty *et al*, 1997; Mishalani *et al*, 2006). These types of studies give investigators the ability to verbally interact with the participant, allowing the investigator to clear up any confusion found by the participant. Because the investigators need to speak with every participant individually, these studies take a significantly longer amount of time and energy to complete and often use smaller sample sizes than web-based surveys.

The largest portion of the survey was the section regarding the Most Memorable Use of traveler information. This section in particular contained multiple discrepancies between participants. This is discussed in the next chapter.

CHAPTER 6

MODELING

This chapter will discuss in detail the process used in building a traveler behavior model to represent the data collected from the Full-Scale Survey. The data used to model traveler switching behavior was pulled from the Most Memorable Use portion of the Full-Scale Survey. Some other demographic responses were also used in the modeling process.

6.1 Model Specification

6.1.1 Background

Modeling choice behavior is often done by the use of a random utility model. Random utility models represent a specific choice between two or more alternatives. These types of models are often used in marketing, where one company wants to know if a consumer will choose their item over another company's item (Hofacker, 2007). In the case of this study, the model will represent the choice of a traveler between travel patterns. This survey only asks for the participant to discuss two alternatives. Therefore the model can be broken down into a binary choice model. Random utility models require three assumptions to be satisfied. The first assumption requires that the choices must be discrete. In the case of this study, no traveler can choose both alternatives, their choice must be fully one or the other. The second assumption requires that the utility of each alternative varies randomly with each participant. The utility represents a measure of attraction or benefit received from choosing one alternative over the other. Logically, the third assumption requires the participant to then choose the alternative with the highest utility (Hofacker, 2007; Ben-Akiva, 1985). Random utility models can also use the concept of disutility, that being each alternative is associated with a negative attraction. In this case the participant would want to choose the alternative with the lowest disutility.

Logit and probit models are two types of commonly used random utility models. This study uses a binary logit model to represent travelers' switching behavior, where the two alternatives are "not to switch" and "to switch." Logit models were used because of their simplicity during estimation and the lack of apparent violation of the i.i.d. (independently and identically distributed) assumption of random terms. In a logit model, utilities are composed of two components: systematic and random. Systematic components, V, are represented by a function of attributes that can be calculated. Random components, ε, are assumed i.i.d. Gumbel, and thus the difference between the random components of two alternatives in the choice set is logistically distributed (Ben-Akiva, 1985). The entire utility of each alternative is calculated by taking the sum of each component for the specific alternative.

$$U_{in} = V_{in} + \varepsilon_{in}$$

$$U_{jn} = V_{jn} + \varepsilon_{jn}$$

$$\varepsilon_n = \varepsilon_{in} - \varepsilon_{jn}$$

Given that the random components are logistically distributed, the probability of choosing an alternative can be calculated as the exponential of the chosen utility divided by the sum of the exponentials of all available utilities.

$$P_n(i) = \Pr\left(U_{in} \geq U_{jn}\right)$$

$$P_n(i) = \frac{e^{-\mu V_{in}}}{e^{-\mu V_{in}} + e^{-\mu V_{jn}}}$$

The Greek letter μ is the scale parameter of the logistic distribution, and cannot be separated from the parameters of the systematic utility functions if a linear-in-parameter functional form is assumed. The common practice is to assume that the scale parameter μ is equal to 1 (Ben-Akiva, 1985).

To find the probability of choosing a given alternative, utility functions need to be defined. Linear-in-parameter functional forms are assumed for V_{in} and V_{jn} where the explanatory variables include both the attributes of the alternatives and characteristics of the decision maker. Parameters provide an effect or tendency to the data.

The Swiss modeling software Biogeme (Bierlaire, 2003), was used to estimate the parameters. This study utilized the Python version of Biogeme, which uses Python coding language to run each estimation. Before Python Biogeme would run the data, the data needed to be cleaned. Without a consistent data file, the program would not estimate parameters correctly.

Although the survey received 329 responses, many of the responses were unusable for modeling purposes. Each observation (response) was read and screened based on specific criteria. A total of 192 observations remained after the cleaning process. The following section will describe the data cleaning process and provide some basic summary statistics of the responses and comments collected.

6.1.2 Data Cleaning

Most of the responses collected were found to have missing answers to a handful of questions. There may be many reasons for the questions to be left blank; unfortunately many participants did not describe themselves. Missing data can cause problems when modeling choice. Cleaning the data relied on analyzing the Most Memorable Use section of questions for each participant. If the response did not include any answers for any question within the section, it was removed. If the participant did not answer their decision, “Did you take the alternative?” the observation was removed. This question provided the choice variable, if the participant chose to switch to an alternate path a value of 1 was recorded; if the participant chose to remain on the original path a value of 2 was recorded. Likewise, if the participant did not select an alternative from the list or include anything that resembled an alternative in comment form, the observation was removed. Removing these observations was simply on the basis that the person did not claim to have an alternative, at that point there would be no switch decision available for the trip and the probability of choosing the original alternative would be 1.

