Travel Behavior Study of Route 9 and Route 116 Commuters: Before Coolidge Bridge Reconstruction.

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16. Abstract

There is a huge body of literature in social psychology describing seventy years of theory and experimentation relating attitudes to behavior. Much of it suggests a stronger causal link between choices and attitudes than between attitudes and choices—attitude models conditioned on revealed choice explain more than knowing peoples' attitudes and determining what choice they will make. Alternate analyses suggest that we need to use attitudinal and other data to determine respondents' intentions rather than desires in order to better predict behavior. Attitude studies are becoming more prevalent in studying transportation behavior, but researchers vary in what kinds of attitudes are considered and how attitudes influence the transportation decision process. In this paper we briefly highlight the social psychology literature, review transportation applications, and present a case study. Cognitive, affective, and behavioral attitudes help explain the intentions of those surveyed for the case study. Our results and the literature suggest that attitudes are very important, but they recommend caution regarding survey wording and capturing behavior intentions. Additionally, the results suggest that a circular behavior process including attitudes is better at explaining choices compared to using only cognitive and affective attitudes to explain behavior.

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CHAPTER 1

INTRODUCTION AND PROBLEM STATEMENT

The Calvin Coolidge Memorial Bridge is a vital transportation link in the Pioneer Valley region of western Massachusetts. The bridge spans the Connecticut River, connecting the city of Northampton, located on the western banks of the river, to the towns of Hadley and Amherst to the east. This bridge also serves as the major transportation link between Interstate 91 and the University of Massachusetts – Amherst (UMass). Opened in 1939, it was designed to carry 15,000 vehicles per day. Current estimates state that the bridge now carries between 35,000 and 40,000 vehicles per day [Cameron, 1999].

Due to its structural condition and lane capacity, the bridge is scheduled to undergo reconstruction in the summer of 2001. As part of this reconstruction, which is expected to take two years to complete, the bridge will be widened to better serve the amount of traffic currently using the bridge. However, the lane capacity will be temporarily reduced during reconstruction, creating a major bottleneck for thousands of commuters and students who use the bridge.

The key focus of this project will be to determine how attitudes and opinions influence traveler choices. This will be done by comparing the "fitness" of route and mode choice models developed for this project. These models use demographic data, travel data, and attitudinal data collected from a survey of Coolidge Bridge users to determine relative differences between models using attitudinal data vs. models that do not. A secondary focus of this research will be to describe the factors that do, in fact, influence predicted travel behavior choices for users of the Coolidge Bridge during the reconstruction project.

The rest of the thesis will be presented as follows. Chapter 2 contains background information on the Coolidge Bridge project and an overview of the relevant research topics covered in this project. Chapter 3 focuses on the methodology used in distributing the mail-based survey used as the data collection tool for this project. Sources of sample bias and a demographic description of the survey sample are also described. Chapter 4 presents a description of the travel data and attitudinal data collected for this research, as well as a discussion of the expected influence of these variables on route and mode choices. Chapter 5 contains the results of the models developed for this project. Lastly, Chapter 6 presents conclusions obtained from this research and proposes future areas of research that may arise from this project.

CHAPTER 2
BACKGROUND

Four areas of background are covered in this section. First, background information is provided on the Coolidge Bridge and the reconstruction project. Second, a relevant case study is presented that provides perspective to the issues encountered in this project. A brief discussion of various choice modeling methodologies follows. Lastly, a discussion of the effects of stated preferences vs. revealed preferences in choice modeling is presented.

2.1 Coolidge Bridge Reconstruction

The Pioneer Valley region encompasses 43 cities and towns in the Connecticut River Valley in mid-western Massachusetts, an area framed on the west by the Berkshires and on the east by the central uplands. An estimated 600,000 people live in the nearly 1,200-square-mile region, which includes the Springfield metropolitan area, the fourth largest in New England. [Pioneer Valley Planning Commission (PVPC), 2000]

One of the most heavily-used transportation corridors in the Pioneer Valley is State Route 9, particularly the section between Northampton, a regional center of commerce, entertainment, and culture, and Amherst, home to the largest employer in the region, the University of Massachusetts – Amherst (UMass). (Figure 1) The Route 9 corridor is the heavy line at the top of the map. This section of Route 9 also passes through the town of Hadley, a mostly rural town that has seen a steady rise in development along the Route 9 corridor. Interstate 91, the major north-south highway that runs along the banks of the Connecticut River, provides access to the area for the rest

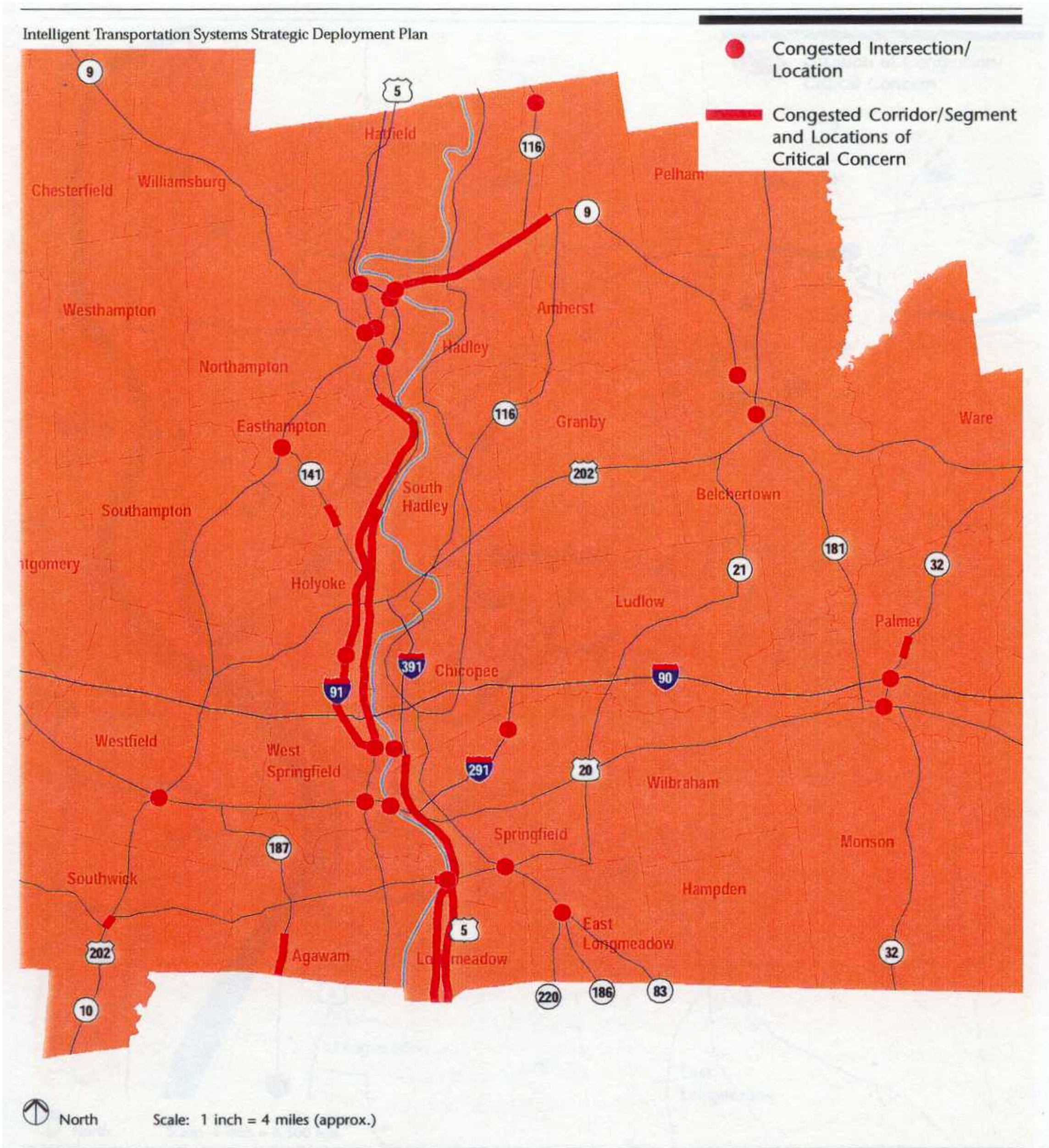

Figure 1: Congested Corridors in the Pioneer Valley Region
Source: MassHighway, 1998

of the Pioneer Valley, particularly larger communities to the south, such as Springfield, Holyoke, and Chicopee.

Employment and retail development along this corridor has generated a growing amount of traffic, resulting in heavy congestion. This is particularly evident between September and May, when classes are in session at area colleges (UMass, Amherst College, Hampshire College, Smith College, and Mount Holyoke College), and many students living in Northampton and other locales west of the Connecticut River use Route 9 to commute to campuses in Amherst and South Hadley. The flow of traffic is also hampered by the lane configuration of Route 9, which is mostly a two-lane arterial through this corridor, with two notable exceptions: a four-lane segment between West Street and East Street in Hadley, and a four-lane segment between the entrance to Mountain Farms Mall and University Drive on the Hadley-Amherst town line.

The most severe choke point for traffic along Route 9 is the Calvin Coolidge Memorial Bridge, which spans the Connecticut River near the interchange with Interstate 91 and connects Northampton to the west and Hadley to the east. The bridge carries two lanes of traffic eastbound (i.e., towards Hadley and Amherst), but only one lane of traffic westbound (i.e., towards Northampton). For this reason, the westbound commute generally sees heavy congestion during the afternoon rush hour.

Alternative routes connecting Northampton and Amherst are few and involve a substantial increase in distance. The Coolidge Bridge is the only direct east-west link between Northampton and Amherst. As can be seen in Figure 1, the nearest alternative river crossings are the Sunderland Bridge (State Route 116) 12 miles to the north, connecting Deerfield and Sunderland, and the Holyoke Bridge (U.S. Route 202) 10 miles to the south, connecting Holyoke and South Hadley. The only non-automobile alternative modes along the Route 9 corridor include bus service, provided by the Pioneer Valley Transit Authority (PVTA), and the Norwottuck Rail Trail, a bicycle trail along an abandoned railroad right-of-way. Bus service is convenient along the corridor, and reliability has been improved with the addition of an express route (the "Minuteman Express") between Northampton and Amherst. (The "Minuteman Express" route will divert its route to travel via the Sunderland Bridge during reconstruction to avoid construction-related delays on the Coolidge Bridge [Delano, 2000].) Bicycling is also popular in this region, compared to other regions of Massachusetts. However, the somewhat rural nature of this region makes the single occupancy vehicle the dominant mode of transportation in this corridor, and in the Pioneer Valley as a whole. 88% of people in the Valley travel to work by car – nearly 77% drive alone. In contrast, 6.4% of Valley residents bicycle or walk to work and 2.7% use public transportation. [PVPC, 2000]

These factors combine to create a daily bottleneck on the 62-year-old Coolidge Bridge that is fast approaching legendary status in western Massachusetts. The eight-mile trip between downtown Northampton and downtown Amherst can take 45 minutes or longer during peak travel periods (AM/PM rush, and after major events at UMass, such as sporting events, concerts, and commencement exercises). This bottleneck near the bridge will likely worsen in the near future with the reconstruction and widening project. The project includes reconstruction of the bridge deck and widening the bridge to accommodate four lanes of traffic, providing two lanes in each direction. To make room for the reconstruction work, traffic on the bridge will be reduced to one lane in each direction during the project, creating a more severe bottleneck in the short-term than currently exists.

This project has been delayed over the last several years for a variety of reasons. Reconstruction is currently set to begin in the summer of 2001 and is scheduled to be completed in two years. (A project to widen a section of Route 9 – from the Hadley town common to the Coolidge Bridge – to four lanes is scheduled to begin during the second year of the reconstruction project [Cameron, 2000]). Plans are being made by both the Massachusetts Highway Department and the Massachusetts State Police to accommodate emergency vehicles needing bridge access during the project and to set up an alternate route for excess passenger traffic (via Interstate 91 and Route 116, utilizing the Sunderland Bridge) from Northampton to

Amherst. Travel for thousands of people who cross the bridge each day will be affected by this project.

2.2 Case Study – San Francisco

One of the elements of this project that makes for a compelling case study is the limited availability of alternate routes across the Connecticut River. This heightens the importance of the Coolidge Bridge in connecting Amherst to Northampton. The greatest fear among many users of the bridge will be that a reduction in lane capacity will result in longer delays for trips across the Connecticut River, regardless of which crossing is taken.

There is evidence, however, that suggests the worst fears of many commuters may not come to pass. Cairns, et al. [1998] suggest that the impact of short-term highway capacity reductions is not as severe as might be imagined. This is attributed to a variety of factors, including:

- Increased use of alternative modes of transportation
- Increased use of other measures, such as carpooling, telecommuting, and flexible work schedules
- Reduction in the number of non-work trips, especially social and recreational trips
- Greater incidence of trip chaining (i.e. traveling to several destinations on one trip)
- Changes in job and/or housing location

Case studies from different cities are included in this study to illustrate the effects of capacity reductions. One case study, in particular, has several similarities to the Coolidge Bridge project. On October 17, 1989, an earthquake struck San Francisco and caused substantial damage to the transportation network in the Bay Area. The most important freeway link temporarily shut down by the earthquake was the Bay Bridge, which connects San Francisco with Oakland and the East Bay suburbs. Prior to the earthquake, the Bay Bridge carried 245,000 vehicles per day; its closure forced users to find other ways of getting to San Francisco. The alternate freeway routes required using either the San Mateo Bridge to the south or the combination of the Richmond-San Rafael Bridge and the Golden Gate Bridge to the north. Each of these routes added at least twenty miles to the commute to San Francisco, not to mention the impact of additional traffic on freeways that were already congested before the earthquake hit. Other modes of travel across San Francisco Bay included BART, the city's rapid transit system, and a ferry service introduced in response to the earthquake and its aftermath.

Considering the importance of the Bay Bridge in moving vehicles through the Bay Area, the traffic impacts of its closure turned out to be less catastrophic than had been imagined. Based on the results of a survey conducted in November 1990 [Deakin, 1991], many East Bay commuters switched to other modes of travel in the wake of the closing of the Bay Bridge. 75% of the respondents used BART to commute to San Francisco in the months after the earthquake, up from 35% usage before the earthquake. (Later surveys showed that 30,000 new BART users were retained once the Bay Bridge reopened.) 10% of respondents used the then-newly instituted ferry service. In addition, only 10% of respondents chose to drive alone (using alternate routes) for their post-quake commute, down from 37% before the quake. One of the results of this mode-switching was that overall travel times were reported to be no more than 15 minutes more than travel times before the earthquake. These survey findings underscore the importance of “redundant infrastructure”, particularly in areas where natural disasters or deficient infrastructure could cause severe disruptions in traffic patterns.

The closure of the Bay Bridge had another after effect. According to the same survey, non-work trips to San Francisco dropped 50% after the earthquake. In addition, the incidence of trip chaining fell 11% after the quake. These two statistics offer a possible explanation for the minimal effect on travel times in the wake of the Bay Bridge closure. Other non-transportation measures were instituted as a result of the earthquake, according to this survey, that may have cushioned the effect of the Bay Bridge closure. The number of employers offering flexible scheduling increased 23%. The number of employers who offered formal schedule changes and the number of employers who offered commuting alternatives (such as four-day work weeks and telecommuting) also increased slightly.

This case study offers several similarities to the Coolidge Bridge scenario. In both cases, there are a limited number of possible automobile links between the main employment center and the major residential area. If the vehicle capacity of the most direct link is negatively impacted, the alternative routes available involve a substantial amount of additional mileage. This heightens the importance of alternate modes of transportation being available and reliable to potentially lessen the effect of minimized capacity along the main link. (In the Coolidge Bridge scenario, the “redundant infrastructure” in place includes the “Minuteman Express” bus route and other PVTA bus routes. Since buses share the same roads as automobiles, their routes cannot truly be considered “redundant”. However, these routes should become significantly more important in the Pioneer Valley transportation network once the bridge reconstruction begins.) The San Francisco case study may also serve as a prediction for traffic patterns during the Coolidge Bridge reconstruction. More specifically, a reduction in non-work trips and an increase in alternative commuting measures, such as telecommuting, four-day work weeks, and flexible work scheduling, may result in response to the bridge reconstruction.

2.3 Choice Modeling Methodologies

Discrete choice models are used to estimate mode choices among a finite set of alternatives, based on disaggregate (i.e., individual) data. These models are assumed to be based on some probabilistic distribution (logistic or Normal, in nearly all cases) and incorporate the concept of *utility*, defined to be the relative likelihood of an individual to choose a particular alternative, dependent on any number of socioeconomic characteristics and the “attractiveness” of the alternative. These utility maximizing models are based on the assumption that, given a set of alternatives, an individual will choose the alternative that maximizes his utility. The most common representation of systematic utility is a simple linear equation of the form

$$V_q = A_0 + A_1x_1 + A_2x_2 + \ldots + A_nx_n + \varepsilon_q$$

where there are n variables representing attributes of mode q or of the individual making the choice. The relative influences of these variables in making a particular choice are indicated by the coefficients $A_0, A_1, \ldots, A_n$. A_0 represents an *alternative-specific constant*, which measures the net influence of any unobservable influence, such as comfort and convenience, which may influence the choice of one option among a set of options. [Ortúzar and Willumsen, 1994]

The most commonly used discrete choice models include multinomial logit, nested logit, and multinomial probit. Ben-Akiva and Lerman [1985] and Ortúzar and Willumsen [1994] provide detailed derivations of these models; the following sections summarize the important advantages and disadvantages of using these models.

Multinomial Logit (MNL)

This is the most commonly used discrete choice model, and is most applicable when distinct, non-correlated alternatives are involved. The model is logistically distributed and takes the form of [Ortúzar and Willumsen, 1994]:

$$P_{iq} = \frac{\exp(V_{iq})}{\sum_{A_j \in A(q)} \exp(V_{iq})}$$

where P_{iq} is the probability of individual i choosing mode q based on the systematic utility for that individual and mode V_{iq}. Binomial probit is a special form of MNL, used when a binary choice (two outcomes) is to be modeled.

The widespread use of MNL in choice modeling can be attributed, at least in part, to its ease of computation relative to other modeling methodologies. However, its primary drawback is that it follows the Independence from Irrelevant Alternatives (IIA) property, which states that the ratio between any two alternatives with non-zero probabilities is independent of the addition or subtraction of other alternatives. Since many mode choices can be grouped together into larger categories (buses and subways are considered “public transit”, for example), many alternatives can be closely correlated with other alternatives, which violates IIA. (The “red bus/blue bus” scenario, where red buses and blue buses can be considered separate modes despite sharing identical characteristics, is a classic illustration of where this property can be problematic in choice modeling.). Another limitation is that, since it is a fixed-coefficient model, MNL cannot account for random taste variations among individuals.

Additional Models

Other econometric models are available which may be more appropriate for different types of applications. Nested logit (also known as hierarchical logit) is one variation of multinomial logit that attempts to overcome the IIA limitation in modeling by nesting choices (for example, a top-level choice of car vs. transit, then second-level choices of drive alone vs. carpool and bus vs. light rail, respectively). Other possibilities include the use of linear regression for determining acceptable travel delay and peak commuting times on the Coolidge Bridge, and the use of ordered logit or ordered probit for a frequency-of-use model. Linear regression estimates coefficients using least squares estimation. Ordered logit and ordered probit model degrees of preference among choices.