The majority of observations that were removed were those that did not answer the choice question. Most of those without a choice also did not answer any of the other attribute questions. A large reasoning for this was the lack of a trip that would fit the scenario. Observing comments led to the realization that many participants had never used information to this extent when traveling. Observations that included attributes for the habitual travel pattern but not the alternative travel patter were included in the data, provided they selected an alternative. Situations where this occurred were alternatives that resulted in canceling the trip or alternatives that would have been available but were not accessible at the time of the decision. These three restraints were verified by reading the comments of each observation to make sure the participant absolutely did not have an answer for the question. Some participants included the answer in the comment, but did not select anything for the question itself. These responses were changed in order to fit what they described.

One of the problems with using open ended responses and comment response is the need to analyze the responses themselves. These responses came in many different forms and styles. Some participants wrote stories, others wrote lists, and some wrote garbled phrases that were difficult to decipher. To make the answers easier to model, each open ended question related to times were re-entered into a consistent format. Travel times were converted to minutes and trip start times were converted to 24 hour time. Any observation that was missing an answer received a "-1" for that question. Ultimately, all questions, save for the comments, were coded into numerical format to allow easy modeling. An example of the cleaned output can be seen in Figure 11.

ORIGIN	DESTINATION	STARTTRIP	MODE	ORIGTT	ORIGVAR	ORIGBUSWAIT	ORIGTRANSFER
1	2	645	1	70	15	-1	-1
6	6	1000	1	70	5	-1	-1
2	1	1730	1	45	15	-1	-1
1	6	1000	1	90	20	1	1
2	1	1730	2	15	7	9	1
2	1	1730	1	30	15	11	2
1	2	800	1	50	10	1	1

Figure 11: Segment of Cleaned Data Output

This snapshot shows a column of data, "MODE", which was not asked explicitly by the survey, but was inferred from the data itself. In this case, MODE was given a "1" if the participant's original travel pattern was by car and a "2" by bus. Some participants included estimated bus wait times and bus transfers, even though they did not actually take the bus as their habitual travel pattern. Discrepancies like this one appeared in several locations throughout observations. These will be discussed in 6.3 Discussions.

After all data cleaning and removal of comment questions, a total of 191 observations remained with entirely numerical answers. These observations were then screened again and categorized by specific scenarios that stood out. Some scenarios that were pulled out are seen in Table 24.

Table 24: Description of Analyzed Categories

Category	Number of Occurences	Description
ALTUNAVAIL	13	the alternative was no longer available to the participant at the time of the decision
ORIGCLOSED	25	the habitual pattern was unavailable at the time of decision
ALLCLEAR	11	the participant considered the habitual route to be normal even with a high delay
ZERODELAY	14	the estimated post info travel time was equal to the original travel time
ZERODIFF	29	the estimated alternative travel time was equal to the post information travel time
RISKY	3	the participant’s choice resembled risk seeking behavior
CANCEL	5	the participant canceled the trip altogether
QUESTION	15	the participants decision was not understandable to investigators
Total	115	

The estimated delay was found by subtracting the estimated travel time of the habitual travel pattern from the estimated travel time after receiving traveler information. These scenarios were pulled out because they represented situations that may throw off the model. More on this will be discussed in the next chapter which describes the modeling process.

In summary, cleaning the data removed all responses that would cause problems when modeling. The model would not run if observations were missing data, most importantly that of the decision and a described alternative.

6.1.3 Correlations

Correlations are examined for the purpose of adding dummy variables to the model that help describe the data set. The objective is to create utility functions that provide a better description of choice probability than a naive model with nothing specified. With no parameters listed in the utility function, the probability of choosing either of the two alternatives is 50/50 provided both alternatives are available.

This survey collected two forms of data, quantitative and qualitative. The quantitative data were collected as estimated travel times. Estimated travel times were the basis for modeling traveler behavior, as it is known that travelers seek paths that minimize travel time, among other things. Besides travel time, other attributes may play a role in a traveler's decision. Some other attributes that were examined from the results of the survey were the number of traffic lights passed during the trip, the type of information found, the source of information found, and various demographic results. Correlation plots were created that compare each response to the recorded choice variable. It was found that potential correlations exist in the participant's income bracket, the participant's gender, the participant's age, and weather at the time of the trip.

Dummies were created to represent different cases for each demographic response. A dummy is often a binary variable that takes a 1 or a 0 depending on if the observation meets given conditions. Dummies are often used in correlation analysis to break up the correlation. For example, instead of modeling participant age as a variable, a dummy was created to model effects of just young participants. In this case, if the participant's age is higher than a specific threshold the value takes a 0, but if the age falls lower than the threshold the value takes a 1. Because dummies are binary, the addition of utility is just the value of the estimated parameter. A list of example dummies that were explored and modeled can be seen in Table 25. A full list of dummies can be seen in the model files attached in Appendix E.

The only quantifiable variables in the model were those relating to the estimated travel times described by the participants. Participants were asked to provide three estimated times: estimated travel time for the habitual travel pattern (ORIG), estimated total travel time for the habitual travel pattern after receiving real-time information (POST), and estimated total travel time for the alternative travel pattern (ALT). First, travel times were treated as generic variables, e.g. the utility functions looked similar to those below where B_TIME is a time parameter.

V1 = B_TIME * POST + …

V2 = ASC_SWITCH + B_TIME * ALT + …

This parameter was found to be insignificant throughout several models that included various other attributes. Next, the TIME parameter was converted to be alternative specific, e.g. each utility function had its own time parameter.

V1 = B_TIME1 * POST + …

V2 = ASC_SWITCH + B_TIME2 * ALT + …

These variables were also found to be insignificant throughout several models that included various other attributes. The next solution was to code variables to relate the times to one another and use relative difference instead of absolute difference. Three variables were created to compare these three responses: Delay, Difference, and Change.

Delay represented a comparison between the post information estimated travel time and the habitual travel time. Subtracting the original travel time from the realized travel time yields the total delay added to the trip. Difference represented a comparison between the realized travel time and the alternative travel time. And Change represented a comparison between the habitual pattern's travel time and the alternative pattern's travel time.

Table 25: Example Dummies from Correlation Analysis

Variable Name	Name Description	Variable Description
GENDER		Participant is Male
YOUNG		Participant is younger than 35
OLD		Participant is older than 55
NONWHITE		Participant is not considered from white descent
LMINCOME	Low to Medium Income	Participant makes between $10k and $50k per year
MHINCOME	Medium to High Income	Participant makes above $60k per year
BADWEATHER		Trip was made during rain or snow
ONTIME		Participant could not be late on arrival
LATE		Participant could arrive 15 minutes late

A description of these three time variables can be seen in Figure 12. Each time variable was turned into a ratio by dividing it by the Original Travel Time or Post Information Travel Time. Turning the variables into ratios allowed the model to provide more reasonable estimates for the time parameters. It should be noted that Difference was turned into a ratio as well, but did not appear to be a significant description of probability in either form.

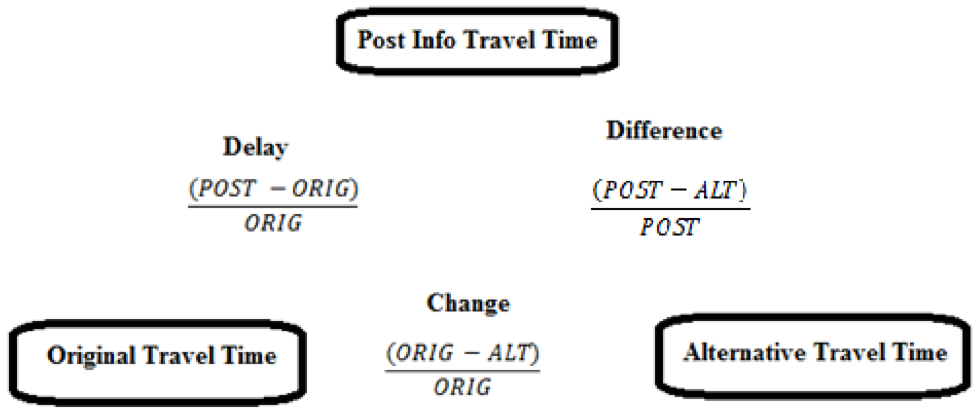

Figure 12: Description of Time Variables

The time variables were calculated under two criteria. Variables were calculated only if the observation contained an estimated time for each case: ORIG, POST, and ALT. If an observation was missing a time, the investigators could not determine the full reasoning for the choice. These observations were, however, used to estimate other parameters of the model. Second, the time variables were not calculated for observations found to be within the questionable categories discussed in Table 24. This was done as a precautionary measure to make sure only the observations that could be calculated legitimately would be used. While calculating the time variables including these observations, the time parameters were found to be the wrong signs. This means that the model predicted an alternative to be preferable if it had a higher travel time than the competing alternative, everything else equal. After including the restraints on the calculation of the time variables, the estimated parameters were found to have the correct signs.

6.1.3 Utility Functions

Each model contained two utility functions to represent a binary choice. In this thesis, the original travel pattern is represented with the utility function "V1." The alternative travel pattern is represented with the utility function "V2." Two models will be discussed, an intermediate model and the final model.