2.3 Stated Preference/Revealed Preference Effects

The effect of attitudes and perceptions on individual travel behavior has been an important topic within the realm of demand modeling. Behavior may be characterized by perceptions of travel alternatives, preferences for the attributes of various alternatives, and the availability of travel alternatives. [Koppelman, et al., 1977] Factors such as convenience, reliability, comfort, and flexibility, while not easily quantified, play as much of a role in determining how people travel as do more traditional indicators that can be easily collected and analyzed (income, age, education level, vehicle ownership, etc.). Clifton and Handy [2001] point out two deficiencies of traditional travel surveys: the shaping of responses by how survey questions are written and the potential for under-representing certain segments of the population, such as the poor and those with little education. Different methods of capturing attitudinal data not normally used in transportation research, such as focus groups, personal interviews, and participant-observer methods, can supplement or even replace surveys in collecting attitudinal data. Such methods are less likely to be influenced by researcher bias and are more likely to include a more accurate cross-section of the population.

The effect of perceptions on travel behavior has been explored in recent research. One example comes from studies of San Diego's I-15 Express Lanes, a High Occupancy-Toll (HOT) facility which allows solo drivers with a transponder to use lanes reserved for high-occupancy vehicles (HOV's) by charging a varying toll based on levels of congestion on the main lanes [Golob, 1999; Golob, 2001; Supernak, et al., 2000]. In this study, four opinions about the transponder program are studied and analyzed for their significance among users of the facility. These attitudes, along with standard demographic variables, are incorporated into "optimal" ordered probit models measuring how approval of the program reflects demand for the HOT lanes. Redmond and Mokhtarian [2001] modeled two measures of commuter time preferences ("Ideal Commute Time" and "Relative Desired Commute") to uncover positive utility in commuting. Attitudinal data, incorporating beliefs such as travel dislike, commute benefit, and travel stress, are found to contribute significantly to determining parameters for one's ideal commute time. Mokhtarian and Salomon [1997] analyzed the influence of attitudinal factors in modeling the desire to telecommute among San Diego city employees. Their research confirmed that demographic variables do not fully describe how individuals make the decision to telecommute; attitudinal data, broken into "drives" and "constraints," was found to be highly significant in their logit choice models. Mahmassani, et al. [1990] used a mix of workplace characteristics, geographic characteristics, use of information (i.e., radio reports), and personal preferences to model the propensity to change route and/or departure times during peak hour commutes. They found that use of information and (to a lesser extent) workplace characteristics (such as arrival time flexibility) were significant factors in making switches in route or departure time. Kuppam, et al. [1999] measure the effect of attitudinal factors in mode choice using 1991 data from the Puget Sound Transportation Panel survey. The use of factor analysis, where a set of attitudinal variables is reduced to a smaller set of variable categories, combined with "best fit" multinomial logit models allows a comparison to be made of how attitudes shape behavior. They found that a model using exclusively attitudinal variables performed better than a model using exclusively demographic variables. (A model using both attitudinal and demographic variables outperformed both.) It should be noted that the methodology presented in this research is in much the same manner as Kuppam's work.

With much research ongoing on the use of attitudinal data in transportation demand modeling, one questions remains: Why are these factors commonly excluded from the demand forecasting process? Ben-Akiva and Lerman [1985] note that the major deficiency in stated preference data is that people often do not actually do what they say they will do. This leads to misleading and erroneous data which, when used to model demand, results in unreliable forecasts. Perhaps for this reason, Kuppam, et al. [1999] reason that such data is often not collected in traditional household travel surveys. Further, when this data is available, it is more difficult to incorporate into forecasting models, and is therefore often deemed useless, from a practical standpoint. Clifton and Handy [2001] state that, due to the often complex nature of attitudinal data, a significant amount of work is involved in the collection, distillation, and interpretation of attitudinal data. This work requires an additional level of training for researchers, along with much time and patience. They further state that only with increased use in attitudinal data in travel behavior research and better training of researchers to use such data will the significance of attitudinal data in modeling travel behavior be fully understood.

In the scope of this research, analyzing the importance of travelers' perceptions is particularly important, since the data collected in our survey can only attempt to measure how attitudes and perceptions will influence traffic in a hypothetical (at the time of the survey) scenario that does not yet exist. The correlation between the choices people *think* they will make and the choices they *actually* make can be measured fully only when travel behavior is surveyed *during* the Coolidge Bridge reconstruction. Such data may be collected at a future time; until that time comes, stated preference data will be used in modeling the results of possible "what-if" scenarios.

CHAPTER 3

SURVEY METHODOLOGY AND RESULTS

This section describes the sample collection process, which involved the use of a mail-based survey to potential Coolidge Bridge users. Survey logistics and potential sources of bias in the sample collection process are also detailed.

3.1 Survey Description

A mail-based survey about the Coolidge Bridge reconstruction was sent in May 2000 to approximately 1450 people residing in the Pioneer Valley of western Massachusetts. The survey asked respondents questions about the project, their weekly driving patterns over the bridge, and demographic information. Parts of the survey design are similar to a survey conducted for research on a High Occupancy-Toll facility in southern California. [Parkany, 1999]

Each section of the survey is further described below. A sample survey is reprinted in the Appendix.

Bridge Reconstruction

The first section of the survey asks respondents to comment on the bridge reconstruction and other issues related to the project. The following questions are posed:

- Before receiving this survey, were you aware of the Coolidge Bridge project?
- Where have you obtained information on the project?
- Do you think the Coolidge Bridge is in need of rehabilitation?
- Do you think the Coolidge Bridge and/or Route 9 should be widened?
- When do you expect the project to start?
- How long do you anticipate the project to take?
- Have you considered changing the location of your residence and/or workplace because of the project?
- Rank the four aspects of the project that most concern you.
- When do you decide which route and/or mode you choose to travel over the bridge?
- Which traffic information sources would you use to get traffic information on Route 9?
- What would be an acceptable amount of traffic delay on Route 9 due to the project?
- Would you support “round-the-clock” construction on the bridge?
- Do you notice a substantial difference in travel conditions over the bridge during the school year compared to the summer months?

General Travel Behavior

The next section of the survey asks respondents to detail their travel patterns over the Coolidge Bridge in the week prior to receiving the survey. Respondents are asked to provide the following information:

- Number of trips over the bridge last week (work/school, shopping, social, other)

- Whether or not a work/school trip was made over the bridge
- Work location
- Work hours
- Number of stops en-route to/from work/school
- Mode of travel to work/school
- Length of trip to/from work/school (actual length and non-rush hour length)

Current Travel Behavior

The third section of the survey features a travel diary, presented as two time grids, allowing respondents to mark when they cross the Coolidge Bridge for work, school, and other trips over the course of the previous week. The diary also allows for whether an SOV (single-occupant vehicle), carpool, or bus is used for each crossing of the bridge. Respondents are also asked to evaluate different alternatives to dealing with congestion on the Coolidge Bridge, indicating whether they currently use or plan to use them as well as the frequency of use in a given week.

Demographics

The final section of the survey asks for demographic information from respondents, and provides a space for comments. The following demographic information is sought:

- Number of vehicles in household
- Number of people in household
- Number of children (18 and under) in household
- Dwelling type
- Gender
- Age
- Occupation
- Education level
- Gross household income

3.1 Survey Logistics

The random sample was compiled by matching license plate numbers observed crossing the Coolidge Bridge during two AM and two PM peak travel periods in April 2000 to a commercially available Massachusetts Registry of Motor Vehicles database. Using the Massachusetts RMV database limits the sample to individuals who have passenger vehicles registered in Massachusetts and garaged within the Pioneer Valley (defined as Franklin, Hampden, and Hampshire Counties). Surveys were sent to the randomly selected sample beginning in early May 2000. An initial mailing of surveys was sent to each address in the sample. A reminder postcard was sent in early June 2000 to those respondents who had not sent in surveys. A second survey mailing was sent to those participants not responding to either mailing in mid-June 2000. These repeated mailings, coupled with an incentive prize of a $300 Best Buy gift certificate to be awarded to a random participant, resulted in 817 responses, a response rate of 56%.

3.2 Potential Sources of Sample Bias

The methods by which the sample was collected introduce some sample bias which should be noted. License plates of vehicles were recorded during several peak periods in the spring of 2000. For morning peak periods, cars traveling eastbound (towards Amherst) were collected; for evening peak periods, cars traveling westbound (towards Northampton) were collected. This is an obvious bias towards those users whose work/school destination is Amherst (or nearby towns). It was believed that since UMass is the largest employer in the area, it would attract most of the vehicular traffic during peak hours. This is due not only to the number of employees at UMass, but also to a substantial student population living off-campus in Northampton and other communities travelling to classes. The nature of sample collection ignores, to a degree, those users who have "unusual" schedules (2nd and 3rd shift workers and part-time workers, in particular) and those who work in Northampton and other communities west of the Connecticut River and along Interstate 91. Certainly, these users will feel the effects of the construction project as well and Northampton, the cultural, business, and governmental center of Hampshire County, generates a sizable amount of traffic. However, the degree of traffic generated by UMass – during peak commuting periods and before and after large events on campus – along with increased commercial development along Route 9 in Hadley (and resulting traffic impacts) lead to the consideration in this research that Amherst be considered the central location of most traffic using the Coolidge Bridge.

Other areas of bias are also present in this research; they are detailed in the following paragraphs.

The sample captures only current automobile users of the Coolidge Bridge. Current users of other routes over the Connecticut River (the Sunderland and Holyoke Bridges) or other modes (buses, carpools, bicycles, walkers, etc.) are not captured. In addition, there are only three mode choices identified for consideration in the choice models (single occupant vehicles, buses, and carpools). Bicycles, walking, and other modes of transportation were not considered explicitly as potential choices because it was determined that the likelihood of a current Coolidge Bridge user switching to these modes would be remote. Such a change would be an option for a limited number of users, due to such factors as distance to work, occupation, bicycle ownership, and adequate storage for bicycles. Another result of excluding other routes and modes is the inability to determine such scenarios as the likelihood of users of other routes to change modes or other driving habits (due to the perception of increased traffic along these routes) or the possibility of bus or carpool users to switch to single occupant vehicles to change their route or some other aspect of their commute. In short, this research studies individuals currently driving over the Coolidge Bridge, since this segment of commuters is the most directly affected group of commuters by the reconstruction project.

Since a Massachusetts RMV database was used to obtain mailing addresses, the sample excludes cars registered in other states. Similarly, the decision to limit the sample to vehicles registered within the Pioneer Valley (i.e., Franklin, Hampshire, and Hampden Counties) eliminates vehicles registered in other parts of Massachusetts. Such cars could be driven by college students or individuals working in the area who live outside the Pioneer Valley. These users would be considered regular users of the bridge, but would not be included in the sample.

Commercial vehicles and vehicles not registered to an individual (such as rental cars or leased vehicles) were also excluded from the survey. Excluding commercial vehicles from the sample results in not capturing a segment of users who likely make multiple crossings of the

Coolidge Bridge on a daily basis and who would be greatly affected by disruptions in travel conditions caused by the project. Registrations of leased vehicles in Massachusetts do not identify the leasee (the individual driving the vehicle), making it impossible to mail a survey to these users and further limiting the scope of the sample.

Sampling weights were not used in developing the survey data. Since the primary focus of this research is to compare the relative effects of attitudinal factors in the decision making process, it was determined that use of unweighted data would not affect such comparisons. Although determining which factors do, in fact, influence the choices made by users in the sample is a secondary objective in conducting this research, the lack of sampling weights, combined with the previously listed areas of sample bias, significantly diminishes the certainty with which such factors can be presented as "strong influences" in the decision making process. To summarize, the main objective is to determine the relative influence of a category of decision-making factors, not the absolute influence of specific factors.

3.3 Sample Sets for Choice Models

Two sample sets were used for the choice models developed for this project. The first sample set is the full survey sample, consisting of 817 respondents. The second sample set is a subset of the full sample representing peak users of the Coolidge Bridge – those who stated in their surveys that they use the bridge during peak hours at least three days per week, in either direction. This subset consists of 354 respondents. Two variables ("Eastbound Peak" and "Westbound Peak") were developed which identified which users were considered peak users; these variables are described in more detail in Chapter 4.

Other possible subsets of the survey sample which were considered for analysis included:

- Frequent users of the bridge, identified as those using the bridge more than five times per week, regardless of when these users crossed the bridge
- Users of the bridge who listed Amherst as their work/school destination
- Users of the bridge who indicated work flexibility (based on whether their work start time was fixed and the time range within which they could arrive for work)

These subsets were not used because it was felt that the two sample sets used for this research would provide a sufficient basis upon which to test the effect of attitudinal factors in the decision making process. The subset of peak users was used because it was determined that this group of users would be most affected by disruptions in travel due to the project and would be the most likely group to consider alternative measures to minimize travel delays along Route 9.

3.4 Demographic Data Variables

Three groups of independent variables are used in these models – demographic variables, travel data variables, and attitudinal variables. These variables derive their values from the survey questions, either directly (as a response to a survey question) or indirectly (inferred from the survey data). These variables will be used as inputs in route choice and mode choice models. Demographic data are presented below; travel and attitudinal data are presented in the next chapter.

The following demographic data were considered for the models (data inferred from raw survey data are noted):

- Vehicles/HH – the number of vehicles in the respondent's household (0 – 4)
- Number/HH – the number of persons living in the respondent's household (0 – 6)
- Children/HH – the number of children (age 18 and under) living in the respondent's household (0 – 6)
- Dwelling – the type of dwelling in which the respondent lives (Single Family Home, Condominium, Apartment, Other)
- Male – a dummy variable indicating the gender of the respondent. A value of "1" indicates Male; a value of "0" indicates Female.
- Age – the stated age of the respondent
- Occupation Type – based on the stated occupation of the respondent, the job category that best fits the respondent, as determined by the researcher (Unknown, Art, Education, Government, Medicine, Professional, Retail, Service, Technical, Other, Retired, Not working)
- Job Level – based on the stated job title of the respondent, the level of responsibility (and, with it, job flexibility and relative income) the respondent has in his/her job (Unknown/Not working, Low, Medium, High)
- North – based on the hometown of the respondent, a dummy variable indicating whether the respondent lives north or south of the Coolidge Bridge. A value of "1" indicates North; a value of "0" indicates South.
- East– based on the hometown of the respondent, a dummy variable indicating whether the respondent lives east or west of the Connecticut River. A value of "1" indicates East; a value of "0" indicates West.
- Education Level – the respondent's highest completed level of education (Some high school, High school graduate, Some college, College graduate, Some graduate school, Postgraduate)
- Household Income – the income category representing the respondent's household income ($0-$25,000; $25,000-$50,000; $50,000-$75,000; $75,000-$100,000; $100,000+)
- Average Income – based on the response to the income category question, the corresponding average income for each category ($18,500; $37,500; $62,500; $87,500; $130,000). This categorization (as opposed to the use of distinct categories in the "Household Income" variable) may be a better representation of household income.

Table 1 summarizes the values for these variables for the full sample and for the peak users subsample. An examination of this data shows that, on average, peak users live in smaller households, have fewer children, and own fewer vehicles than the full sample. Many college students fit this description, and are likely to be a substantial portion of peak users. (Interestingly, the average age of users in both sample sets are nearly identical, which contradicts this notion.) A majority of users in both samples are female – nearly 60% in both samples. Among occupation types, the largest proportion of users in both samples are in the education field, either as students or staff; this is not surprising given the number of colleges in the study area. Job levels are relatively modest; many users are in entry-level or mid-level jobs. A majority of users (35% of the full sample and over 40% of peak users) live in Northampton or Florence (a village within Northampton); their proximity to transit and the Sunderland Bridge may suggest that most users in the sample will gravitate towards those alternatives should their travel habits change. Education levels and income levels in both samples are fairly level across all categories, capturing a representative cross-section of Pioneer Valley residents in these areas.

Table 1: Demographic Data Summary for Coolidge Bridge Sample

Variable		***All Users***		***Peak Users***	
Number of respondents		817		354	
Vehicles/HH		2.02	Average	0.90	Average
Persons/HH		2.66	Average	1.77	Average
Children/HH		0.62	Average	0.27	Average
Age		41.36	Average	41.40	Average
Dwelling Type	Single family home	524	64.1%	228	64.4%
	Condo	33	4.0%	14	4.0%
	Apartment	200	24.5%	79	22.3%
	Other	35	4.3%	21	5.9%
	No response	25	3.1%	12	3.4%
Male	Male	327	40.0%	135	38.1%
	Female	468	57.3%	211	59.6%
	No response	22	2.7%	8	2.3%
Occupation Type	Unknown	40	4.9%	19	5.4%
	Art	22	2.7%	13	3.7%
	Education	213	26.1%	82	23.2%
	Government	12	1.5%	7	2.0%
	Medicine	75	9.2%	36	10.2%
	Professional	130	15.9%	51	14.4%
	Retail	54	6.6%	27	7.6%
	Service	96	11.8%	42	11.9%
	Technical	38	4.7%	17	4.8%
	Other	79	9.7%	36	10.2%
	Retired	49	6.0%	23	6.5%
	Not Working	9	1.1%	1	0.3%
Job Level	Unknown/Not working	98	12.0%	43	12.1%
	Low	397	48.6%	168	47.5%
	Medium	252	30.8%	116	32.8%
	High	70	8.6%	27	7.6%
Hometown (Top 5 Responses)	Northampton	166	20.3%	58	16.4%
	Florence	120	14.7%	93	26.3%
	Easthampton	71	8.7%	18	5.1%
	Amherst	70	8.6%	17	4.8%
	Hadley	44	5.4%	23	6.5%
North	North	541	66.2%	258	72.9%
	South	276	33.8%	96	27.1%
East	East	232	28.4%	86	24.3%
	West	585	71.6%	268	75.7%
Education Level	Some high school	17	2.1%	10	2.8%
	High school graduate	82	10.0%	34	9.6%
	Some college	162	19.8%	76	21.5%
	College graduate	202	24.7%	80	22.6%
	Some graduate school	82	10.0%	39	11.0%
	Postgraduate	246	30.1%	105	29.7%
	No response	26	3.2%	10	2.8%
Household Income	< $25,000	135	16.5%	61	17.2%
	$25,000-$50,000	255	31.2%	101	28.5%
	$50,000-$75,000	187	22.9%	86	24.3%
	$75,000-$100,000	86	10.5%	42	11.9%
	>$100,000	54	6.6%	18	5.1%
	No response	100	12.2%	46	13.0%

CHAPTER 4

DESCRIPTION AND INFLUENCE OF VARIABLES

Before presenting the results of the various route and mode choice models, a closer look at the expected influences of the various independent variables included in these models is warranted. A general expectation prior to conducting this research is that perceptions and attitudes play a significant role in the choices made by commuters, particularly regarding a choice that will not be made until some future date. These attitudes and perceptions are formed over time by summing one's prior experiences traveling this route, specific aspects of the particular journey (such as the general behavior of other travelers), the reliability of the mode of travel or traffic control along an intended route, and the prior frequency and effects of such abnormalities as construction work, accidents, and special events. In making travel behavior choices in the present, a traveler uses known information about his journey, such as the intended destination, the desired time of arrival, the optimal route and mode to be used, and any other unusual circumstances (such as whether a special event is taking place or whether unusual travel conditions such as traffic or weather exist). This current "real-time" information is then combined with one's own attitudes and perceptions to determine the best course of action to take (when to leave, how to travel, which route to take). Where an individual is making travel decisions regarding a scenario that does not yet exist (such as the Coolidge Bridge reconstruction), the same decision-making process is employed; the difference lies in the type of information available to an individual from which to make a decision. The "real-time" information is modified to exclude specific abnormalities of the trip and include a fundamental change in some aspect of the journey, such as a change in route, capacity, or travel time. The perception of both the nature and effect of this type of change differs for each individual, and, when combined with existing perceptions of a particular trip, strengthens the influence of perceptions and attitudes in the decision-making process. A comparison of the validity of choice models with and without these attitudinal factors should support this hypothesis.

4.1 Travel Data Variables

As mentioned in the previous chapter, demographic data, travel data, and attitudinal data are the three variable groups used in developing choice models for this project. Demographic data were described in the previous section; travel data and attitudinal data are presented below.

Travel data variables, many of which are obtained from answers given in the "current travel behavior" section of the survey, aim to describe the current travel habits and patterns of respondents in crossing the Connecticut River. The following travel data variables were considered for the models. (Most of these correspond directly with survey questions, as can be confirmed with the survey in the Appendix. The dummy (Yes, No) questions are in response to measures currently taken to avoid Coolidge Bridge traffic congestion. Dummy variables are coded "1" for Yes and "0" for No, unless otherwise noted. Data inferred from survey questions are noted.):

- # of Work Trips – the number of work round-trips made last week by the respondent over the Coolidge Bridge

- # of Shopping Trips– the number of shopping round-trips made last week by the respondent over the Coolidge Bridge
- # of Social Trips– the number of social round-trips made last week by the respondent over the Coolidge Bridge
- # of Other Trips– the number of other round-trips made last week by the respondent over the Coolidge Bridge
- # of Total Trips– based on the previous responses, the total number of round-trips made last week by the respondent over the Coolidge Bridge
- CB Last Week – a dummy variable indicating whether or not the respondent made a work trip last week over the Coolidge Bridge
- Work Hours – based on the stated start and end times of the respondent's job, the number of hours in the respondent's workday
- Fixed Start – an indicator of whether the respondent's work start time is fixed (Fixed, Partial, Not Fixed)
- Flex Range – based on the stated times between which the respondent's can start work (if applicable), the number of hours the respondent has in his/her start time "range"
- Work Flexibility – based on the response to the fixed start question, a dummy variable indicating whether the respondent has partial flexibility in arriving to work (Yes, No)
- # of Stops To Work – the number of stops the respondent made in his/her last trip to work over the Coolidge Bridge (0 – 5)
- # of Stops From Work – the number of stops the respondent made in his/her last trip home from work over the Coolidge Bridge (0 – 5)
- Mode – the mode used to make the respondent's last work trip (Single Occupant Vehicle, Bus, Carpool)
- Travel Time To Work – the amount of time taken by the respondent to travel to work
- Travel Time From Work – the amount of time taken by the respondent to travel from work
- Non-Rush Travel Time To Work – the amount of time taken by the respondent to travel to work during off-peak periods (i.e., with no traffic or congestion)
- Non-Rush Travel Time From Work – the amount of time taken by the respondent to travel from work during off-peak periods (i.e., with no traffic or congestion)
- Time Difference To Work – based on the travel times given by the respondent, the difference (i.e., delay) in traveling to work during peak hour periods vs. non peak hour periods
- Time Difference From Work – based on the travel times given by the respondent, the difference (i.e., delay) in traveling from work during peak hour periods vs. non peak hour periods
- Eastbound Trips – based on the travel survey diary grid, the number of eastbound trips made by the respondent over the Coolidge Bridge
- Eastbound Peak Trips– based on the travel survey diary grid, the number of eastbound trips made by the respondent over the Coolidge Bridge during the AM peak hours (7 – 9 AM)
- Eastbound Off Peak Trips– based on the travel survey diary grid, the number of eastbound trips made by the respondent over the Coolidge Bridge during non-peak AM periods

- Westbound Trips – based on the travel survey diary grid, the number of westbound trips made by the respondent over the Coolidge Bridge
- Westbound Peak Trips– based on the travel survey diary grid, the number of westbound trips made by the respondent over the Coolidge Bridge during the PM peak hours (4 – 6 PM)
- Westbound Off Peak Trips– based on the travel survey diary grid, the number of westbound trips made by the respondent over the Coolidge Bridge during non-peak PM periods
- Eastbound Peak – based on the number of eastbound peak trips, a dummy variable indicating whether a respondent crosses the bridge eastbound in the morning at least three days per week (Yes, No)
- Westbound Peak – based on the number of westbound peak trips, a dummy variable indicating whether a respondent crosses the bridge westbound in the evening at least three days per week (Yes, No). This variable and "Eastbound Peak" are used to determine which respondents are included in the peak users subset, which consists of respondents who use the bridge three or more times in either peak direction/hour combination.
- Work Distance – This variable is derived from two sources. The respondent's hometown was obtained from the RMV database. The respondent's work town is asked for in the survey. Using Mapquest, a mapping service on the World Wide Web, the distance between these two town centers was obtained and used as the value for this variable.
- Early AM (Current Use) – a dummy variable indicating whether a respondent currently travels earlier in the morning to avoid bridge traffic (Yes, No)
- Early PM (Current Use) – a dummy variable indicating whether a respondent currently travels earlier in the evening to avoid bridge traffic (Yes, No)
- Late AM (Current Use) – a dummy variable indicating whether a respondent currently travels later in the morning to avoid bridge traffic (Yes, No)
- Late PM (Current Use) – a dummy variable indicating whether a respondent currently travels later in the evening to avoid bridge traffic (Yes, No)
- Sunderland Bridge (Current Use) – a dummy variable indicating whether a respondent currently travels across the Sunderland bridge to avoid bridge traffic (Yes, No)
- Holyoke Bridge (Current Use) – a dummy variable indicating whether a respondent currently travels across the Holyoke bridge to avoid bridge traffic (Yes, No)
- Bus (Current Use) – a dummy variable indicating whether a respondent currently travels by bus to avoid bridge traffic (Yes, No)
- Carpool (Current Use) – a dummy variable indicating whether a respondent currently travels by carpool to avoid bridge traffic (Yes, No)
- Other Behavior (Current Use) – a dummy variable indicating whether a respondent currently employs another kind of behavior to avoid bridge traffic (Yes, No)

The values for these variables for the full sample and for the peak users subsample are summarized in Tables 2 and 3. Table 2 presents a statistical summary of Coolidge Bridge travel in both sample sets, while Table 3 shows a breakdown of the

Table 2: Travel Data Summary for Coolidge Bridge Sample - Statistical Summary of Coolidge Bridge Use

Variable		***All Users***		***Peak Users***	
Number of respondents		817		354	
# of Work Trips		3.42	Average	3.37	Average
# of Shopping Trips		0.65	Average	0.67	Average
# of Social Trips		0.54	Average	0.61	Average
# of Other Trips		0.33	Average	0.37	Average
# of Total Trips		4.94	Average	5.00	Average
CB Last Week	Yes	587	71.8%	249	70.3%
	No	230	28.2%	105	29.7%
Work Hours		8.04	Average	7.75	Average
Fixed Start	Yes	267	32.7%	120	33.9%
	No	93	11.4%	38	10.7%
	Partially	184	22.5%	74	20.9%
	No response	273	33.4%	122	34.5%
Flex Range (Hours)		1.72	Average	0.91	Average
Work Flexibility	Yes	184	22.5%	74	20.9%
	No	633	77.5%	280	79.1%
# of Stops To Work		0.66	Average	0.38	Average
# of Stops From Work		0.80	Average	0.49	Average
Mode	SOV	510	62.4%	301	85.0%
	Bus	5	0.6%	2	0.6%
	Carpool	59	7.2%	33	9.3%
	Other	4	0.5%	3	0.8%
	No response	239	29.3%	15	4.2%
Travel Time To Work (Minutes)		20.23	Average	27.9	Average
Travel Time From Work (Minutes)		24.04	Average	34.71	Average
Non-Rush Travel Time To Work (Minutes)		16.66	Average	23.02	Average
Non-Rush Travel Time From Work (Minutes)		16.72	Average	23.31	Average
Time Difference To Work (Minutes)		5.15	Average	10.19	Average
Time Difference From Work (Minutes)		10.54	Average	16.72	Average
Eastbound Trips		4.02	Average	5.77	Average
Eastbound Peak Trips		1.93	Average	4.11	Average
Eastbound Off Peak Trips		2.09	Average	1.66	Average
Westbound Trips		3.74	Average	5.3	Average
Westbound Peak Trips		1.52	Average	3.13	Average
Westbound Off Peak Trips		2.22	Average	2.17	Average
Eastbound Peak	Yes	300	36.7%	300	84.7%
	No	517	63.3%	54	15.3%
Westbound Peak	Yes	224	27.4%	224	63.3%
	No	593	72.6%	130	36.7%
Work Distance		9.18	Average	8.87	Average

Table 3: Travel Data Summary for Coolidge Bridge Sample - Breakdown of Current Use of Alternatives

Variable		***All Users***		***Peak Users***	
Number of respondents		817		354	
Early AM (Current Use)	Yes	197	24.1%	83	23.4%
	No	620	75.9%	271	76.6%
Early PM (Current Use)	Yes	164	20.1%	73	20.6%
	No	653	79.9%	281	79.4%
Late AM (Current Use)	Yes	67	8.2%	35	9.9%
	No	750	91.8%	319	90.1%
Late PM (Current Use)	Yes	142	17.4%	65	18.4%
	No	675	82.6%	289	81.6%
Sunderland Bridge (Current Use)	Yes	200	24.5%	96	27.1%
	No	617	75.5%	258	72.9%
Holyoke Bridge (Current Use)	Yes	114	14.0%	51	14.4%
	No	703	86.0%	303	85.6%
Bus (Current Use)	Yes	25	3.1%	11	3.1%
	No	792	96.9%	343	96.9%
Carpool (Current Use)	Yes	28	3.4%	14	4.0%
	No	789	96.6%	340	96.0%
Other Behavior (Current Use)	Yes	66	8.1%	32	9.0%
	No	751	91.9%	322	91.0%

nature and frequency of the current use of alternatives to driving across the Coolidge Bridge among users in both sample sets. Respondents in our sample average approximately five round trips per week across the Coolidge Bridge; work trips average over three round trips per week per respondent. In both sample sets, over 70% of users made at least one trip over the Coolidge Bridge in the week prior to receiving the survey. Over 20% of users in both sample sets indicate some flexibility in their work arrival times; this may be an indicator of the likelihood of a user to change her travel habits. It is not surprising that, on average, peak users have less work flexibility in terms of the length of the "flexible window" within which to arrive at work compared to the total sample. The majority of users in both sample sets used a single-occupant vehicle (SOV) in their last trip over the Coolidge Bridge – over 60% of all users and 85% of peak users drove alone. The average travel time to work is 20 minutes for all users; for peak users, the average travel time increases to 28 minutes. The return trip from work is longer, on average, for both sample sets – 24 minutes for all users and nearly 35 minutes for peak users. Current average travel delays in crossing the bridge are 5 to 10 minutes for home-to-work trips and 10 to 15 minutes for work-to-home trips. (Presumably, most home-to-work trips are made during the AM peak and most work-to-home trips are made during the PM peak.) As expected, peak users experience significantly longer travel times and delays, compared to the whole sample (which includes peak users). Changes in travel habits are currently being explored among users in our sample; earlier departures at both ends of the commute and use of the Sunderland Bridge as an alternate route are being pursued by at least 20% of the users in both sample sets. Clearly, users who currently are willing to pursue alternative travel choices are more likely to continue to make such choices as the bridge reconstruction project progresses.

4.2 Attitudinal Data Variables

Attitudinal data variables indicate beliefs of respondents regarding the Coolidge Bridge project or choices made in hypothetical situations. The importance of these beliefs in the decision making process is a core topic of investigation in this research. The following attitudinal data variables were considered for the models (variables inferred from raw survey data are noted):

- Awareness – a dummy variable indicating whether or not the respondent is aware of the bridge project (Yes, No)
- Newspaper Info – a dummy variable indicating whether or not the respondent received information about the project from newspaper accounts (Yes, No)
- Radio Info – a dummy variable indicating whether or not the respondent received information about the project from radio (Yes, No)
- TV Info – a dummy variable indicating whether or not the respondent received information about the project from television (Yes, No)
- MHD Info – a dummy variable indicating whether or not the respondent received information about the project from representatives of MassHighway (Yes, No)
- Government Info – a dummy variable indicating whether or not the respondent received information about the project from representatives of another government entity (such as town officials, city council, or regional planning agencies) (Yes, No)
- Other Info – a dummy variable indicating whether or not the respondent received information about the project from another source (Yes, No)
- Project Sources – based on the responses to the dummy variables listed above, the number of sources from which the respondent has obtained information about the project (0-7)
- Sufficient Info – a dummy variable indicating whether the respondent believes that sufficient info about the project has been made available (Yes, No/Don't Know)
- Rehabilitation – a dummy variable indicating whether the respondent believes the Coolidge Bridge should be rehabilitated (Yes, No/Don't Know)
- Widening – a dummy variable indicating whether the respondent believes the bridge and/or Route 9 should be widened. A value of "1" (Yes) represents the belief that widening of the bridge and/or Route 9 is needed; a value of "0" (No) represents either that no widening should take place or an unknown opinion.
- Project Start – an indicator of when the respondent believes the reconstruction project will start (Summer 2000, Fall 2000, Winter 2001 or later)
- Project Length – an indicator of how long the respondent believes the project will take to complete (< 2 years, 2-4 years, > 4 years)
- Move – a dummy variable indicating whether the respondent has considered a change in home and/or workplace location because of the project. A value of "1" (Yes) represents of at least one type of move; a value of "0" (No) represents either no consideration of a move or an unknown opinion.
- Concern - Project Length – an indicator of how strongly the respondent ranks the project's length as a concern regarding this project, on a scale of 1-4 (with "4" being the greatest concern and "1" being the 4^{th} greatest concern). A value of "0" indicates that this issue was not ranked by the respondent.

- Concern - Project Cost – an indicator of how strongly the respondent ranks the project's cost as a concern regarding this project, on a scale of 1-4 (with "4" being the greatest concern and "1" being the 4^{th} greatest concern). A value of "0" indicates that this issue was not ranked by the respondent.
- Concern - Rush Hour Effect– an indicator of how strongly the respondent ranks the project's effect on rush hour traffic as a concern regarding this project, on a scale of 1-4 (with "4" being the greatest concern and "1" being the 4^{th} greatest concern). A value of "0" indicates that this issue was not ranked by the respondent.
- Concern - Non-Rush Hour Effect– an indicator of how strongly the respondent ranks the project's effect on non-rush hour traffic as a concern regarding this project, on a scale of 1-4 (with "4" being the greatest concern and "1" being the 4^{th} greatest concern). A value of "0" indicates that this issue was not ranked by the respondent.
- Concern - Noise – an indicator of how strongly the respondent ranks noise associated with construction as a concern regarding this project, on a scale of 1-4 (with "4" being the greatest concern and "1" being the 4^{th} greatest concern). A value of "0" indicates that this issue was not ranked by the respondent.
- Concern - Pollution – an indicator of how strongly the respondent ranks pollution associated with the project as a concern regarding this project, on a scale of 1-4 (with "4" being the greatest concern and "1" being the 4^{th} greatest concern). A value of "0" indicates that this issue was not ranked by the respondent.
- Concern - Route 9 Widening – an indicator of how strongly the respondent ranks potential widening of Route 9 as a concern regarding this project, on a scale of 1-4 (with "4" being the greatest concern and "1" being the 4^{th} greatest concern). A value of "0" indicates that this issue was not ranked by the respondent.
- Concern - Emergency Vehicle Access – an indicator of how strongly the respondent ranks the project's effect on emergency vehicle access as a concern regarding this project, on a scale of 1-4 (with "4" being the greatest concern and "1" being the 4^{th} greatest concern). A value of "0" indicates that this issue was not ranked by the respondent.
- Concern - Traffic Increase on Other Roads – an indicator of how strongly the respondent ranks the project's effect on traffic along nearby roads as a concern regarding this project, on a scale of 1-4 (with "4" being the greatest concern and "1" being the 4^{th} greatest concern). A value of "0" indicates that this issue was not ranked by the respondent.
- Concern - Other – an indicator of how strongly the respondent ranks another issue as a concern regarding this project, on a scale of 1-4 (with "4" being the greatest concern and "1" being the 4^{th} greatest concern). A value of "0" indicates that this issue was not ranked by the respondent.
- Dynamic Decide Route – a dummy variable indicating whether the respondent decides which route to use to cross the Connecticut River before or after the start of the trip. A value of "1" (Yes) indicates that the respondent decides his route AFTER the start of the trip (i.e., en route); a value of "0" (No) indicates that the respondent decides his route BEFORE the start of the trip.
- Radio/TV Traffic Info – a dummy variable indicating whether or not the respondent would use radio or TV reports to obtain Coolidge Bridge traffic information if it was available (Yes, No)

- HAR Traffic Info – a dummy variable indicating whether or not the respondent would use Highway Information Radio to obtain Coolidge Bridge traffic information if it was available (Yes, No)
- EMS Traffic Info – a dummy variable indicating whether or not the respondent would use electronic message signs to obtain Coolidge Bridge traffic information if it was available (Yes, No)
- Internet Traffic Info – a dummy variable indicating whether or not the respondent would use the internet to obtain Coolidge Bridge traffic information if it was available (Yes, No)
- Telephone Traffic Info – a dummy variable indicating whether or not the respondent would use a telephone service to obtain Coolidge Bridge traffic information if it was available (Yes, No)
- Other Traffic Info – a dummy variable indicating whether or not the respondent would use another source of information to obtain Coolidge Bridge traffic information if it was available (Yes, No)
- Traffic Sources – based on the responses to the dummy variables listed above, the number of traffic information sources the respondent would use to obtain Coolidge Bridge traffic information (0-6)
- Acceptable Delay – a variable indicating the amount of time, in minutes, the respondent believes would be an acceptable amount of delay in travel time on Route 9 due to the bridge reconstruction project
- 24 Hour Support – a dummy variable indicating whether or not the respondent supports construction work on the bridge 24 hours a day in an effort to shorten the length of the project (Yes, No/Don't Know)
- School Heavy Traffic – a dummy variable indicating whether the respondent notices an increase in traffic volumes during the school year vs. the summer months. A value of "1" (Yes) indicates that the respondent feels school traffic is heavier than summer traffic; a value of "0" (No) indicates that either summer traffic is heavier, traffic remains constant year round, or an unknown opinion.
- Change Habit – a dummy variable indicating whether or not the respondent intends to change their travel habits due to the project (Yes, No)
- More Questions – an indicator of whether the respondent is willing to answer further questions about the bridge project (Yes, No/Don't Know)

Additionally, several variables were developed based on comments from survey respondents. These variables include the following:

- Second Bridge – based on written comments from the survey questionnaire, a dummy variable indicating whether or not the respondent explicitly favors the building of a second bridge for the Route 9 corridor (Yes, No)
- New Transit – based on written comments from the survey questionnaire, a dummy variable indicating whether or not the respondent explicitly states a preference for increased transit operations along Route 9 (Yes, No)
- Route 9 Development – based on written comments from the survey questionnaire, a dummy variable indicating whether or not the respondent explicitly states a concern that the bridge project will result in increased commercial development along the Route 9 corridor (Yes, No)

- Infrequent User – based on written comments from the survey questionnaire, a dummy variable indicating whether or not the respondent explicitly describes him/herself as an infrequent user of the Coolidge Bridge (Yes, No)
- Use Less – based on written comments from the survey questionnaire, a dummy variable indicating whether or not the respondent explicitly states an intention to use the bridge less as a result of this project (Yes, No)
- Reversible Lane – based on written comments from the survey questionnaire, a dummy variable indicating whether or not the respondent explicitly favors the use of a reversible travel lane on the bridge (Yes, No)
- UMass Criticism – based on written comments from the survey questionnaire, a dummy variable indicating whether or not the respondent explicitly criticizes UMass in connection to the project (Yes, No)
- Government Criticism – based on written comments from the survey questionnaire, a dummy variable indicating whether or not the respondent explicitly criticizes government (local, state, or federal) in connection to this project (Yes, No)
- Other Road Problems – based on written comments from the survey questionnaire, a dummy variable indicating whether or not the respondent explicitly mentions traffic issues in other locations near the Coolidge Bridge or near the Route 9 corridor (Yes, No)

Table 4 summarizes the values for these variables for the full sample and for the peak users subsample; variables shown in boldface are statistically significant in at least one of the choice models presented in Chapter 5. Most respondents indicate an awareness of the bridge reconstruction project, and approximately 75% of users in both sample sets get information from newspapers. There is no clear majority of opinion as to whether sufficient information about the project has been made known. Approximately 75% of users in both sample sets believe both the Coolidge Bridge and Route 9 should be widened – hopefully an indication that some level of inconvenience will be tolerated during the project. Most users in the sample are optimistic about the project's start date, but are somewhat less hopeful that the project will end swiftly. While many respondents do not plan to relocate their home or work location because of the project, approximately 20% of users in both sample sets are considering at least one type of location change.