Intermediate Model

The following model utility functions were created as a result of the many initial models over the course of this study. Models were created during each stage of the data cleaning process. All models were not re-estimated after each "cleaning" effort. Instead, only the most recent model was continually altered. Utility functions were altered by including combinations of demographic dummies, time variables, and information source dummies. Models were made including bus information such as wait time and number of transfers, however none of these were found to be significant in any model. Similarly, the number of traffic lights for each alternative was also added but found to be insignificant. The intermediate utility functions are seen below. Parameters are denoted by "B_" followed by the corresponding variable name. Alternative specific constants are denoted by "ASC_" followed by the corresponding alternative name. An alternative specific constant works similar to an intercept. In this case, when nothing else is in the model there is a predetermined attraction or repulsion to V2. Only items that were directly related to the alternative travel pattern were placed on V2, everything else was kept on V1. As a result, V2 includes variables for Alternative Type and knowledge of alternative travel time. Note that alternative type and information sources and types are included as dummies that take a 1 if the participant selected it and a zero otherwise. After the modeling process, it has been thought that interactions might exist between the estimated travel times and the information sources/types. These interactions were not explored in the following models however. Interactions were explored in preliminary models, but were not found to be significant with the preliminary data sets.

V1 = B_DELAY * DELAY + B_YOUNG * YOUNG + B_GENDER * GENDER + B_LMINCOME * LMINCOME + B_SORADIO * SORADIO

V2 = ASC_SWITCH + ASC_ROUTE * ALROUTE + B_KNOWLEDGE * KNOWLEDGE + B_CHANGE * CHANGE

The following table, Table 26, describes each variable and what it represents.

Table 26: Explanation of Variables (Intermediate Model)

Variable Name	Name Description	Variable Description
GENDER		1 if Participant is Male, 0 otherwise
YOUNG		1 if Participant is younger than 35, 0 otherwise
SORADIO	Source = Radio	1 if Participant received information from Radio, 0 otherwise
LMINCOME	Low to Medium Income	1 if Participant makes between $10k and $50k per year, 0 otherwise
ALROUTE	Alterative = Route Switch	1 if Participant's alternative was to switch routes, 0 otherwise
DELAY	(POST-ORIG)/(ORIG)	Delay calculated without using observations specified previously
CHANGE	(ALT-ORIG)/(ORIG)	Change calculated without using observations specified previously
KNOWLEDGE	Knowledge of ALT	1 if the participant included an estimate for ALT, 0 otherwise

Final Model

This model was created by adding all information sources, information types, and alternative types to the intermediate model as dummies. Similar to the intermediate model, all alternative types were added to V2 and all information sources/types were added to V1. This was because the information only applied to the original travel pattern. One question asked participants if information was provided for the alternative travel pattern, almost everyone said that there wasn't. After removing all of the insignificant parameters from the model, the utility functions below remain.

The addition of information sources and types was found to make B_CHANGE insignificant, which means that including information types explains more variability than Change. A description of the variables included in this model is included in Table 27.

V1 = B_DELAY * DELAY + B_YOUNG * YOUNG + B_GENDER * GENDER + B_SORADIO * SORADIO + B_TYCONGTT * TYCONGTT + B_TYCRASH * TYCRASH

V2 = ASC_SWITCH + ASC_ROUTE * ALROUTE + B_KNOWLEDGE * KNOWLEDGE

Table 27: Explanation of Variables (Final Model)

Variable Name	Name Description	Variable Description
GENDER		1 if Participant is Male, 0 otherwise
YOUNG		1 if Participant is younger than 35, 0 otherwise
SORADIO	Source = Radio	1 if Participant received information from Radio, 0 otherwise
TYCONGTT	Type = Congestion + Travel Time	1 if Participant received information regarding congestion and travel times, 0 otherwise
TYCRASH	Type = Crash and Accidents	1 if Participant received information regarding crashes and accidents, 0 otherwise
ALROUTE	Alterative = Route Switch	1 if Participant's alternative was to switch routes, 0 otherwise
DELAY	(POST-ORIG)/(ORIG)	Delay calculated without using observations specified previously
KNOWLEDGE	Knowledge of ALT	1 if the participant included an estimate for ALT, 0 otherwise

Small models were examined, as a goal in modeling is to explain the most amount of variability with the least amount of parameters possible. When examining models, investigators validated whether the estimates made logical sense, and followed the assumptions of random utility models. A discussion of expected parameter values is provided in the next section.

6.1.4 Expected Values (Positive/Negative Effects)

When analyzing the results of the Python Biogeme estimation, the investigators verified expected values of each parameter, as shown in Table 28. Beginning models resulted in statistically significant parameters that held opposite signs than expected. After examining the data it was found that discrepancies in the recorded answers may be causing the sign changes. After correcting and cleaning many of the responses, the calculated estimates began to show the correct signs.

It is widely known that long travel times cause traveler to become frustrated. Therefor travel time is often associated as a disutility. Since the model collects utility for each alternative, travel time should then have a negative effect on total utility. Delay was expected to have a negative value associated with its parameter. Change was not however as it was located on V2, the alternative's utility function. Change compares the difference between ORIG and ALT, which will be positive when the travel time for the habitual travel pattern is larger than the alternative travel pattern. The traveler wants to pick the alternative with the shortest travel time, so the resulting parameter should be positive.