Table 4: Attitudinal Data Summary for Coolidge Bridge Sample

Variable		***All Users***		***Peak Users***	
Number of respondents		817		354	
Awareness	Yes	765	93.6%	332	93.8%
	No	52	6.4%	22	6.2%
Newspaper Info	Yes	611	74.8%	270	76.3%
	No	206	25.2%	84	23.7%
Radio Info	Yes	312	38.2%	149	42.1%
	No	505	61.8%	205	57.9%
TV Info	Yes	207	25.3%	98	27.7%
	No	610	74.7%	256	72.3%
MHD Info	Yes	37	4.5%	15	4.2%
	No	780	95.5%	339	95.8%
Government Info	Yes	41	5.0%	18	5.1%
	No	776	95.0%	336	94.9%
Other Info	Yes	281	34.4%	121	34.2%
	No	536	65.6%	233	65.8%
Project Sources		1.82	Average	1.9	Average
Sufficient Info	Yes	289	35.4%	127	35.9%
	No/Don't know	463	56.7%	201	56.8%
	No response	65	8.0%	26	7.3%
Rehabilitation	Yes	748	91.6%	327	92.4%
	No/Don't know	62	7.6%	22	6.2%
	No response	7	0.9%	5	1.4%
Widening	Yes	729	89.3%	317	89.5%
	No/Don't know	77	9.4%	33	9.3%
	No response	11	1.3%	4	1.1%
Project Start	Summer 2000	477	58.4%	214	60.5%
	Fall 2000	163	20.0%	70	19.8%
	Winter 2001 or later	123	15.1%	50	14.1%
	No response	54	6.6%	20	5.6%
Project Length	Less than 2 years	251	30.7%	112	31.6%
	2-4 years	444	54.3%	190	53.7%
	More than 4 years	86	10.5%	39	11.0%
	No response	36	4.4%	13	3.7%
Move	Yes	177	21.6%	70	19.7%
	No/Don't know	614	75.2%	275	77.7%
	No response	26	3.2%	9	2.5%
Concern – Project Length	Greatest concern	162	19.8%	72	20.3%
	2nd greatest concern	137	16.8%	54	15.3%
	3rd greatest concern	161	19.7%	67	19.0%
	4th greatest concern	101	12.4%	42	11.9%
	Not ranked	256	31.3%	119	33.6%
Concern – Project Cost	Greatest concern	24	2.9%	12	3.4%
	2nd greatest concern	61	7.5%	29	8.2%
	3rd greatest concern	47	5.8%	18	5.1%
	4th greatest concern	87	10.7%	35	9.9%
	Not ranked	598	73.2%	260	73.5%
Concern – Rush Hour Effect	Greatest concern	328	40.2%	139	39.3%
	2nd greatest concern	157	19.2%	75	21.2%
	3rd greatest concern	74	9.1%	28	7.9%
	4th greatest concern	34	4.2%	11	3.1%
	Not ranked	224	27.4%	101	28.5%

Note: The highlighted variables are significant in at least one of the models presented in Chapter 5.

Table 4: Attitudinal Data Summary for Coolidge Bridge Sample (continued)

Variable		***All Users***		***Peak Users***	
Number of respondents		817		354	
Concern – Non-Rush Hour Effect	Greatest concern	36	4.4%	13	3.7%
	2nd greatest concern	149	18.2%	64	18.1%
	3rd greatest concern	108	13.2%	56	15.8%
	4th greatest concern	70	8.6%	28	7.9%
	Not ranked	454	55.6%	193	54.5%
Concern - Noise	Greatest concern	0	0.0%	0	0.0%
	2nd greatest concern	5	0.6%	1	0.3%
	3rd greatest concern	8	1.0%	3	0.9%
	4th greatest concern	12	1.5%	6	1.7%
	Not ranked	792	96.9%	344	97.2%
Concern - Pollution	Greatest concern	10	1.2%	2	0.6%
	2nd greatest concern	20	2.5%	11	3.1%
	3rd greatest concern	34	4.2%	16	4.5%
	4th greatest concern	42	5.1%	19	5.4%
	Not ranked	711	87.0%	306	86.4%
Concern – Route 9 Widening	Greatest concern	21	2.6%	10	2.8%
	2nd greatest concern	23	2.8%	6	1.7%
	3rd greatest concern	37	4.5%	16	4.5%
	4th greatest concern	51	6.2%	20	5.7%
	Not ranked	685	83.8%	302	85.3%
Concern – Emergency Access	Greatest concern	62	7.6%	25	7.1%
	2nd greatest concern	53	6.5%	21	5.9%
	3rd greatest concern	87	10.7%	31	8.8%
	4th greatest concern	82	10.0%	35	9.9%
	Not ranked	533	65.2%	242	68.4%
Concern – Traffic Increase on Other Roads	Greatest concern	18	2.2%	9	2.5%
	2nd greatest concern	52	6.4%	19	5.4%
	3rd greatest concern	88	10.8%	36	10.2%
	4th greatest concern	136	16.7%	60	17.0%
	Not ranked	523	64.0%	230	65.0%
Concern – Other	Greatest concern	12	1.5%	4	1.1%
	2nd greatest concern	4	0.5%	1	0.3%
	3rd greatest concern	5	0.6%	1	0.3%
	4th greatest concern	10	1.2%	5	1.4%
	Not ranked	786	96.2%	343	96.9%
Dynamic Decide Route	Yes	275	33.7%	106	29.9%
	No	490	59.9%	224	63.3%
	No response	52	6.4%	24	6.8%
Radio/TV Traffic Info	Yes	636	77.8%	286	80.8%
	No	181	22.2%	68	19.2%
HAR Traffic Info	Yes	282	34.5%	123	34.7%
	No	535	65.5%	231	65.3%
EMS Traffic Info	Yes	278	34.0%	123	34.7%
	No	539	66.0%	231	65.3%
Internet Traffic Info	Yes	158	19.3%	68	19.2%
	No	659	80.7%	286	80.8%
Telephone Traffic Info	Yes	110	13.5%	43	12.1%
	No	707	86.5%	311	87.9%
Other Traffic Info	Yes	42	5.1%	15	4.2%
	No	775	94.9%	339	95.8%
Note: The highlighted variables are significant in at least one of the models presented in Chapter 5.					

Table 4: Attitudinal Data Summary for Coolidge Bridge Sample (continued)

Variable		*All Users*		*Peak Users*	
Number of respondents		817		354	
Traffic Sources		1.84	Average	1.86	Average
Acceptable Delay		12.09	Average	12.49	Average
24 Hour Support	Yes	420	51.4%	181	51.1%
	No/Don't know	363	44.4%	163	46.1%
	No response	34	4.2%	10	2.8%
School Heavy Traffic	Yes	620	75.9%	261	73.7%
	No/Don't know	170	20.9%	86	24.3%
	No response	27	3.3%	7	2.0%
Change Habit	Yes	555	67.9%	235	66.4%
	No	262	32.1%	119	33.6%
More Questions	Yes	464	56.8%	194	54.8%
	No	183	22.4%	86	24.3%
	Don't know	136	16.6%	62	17.5%
	No response	34	4.2%	12	3.4%
Number of respondents w/ comments		404	49.4%	172	48.6%
Second Bridge	Yes	94	11.5%	40	11.3%
	No	723	88.5%	314	88.7%
New Transit	Yes	28	3.4%	15	4.2%
	No	789	96.6%	339	95.8%
Route 9 Development	Yes	19	2.3%	12	3.4%
	No	798	97.7%	342	96.6%
Infrequent User	Yes	28	3.4%	11	3.1%
	No	789	96.6%	343	96.9%
Use Less	Yes	19	2.3%	8	2.3%
	No	798	97.7%	346	97.7%
Reversible Lane	Yes	9	1.1%	4	1.1%
	No	808	98.9%	350	98.9%
UMass Criticism	Yes	17	2.1%	8	2.3%
	No	800	97.9%	346	97.7%
Government Criticism	Yes	33	4.0%	16	4.5%
	No	784	96.0%	338	95.5%
Other Road Problems	Yes	45	5.5%	18	5.1%
	No	772	94.5%	336	94.9%

Note: The highlighted variables are significant in at least one of the models presented in Chapter 5.

The most frequent concerns among respondents include impacts on bridge traffic (during both peak and non-peak periods), the length of the project, and traffic impacts on nearby roads. Approximately 50% of users in both samples decide their route prior to the trip; this may be due to acquired travel habits or the inability to obtain timely traffic information to allow a bridge user to change his route mid-trip. In fact, approximately 80% of users in both sample sets would utilize radio and TV traffic reports, if available. Respondents state an average acceptable delay of approximately 12 minutes due to the project. We can assume that this is in addition to the 10 and 16 minutes of delay that all users and peak users, respectively, already experience during peak hours. Just over 50% of users support 24-hour work on the project. Approximately 50% of the respondents submitted written comments in their surveys. Among the comment-based variables, positive endorsement of a second bridge crossing the Connecticut River is unquestionably the most frequently stated sentiment among respondents. Wanting a second bridge was noted by 20% of those writing comments and 11% of respondents overall.

4.3 Expected Influence of Variables

Focusing specifically on the effect of the Coolidge Bridge reconstruction on Pioneer Valley commuters, and keeping in mind the "disclaimer" previously stated about the predictive certainty of the choice models conducted for this research, the following section discusses, by category, how certain variables should influence the decision-making process.

Demographic Data Variables

Demographic variables concerning location and flexibility of choice should be stronger factors in the decision making process than other demographics. Variables describing the user's relative location to the Coolidge Bridge ("North" and "East") are hypothesized to be very strong indicators of route choice. "Income" and other related indicators ("Education Level", "Dwelling") also indicate choice flexibility; users with higher incomes, more education, and more desirable dwellings are more likely to change routes, but less likely to switch to an alternate mode of transportation. Users from bigger households (including those with relatively more children) are more likely to engage in trip chaining (i.e., making several trips at once), resulting in less route and mode choice flexibility. Users from households with more vehicles likely have greater route choice flexibility, but less mode choice flexibility. Women are less likely to change routes and more likely to use alternative modes. Variables such as "Age", "Occupation Type", and "Job Level" are not expected to be significantly influential factors in decisions of route and mode choice.

Travel Data Variables

Among this group of variables, indicators of more frequent travel over the Coolidge Bridge and current use of alternative routes and/or modes are most likely to indicate increased willingness to change travel habits. Variables in these groups include the "Trips" variables ("Work Trips", "Shopping Trips", etc.), the "Eastbound/ Westbound" variables ("Eastbound Trips", "Eastbound Peak Trips", etc.), and the "Current Use" variables ("Early AM (Current Use)", "Early PM (Current Use)", etc.). Another key indicator is "Work Distance"; longer work distances increase route choice flexibility, but decrease mode choice flexibility. Increased work flexibility (indicated in the "Work Flexibility" and "Flex Range" variables) should indicate an increased willingness to change travel habits. A higher number of stops en route to and from work may indicate a decreased likelihood to change routes and probably indicates a decreased likelihood to change modes. Users who work more hours are likely to be regular commuters traveling during peak periods, and are therefore likely to be more sensitive to delays; more work hours should indicate more of a willingness to change travel habits. Users with greater travel times, and with higher delays (indicated by "Time Difference to Work" and "Time Difference from Work"), are also more likely to change travel habits, especially route choice. (This is true even though some may realize that a route change does not always bring actual time savings; however, the perception of "moving" versus being stuck in traffic is often enough motivation for people to consider making a route change.)

Attitudinal Data Variables

Increased awareness of the project and its potential for traffic disruption is likely to encourage changes in commuting habits. Positive responses to such variables as "Awareness" and the "Info" variables ("Newspaper Info", "Radio Info", etc.) – including the "Project Sources" variable (the number of positive responses to the "Info" variables), should be positive factors in choosing alternative routes or (to a lesser extent) modes. On the issue of whether "Sufficient Info" has been made available, a positive response should indicate a <u>decreased</u> likelihood of changed behavior due to a perceived sense of complacency and trust that those who are responsible for the project will have figured out how to minimize traffic delays. Those who feel the project is necessary (indicated by "Rehabilitation" and "Widening") may be more tolerant of the traffic effects and a positive response may indicate a disinclination to change their behavior.

On issues of the timeliness and length of the project (indicated by "Project Start" and "Project Length"), users should be more likely to change habits if they feel the project will start sooner rather than later, and if the timeline of the project is longer rather than shorter. Those who are less tolerant of traffic delays are likely to consider changing their habits; this group includes those who indicate small "Acceptable Delays", positive responses to the "Traffic Info" variables (including "Traffic Sources") and "24 Hour Support", and those who likely plan ahead before beginning their trip ("Dynamic Decide Route").

The variables that were derived from survey comments are likely to have less influence in the models, due to the reduced number of users who made such comments. However, some interesting patterns of thought were discovered among the comments that made it worthwhile to develop variables from users' comments. The most frequent comment (and the variable from this group likely to have the most significance) was the expressed need for a second bridge along the Route 9 corridor ("Second Bridge"). It is a popular opinion among many Pioneer Valley residents who fear that even a rebuilt Coolidge Bridge will not sufficiently handle traffic volumes along Route 9. A positive response indicates an increased awareness of the project and should show an increased likelihood of change.

Other variables based on user comments (and how they would influence choices) include:

- "New Transit" – Those users who indicate a need for an increased transit presence along the Route 9 corridor should be more likely to utilize transit and probably are less likely to change routes as a result.
- "Development" – Those who indicate a fear of increased development along Route 9 as a result of the project probably fear that more traffic will follow that development, making them more likely to change their habits.
- "Infrequent User" – Those who describe themselves as an infrequent user of the bridge will probably be more tolerant of project related delays and be less likely to change their habits.
- "Use Less" – Those users who predict their use of the bridge will decrease because of the project should be more likely to change their habits, especially route choice.
- "Reversible Lane" – Those who indicate a desire to implement a reversible lane on the bridge (where the direction of traffic changes at different times of the day) are likely to be acutely aware of the project and have a strong interest in seeing an improvement in traffic

flow on the bridge. This reasoning should make these users very unlikely to change routes, and, for that reason, more likely to change other habits.

- "UMass Criticism" – Those users who express criticism towards UMass generally feel that the university has not done enough to decrease university-generated traffic and that such measures as increased carpooling, increased transit, and more restrictive parking policies would improve traffic along Route 9. Such criticism likely leads to the belief that Coolidge Bridge traffic will remain heavy, and likely make these users more inclined to change habits.
- "Government Criticism" – Those users who express criticism towards the role of government (local, state, or federal) in completing the bridge project likely feel that the project will encounter further delays, making them more likely to change their travel habits, especially route choice.
- "Other Road Problems" – Those users who are concerned with traffic issues at other locations along the Route 9 corridor likely feel that traffic problems elsewhere contribute as much, if not more, to traffic congestion along Route 9. These users may feel that the bridge project alone will not ease traffic congestion, and may make them more likely to change their habits, particularly route choice.

CHAPTER 5

MODEL ESTIMATION RESULTS

Two categories of choice models will be used in this research: route choice models and mode choice models. These are the primary choices Coolidge Bridge users will need to make when determining if and how their travel patterns over the bridge will be affected by the project. At the time the survey was distributed, major reconstruction had not yet begun on the bridge, leading to the belief that decisions about route and mode changes for many users were still predictive. As the project runs its course, additional factors not considered by users at the time of this survey may influence actual route and mode choices made by Coolidge Bridge users during the project. These actual choices may (and perhaps are likely to) be different from the choices people think they will make beforehand. The study of how predicted choices differ from realized choices is a natural follow up to the research presented here and, not surprisingly, is outside the scope of this project.

This chapter presents the results of the model estimation for both route and mode choice based on the variables presented earlier. Variables in the following models were chosen if their coefficients were statistically significant – that is, the absolute value of the corresponding *z*-statistic was greater than 1.645, representing a 90% confidence level that the absolute value of the coefficient is different from zero. Best models in all cases were chosen based on obtaining the highest possible adjusted ρ^2 value while keeping statistically significant coefficients in the model.

5.1 Route Choice Breakdown

Route choice models seek to determine which route a user will choose to cross the Connecticut River during the project (Coolidge Bridge, Sunderland Bridge, Holyoke Bridge). A dependent variable for this choice ("Route Choice") was derived to indicate which route a user was likely to choose. This determination was made using answers to these survey questions:

- Does the user plan to use the Sunderland Bridge to avoid Coolidge Bridge traffic during the project?
- How many days per week does the user plan to use the Sunderland Bridge during the project?
- Does the user plan to use the Holyoke Bridge to avoid Coolidge Bridge traffic during the project?
- How many days per week does the user plan to use the Holyoke Bridge during the project?

The answers to these questions were used to infer whether or not the user would use the Coolidge Bridge on a regular basis during the project and how many days per week the Coolidge Bridge would be used. It was determined that if a user stated an intention to use one of the routes at least three days a week, the value of the "Route Choice" variable would indicate that particular route. If a user stated an intention to use more than one route at least three days per week, or stated an intention to use none of the routes at least three days a week, the value of the "Route Choice" variable would indicate a value of "no particular choice." This possibility may occur if a user currently displays limited or irregular use of the Coolidge Bridge, due to limited use of the bridge or if the bridge is primarily used for non-work related trips (shopping, medical visits, etc.). Based on this methodology, Table 5 shows the route choice breakdown in both sample sets:

Table 5: Future Route Choice Breakdown Among Respondents

Route Choice	***All Users***		***Peak Users***	
Number of respondents	817		354	
Coolidge Bridge	588	72.0%	258	72.9%
Sunderland Bridge	158	19.3%	70	19.8%
Holyoke Bridge	66	8.1%	23	6.5%
No particular choice	5	0.6%	3	0.8%

In both sample sets, a significant number of users are inclined to use the Coolidge Bridge during the project. However, approximately 20% of users plan to use the Sunderland Bridge as an alternative. The breakdown of the sample in both sets allows us to use a multinomial choice model to determine the factors that influence these choices. A general rule is to have at least 30 observations for a particular choice within a sample to obtain a statistically sound analysis. It is noted that only 23 observations in the peak users sample set are observed to choose the Holyoke Bridge route. The MNL model will be used for this sample set, and no statistical anomalies are expected; however, the small size of this choice group will be noted and taken under consideration when examining model results for this set.

5.2 Route Choice Model Estimation Results

The following section presents the results from the Coolidge Bridge route choice models developed for this research. Various combinations of variable categories in these route models, using both the full sample and the peak user subsample, will highlight the effect of attitudinal factors in the decision-making process. The following models will be developed and presented as follows:

1. Route choice – All users – Best Demographic Data Model
2. Route choice – All users – Best Travel Data Model
3. Route choice – All users – Best Attitudinal Data Model
4. Route choice – All users – Best Demographic Data + Travel Data Model
5. Route choice – All users – Best Demographic Data + Attitudinal Data Model
6. Route choice – All users – Best Demographic Data from Model #5
7. Route choice – All users – Best Travel Data + Attitudinal Data Model
8. Route choice – All users – Best Travel Data from Model #7
9. Route choice – All users – Best Demographic Data + Travel Data + Attitudinal Data Model
10. Route choice – All users – Best Demographic Data + Travel Data from Model #9
11. Route choice – Peak users – Best Demographic Data Model
12. Route choice – Peak users – Best Travel Data Model
13. Route choice – Peak users – Best Attitudinal Data Model
14. Route choice – Peak users – Best Demographic Data + Travel Data Model

15. Route choice – Peak users – Best Demographic Data + Attitudinal Data Model
16. Route choice – Peak users – Best Demographic Data from Model #15
17. Route choice – Peak users – Best Travel Data + Attitudinal Data Model
18. Route choice – Peak users – Best Travel Data from Model #17
19. Route choice – Peak users – Best Demographic Data + Travel Data + Attitudinal Data Model
20. Route choice – Peak users – Best Demographic Data + Travel Data from Model #19

Within each grouping of ten models, the first three models show the significance of each unique category of independent variables in explaining route choices. The next five models show the effect of two categories of variables in explaining choices. Two of these models (Models 6 and 8 in the first group of ten, Models 16 and 18 in the second group) estimate only the demographic (or travel) variables in the two-category models that included attitudinal variables; this is done to further show the effect of attitudinal variables in route choice decisions. The final two models in each group show the effect of all three categories in making route choices; the last model in each group of ten (Models 10 and 20, respectively) estimate only the demographic and travel variables from the three-category model to measure the effect of attitudinal data.

As these models are presented, some examination into the significance of certain variables and the reasons for their importance will be conducted. It is important to reiterate that the model comparisons which follow primarily aim to show the significance of attitudinal variables in modeling choice behavior; the insight they provide into how users of the Coolidge Bridge may change their travel patterns is an aside to the main focus of this research.

Route Choice Model Results with All Users

The first grouping of choice models involves modeling route choice using the full sample. Multinomial logit was performed for this exercise, with the Coolidge Bridge choice as the base case for comparison. Table 6 presents Models 1-3, route choice models each modeling the whole sample using one category of independent variables. Positive coefficients indicate a greater likelihood of using that bridge with larger values of the indicated independent variable compared to the Coolidge Bridge. Negative coefficients indicate that higher values of the variable are more likely to use the Coolidge Bridge. Models with reasonable coefficients can be compared with each other by looking at the adjusted ρ^2 value (closer to 1.0 is preferable) and higher (i.e., less negative) log likelihood values.

For each model, the variables of that type were tested in various combinations until the best performing variables in terms of coefficients and model statistics were obtained. Model 1 is the best route choice model using only demographic variables; Model 2 is the best route choice model using only travel data variables. These models serve as a basis of comparison for the effect of Model 3, the route choice model where

Table 6: Route Choice Models with All Users: One-Category Models

Route Choice Model: All Users	***Variables***	***Sunderland Bridge***		***Holyoke Bridge***	
		Coefficient	***z-statistic***	***Coefficient***	***z-statistic***
Model 1: Demographic Variables	North	**0.489059**	**2.257**	**-3.12076**	**-7.132**
	East	**-0.76033**	**-3.305**	0.003646	0.012
	Constant	**-1.49933**	**-7.632**	**-1.09984**	**-6.140**
ρ^2 =0.100; Adjusted ρ^2 = 0.090; L(0) = -614.072; L(β) = -552.740; χ^2 = 122.664 with 4 df					
Model 2: Travel Variables	# of Shopping Trips	-0.01456	-0.131	**-0.68819**	**-2.407**
	# of Total Trips	0.023696	0.690	**0.124853**	**1.760**
	Work Flexibility	0.397967	1.500	**-0.99792**	**-1.688**
	Time Difference To Work	0.015659	0.987	**0.092419**	**3.411**
	Holyoke Bridge (Cur. Use)	**-1.52673**	**-2.749**	**2.797641**	**6.053**
	Work Distance	**0.055696**	**4.666**	**0.072562**	**3.800**
	Constant	**-2.02579**	**-8.308**	**-5.12127**	**-8.049**
ρ^2 = 0.164; Adjusted ρ^2 = 0.130; L(0) = -401.741; L(β) = -335.707; χ^2 = 132.068 with 12 df					
Model 3: Attitudinal Variables	Awareness	**0.884191**	**1.662**	0.583715	0.686
	Newspaper Info	**-0.61142**	**-2.267**	-0.12239	-0.306
	MHD Info	**-1.31253**	**-2.306**	-0.53705	-0.810
	Project Start	0.210347	1.576	**-0.40318**	**-1.799**
	Concern – Project Length	**0.128907**	**1.827**	0.110415	1.143
	Concern – Rt 9 Widening	-0.19904	-1.566	**-0.37439**	**-1.718**
	HAR Traffic Info	0.300602	1.386	**-0.65205**	**-1.906**
	24 Hour Support	-0.00884	-0.042	**0.594665**	**1.969**
	Change Habit	**4.795099**	**4.750**	**3.855971**	**3.799**
	More Questions	**0.511733**	**2.261**	0.20451	0.675
	Second Bridge	**0.61603**	**1.995**	-0.48412	-0.857
	Constant	**-6.83636**	**-5.838**	**-5.65288**	**-4.177**
ρ^2 = 0.201; Adjusted ρ^2 = 0.158; L(0) = -551.201; L(β) = -440.243; χ^2 = 221.916 with 22 df					

Note:
1. **Bold** items are statistically significant at the 90% confidence level.
2. The Coolidge Bridge outcome is taken to be the base case.
3. Positive coefficients indicate a greater propensity to choose the Holyoke or Sunderland Bridge compared to the base case of choosing the Coolidge Bridge. Coefficients should be compared to taking the Coolidge Bridge.

only attitudinal variables are used. A comparison of the three models shows that Model 3 – the attitudinal data model – performs better than the other two models. The statistical significance of its many variables supports the relative strength of this model. The travel data model also shows several significant variables, particularly for the Holyoke Bridge choice. Given the historical significance of demographic data in model development, it is interesting to note that Model 1 – the demographic variable model – shows the lowest adjusted ρ^2 value, our basis for model comparison. The most significant attitudinal indicator of using an alternate bridge is the "change habit" variable, which takes a value of "1" (Yes) if the respondent thinks that they'll change route, travel time, or mode.

The next grouping of route choice models, Models 4 – 8, uses two categories of independent variables; they are presented in Table 7 below.

Table 7: Route Choice Models with All Users: Two-Category Models

Route Choice Model: All Users	***Variables***	***Sunderland Bridge***		***Holyoke Bridge***	
		Coefficient	***z-statistic***	***Coefficient***	***z-statistic***
Model 4: Demographic & Travel Variables	Vehicles/HH	-0.14867	-0.668	**1.0135**	**2.099**
	Persons/HH	0.088565	0.402	**-1.23294**	**-2.489**
	Children/HH	-0.16046	-0.671	**1.019891**	**2.310**
	Male	**-0.45511**	**-1.842**	-0.95582	-1.630
	Age	0.009133	1.068	**0.044324**	**1.963**
	North	**0.943029**	**2.990**	**-3.05912**	**-3.738**
	East	**-0.90217**	**-2.813**	-0.56667	-1.064
	Income	**0.165319**	**1.728**	0.166638	0.885
	# of Shopping Trips	-0.01457	-0.144	**-0.72812**	**-2.119**
	Time Difference To Work	0.005418	0.305	**0.084367**	**2.676**
	Time Difference From Work	**0.023589**	**2.096**	0.029026	1.283
	EB Peak Trips	**-0.09791**	**-1.953**	-0.14799	-1.294
	Holyoke Bridge (Cur. Use)	**-1.27553**	**-2.100**	**2.793526**	**4.907**
	Work Distance	**0.069803**	**4.859**	**0.059384**	**2.654**
	Constant	**-2.79936**	**-4.388**	**-4.77053**	**-3.359**
$\rho^2 = 0.249$; Adjusted $\rho^2 = 0.172$; L(0) = -389.852; L(β) = -292.845; $\chi^2 = 194.013$ with 28 df					

Note:
1. **Bold** items are statistically significant at the 90% confidence level.
2. The Coolidge Bridge outcome is taken to be the base case.
3. Positive coefficients indicate a greater propensity to choose the Holyoke or Sunderland Bridge compared to the base case of choosing the Coolidge Bridge. Coefficients should be compared to taking the Coolidge Bridge.

Table 7: Route Choice Models with All Users: Two-Category Models (continued)

Route Choice Model: All Users	*Variables*	*Sunderland Bridge*		*Holyoke Bridge*	
		Coefficient	*z-statistic*	*Coefficient*	*z-statistic*
Model 5: Demographic & Attitudinal Variables	Male	-0.3088	-1.326	**-0.82514**	**-2.036**
	North	0.336856	1.272	**-3.92341**	**-6.965**
	East	**-0.70316**	**-2.463**	0.642283	1.547
	Education Level	**-0.13817**	**-1.709**	-0.13849	-1.014
	Awareness	**1.380745**	**2.321**	**2.219897**	**1.902**
	Newspaper Info	**-1.00175**	**-3.064**	**-1.0876**	**-1.855**
	MHD Info	**-1.54116**	**-2.552**	-0.0793	-0.086
	Other Info	**-0.85717**	**-3.069**	**-0.97851**	**-2.086**
	Rehabilitation	-0.09519	-0.210	**2.397036**	**2.068**
	Project Start	0.205457	1.436	**-0.76618**	**-2.632**
	Concern – Project Length	**0.129799**	**1.647**	**0.246815**	**1.857**
	Concern – Project Cost	-0.09069	-0.801	**0.299536**	**1.657**
	Concern – Rush Hr. Effect	0.091164	1.235	**-0.21032**	**-1.754**
	Concern – Pollution	0.001443	0.009	**-1.02654**	**-2.075**
	Concern – Rt 9 Widening	**-0.24782**	**-1.863**	**-0.60544**	**-2.178**
	Concern – Emer. Access	**-0.16196**	**-1.743**	-0.00268	-0.020
	Concern – Traf. On Oth Rds	-0.07539	-0.637	**0.294342**	**1.659**
	HAR Traffic Info	**0.410195**	**1.748**	**-0.75889**	**-1.745**
	24 Hour Support	0.115173	0.505	**0.672583**	**1.746**
	Change Habit	**4.848966**	**4.783**	**4.595037**	**4.277**
	More Questions	**0.449856**	**1.878**	0.19414	0.484
	Second Bridge	**0.746459**	**2.243**	-0.62751	-0.892
	Reversible Lane	-1.30528	-1.076	**2.36891**	**1.765**
	Constant	**-6.12037**	**-4.694**	**-6.63646**	**-3.390**
$\rho^2 = 0.304$; Adjusted $\rho^2 = 0.259$; $L(0) = -614.072$; $L(\beta) = -427.304$; $\chi^2 = 373.536$ with 26 df					
Model 6: Demographic Variables from Model 5	Male	-0.27363	-1.434	-0.43109	-1.433
	North	**0.485519**	**2.213**	**-3.05798**	**-6.944**
	East	**-0.77857**	**-3.313**	0.021565	0.072
	Education Level	-0.01616	-0.255	-0.00507	-0.050
	Constant	**-1.27972**	**-3.856**	**-0.91976**	**-1.999**
$\rho^2 = 0.103$; Adjusted $\rho^2 = 0.086$; $L(0) = -594.385$; $L(\beta) = -533.263$; $\chi^2 = 122.246$ with 8 df					
Model 7: Travel & Attitudinal Variables	# of Shopping Trips	-0.0090809	-0.079	**-0.5768662**	**-2.411**
	# of Total Trips	0.0240387	0.671	**0.1343643**	**2.113**
	Work Flexibility	0.3764536	1.394	**-1.041265**	**-1.816**
	Time Difference From Work	**0.0182991**	**1.803**	**0.0320682**	**1.850**
	Work Distance	**0.0556357**	**4.537**	**0.1234337**	**6.553**
	Newspaper Info	-0.199503	-0.748	**1.242617**	**1.832**
	Project Start	**0.2660784**	**1.868**	-0.3932372	-1.262
	Concern – Project Length	**0.1375023**	**1.840**	0.108339	0.844
	Constant	**-2.740983**	**-6.246**	**-5.265386**	**-5.453**
$\rho^2 = 0.116$; Adjusted $\rho^2 = 0.069$; $L(0) = -383.973$; $L(\beta) = -339.389$; $\chi^2 = 89.167$ with 16 df					
Model 8: Travel Variables from Model 7	# of Shopping Trips	-0.0224396	-0.202	**-0.5758832**	**-2.380**
	# of Total Trips	0.0185401	0.542	**0.1094688**	**1.899**
	Work Flexibility	0.3606114	1.370	-0.8664484	-1.607
	Time Difference From Work	**0.0199037**	**2.021**	**0.0322256**	**1.971**
	Work Distance	**0.049941**	**4.347**	**0.1040351**	**6.209**
	Constant	**-2.171091**	**-8.811**	**-4.208341**	**-8.533**
$\rho^2 = 0.082$; Adjusted $\rho^2 = 0.052$; $L(0) = -401.741$; $L(\beta) = -368.696$; $\chi^2 = 66.091$ with 10 df					

Note:
1. **Bold** items are statistically significant at the 90% confidence level.
2. The Coolidge Bridge outcome is taken to be the base case.
3. Positive coefficients indicate a greater propensity to choose the Holyoke or Sunderland Bridge compared to the base case of choosing the Coolidge Bridge. Coefficients should be compared to taking the Coolidge Bridge.

The adjusted ρ^2 values for Models 4, 5, and 7 – the three models in the previous table using two different categories of independent variables – show that Model 5, which included attitudinal and demographic variables, outperformed the other two-category models (Models 4 & 7). The relative strength of this model can be attributed to the substantial number of attitudinal variables found in the model (19 attitudinal variables, compared with four demographic variables). This imbalance agrees with the findings of the one-category models presented earlier (Models 1-3), which showed the attitudinal model (Model 3) as the best performer and the demographic model (Model 1) as the worst. A comparison of Models 4, 5, & 7 with the one-category models that have attitudinal variables removed (Models 6 & 8) shows that, for both demographic and travel data variables, the removal of attitudinal variables resulted in lower adjusted ρ^2 values than was seen for the models that did include attitudinal data. These findings support the hypothesis that attitudinal data affect the modeling of traveler choice.

The three-category route choice model is now examined to see if a similar pattern of influence by attitudinal variables is present. Table 8 below presents the results of this model estimation, along with its two-variable counterpart, which excludes attitudinal data. The adjusted ρ^2 value for the three-category model (Model 9) is found to be the highest of the models in this set. Nearly 50% of the significant variables in this model are attitudinal variables. In addition, a comparison between Models 9 & 10 shows a significant drop in the adjusted ρ^2 value when attitudinal variables are removed. These findings further support the findings of the first model group, where the attitudinal data model had the highest adjusted ρ^2 value of the three one-category models.

Table 8: Route Choice Models with All Users: Three-Category Models

Route Choice Model: All Users	*Variables*	*Sunderland Bridge*		*Holyoke Bridge*	
		Coefficient	*z-statistic*	*Coefficient*	*z-statistic*
Model 9: Demographic, Travel, & Attitudinal Variables	Vehicles/HH	-0.0095375	-0.043	**1.310662**	**2.211**
	Persons/HH	0.0753297	0.527	**-0.9281697**	**-2.126**
	Male	**-0.514809**	**-1.769**	**-2.457786**	**-2.740**
	Age	0.0070715	0.708	**0.0728456**	**2.570**
	North	**1.220216**	**3.238**	**-5.197144**	**-3.608**
	Time Difference To Work	0.0156816	0.748	**0.167804**	**3.656**
	EB Peak Trips	**-0.152985**	**-2.414**	-0.0976176	-0.582
	WB Peak Trips	**0.1228454**	**1.810**	0.0983755	0.562
	Holyoke Bridge (Cur. Use)	**-1.742717**	**-2.522**	**4.139031**	**4.281**
	Work Distance	**0.0913498**	**4.883**	**0.0787999**	**2.684**
	Concern – Project Length	**0.2339001**	**2.523**	0.3509555	1.540
	Concern – Rush Hr. Effect	0.1147587	1.338	**-0.4628122**	**-1.966**
	Concern – Noise	-1.13707	-1.321	**1.349722**	**1.891**
	Concern – Emer. Access	-0.1469623	-1.279	**0.6140002**	**2.422**
	24 Hour Support	0.0329464	0.120	**1.975709**	**2.463**
	Change Habit	**4.78617**	**4.585**	**4.114051**	**3.097**
	Second Bridge	**1.155394**	**2.750**	0.4616833	0.393
	Constant	**-8.148364**	**-5.991**	**-13.12072**	**-4.622**
ρ^2 = 0.437; Adjusted ρ^2 = 0.341; L(0) = -374.300; L(β) = -210.672; χ^2 = 327.255 with 34 df					
Model 10: Demographic and Travel Variables from Model 9	Vehicles/HH	-0.0842616	-0.472	0.3872245	1.142
	Persons/HH	0.0056502	0.049	-0.2031808	-0.860
	Male	**-0.4828392**	**-1.989**	-0.8871975	-1.603
	Age	0.0074437	0.903	**0.0433035**	**2.126**
	North	**1.017191**	**3.258**	**-2.902921**	**-3.685**
	Time Difference To Work	0.0151534	0.929	**0.0820122**	**2.940**
	EB Peak Trips	**-0.0934239**	**-1.709**	-0.1013667	-0.773
	WB Peak Trips	0.0839247	1.469	0.010453	0.082
	Holyoke Bridge (Cur. Use)	**-1.34944**	**-2.289**	**2.435703**	**4.814**
	Work Distance	**0.0686937**	**4.908**	**0.0536148**	**2.503**
	Constant	**-2.589279**	**-4.387**	**-5.237186**	**-4.146**
ρ^2 = 0.216; Adjusted ρ^2 = 0.160; L(0) = -391.774; L(β) = -307.176; χ^2 = 169.197 with 20 df					

Note:
1. **Bold** items are statistically significant at the 90% confidence level.
2. The Coolidge Bridge outcome is taken to be the base case.
3. Positive coefficients indicate a greater propensity to choose the Holyoke or Sunderland Bridge compared to the base case of choosing the Coolidge Bridge. Coefficients should be compared to taking the Coolidge Bridge.

Route Choice Model Results with All Users – Hypothesis Test

Likelihood ratio χ^2 tests will be used to further measure the influence of attitudinal variables in the models. This test facilitates the comparison of two models, with one model containing an exact subset of variables from the other model. Using this test, the null hypothesis that the additional explanatory variables in the larger model collectively add insignificant explanatory power can be examined. In other words, this tests attempts to show whether the coefficients of the additional explanatory variables can be restricted to zero with no significant loss in explanatory power. [Kuppam, et. al, 1999]

A test statistic, χ_t^2, will be computed to examine the significance of attitudinal variables in the models using the following equation:

$$\chi_t^{\ 2} = 2\left[L(\beta)^{ATT} - L(\beta)^{*}\right]$$

where

χ_t^2 = asymptotically distributed with degrees of freedom equal to the number of parameter restrictions imposed by the null hypothesis [Ben-Akiva, et al., 1985; McFadden, et al., 1977],

$L(\beta)^{ATT}$ = the log-likelihood value at convergence for a model (two- or three-category) containing attitudinal variables, and

$L(\beta)^{*}$ = the log-likelihood value at convergence for Model ATT with the attitudinal variables removed.

The χ_t^2 test statistic will be compared to the χ_0^2 value at the 90% confidence level for the appropriate degrees of freedom. If the χ_t^2 test statistic is greater than the χ_0^2 value, the null hypothesis (coefficients of the attitudinal variables can be restricted to zero with no significant loss in explanatory power) is rejected.