Table 28: Expected Values of Parameters

Variable Name	Name Description	Model	Utility Function	Expected Value
GENDER		Both	V1	Unknown
YOUNG		Both	V1	Unknown
SORADIO	Source = Radio	Both	V1	Unknown
TYCONGTT	Type = Congestion + Travel Time	Final	V1	Unknown
TYCRASH	Type = Crash and Accidents	Final	V1	Unknown
DELAY	(POST-ORIG)/(ORIG)	Both	V1	Negative
LMINCOME	Low to Medium Income	Intermediate	V1	Unknown
KNOWLEDGE	Knowledge of ALT	Both	V2	Positive
ALROUTE	Alterative = Route Switch	Both	V2	Unknown
CHANGE	(ALT-ORIG)/(ORIG)	Intermediate	V2	Positive

Knowledge was expected to be positive. Knowledge takes a 1 when the user included a time estimate for the alternative travel pattern. Some participants did not include a time because they had never attempted the alternative before, and had no basis to estimate. This variable is also calculated for the entire data set, and serves a potential ability to pick up the observations that were not collected with the travel time variables. An observation could include ORIG and ALT but not POST. If this is the case neither Delay nor Change would be calculated because POST is missing. This observation would still receive a 1 for Knowledge. The expected values of information sources and types were unclear. The base case of these models (if radio, congestion, and crashes were not selected) represents any other source or information type. Expected values of demographics were also unclear. Some studies have shown that males have a higher tendency to switch travel patterns (Emmerink *et al*, 1996). A discussion of the estimation results is included in the next section.

6.2 Estimation Results

This section will discuss the process of using Python Biogeme and discuss the results of the models. Estimations were run by utilizing the example Binary Logit Model example from the Biogeme Website, found at http://biogeme.epfl.ch/swissmetro.php. These example files use data from a previous study regarding choices between rail travel and the Swiss Metro. The examples file includes pre-written code that calls for the Logit estimation process. Users can alter the code to create their own dummy variables, utility functions and availabilities.

These models changed availability restraints and exclude restraints. The original travel pattern was set to be unavailable if the observation was included in the “OrigClosed” group. The alternative travel pattern was set to be unavailable if the observation was included in the “AltUnavailable” group. All observations that were included in the “Risky” group were excluded entirely from estimation. The full model files can be seen in Appendix E. It should be noted that many dummy variables and parameter definitions are included in the model files. These were created and included in the models but resulted in becoming insignificant.

Python Biogeme was run using the Ubuntu operating system. Biogeme installs to Windows but the Python version would not run correctly. Model and data files were edited in a text editor or spreadsheet program. Estimations were run by accessing the Terminal, and calling the Python Biogeme program. The entire estimation was run inside Terminal, without bringing up any other screen. Once completed, Biogeme generated a webpage (.html) file that included the results. A summary of the results for the Intermediate Model and the Final Model are included in Table 29 and Table 30 respectively.

Intermediate Model

The intermediate model found all estimates parameters except one (Change) to be statistically significant at the level of 0.05, while the parameter to Change has a reasonable p-value of 0.06. With 191 observations, the initial log-likelihood was found to be -103.972; the final log-likelihood was found to be -57.078. The model results in an adjusted rho squared value of 0.364 which shows that the model represents the data better than a naïve equal-probability model. A total of 57 individuals chose the habitual pattern, and 137 individuals chose the alternative pattern.

It has been found that males within the low to medium income bracket are less likely to maintain on the habitual path in the event of an issue. It is not sure why this is the case for the area. Perhaps these individuals are more open to exploring new areas, or these individuals have a stricter schedule and need to make the change to arrive on time.

Table 29: Intermediate Model Results

Parameter Name	Variable Name	Utility Function	Estimate	Robust Std Err	Robust t-statistic	p-value
B_SORADIO	Information Source = Radio	V1	-2.29	0.806	-2.84	0
B_LMINCOME	$10k to $50k income	V1	-1.92	0.846	-2.27	0.02
B_GENDER	Male	V1	-1.86	0.652	-2.86	0
B_DELAY	Delay Ratio	V1	-1.18	0.426	-2.78	0.01
B_YOUNG	Less than 35 years	V1	1.89	0.81	2.34	0.02
ASC_SWITCH	General Switch Intercept	V2	-2.44	0.864	-2.82	0
B_CHANGE	Change Ratio	V2	1.11	0.587	1.89	0.06
B_KNOWLEDGE	Estimated ALT	V2	1.59	0.51	3.11	0
ASC_ROUTE	Route Switch Alt	V2	1.99	0.667	2.99	0

Sample size:	191
Init log-likelihood:	-103.972
Final log-likelihood:	-57.078
ρ^2:	0.451
ρ^2 bar:	0.364
Alt. 1 available:	166
Alt. 1 chosen:	54
Alt. 2 available:	178
Alt. 2 chosen:	137

Younger individuals were found to be more likely to maintain on the original path. This could be because younger individuals do not know the area as well as older individuals. A desire to stay on known routes may be a big enough push to make this estimate positive. Receiving information from radio was found to make the habitual pattern less attractive. This suggests that radio may be more trustworthy to travelers than other sources of information, resulting in more switches. The intercept located on V2 is negative; this means there is a pre-determined desire to remain following the habitual pattern. Coupled with this is a positive parameter for when the best alternative is a route switch, which suggests that route switches are more likely, compared to other types of switches (departure time, mode, destination, trip cancellation). Change was found to be positive, which suggests that when ORIG (the original estimated travel time) is larger than ALT (the alternative travel time) travelers will more likely choose the alternative. The absolute values of the estimates for Change and Delay are similar, which suggests that a 1% increase in delay on the habitual pattern has the same effect as a 1% decrease in alternative travel time. Knowledge was found to have positive parameters, which suggests that having a familiarity with the alternate path also provides a bit of a draw towards switching.

Final Model

The final model found all estimates to be statistically significant at the level of 0.05. With 191 observations, the initial log-likelihood was found to be -103.972; the final log-likelihood was found to be -54.177. The model results in a rho bar of 0.392. The rho bar value is much better than the intermediate model. The availabilities of the alternatives are the same because the data has not changed between models. Similar to the intermediate model, receiving information from radio attributes to a higher probability of switching. Likewise, if the information is crash related or congestion related, the push to switch is increased. A possible explanation for this may be that radio is seen as more trustworthy than other sources due to its age. Radio transmitted information often comes from traffic reports including that of crashes and congestion in real-time physically seen by someone. Focus groups found that participants would rather physically see a situation instead of receiving text information, radio works similarly except they are relayed a message from another person. Familiarity with this kind of information may cause its estimates to be negative. Males are also found more likely to switch again. It is unclear why this is. Perhaps males are more adventurous than females in this area, or perhaps males are more appalled by sitting in traffic than females. Delay was found to be negative, but less so than in the previous model. This again is an effect of adding the sources and types into the model, as we can see here Change was removed as it was highly insignificant. Young persons are again less likely to switch. Similarly to the previous model, route switches are more likely to entice travelers. Familiarity with the alternative is another draw.

Table 30: Final Model Results

Parameter Name	Variable Name	Utility Function	Estimate	Robust Std Err	Robust t-statistic	p-value
B_SORADIO	Information Source = Radio	V1	-2.14	0.906	-2.36	0.02
B_TYCRASH	Information Type = Crashes	V1	-2.06	0.779	-2.64	0.01
B_GENDER	Male	V1	-2.02	0.651	-3.1	0
B_TYCONGTT	Information Type = Congestion/TT	V1	-1.17	0.492	-2.39	0.02
B_DELAY	Delay Ratio	V1	-0.955	0.369	-2.59	0.01
B_YOUNG	Less than 35 years	V1	1.36	0.636	2.13	0.03
ASC_SWITCH	General Switch Intercept	V2	-2.89	0.715	-4.05	0
B_KNOWLEDGE	Estimated ALT	V2	1.13	0.49	2.3	0.02
ASC_ROUTE	Route Switch Alt	V2	2.12	0.59	3.59	0

Sample size:	191
Init log-likelihood:	-103.972
Final log-likelihood:	-54.177
ρ^2:	0.479
ρ^2 bar:	0.392
Alt. 1 available:	166
Alt. 1 chosen:	54
Alt. 2 available:	178
Alt. 2 chosen:	137

This model only includes three items for V2, one of which is the intercept. If a traveler has knowledge about the alternative route (e.g. Knowledge = 1 and Route = 1), a maximum utility of 0.36 is obtained for the alternative route. This means that for someone to have a larger that 50% chance of switching, the V1 utility needs to be less than 0.36. Given the large amount of negative estimates, this should occur frequently.