Table 9 below shows likelihood ratio χ^2 tests for the two- and three-category models containing attitudinal variables.

Table 9: Route Choice Models with All Users: Likelihood Ratio χ^2 Tests

Variable Categories	*ATT Model*	** Model*	*$L(\beta)^{ATT}$*	*$L(\beta)^{*}$*	*χ_t^2 Test Statistic*	*Critical χ_0^2 Value*	*Degrees of Freedom*
Demographic/ Attitudinal	Model 5	Model 6	-350.042	-533.263	183.221	13.362	8
Travel/ Attitudinal	Model 7	Model 8	-339.389	-368.696	29.307	15.987	10
Demographic/ Travel/Attitudinal	Model 9	Model 10	-210.672	-307.176	96.504	28.412	20

In each of these three cases, the χ_t^2 test statistic exceeds the critical χ_0^2 value, confirming the hypothesis that the attitudinal variables in these models have a significant explanatory influence in estimating route choices.

5.2.3 Route Choice Model Results with All Users – Influential Variables

A further examination of the composition of the models in this sample set reveals the significance of several variables in predicting route choice. A wide variety of attitudinal factors appears to exist among users in the sample. The importance of several concerns regarding the project (such as the project's length and its effect on rush hour conditions, support for non-stop construction, the need for bridge rehabilitation, awareness of the project, and the importance of obtaining information about the project's progress consistently are cited as influencing factors in the route choice models. In addition, support for a second bridge and support for a reversible lane on the bridge highlight how contrasting beliefs about the best course of action to solving traffic problems on the bridge may indicate general support for (or against) the project, which may in turn influence the attractiveness of one alternate route over another. Geography, described by work distance and relative location to the Coolidge Bridge (North, East), plays a key role in determining route choice among all users. For a substantial number of users, geography may be the single most important determining factor in route choice decisions. The current use of alternative routes or other measures (particularly current use of the Holyoke Bridge) is also a strong factor in predicting route choice, as is the amount of delay currently experienced by Coolidge Bridge drivers.

Route Choice Model Results with Peak Users

The next set of models also look at modeling route choice, but the sample in this set only includes peak users of the Coolidge Bridge, as identified earlier. Modeling future route choice decisions for peak users of the bridge should reveal interesting patterns of influencing factors. Since these users are likely more sensitive to delays in their commute, and are perhaps less likely or able to change other aspects of their commute (such as arrival/departure time), the factors which do influence changes in route should be more pronounced.

Models in this set (and in the mode choice models sets which follow) will be presented in the same order as the previous set of models. The first group of models in this set (Models 11-13) is composed of one-category route choice models; the results are presented in Table 10 below. Models 11-13 show a marked contrast in the relevance of attitudinal variables when compared to Models 1-3 for the full sample. The attitudinal data model is by far the worst performing of this set of models (particularly for the Holyoke Bridge choice), despite having six statistically significant variables. Because peak users are the group being modeled here, attitudes about the project may have less influence in deciding to change routes than more tangible factors such as the proximity to alternate routes, the need to minimize travel delays while commuting, and the opportunity (from income, number of vehicles, size of household, etc.) to change existing travel habits.

Table 10: Route Choice Models with Peak Users: One-Category Models

Route Choice Model: Peak Users	*Variables*	*Sunderland Bridge*		*Holyoke Bridge*	
		Coefficient	*z-statistic*	*Coefficient*	*z-statistic*
Model 11: Demographic Variables	Male	-0.294409	-1.035	**-1.560413**	**-2.456**
	Age	0.004641	0.490	**0.035352**	**1.725**
	North	**0.722579**	**1.835**	**-4.593185**	**-4.304**
	Constant	**-1.950356**	**-3.884**	**-1.905588**	**-2.339**
ρ^2 = 0.136; Adjusted ρ^2 = 0.105; L(0) = -252.465; L(β) = -218.063; χ^2 = 68.804 with 6 df					
Model 12: Travel Variables	# of Shopping Trips	-0.0643271	-0.469	**-1.168133**	**-2.335**
	Work Flexibility	**0.6247287**	**1.917**	-0.9468984	-1.218
	# of Stops From Work	0.0943975	0.867	**0.3773551**	**1.893**
	EB Peak Trips	-0.0742131	-0.936	**-0.3054919**	**-1.916**
	Holyoke Bridge (Cur. Use)	**-1.227706**	**-1.860**	**2.813032**	**4.223**
	Work Distance	**0.0369733**	**2.251**	**0.074696**	**2.965**
	Constant	**-1.398409**	**-3.361**	**-3.084994**	**-3.726**
ρ^2 = 0.156; Adjusted ρ^2 = 0.094; L(0) = -225.690; L(β) = -190.432; χ^2 = 70.517 with 12 df					
Model 13: Attitudinal Variables	Awareness	**1.917652**	**2.206**	0.1983797	0.148
	Newspaper Info	**-0.952416**	**-2.322**	0.2005437	0.241
	Other Info	**-0.9880039**	**-2.661**	**-1.227432**	**-1.784**
	Project Start	**0.4731745**	**2.628**	-0.1823465	-0.521
	Concern – Rush Hr. Effect	**0.1798395**	**1.913**	0.0172801	0.129
	HAR Traffic Info	0.14988	0.498	**-1.697974**	**-2.227**
	Constant	**-3.358105**	**-3.803**	-1.886829	-1.508
ρ^2 = 0.071; Adjusted ρ^2 = -0.014; L(0) = -242.774; L(β) = -225.428; χ^2 = 34.690 with 12 df					

Note:
1. **Bold** items are statistically significant at the 90% confidence level.
2. The Coolidge Bridge outcome is taken to be the base case.
3. Positive coefficients indicate a greater propensity to choose the Holyoke or Sunderland Bridge compared to the base case of choosing the Coolidge Bridge. Coefficients should be compared to taking the Coolidge Bridge.

Models 14 -18, the two-category route choice models (and related one-category comparison models), are presented in Table 11 below. All three models in this set show similar adjusted ρ^2 values; however, the two-category models with attitudinal variables (Models 15 & 17) outperformed the model without attitudinal variables (Model 14). Comparison of Models 15 & 17 to Models 16 & 18 (where the attitudinal variables have been removed) shows a moderate decrease in the adjusted ρ^2 values. These results are consistent with the first set of route choice models for the full sample. However, these results are contrary to the earlier reasoning that, for this user group, attitudes hold less relevance in the decision-making process than more tangible factors (minimizing delays, opportunity to use alternate routes).

Table 11: Route Choice Models with Peak Users: Two-Category Models

Route Choice Model: Peak Users	***Variables***	***Sunderland Bridge***		***Holyoke Bridge***	
		Coefficient	***z-statistic***	***Coefficient***	***z-statistic***
Model 14: Demographic & Travel Variables	Age	**0.0189074**	**1.820**	0.010756	0.491
	East	**-0.8750858**	**-2.064**	-0.1134938	-0.173
	# of Shopping Trips	-0.0578425	-0.435	**-1.10146**	**-2.153**
	# of Stops From Work	0.0982499	0.908	**0.3553404**	**1.779**
	EB Peak Trips	-0.126594	-1.557	**-0.2776342**	**-1.758**
	Holyoke Bridge (Cur. Use)	**-1.213265**	**-1.775**	**2.698**	**4.154**
	Work Distance	**0.0472808**	**2.736**	**0.0732194**	**2.902**
	Constant	**-1.778627**	**-2.784**	**-3.690619**	**-2.970**
$\rho^2 = 0.163$; Adjusted $\rho^2 = 0.092$; $L(0) = -225.690$; $L(\beta) = -188.964$; $\chi^2 = 73.453$ with 14 df					
Model 15: Demographic & Attitudinal Variables	Persons/HH	-0.0117817	-0.095	**-0.416491**	**-1.709**
	Age	0.0126015	1.278	**0.0379113**	**1.787**
	Occupation Type	-0.0497894	-0.999	**-0.1947571**	**-1.723**
	North	**0.7891246**	**1.930**	**-4.990584**	**-4.407**
	East	-0.5951469	-1.606	-0.9807798	-1.582
	Concern – Project Length	**0.1866892**	**1.943**	-0.0085337	-0.048
	Concern – Project Cost	-0.2078759	-1.352	**0.4513264**	**2.092**
	Concern – Non Rush Hr. Eff.	**0.2082963**	**1.956**	0.029146	0.137
	Second Bridge	**0.6912512**	**1.694**	0.7323458	0.783
	Constant	**-2.60694**	**-3.607**	-0.495716	-0.369
$\rho^2 = 0.175$; Adjusted $\rho^2 = 0.095$; $L(0) = -251.512$; $L(\beta) = -207.606$; $\chi^2 = 87.811$ with 18 df					
Model 16: Demographic Variables from Model 15	Persons/HH	-0.0478979	-0.393	-0.3624516	-1.608
	Age	0.0118357	1.231	0.0327188	1.643
	Occupation Type	-0.0547566	-1.117	-0.1729511	-1.629
	North	0.6455448	1.618	**-4.673876**	**-4.361**
	East	-0.5764045	-1.581	-0.6698739	-1.215
	Constant	**-1.768887**	**-2.747**	-0.2447467	-0.235
$\rho^2 = 0.140$ Adjusted $\rho^2 = 0.093$; $L(0) = -251.512$; $L(\beta) = -216.186$; $\chi^2 = 70.651$ with 10 df					
Model 17: Travel & Attitudinal Variables	# of Shopping Trips	-0.0482046	-0.356	**-0.9861503**	**-1.785**
	# of Stops From Work	0.1125128	1.022	**0.462753**	**2.076**
	Holyoke Bridge (Cur. Use)	**-1.174667**	**-1.786**	**2.711837**	**4.129**
	Work Distance	**0.0369379**	**2.143**	**0.0843223**	**3.054**
	Acceptable Delay	-0.0253713	-1.230	**-0.075433**	**-1.728**
	More Questions	**0.856419**	**2.617**	-1.019623	-1.573
	Constant	**-1.797484**	**-4.509**	**-3.278287**	**-4.350**
$\rho^2 = 0.171$; Adjusted $\rho^2 = 0.106$; $L(0) = -215.946$; $L(\beta) = -179.065$; $\chi^2 = 73.761$ with 12 df					
Model 18: Travel Variables from Model 17	# of Shopping Trips	-0.0775573	-0.582	**-1.055067**	**-2.146**
	# of Stops From Work	0.1146862	1.079	**0.3913076**	**1.980**
	Holyoke Bridge (Cur. Use)	**-1.209372**	**-1.844**	**2.537612**	**4.103**
	Work Distance	**0.0396408**	**2.455**	**0.0726171**	**2.927**
	Constant	**-1.585829**	**-6.728**	**-4.336741**	**-6.959**
$\rho^2 = 0.135$; Adjusted $\rho^2 = 0.091$; $L(0) = -225.690$; $L(\beta) = -195.240$; $\chi^2 = 60.901$ with 8 df					

Note:
1. **Bold** items are statistically significant at the 90% confidence level.
2. The Coolidge Bridge outcome is taken to be the base case.
3. Positive coefficients indicate a greater propensity to choose the Holyoke or Sunderland Bridge compared to the base case of choosing the Coolidge Bridge. Coefficients should be compared to taking the Coolidge Bridge.

Models 19 and 20, the three-category route choice model and its two-variable counterpart without attitudinal variables, are presented in Table 12 below.

Table 12: Route Choice Models with Peak Users: Three-Category Models

Route Choice Model: Peak Users	***Variables***	***Sunderland Bridge***		***Holyoke Bridge***	
		Coefficient	***z-statistic***	***Coefficient***	***z-statistic***
Model 19: Demographic, Travel, & Attitudinal Variables	Vehicles/HH	-0.2341851	-0.946	**1.413991**	**1.941**
	Number/HH	-0.0026983	-0.016	**-1.369925**	**-2.033**
	Age	**0.0306501**	**2.369**	0.0116315	0.350
	# of Stops From Work	0.1376252	1.071	**0.5343722**	**1.925**
	Holyoke Bridge (Cur. Use)	**-1.687566**	**-2.298**	**4.200011**	**3.534**
	Work Distance	**0.0457873**	**2.425**	**0.0868271**	**2.332**
	Newspaper Info	-0.0498692	-0.099	**4.527002**	**2.228**
	Radio Info	0.4671346	1.009	**2.923439**	**2.058**
	TV Info	**0.8365372**	**1.731**	**3.106061**	**2.076**
	MHD Info	0.0851527	0.088	**4.905047**	**1.893**
	# of Project Sources	-0.3105441	-0.879	**-2.783132**	**-2.453**
	Project Start	**0.7287644**	**3.365**	-0.9678313	-1.498
	Concern – Project Length	**0.1860782**	**1.679**	**0.8808904**	**2.466**
	Concern – Project Cost	**-0.3007588**	**-1.683**	-0.1463069	-0.382
	HAR Traffic Info	0.2355009	0.685	**-3.53808**	**-2.196**
	More Questions	**1.017636**	**2.781**	-0.5451852	-0.639
	Constant	**-4.385144**	**-3.860**	**-6.950064**	**-2.328**
$\rho^2 = 0.290$; Adjusted $\rho^2 = 0.127$; L(0) = -208.109; L(β) = -147.686; $\chi^2 = 120.847$ with 32 df					
Model 20: Demographic and Travel Variables from Model 19	Vehicles/HH	-0.0639301	-0.295	0.3321348	0.869
	Number/HH	-0.0506693	-0.341	-0.340566	-1.007
	Age	**0.0205455**	**1.924**	0.0050094	0.246
	# of Stops From Work	0.0671144	0.616	0.3086905	1.643
	Holyoke Bridge (Cur. Use)	**-1.28434**	**-1.937**	**2.460168**	**3.983**
	Work Distance	**0.050219**	**2.838**	**0.0662224**	**2.689**
	Constant	**-2.264313**	**-3.189**	**-4.479462**	**-3.607**
$\rho^2 = 0.130$; Adjusted $\rho^2 = 0.067$; L(0) = -222.550; L(β) = -193.701; $\chi^2 = 57.698$ with 12 df					

Note:
1. **Bold** items are statistically significant at the 90% confidence level.
2. The Coolidge Bridge outcome is taken to be the base case.
3. Positive coefficients indicate a greater propensity to choose the Holyoke or Sunderland Bridge compared to the base case of choosing the Coolidge Bridge. Coefficients should be compared to taking the Coolidge Bridge.

Model 19, the three-category route choice model, turns out to be the strongest model in this set; its adjusted ρ^2 value is higher than any other model in this set. A comparison of Model 19 with Model 20 (where attitudinal variables have been removed) shows a significant drop in the adjusted ρ^2 value, confirmation that the attitudinal variables account for a significant portion of the explanatory power of the three-category model for this set. Surprisingly, based on these model results, attitudinal variables carry significant explanatory power in modeling route choice decision among the peak users sample, despite the reasoning stated earlier that more tangible factors are more influential in the decision-making process. These two sets of models have also presented a pattern: the combining of independent variable categories is noticeably significant in studying the explanatory power of the models. This can be seen in comparing adjusted ρ^2 values of multi-category models versus models containing subsets of the category groups in those models.

Route Choice Model Results with Peak Users – Hypothesis Test

Likelihood ratio χ^2 tests, performed in the same manner as with the first set of models, have also been conducted for the multiple category models in this set containing attitudinal variables to examine the significance of attitudinal variables in the estimation results. Table 13 below shows likelihood ratio χ^2 tests for the two- and three-category models in this set containing attitudinal variables.

Table 13: Route Choice Models with Peak Users: Likelihood Ratio χ^2 Tests

Variable Categories	*ATT Model*	** Model*	$L(\beta)^{ATT}$	$L(\beta)^{*}$	χ_t^2 *Test Statistic*	*Critical* χ_0^2 *Value*	*Degrees of Freedom*
Demographic/ Attitudinal	Model 15	Model 16	-207.606	-216.186	8.580	15.987	10
Travel/ Attitudinal	Model 17	Model 18	-179.065	-195.240	16.175	13.362	8
Demographic/ Travel/Attitudinal	Model 19	Model 20	-147.686	-193.701	46.015	18.549	12

In two of the three cases shown above, the χ_t^2 test statistic is higher than the corresponding critical χ_0^2 value; only the comparison of Models 15 & 16 (involving demographic variables) fails this test. This failure may be explained by examining the z-statistics for the coefficients in Model 15. The variables found to be statistically significant for this model have *z*-statistics that lie on the threshold of statistical significance. Though the differences between these two values are clearly not as high as such differences were with the first group of models, these results confirm that the attitudinal variables in these models do have some explanatory power in modeling route choice decisions of peak period users of the Coolidge Bridge.

Route Choice Model Results with Peak Users – Influential Variables

Based on the results presented in this set of models, it is not surprising to see that travel data variables are strong indicators of route choice among peak users. Specifically, work distance, the number of stops on the way home from work, and current use of the Holyoke Bridge as an alternate route are variables consistently present in the route choice models for the peak user sample set. Attitudinal factors such as awareness of the project, the sources of information about the project, and the types of concerns peak users have about the project are shown to be significant for this user group. Geography (particularly north/south geography) is not shown to be as significant an indicator of route choice among peak users as it was in the earlier models with all users. Age and household size are demographic variables that are also strong factors in these models.

5.3 Mode Choice Breakdown

Mode choice models seek to determine how a user will cross the Connecticut River during the project (SOV, bus, carpool), independent of a predicted route choice. A dependent variable for this choice (“Mode Choice”) was also derived to indicate the likely mode a user intends to choose to cross the river. This was determined using the responses to these survey questions:

- Does the user plan to use the bus to avoid Coolidge Bridge traffic during the project?
- How many days per week does the user plan to use the bus during the project?
- Does the user plan to use a carpool to avoid Coolidge Bridge traffic during the project?
- How many days per week does the user plan to use a carpool during the project?

In a similar manner to the methodology used for route choice, the answers to these questions were used to infer whether or not the user would use a single occupant vehicle (SOV) on a regular basis during the project and how many days per week an SOV would be used. It was determined that if a user stated an intention to use one of the modes at least three days a week, the value of the "Mode Choice" variable would indicate that particular mode. If a user stated an intention to use more than one mode at least three days per week, or stated an intention to use none of these modes at least three days a week, the value of the "Mode Choice" variable would indicate a value of "no particular choice". As before, infrequent use of the Coolidge Bridge, a mix of modes used, or specific reasons for traveling along the Route 9 corridor would result in "no particular choice" for mode. The mode choice breakdown in both sample sets is shown in Table 14:

Table 14: Future Mode Choices Among Respondents

Mode Choice	***All Users***		***Peak Users***	
Number of respondents	817		354	
SOV	594	72.7%	261	73.7%
Bus	10	1.2%	5	1.4%
Carpool	8	1.0%	4	1.1%
No particular choice	205	25.1%	84	23.7%

The single occupant vehicle seems to be how most people in both sample sets plan to travel across the Connecticut River. However, very few people in both sets plan to choose an alternative mode over using a car; approximately 25% of the respondents in both sample sets do not indicate any future mode preference. This may be due to current infrequent use of the Bridge (as previously described), uncertainty over whether a user is able to make a mode switch to accommodate his/her schedule, uncertainty over whether such a switch is necessary, or simply a user not indicating the intended frequency of use for a planned mode switch. It is quite possible that many of these users who are regular commuters or frequent users are planning to continue their current commuting patterns (i.e., driving over the Coolidge Bridge) and are holding off a decision about whether or not to change to a different mode until they have assessed actual traffic conditions once the project gets underway.

Since the sample sizes for the non-SOV mode choices are extremely small, using a multinomial logit model for mode choice is likely to produce unreliable results. In lieu of using MNL, a binomial logit model will be used for mode choice in this research, with SOV or "non-SOV" (which includes those who indicate "no particular choice") as the possible outcomes. (A second "Mode Choice" dependent variable was derived from the outcomes of the first "Mode Choice" variable and will be used for the binomial logit model.)

5.4 Mode Choice Model Estimation Results

The following section presents the results from the Coolidge Bridge mode choice models developed for this research. As was done for route choice models, various combinations of variable categories in these mode choice models, using both the full sample and the peak user subsample, will highlight the effect of attitudinal factors in the decision-making process. The following models will be developed and presented as follows:

21. Mode choice – All users – Best Demographic Data Model
22. Mode choice – All users – Best Travel Data Model
23. Mode choice – All users – Best Attitudinal Data Model
24. Mode choice – All users – Best Demographic Data + Travel Data Model
25. Mode choice – All users – Best Demographic Data + Attitudinal Data Model
26. Mode choice – All users – Best Demographic Data from Model #25
27. Mode choice – All users – Best Travel Data + Attitudinal Data Model
28. Mode choice – All users – Best Travel Data from Model #27
29. Mode choice – All users – Best Demographic Data + Travel Data + Attitudinal Data Model
30. Mode choice – All users – Best Demographic Data + Travel Data from Model #29
31. Mode choice – Peak users – Best Demographic Data Model
32. Mode choice – Peak users – Best Travel Data Model
33. Mode choice – Peak users – Best Attitudinal Data Model
34. Mode choice – Peak users – Best Demographic Data + Travel Data Model
35. Mode choice – Peak users – Best Demographic Data + Attitudinal Data Model
36. Mode choice – Peak users – Best Demographic Data from Model #35
37. Mode choice – Peak users – Best Travel Data + Attitudinal Data Model
38. Mode choice – Peak users – Best Travel Data from Model #37
39. Mode choice – Peak users – Best Demographic Data + Travel Data + Attitudinal Data Model
40. Mode choice – Peak users – Best Demographic Data + Travel Data from Model #39

Mode Choice Model Results with All Users

The third set of models to be presented focuses on modeling mode choice for all users in the survey sample. As mentioned earlier, a very small number of users state a preference to switch to another mode – ten users favor the bus, eight users favor a carpool. Therefore, binomial logit is used for the mode choice models. A positive ("1") response indicates that the user states that a single occupant vehicle (SOV) will not be his primary mode of travel; this may mean that the bus or carpool will be the primary mode or (most likely) that no one mode is chosen as the primary mode. Users who do not indicate a primary mode are likely to experiment with public transit, ridesharing, or another mode (such as bicycle) not captured explicitly in the survey, until he/she settles on a travel mode – which may very well be continued use of an SOV. Since the mode choice outcomes are skewed by insufficient representation of alternative modes, the mode choice models that follow attempt to explain why a user in the sample did not conclusively choose SOV as his/her primary mode of choice.

Models 21-23, the one-category mode choice models, are presented in Table 15 below. The travel data model (Model 22) performs better than the attitudinal data model (Model 23), which performs much better than the demographic data model (Model 21). It should be noted that the variables in the travel data model can be correlated to driving, either due to a change in arrival or departure time or as a function of distance to work. Based on the breakdown of users in the sample (and in the peak sample as well), this trend in travel data variables is likely to emerge throughout the mode choice models. The results shown for this group of models also continue a pattern seen in earlier model results: the importance of gathering information among users in the sample, fueled by

Table 15: Mode Choice Models with All Users: One-Category Models

Mode Choice Model: All Users	***Variables***	***Non – SOV or No Main Choice***	
		Coefficient	***z-statistic***
Model 21: Demographic Variables	Age	**0.0104559**	**2.130**
	Job Level	**-0.2423195**	**-2.426**
	Constant	**-1.096585**	**-4.190**
$\rho^2 = 0.011$; Adjusted $\rho^2 = 0.005$; L(0) = -478.902; L(β) = -473.495; $\chi^2 = 10.813$ with 2 df			
Model 22: Travel Variables	Early PM (Current Use)	**-0.8033889**	**-3.225**
	Late AM (Current Use)	**-0.8662559**	**-2.254**
	Work Distance	**-0.1085403**	**-8.465**
	Constant	-0.0186383	-0.161
$\rho^2 = 0.128$; Adjusted $\rho^2 = 0.120$; L(0) = -478.902; L(β) = -417.656; $\chi^2 = 122.490$ with 3 df			
Model 23: Attitudinal Variables	Sufficient Info	**-0.36887**	**-1.960**
	Rehabilitation	**1.212883**	**2.363**
	Concern – Project Length	**0.113832**	**1.860**
	Concern – Rush Hr. Effect	**-0.09991**	**-1.754**
	Concern – Traf. On Oth. Rds	**-0.20888**	**-2.178**
	24 Hour Support	**-0.51918**	**-2.844**
	Change Habit	**-0.37687**	**-1.996**
	More Questions	**-0.42379**	**-2.346**
	Infrequent User	**2.306422**	**4.245**
	Constant	**-1.1968**	**-2.169**
$\rho^2 = 0.071$; Adjusted $\rho^2 = 0.046$; L(0) = -405.343; L(β) = -376.622; $\chi^2 = 57.442$ with 9 df			
Note: 1. **Bold** items are statistically significant at the 90% confidence level. 2. The single occupant vehicle (SOV) outcome is taken to be the base case. 3. Positive coefficients indicate a greater propensity to choose another primary travel mode (or **no** primary travel mode) compared to the base case of choosing the SOV mode. Coefficients should be compared to using the SOV mode.			

strong concerns over several aspects of the project's impact on Coolidge Bridge traffic, is a significant factor in the decision making process for Coolidge Bridge users.

Models 24-28, the two-category models (with respective comparison models) are shown in Table 16 below. Looking at the adjusted ρ^2 values of the three two-category models, the models that include travel data variables have the two highest adjusted ρ^2 values; this result, combined with the performance of the one-category mode choice models, supports the notion that travel data is a much stronger influence in mode choice decisions among users in the sample. Further, the fact that the demographic and attitudinal data model (Model 25) has the lowest adjusted ρ^2 value among the two-category models indicates that attitudinal data seems to have no more than a marginal

Table 16: Mode Choice Models with All Users: Two-Category Models

Mode Choice Model: All Users	*Variables*	*Non – SOV or No Main Choice*	
		Coefficient	*z-statistic*
Model 24: Demographic & Travel Variables	North	**-0.7107935**	**-3.614**
	# of Work Trips	**-0.1081489**	**-1.746**
	# of Shopping Trips	-0.1880142	-1.568
	# of Total Trips	**0.1126264**	**1.952**
	Early PM (Cur. Use)	**-0.8842047**	**-3.414**
	Late AM (Cur. Use)	**-1.002867**	**-2.420**
	Carpool (Cur. Use)	**1.148196**	**2.515**
	Work Distance	**-0.1215544**	**-8.990**
	Constant	**0.4549849**	**2.099**
ρ^2 = 0.152; Adjusted ρ^2 = 0.133; L(0) = -477.601; L(β) = -405.233; χ^2 = 144.738 with 8 df			
Model 25: Demographic & Attitudinal Variables	Age	**0.015331**	**2.526**
	Sufficient Info	**-0.3945447**	**-2.069**
	Rehabilitation	**1.151354**	**2.215**
	Concern – Project Length	**0.1210897**	**1.950**
	Concern – Rush Hr Effect	**-0.1109937**	**-1.907**
	Concern – Traf. On Oth. Rds	**-0.1981058**	**-2.036**
	Internet Traffic Info	**-0.4031156**	**-1.683**
	24 Hour Support	**-0.4480277**	**-2.416**
	Change Habit	**-0.4117055**	**-2.146**
	More Questions	**-0.4218879**	**-2.294**
	New Transit	**0.8605362**	**1.944**
	Infrequent User	**2.233854**	**4.042**
	Use Less	**0.8768027**	**1.649**
	Constant	**-1.775191**	**-2.829**
ρ^2 = 0.089; Adjusted ρ^2 = 0.055; L(0) = -405.343; L(β) = -369.201; χ^2 = 72.283 with 13 df			
Model 26: Demographic Variables from Model 25	Age	**0.0109518**	**2.176**
	Constant	**-1.439567**	**-6.302**
ρ^2 = 0.005; Adjusted ρ^2 = 0.001; L(0) = -478.902; L(β) = -476.495; χ^2 = 4.812 with 1 df			
Model 27: Travel & Attitudinal Variables	Early PM (Cur. Use)	**-0.88685**	**-3.260**
	Late PM (Cur. Use)	**-0.6650574**	**-2.337**
	Carpool (Cur. Use)	**1.135457**	**2.376**
	Work Distance	**-0.0911536**	**-7.084**
	Rehabilitation	**1.008285**	**2.268**
	Concern – Traf. On Oth. Rds	**-0.2318208**	**-2.422**
	24 Hour Support	**-0.380009**	**-2.065**
	More Questions	**-0.4824926**	**-2.622**
	Infrequent User	**2.227932**	**3.768**
	Constant	-0.533348	-1.165
ρ^2 = 0.166; Adjusted ρ^2 = 0.143; L(0) = -435.632; L(β) = -363.362; χ^2 = 144.540 with 9 df			
Model 28: Travel Variables from Model 27	Early PM (Cur. Use)	**-0.86879**	**-3.436**
	Late PM (Cur. Use)	**-0.70696**	**-2.664**
	Carpool (Cur. Use)	**1.01535**	**2.271**
	Work Distance	**-0.10779**	**-8.328**
	Constant	-0.00753	-0.064
ρ^2 = 0.134; Adjusted ρ^2 = 0.123; L(0) = -478.902; L(β) = -414.954; χ^2 = 127.896 with 4 df			
Note: 1. **Bold** items are statistically significant at the 90% confidence level. 2. The single occupant vehicle (SOV) outcome is taken to be the base case. 3. Positive coefficients indicate a greater propensity to choose another primary travel mode (or **no** primary travel mode) compared to the base case of choosing the SOV mode. Coefficients should be compared to using the SOV mode.			

influence on mode choice decisions, a hypothesis confirmed by comparing the adjusted ρ^2 values of the one-category models.

Models 29 and 30, the three-category model and its corresponding two-category model without attitudinal data, are shown in Table 17 below.

Table 17: Mode Choice Models with All Users: Three-Category Models

Mode Choice Model: All Users	*Variables*	*Non – SOV or No Main Choice*	
		Coefficient	*z-statistic*
Model 29: Demographic, Travel & Attitudinal Variables	North	**-0.6600961**	**-3.153**
	Early PM (Cur. Use)	**-0.8581703**	**-3.186**
	Late PM (Cur. Use)	**-0.5971844**	**-2.121**
	Carpool (Cur. Use)	**1.39123**	**3.004**
	Work Distance	**-0.1082293**	**-7.951**
	Awareness	**-0.7022781**	**-1.728**
	Rehabilitation	**1.016878**	**2.343**
	Concern – Traf. On Oth. Rds	**-0.218438**	**-2.290**
	More Questions	**-0.4779915**	**-2.597**
	Infrequent User	**2.155244**	**3.721**
	Use Less	**1.040917**	**1.934**
	Constant	0.4146971	0.749
ρ^2 = 0.178; Adjusted ρ^2 = 0.151; L(0) = -449.683; L(β) = -369.620; χ^2 = 160.127 with 11 df			
Model 30: Demographic and Travel Variables from Model 29	North	**-0.6779755**	**-3.463**
	Early PM (Cur. Use)	**-0.8486681**	**-3.331**
	Late PM (Cur. Use)	**-0.6347004**	**-2.373**
	Carpool (Cur. Use)	**1.172218**	**2.605**
	Work Distance	**-0.1196102**	**-8.918**
	Constant	**0.5177576**	**2.669**
ρ^2 = 0.146; Adjusted ρ^2 = 0.134; L(0) = -478.902; L(β) = -408.904; χ^2 = 139.995 with 5 df			

Note:
1. **Bold** items are statistically significant at the 90% confidence level.
2. The single occupant vehicle (SOV) outcome is taken to be the base case.
3. Positive coefficients indicate a greater propensity to choose another primary travel mode (or **no** primary travel mode) compared to the base case of choosing the SOV mode. Coefficients should be compared to using the SOV mode.

The three-category model has the highest adjusted ρ^2 value among the models presented in this set. It should be noted that only one demographic variable (North) is shown to be highly statistically significant in this model, compared to six attitudinal variables and four travel data variables. This development is expected given the lack of explanatory power accorded to demographic data, based on the adjusted ρ^2 values of the one-category models. These results also support the earlier hypothesis of the significant power of travel data variables in explaining mode choice decisions.

Mode Choice Model Results with All Users – Hypothesis Test

Likelihood ratio χ^2 tests, performed in the same manner as with the earlier models, have also been conducted for the multiple category models using attitudinal variables to examine the significance of attitudinal variables in predicting mode choice. Table 18 below shows likelihood ratio χ^2 tests for the two- and three-category models in this set containing attitudinal variables.

Table 18: Mode Choice Models with All Users: Likelihood Ratio χ^2 Tests

Variable Categories	*ATT Model*	** Model*	*$L(\beta)^{ATT}$*	*$L(\beta)^{*}$*	*χ_t^2 Test Statistic*	*Critical χ_0^2 Value*	*Degrees of Freedom*
Demographic/ Attitudinal	Model 25	Model 26	-369.201	-476.495	107.294	2.706	1
Travel/ Attitudinal	Model 27	Model 28	-363.362	-414.954	51.592	7.779	4
Demographic/ Travel/Attitudinal	Model 29	Model 30	-369.620	-408.904	39.284	9.236	5

The χ_t^2 test statistics exceed the critical χ_0^2 values in each case. This leads to the belief that attitudinal data provides significant explanatory power in modeling mode choices among users in our sample. The adjusted ρ^2 values from the mode choice models, however, suggest that this explanatory power may not be as significant in determining mode choices as it was in explaining route choices.

Mode Choice Model Results with All Users – Influential Variables

The results presented for this set of models are consistent with an overall observation, based on all of the models presented to this point: Attitudes do carry some influence over expected travel behavior, but, among the sampled group of users, current travel patterns are at least as strong of an indicator, if not stronger. "Work Distance" and some of the "Current Use" variables ("Carpool", "Early PM", "Late AM", "Late PM") occur throughout the mode choice models, and many of the travel variables involve driving. This suggests that many users may prefer to continue to drive across the Coolidge Bridge even during construction, and will change their travel behavior only if they experience worsening conditions along Route 9 firsthand. Attitudinal variables that are significant in these mode choice models include "Infrequent User" and "Use Less", (two variables generated by user comments), some of the "Concern" variables (especially "Traffic Increase on Other Roads"), and "Change Habit" – a clear indicator of a user's likelihood to consider changing modes. Respondents indicating that they will lessen their use of the Coolidge Bridge may be more willing to consider alternative modes to reduce their apparent frustration with driving along Route 9 when congestion exists. Age and job level are shown to be significant demographic factors; this may indicate that other factors (such as safety, comfort, convenience, etc.) not measured in the survey that appeal to certain demographic groups may be significant in influencing mode choice decisions.

Mode Choice Model Results with Peak Users

The final set of models includes binary logit mode choice models for peak users in the survey sample. As with the previous set of models, a positive response indicates that the user states that a single occupant vehicle (SOV) will not be his primary mode of travel. Models 31-33, the one-category models, are presented in Table 19 below.

Table 19: Mode Choice Models with Peak Users: One-Category Models

Mode Choice Model: Peak Users	*Variables*	*Non – SOV or No Main Choice*	
		Coefficient	*z-statistic*
Model 31: Demographic Variables	Children/HH	**0.2717213**	**2.177**
	Constant	**-1.250727**	**-8.044**
ρ^2 = 0.012; Adjusted ρ^2 = 0.002; L(0) = -193.060; L(β) = -190.738; χ^2 = 4.652 with 1 df			
Model 32: Travel Variables	Early PM (Cur. Use)	**-0.89574**	**-3.641**
	Work Distance	**-0.10781**	**-8.416**
	Constant	-0.06624	-0.580
ρ^2 = 0.122; Adjusted ρ^2 = 0.115; L(0) = -478.902; L(β) = -420.590; χ^2 = 116.623 with 2 df			
Model 33: Attitudinal Variables	Project Start	0.3011448	1.625
	Concern – Rush Hr. Effect	**-0.2294346**	**-2.715**
	HAR Traffic Info	**0.5619419**	**1.931**
	24 Hour Support	**-0.6071818**	**-2.130**
	School Heavy Traffic	**-0.5489008**	**-1.696**
	More Questions	**-0.8645383**	**-2.987**
	Infrequent User	**2.625742**	**3.077**
	Other Road Problems	**1.196042**	**2.155**
	Constant	-0.2391444	-0.498
ρ^2 = 0.124; Adjusted ρ^2 = 0.074; L(0) = -179.947; L(β) = -157.692; χ^2 = 44.510 with 8 df			
Note: 1. **Bold** items are statistically significant at the 90% confidence level. 2. The single occupant vehicle (SOV) outcome is taken to be the base case. 3. Positive coefficients indicate a greater propensity to choose another primary travel mode (or **no** primary travel mode) compared to the base case of choosing the SOV mode. Coefficients should be compared to using the SOV mode.			

The pattern of adjusted ρ^2 values for these models follows the one-category route choice models sampling all users (Models 1-3). The attitudinal data model and the travel data model have equal adjusted ρ^2 values; the adjusted ρ^2 value for the demographic data model is much lower. Once again, the travel data variables are correlated with driving (clearly the dominant mode of travel along the Route 9 corridor), which likely explains the travel data model nearly equal standing with the attitudinal model, which has eight statistically significant variables. The attitudinal model focuses mostly on the ability to gather information – a pattern seen throughout the attitudinal models for both route and mode choice.

Models 34-38, the two-category mode choice models for peak users (with appropriate one-category comparison models) are presented in Table 20 below.

Table 20: Mode Choice Models with Peak Users: Two-Category Models

Mode Choice Model: Peak Users	Variables	Non – SOV or No Main Choice	
		Coefficient	z-statistic
Model 34: Demographic & Travel Variables	North	**-0.6722682**	**-3.490**
	Early PM (Cur. Use)	**-0.8592769**	**-3.465**
	Work Distance	**-0.1193885**	**-9.021**
	Constant	**0.4666735**	**2.427**
ρ^2 = 0.135; Adjusted ρ^2 = 0.126; L(0) = -478.902; L(β) = -414.450; χ^2 = 128.899 with 3 df			
Model 35: Demographic & Attitudinal Variables	Children/HH	**0.3359169**	**2.389**
	Move	**-0.8067631**	**-2.005**
	Concern – Rush Hr. Effect	**-0.2100861**	**-2.480**
	HAR Traffic Info	**0.5281118**	**1.790**
	24 Hour Support	**-0.6751873**	**-2.318**
	More Questions	**-0.9257982**	**-3.177**
	Infrequent User	**2.450242**	**2.961**
	Other Road Problems	**1.041939**	**1.773**
	Constant	-0.1926885	-0.575
ρ^2 = 0.131; Adjusted ρ^2 = 0.080; L(0) = -175.206; L(β) = -152.236; χ^2 = 45.939 with 8 df			
Model 36: Demographic Variables from Model 35	Children/HH	**0.2717213**	**2.177**
	Constant	**-1.250727**	**-8.044**
ρ^2 = 0.012; Adjusted ρ^2 = 0.002; L(0) = -193.064; L(β) = -190.738; χ^2 = 4.652 with 1 df			
Model 37: Travel & Attitudinal Variables	Early PM (Cur. Use)	**-1.467258**	**-3.185**
	Holyoke Bridge (Cur. Use)	**0.9942482**	**2.174**
	Work Distance	**-0.0788846**	**-3.918**
	Project Start	**0.3451127**	**1.672**
	Concern – Rush Hr. Effect	**-0.2205125**	**-2.412**
	HAR Traffic Info	**0.5831512**	**1.829**
	24 Hour Support	**-0.5370442**	**-1.738**
	School Heavy Traffic	**-0.7563854**	**-2.136**
	More Questions	**-0.8480835**	**-2.720**
	Infrequent User	**2.625414**	**2.859**
	Other Road Problems	**1.546132**	**2.577**
	Constant	0.4953772	0.930
ρ^2 = 0.216; Adjusted ρ^2 = 0.148; L(0) = -175.510; L(β) = -137.619; χ^2 = 75.783 with 11 df			
Model 38: Travel Variables from Model 37	Early PM (Cur. Use)	**-1.009379**	**-2.640**
	Holyoke Bridge (Cur. Use)	**0.6636389**	**1.705**
	Work Distance	**-0.1064359**	**-5.345**
	Constant	-0.215023	-1.215
ρ^2 = 0.116; Adjusted ρ^2 = 0.096; L(0) = -203.860; L(β) = -180.270; χ^2 = 47.190 with 3 df			

Note:
1. **Bold** items are statistically significant at the 90% confidence level.
2. The single occupant vehicle (SOV) outcome is taken to be the base case.
3. Positive coefficients indicate a greater propensity to choose another primary travel mode (or **no** primary travel mode) compared to the base case of choosing the SOV mode. Coefficients should be compared to using the SOV mode.