6.3 Discussions

The models represent switching behavior in a logical manner that satisfies the three assumptions of the random utility model. All of the expected effects are met in a significant manner. The rho bars could be larger, but the models do statistically represent a better model than the null model. One of the reasons for the low rho bar is likely due to the amount of variability in the styles of answers. This study tried to build a model that represented all types of switches in response to traveler information. Most studies hone in on one type of switch, route choice models are common in literature. The data in this study is a collection of six main switches: mode switch, route switch, departure time switch, activity switch, destination switch and an abort trip switch. Users were also allowed to select a combination of these available switches. Each switch represents a different number of characteristics and driving factors regarding the switch. To better model this data, multiple models would need to be constructed using data for individual types of switches. For instance, one model would represent route switches and another model would represent only mode switches. Examining only one alternative situation would reduce the number of observation in the data set, potentially causing some variable effects to be overlooked. Of over 8000 emails only 191 responses were usable to model, and most of these were thrown out when calculating time variables. This is attributed to the confusion when answering the questions. Matching stated routes and travel times was difficult as many of the trips were taken outside of the Pioneer Valley. When asked to describe the most memorable trip that utilized an information source, many picked a long trip in areas they were unfamiliar with, making it very difficult to visualize the best alternative. Information sources were also not limited to that of RTIC itself. It was thought that with a small awareness of RTIC only a small amount of observations would be usable to model. For this reason, users were free to describe any kind of information they saw fit. The problem with this was many participants described information sources that were not technological at all but instead sensory, for instance many selected that they could see the traffic jam as their only source of information. Some other used the ability of phoning their friends or co-workers to see what was going on up ahead. Though this is technically information, it is not information portrayed by RTIC. The survey also contains both pre-trip and en-route information trips. Receiving information en-route is one of the main reasons participants could not take their best alternative because they had already traveled too far to switch. Likewise, those who received pre-trip information discussed situations where they just decided to wait and leave later. In this case their alternative is to change departure time, however just examining travel times would not bring this to light as the alternative travel time would be the same as the original travel time. Similarly, modeling canceled trips was difficult as the resulting attributes describing the alternative were non-existent. These observations were not included in the calculation of the time variables for this reason.

There was a misunderstanding as to the meaning of some of the alternatives as they were not described specifically, allowing participants to have their own perspective on what it meant. Many participants contradicted themselves when talking about their alternatives. Some would select one item but then describe a completely different alternative from what they selected. This made analyzing and modeling difficult as the model may not accurately portray their experience. The alternatives should have been given discrete definitions in order to minimize confusion.

The most popular alternatives were found to be route switches and departure time switches. As noted above, these two switches occur when pre-trip information is received. This result is not uncommon as Kyoung-Sik (2003) conducted a survey to investigate the effect of pre-trip information on travel switches. The survey found most drivers either changed route or departure time in response to pre-trip information. In this study, no participant selected a destination switch. It was found that most participants used computers as their source of information, followed by radio and sight. The most popular types of information found were congestion and crash information.

CHAPTER 7

CONCLUSIONS AND SUGGESTIONS

This study set out to comprehensively evaluate the Regional Traveler Information Center by analyzing the local awareness and usage of the system. To report the overall effectiveness of the system, surveys and focus groups solicited local opinion towards the website, MassTraveler. Users noted their perceived usefulness of each piece of information provided by MassTraveler. Participants of the survey and focus groups were also asked to discuss any benefits they felt were obtained from receiving and using real-time travel information.

Three focus groups, two public meetings, and two surveys confirmed that local knowledge of RTIC and MassTraveler is very low. Many participants were unaware of the system until it was mentioned in the focus groups or surveys. It seemed that many participants used the experience to learn about the system and find out how they could use it. Many even claimed they would recommend it to their peers. Select populations of participants were aware of RTIC prior to the survey, likely from the time of its initial launch during the Coolidge Bridge reconstruction. These university staff members use the website for its webcams and for the travel time information displayed on Route 9 and Route 116. Those who were accessing the website for the first time, were looking primarily for road closures in areas severely damaged by passing storms. Currently MassTraveler contains an advisory map that shows road closures and construction projects throughout the state. This map is managed and updated by MassDOT.

Unfortunately the map is rarely up to date in the western portion of the state and could use a large overhaul.

A barrage of comments was received from participants pleading for the bus tracker to be brought back online. The bus tracker provided real-time locations of the UMass Transit Services buses such that wait time was much easier to calculate. UMass Transit does have a system that will tell riders the estimated wait time for the next bus for any given stop on their routes, however this information is based off of schedule times and not actual vehicle locations. It is known that the PVTA is working on a new ITS system that may encompass a new bus tracking software.

The most troublesome areas were found to be the Coolidge Bridge, I-91, Route 9, and several surrounding towns in the area. Many staff and faculty commute to campus and would like to see more information stretch farther away from Amherst and the Five Colleges. MassTraveler claims to provide information for the Pioneer Valley, but it really does not branch much farther out than Amherst and Northampton. One way to help spread RTIC's presence is to advertise in specific areas. Planning official meetings confirmed that towns would sponsor ITS projects in their area if they knew how to do so. Spreading advertisements around the area would also raise awareness and give RTIC better feedback on its system from users outside of those targeted in this study.

The full-scale web survey was found to obtain significant data regarding traveler characteristics including vehicle ownership and commute mode. The survey obtained perceived usefulness of RTIC currently and solicited the interest in new technologies proposed by the investigators. It was found that most participants are interested in better quality information regarding congested roads with high travel times, and the locations of damaged or blocked roadways. The webcams were favored over the travel time sensors in the fact that users could visually see what was going on. They do recommend, however, live stream instead of still images captured every interval.