Based on the previous set of models, it should not be surprising that the model with travel and attitudinal variables (Model 37) has the highest adjusted ρ^2 value among the three two-category models. Both two-category models containing demographic data variables have nearly identical (and much lower) adjusted ρ^2 values; each of these models contains only one statistically significant demographic variable.

Models 39 and 40, the three-category model and its related two-category test model, are presented in Table 21 below.

Table 21: Mode Choice Models with Peak Users: Three-Category Models

Mode Choice Model: Peak Users	*Variables*	*Non – SOV or No Main Choice*	
		Coefficient	*z-statistic*
Model 39: Demographic, Travel & Attitudinal Variables	North	**-0.6359075**	**-3.196**
	Early PM (Cur. Use)	**-0.7924728**	**-3.131**
	Work Distance	**-0.1109009**	**-8.357**
	More Questions	**-0.4332971**	**-2.454**
	Constant	**0.5945062**	**2.709**
$\rho^2 = 0.130$; Adjusted $\rho^2 = 0.119$; $L(0) = -451.215$; $L(\beta) = -392.352$; $\chi^2 = 117.727$ with 4 df			
Model 40: Demographic and Travel Variables from Model 39	North	**-0.6722682**	**-3.490**
	Early PM – Current Use	**-0.8592769**	**-3.465**
	Work Distance	**-0.1193885**	**-9.021**
	Constant	**0.4666735**	**2.427**
$\rho^2 = 0.135$; Adjusted $\rho^2 = 0.126$; $L(0) = -478.902$; $L(\beta) = -414.452$; $\chi^2 = 128.899$ with 3 df			

Note:
1. **Bold** items are statistically significant at the 90% confidence level.
2. The single occupant vehicle (SOV) outcome is taken to be the base case.
3. Positive coefficients indicate a greater propensity to choose another primary travel mode (or **no** primary travel mode) compared to the base case of choosing the SOV mode. Coefficients should be compared to using the SOV mode.

The adjusted ρ^2 value of the three-category model suffers due to the presence of one demographic variable, when compared to the travel/attitudinal model (Model 37). This result further affirms the results found in earlier models in this set: For mode choice decisions, travel data and attitudinal data carry significant explanatory power, while demographic data variables contribute little explanatory power.

Mode Choice Model Results with Peak Users – Hypothesis Test

Likelihood ratio χ^2 tests have also been conducted for the multiple category models using attitudinal variables to examine the significance of attitudinal variables in predicting mode choices for the peak user subsample. Table 22 below shows likelihood ratio χ^2 tests for the two- and three-category models in this set containing attitudinal variables.

Table 22: Mode Choice Models with Peak Users: Likelihood Ratio χ^2 Tests

Variable Categories	*ATT Model*	** Model*	$L(\beta)^{ATT}$	$L(\beta)^{*}$	χ_t^2 *Test Statistic*	*Critical* χ_0^2 *Value*	*Degrees of Freedom*
Demographic/ Attitudinal	Model 35	Model 36	-152.236	-190.738	38.502	2.706	1
Travel/ Attitudinal	Model 37	Model 38	-137.619	-180.270	42.651	6.251	3
Demographic/ Travel/Attitudinal	Model 39	Model 40	-392.352	-414.452	22.100	6.251	3

The χ_t^2 test statistics exceed the critical χ_0^2 values in each case, further affirming the hypothesis that attitudinal variables carry some explanatory power in estimating mode choice decisions. However, the adjusted ρ^2 values of models in this set suggest that attitudinal data is at least as important as travel data in determining mode choice decisions for peak users.

Mode Choice Model Results with Peak Users – Influential Variables

The patterns that have emerged in evaluating previous sets of choice models continue to emerge in this mode choice model set. Travel data clearly shows significance in the models – at least as much as attitudinal data, but universally less than demographic data. This set of models shows more variability of variables within categories than other sets of models presented here. "Infrequent User", for example, emerges as a significant variable among attitudinal data, with a positive correlation in the models. This significance may indicate that many infrequent users are determined to not have a main mode to cross the bridge, due to their infrequent use. While likely to use the SOV mode to cross the Coolidge Bridge on the few occasions they do so, their designation as having "no main choice" of mode can explain the significance of this variable. Still, some variables consistently appear to be significant throughout the choice models. "Work Distance" and "Late PM (Current Use)" are travel data variables that appear throughout this set of models. Household size (particularly the number of children in the household) and north/south geography are significant demographic variables; as with the full sample, factors not accounted for in the survey (such as safety, convenience, etc.) may explain the significance of these variables. The negative correlation of "North" in the models may be due to a larger transit presence in cities south of Amherst (such as Holyoke and Chicopee), increasing the opportunities for mode switching for users living in these areas.

CHAPTER 6

CONCLUSIONS AND FUTURE RESEARCH

In reviewing the results of these choice models, it is clear that a pattern of explanatory significance occurs among the three categories of data used in the model estimation process developed for this research. The hypothesis presented prior to presenting the model estimation results stated that attitudes and perceptions played a significant role in the decision making process of travelers. The results of the route and mode choice models presented here do not fully support this hypothesis. Rather, the models present clear evidence that travel-based data are a strong indicator of expected mode and route choices made by users in the survey sample; often, the influence of travel data is stronger than attitudinal data. Factors such as work distance and the current use of alternative routes and modes appear in nearly every model that includes travel-based data, and comparisons of adjusted ρ^2 values among models further support this notion. These results seem to indicate that Coolidge Bridge users in our sample generally are resistant to changing their driving habits over the bridge. This reluctance to changing travel behavior may be due to a user's reluctance to forgo the security of knowing the frustrating, yet familiar parameters of their regular commute for the uncertainty of taking a longer route or using another mode of travel.

Another conclusion that can be inferred from the estimation results is that attitudinal data turns out to be as significant, if not more significant, than demographic data used in these models. The likelihood ratio χ^2 tests performed with each set of models showed that, for nearly every case presented, attitudinal variables carried explanatory power of at least some significance in estimating choice behavior. Further, comparisons of adjusted ρ^2 values among the models showed that models using attitudinal variables performed consistently better than models using demographic data, regardless of the type of choice modeled or the sample set used. Perceptions and attitudes influence the decisions made by travelers every day. As the use of demographic data is widely acknowledged to be crucial to successfully forecast travel demand, the results presented here support the increased inclusion of attitudinal variables as an essential part of both the data gathering (survey) process and in model estimation.

In modeling route and mode choices expected to be made by respondents to the survey, more specific influences emerge from the general categorical influences just described. Perhaps no greater deciding factor can be found among the Coolidge Bridge users in the sample than distance to work. The distance between work and home dictates travel time (under normal circumstances), whether certain alternative routes are truly alternatives, and whether a user's choices of alternative modes are limited. Coolidge Bridge users who have a short distance to travel (for instance, those who live in downtown Northampton) have many options open to them, including more transit and carpool opportunities, traveling across the Sunderland or Holyoke Bridges, and a greater tolerance of travel delays. On the other hand, Coolidge Bridge users needing to travel a longer distance may not live near a bus route, may have only one clear alternative to using the Coolidge Bridge, and are less likely to accept delays in their commute. The other travel data factor shown to be significant in many of the models involves whether users currently explore alternative measures to avoid existing congestion on the Coolidge Bridge. Use of such measures is likely to continue (and perhaps increase) as travel conditions are expected to worsen, making these important indicators of future choices.

Other factors emerge as significant among many of the models. Whether a user lives north or south of the Coolidge Bridge is a significant factor for route choice, as it essentially determines which alternative is more feasible. Location relative to the Coolidge Bridge is less significant for mode choice; however, a greater number of bus routes in communities south of the Coolidge Bridge may explain its significance in explaining mode choice. Concerns about the effects of the project also emerge as a clear influence in choices. Increases in traffic, noise, and congestion, as well as perceptions about the timeline of the project, are reasons for Coolidge Bridge users to consider other travel alternatives.

Other significant factors in choice decisions include household size and the delivery of information about the project, both "how" and "how much." Household size (and related factors such as number of children and vehicles) determines how many trips are generated from one location, the availability of SOV and non-SOV modes (such as carpool), and the potential for chaining multiple trips together. The presence in the choice models of information factors, such as sources of information – both real and desired – and whether enough information has been gathered, highlight the importance of empowering the traveling public with knowledge of current travel conditions and available travel options. Such knowledge allows drivers and other commuters to adjust to unforeseen changes in travel conditions – particularly in a scenario, such as the Coolidge Bridge, where many travelers are familiar with both the main streets and many back-road shortcuts.

There is a growing body of literature discussing the effects of attitudinal data in travel demand forecasting. Modelers need to incorporate the gathering of such data in travel surveys and other data collection methods. As this subject is still relatively new, improvements in the type of data sought and the methods for obtaining such data are inevitable and necessary. For the specific case of the Coolidge Bridge, further investigation of the conclusions presented here will be necessary to determine if the factors that users believe will influence their route and mode choices are accurate. Surveying users of the Coolidge Bridge, alternative routes, and alternative modes while the reconstruction is in progress, and analyzing the resulting data would prove valuable in testing the hypotheses posed in this project. These future surveys should gather additional preference data not collected for this research; this data can include rankings of various characteristics of different routes and modes (comfort, convenience, safety, timeliness, cost, etc.) and the likelihood of maintaining travel patterns once the Coolidge Bridge reconstruction is complete.

APPENDIX
COOLIDGE BRIDGE SURVEY

Calvin Coolidge Bridge Reconstruction Survey

The University of Massachusetts is conducting research on travel behavior related to the upcoming reconstruction of the Calvin Coolidge Bridge (Route 9), connecting Northampton and Hadley. Your answers to the following questions will help us in our efforts to suggest policies and guidelines to improve transportation in the Pioneer Valley in the near future.

All respondents will be eligible for a prize of a $300 gift certificate to Best Buy™. Thank you for your help!

Section 1: Bridge Reconstruction

1A. Before receiving this survey, were you aware of the Coolidge Bridge reconstruction project?

Yes No (If "No", skip to Question 2)

1B. If "Yes", where have you obtained your information about the project? (Check all that apply)

_____ Newspapers
_____ Radio
_____ Television
_____ Directly from MassHighway
_____ Another government (Town Meeting, City Hall, etc.)
_____ Other: ____________________________________

1C. Has information about the project been made available in a sufficient manner?

Yes No Don't know

2. Do you think the Coolidge Bridge is in need of rehabilitation?

Yes No Don't know

3. Do you think the Coolidge Bridge and/or Route 9 from the bridge to Amherst should be widened (to four lanes, two in each direction)?

_____ The Coolidge Bridge needs to be widened
_____ Route 9 needs to be widened
_____ Both the bridge and Route 9 need to be widened
_____ Neither the bridge nor Route 9 need to be widened
_____ Don't know

4. When do you expect the Coolidge Bridge project to start?

_____ Summer 2000
_____ Fall 2000
_____ Winter 2001 or later

5. How long do you anticipate the Coolidge Bridge project to take?

_____ Less than two years
_____ Two to four years
_____ More than four years

6. Have you considered changing the location of your residence or work because of the anticipated length of this project?

_____ No change
_____ Change of residence
_____ Change of workplace
_____ Change of both residence and workplace
_____ Don't know

7. Please rank the four aspects of the Coolidge Bridge reconstruction project that most concern you. Rank using the numbers 1-4, with "1" being the aspect that most concerns you.

_____ Length of project
_____ Cost of project
_____ Effect on rush hour traffic
_____ Effect on non-rush hour traffic
_____ Noise
_____ Pollution
_____ Potential widening of Route 9
_____ Access to emergency vehicles
_____ Traffic increase on other roads
____ Other: __________________

8. When do you decide which route and/or mode you choose to travel over the Coolidge Bridge?

_____ Before the trip (at home/work)
_____ Radio reports
_____ When I see what traffic is like
_____ Other: ______________________________

9. Assuming all of the following traffic information sources were available, which of the following would you use to get traffic information on Route 9? (Check all that apply)

_____ Radio/TV reports
_____ Highway Advisory Radio (a dedicated station for traffic information)
_____ Electronic message signs
_____ Internet
_____ Telephone/cellular phone
_____ Other: ______________________________

10. Would you support "round-the-clock" construction on the bridge in order to finish the project sooner, knowing that rush hour traffic times over the bridge would likely increase?

Yes No Don't know

11. Do you notice a substantial difference in travel conditions over the bridge during the school year (September – May) compared with the summer months (June – August)?

_____ Heavier during the school year
_____ Heavier during the summer months
_____ About the same year-round (no difference)
_____ I don't know

Section 2: General Travel Information

Please answer the following questions about your travel over the Coolidge Bridge in the <u>week prior to receiving this survey</u>.

12. How many times did you make a trip over the Coolidge Bridge <u>last week</u> for the following reasons? (Count round-trips as <u>one</u> trip.)

_____ Work/School
_____ Shopping
_____ Social (dining, entertainment, etc.)
_____ Other: ______________________________

13. Did you make a work/school trip over the Coolidge Bridge <u>last week</u>?

Yes No (If "No", skip to Question 24)

14. In which city or town do you work/attend school?

____

15A. Do you have official work hours?

Yes No (If "No", skip to Question 16)

15B. If "Yes", what are they?

From _____________ to _______________

16. Is <u>your own</u> start time at work fixed?

_____ Yes, I start at ______________

_____ Partly, I start between _____________ and _______________

_____ No, I can start whenever I want

Please answer the following questions about your most recent work or school trip over the Coolidge Bridge prior to receiving this survey.

17. When was your most recent work/school trip over the Coolidge Bridge?

____

18. On this trip, what time did you arrive at your workplace?

____

19. What time did you leave your workplace?

____

20. How many stops did you make?

To work/school:	0	1	2	3	4	5+
From work/school:	0	1	2	3	4	5+

21. How did you travel to work/school?

_____ Drove alone
_____ Rode the bus
_____ In a car with ______ other person(s)
_____ Other: ____________________________

22. How long was your trip, excluding stops?

To work/school: _____ minutes
From work/school: _____ minutes

23. If you had made this trip during a non-rush hour period (when there are no traffic delays), how long would your trip take?

To work/school: _____ minutes
From work/school: _____ minutes

Section 3: Current Travel Behavior

24. Please use the following grids to mark trips you made across the Coolidge Bridge in the past week. Mark each work trip with a "W", each school trip with an "S", and each non-work or non-school trip with an "N". If any trips were made on the bus, denote them with a circle, such as W or N . If any trips were made in a carpool, mark them with an X (traveled with one other person) or XX (traveled with two or more other people), such as W^X or S^{XX}. Mark the boxes that correspond to *the time you were on the bridge*.

	Eastbound (Northampton to Amherst)						
	Before 6AM	**6AM-7AM**	**7AM-8AM**	**8AM-9AM**	**9AM-10AM**	**10AM-11AM**	**After 11AM**
Mon							
Tue							
Wed							
Thu							
Fri							
Sat							
Sun							

	Westbound (Amherst to Northampton)						
	Before 2PM	**2PM-3PM**	**3PM-4PM**	**4PM-5PM**	**5PM-6PM**	**6PM-7PM**	**After 7PM**
Mon							
Tue							
Wed							
Thu							
Fri							
Sat							
Sun							

25. Please indicate below what measures, if any, you are <u>currently</u> taking to avoid traffic congestion on the Coolidge Bridge and how many days per week you utilize these measures:

Travel Behavior	**Do I currently do this?**	**# Days per Week**
Earlier departure time – AM travel	Yes No	0 1 2 3 4 5+
Earlier departure time – PM travel	Yes No	0 1 2 3 4 5+
Later departure time – AM travel	Yes No	0 1 2 3 4 5+
Later departure time – PM travel	Yes No	0 1 2 3 4 5+
Use Route 116 – Sunderland Bridge	Yes No	0 1 2 3 4 5+
Use Route 116 – Holyoke Bridge	Yes No	0 1 2 3 4 5+
Commute via bus	Yes No	0 1 2 3 4 5+
Commute via carpool	Yes No	0 1 2 3 4 5+
Other:	Yes No	0 1 2 3 4 5+

26A. Do you anticipate changing your travel habits during the Coolidge Bridge reconstruction project?

Yes No (If “No”, skip to Question 27)

26B. If “Yes”, indicate what changes may occur in your travel habits and how many days per week you think they will take effect:

Travel Behavior Change	**Will I make this change?**	**# Days per Week**
Earlier departure time – AM travel	Yes No	0 1 2 3 4 5+
Earlier departure time – PM travel	Yes No	0 1 2 3 4 5+
Later departure time – AM travel	Yes No	0 1 2 3 4 5+
Later departure time – PM travel	Yes No	0 1 2 3 4 5+
Use Route 116 – Sunderland Bridge	Yes No	0 1 2 3 4 5+
Use Route 116 – Holyoke Bridge	Yes No	0 1 2 3 4 5+
Switch to bus mode	Yes No	0 1 2 3 4 5+
Switch to carpool mode	Yes No	0 1 2 3 4 5+
Other:	Yes No	0 1 2 3 4 5+

Section 4: Demographic Information

Your answers to the following questions will help us in ensuring that we obtain a representative sample of Pioneer Valley commuters.

27. How many vehicles do you or other members of your household own?
    0 1 2 3 4 or more

28. How many people are in your household?
    0 1 2 3 4 5 6 or more

29. How many children 18 or under are in your household?
    0 1 2 3 4 5 6 or more

30. Where do you live?
    _____ Single Family Home
    _____ Condominium
    _____ Apartment
    _____ Other

31. What is your gender?
Male Female

32. How old are you? ________

33. What is your occupation and job title?
Occupation: ______________________________
Job Title: ________________________________

34. What is the highest level of education you have achieved?
_____ Some high school
_____ High school graduate
_____ Some college
_____ College graduate (Associate/Bachelor's Degree)
_____ Some graduate school
_____ Postgraduate (Master's/Doctoral Degree)

35. What is your annual gross household income?
_____ $25,000 or less
_____ $25,001 to $50,000
_____ $50,001 to $75,000
_____ $75,001 to $100,000
_____ More than $100,000

36. Would you be willing to answer further questions about the Coolidge Bridge project?
Yes No Don't know

37. Feel free to add any comments about our survey or the project in the space below:
____
____
____
____
____
____
____
____

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