Traveler switching behavior was modeled using a binary random utility model. The logit models were created using survey responses that collected attributes regarding a most memorable use of traveler information. The model used attributes for both a habitual travel pattern, including: departure time, route, mode, estimated travel time, and several other characteristics. Participants then described the information they received and how they perceived it would alter their original travel pattern. To complete the narrative, participants then described their best alternative in traveling to their destination. Many attributes were added to the models. The only quantifiable attributes that could be modeled were the estimated travel times. It was assumed users would choose the alternative with the lowest travel time. Although a significant model was found including travel time characteristics, demographic characteristics, and information related characteristics, the rho bar was found to be just fewer than 40%. This is decent for modeling traveler behavior in this kind of situation. These results should be used carefully as the data contains several discrepancies even after cleaning. Many participants did not correctly answer the questions as envisioned. This was likely due to the amount of reading load and the unfamiliarity with the language used in the survey. Many participants selected different types of alternatives to their travel methods. The model could be improved by modeling each alternative choice individually. The only way to do this effectively would be to collect more concise data. It is recommended that a new survey be distributed that only asks questions regarding a previous use, instead of adding the bulk of the other questions regarding RTIC usage and awareness. Smaller surveys reduce the load on the participant and will make it easier for them to complete.

The next part of this study is to relate the revealed preference data with stated preference data, similar to that of the study by Polydoropoulou *et al* (1999). The investigators collected RP data regarding a most recent use of traveler information in the San Francisco Bay area; and SP data regarding various created hypothetical scenarios with hypothetical traveler information schemes. This type of study was organized in the evaluation of RTIC as well, but the investigators could not find a viable real location for a hypothetical scenario. It was found that the congested areas in the Amherst and Northampton area have very few alternatives to avoid the congestion.

Currently a survey similar to that of the full-scale web survey was mailed to 17000 households in Northampton and Amherst, Massachusetts. These surveys asked questions regarding the awareness and usage of RTIC, coupled with some demographic questions. Over a span of three months, close to 1500 surveys were returned. These surveys are being tabulated and will be used in the next phase of the RTIC evaluation.

APPENDIX A

FOCUS GROUP ENTRANCE AND EXIT QUESTIONNAIRE

FOCUS GROUP ENTRANCE QUESTIONNAIRE
Real-Time Traveler Information Study

Please take 5-10 minutes to answer the questions provided. Your responses are greatly appreciated. Thank you very much for devoting your time in taking part in our discussion.

This entrance questionnaire will help the investigators better understand the demographics of the UMass community who take part in this study.

How many years of age are you?

___

What is your gender?

___

What is your affiliation with the University of Massachusetts?

___

What is your primary mode of travel when commuting to campus? (Bus, Car, Bike, Walking, etc)

___

How many years have you had your driver's license?

___

EXIT QUESTIONNAIRE

Please take 5-10 minutes to answer the questions provided. Your responses are greatly appreciated. Thank you very much for devoting your time in taking part in our discussion.

Have you ever seen anyone using the current system for their own navigational purposes? If so, please briefly describe the situation and how the system was used.

____

____

When might be a good time to implement the field experiment?

____

____

Would you take part in the field experiment? Why or Why Not?

____

____

____

____

Is there anything about the field experiment that you think would bother or influence people not to participate?

____

____

____

____

APPENDIX B

POPUP SURVEY

Items	**Location**
PopupSurvey.pdf	See Supplemental File

APPENDIX C

MASSTRAVELER INITIAL RESULTS FOR MASSDOT

Items	**Location**
MassTravelerInitialResultsForMassDOT.pdf	See Supplemental File

APPENDIX D

FULL SCALE SURVEY AND ZIP CODES

Items	Location
FullScaleSurvey.pdf	See Supplemental File
Zip Codes	123

Responses	Town
91	Amherst
36	Northampton
21	Belchertown
17	Greenfield
13	Leverett
12	Hadley
11	Sunderland
10	South Hadley
7	Easthampton
6	Shutesbury
5	Granby
5	Holyoke
4	Montague
4	South Deerfield
4	Ware
3	Chicopee
3	Conway
3	Hatfield
3	Springfield
3	Turners Falls
3	Whately
2	East Otis
2	Erving
2	Haydenville
2	Longmeadow
2	Ludlow
2	Shelburne Falls
1	Ashfield
1	Barnstable
1	Boston College
1	Brimfield
1	Cambridge
1	Colrain
1	Deerfield
1	Gill
1	Goshen
1	Hampden
1	Huntington
1	Mattapoisett
1	Millers Falls
1	Monterey
1	New Salem
1	North Brookfield
1	North Hatfield
1	Rowe
1	Sandwich
1	Thorndike
1	Three Rivers
1	Warwick
1	Wendell
1	Wilbraham
1	Williamsburg
1	Worthington
1	CT
1	NJ
1	RI
1	VT
306	**Total**

APPENDIX E

MODEL FILES AND OUTPUT

Items	Location
IntermediateModel.py	See Supplemental File
FinalModel.py	See Supplemental File
IntermediateOutput.pdf	See Supplemental File
FinalOutput.pdf	See Supplemental File

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