TRAVELER INFORMATION SYSTEMS
Evaluation of UDOT's ATIS Technologies

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Disclaimer

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LIST OF ACRONYMS

ADOT	Arizona Department of Transportation
ATIS	Advanced Traveler Information System
CCTV	Closed Circuit Television
HAR	Highway Advisory Radio
O-D	Origin-Destination
RWIS	Road Weather Information System
TRB	Transportation Research Board
UDOT	Utah Department of Transportation
UTL	Utah Traffic Laboratory
VMS	Variable Message Signs
WSDOT	Washington State Department of Transportation

EXECUTIVE SUMMARY

This report details the findings of a study on the Utah Department of Transportation's (UDOT's) Advanced Traveler Information Systems (ATISs). The purpose of the study was to determine the public's awareness and use of four main ATISs, namely Variable Message Signs (VMS), Highway Advisory Radio (HAR), the 511 phone system, and the CommuterLink website. A random survey of 201 respondents was conducted in the Salt Lake Valley. Of the 201 surveyed respondents, 58 (28.9%) were aware of all four systems. Educated middle-aged men with flexible schedules, who drive at least 100 miles per week, are the most likely group to be aware of all four ATISs. Of the 201 surveyed respondents, 8 respondents (4.0%) had used all four ATISs. It was found that educated young men with flexible schedules are the main ATIS users. Among those who used the ATIS services, users' satisfaction levels were consistently high. There was a higher level of awareness and use associated with en-route ATIS such as VMS and HAR, when compared to pre-trip ATIS such as the 511 phone system and the CommuterLink website. As acceptance of technology grows, the use of cell phones and web-based traveler information services is likely to increase.

Based on the findings from the public survey, the analysis of UDOT's 511 and the CommuterLink website logs, it was found that ATIS use is increasing. The use of 511 and the CommuterLink website peaks during inclement weather conditions and holidays or special events that generate an increased number of trips.

Recommendations have been made based on the shortcomings identified from the respondents' responses and comments. It was recommended that marketing and outreach programs should be focused on awareness as well as education. The messages on one system may be supplemented with messages on the other systems. Implementing changes during the winter should be avoided, as it is a period of highest use and demand for the ATISs. System-specific recommendations have also been made. An ATIS evaluation using VISUM-online has been suggested for future work. VISUM-online can be used to accurately and directly measure ATIS performance.

1. INTRODUCTION

1.1 Background

The Advanced Traveler Information System (ATIS) uses communication and information technologies to collect, process, and distribute useful information to the traveling public (*1, 2*). ATIS provides timely information on traffic, construction, road conditions, travel times, expected delays, alternative routes, and weather, thereby giving travelers the opportunity to make informed decisions on when to go, what transportation mode to use, and which route to take.

An important objective of a transportation management program is to optimize the existing road network capacity by efficiently managing and controlling vehicles on the roadway. Drivers can use ATIS to dynamically react to road conditions and thereby optimize the road network by changing their departure time, taking an alternative route or choosing a different travel mode. Pre-trip information, such as roadway conditions and route congestion, is available to motorists in Utah through online services (CommuterLink website) and telephone services (511). En-route information on incidents, roadway and environmental conditions, and alternative routes is available to the traveling public through Variable Message Signs (VMS) and Highway Advisory Radio (HAR). Adverse weather conditions significantly influence the safety and operation of roads. The Road Weather Information System (RWIS) is a national program that coordinates efforts from a variety of agencies to inform the traveling public about accurate road conditions. The information is presented through VMS, HAR, and internet/wireless/phone. RWIS is used by the Utah Department of Transportation (UDOT) maintenance personnel to make effective and timely winter maintenance decisions (*3*).

1.2 Problem Description

There is a need to assess whether ATISs are effective in informing the public about traffic, construction, incidents, and weather. The improvements that would make ATIS technologies more beneficial and useful to the traveling public need to be determined. A public opinion survey on ATIS gauges its level of effectiveness and identifies the problems that need to be addressed. The purpose of this research is to evaluate the effectiveness of UDOT's ATIS. The four ATISs that were evaluated have been described in the subsequent sections.

1.2.1 Variable Message Signs

VMS are roadside boards that display text messages. Also known as changeable message signs, electronic roadway signs or dynamic message signs, VMS are useful in conveying information to the public concerning congestion, road conditions, travel times, and other alerts. The messages can be automated or entered manually, depending on the situation. UDOT currently deploys more than 40 VMS on freeways, 17 on surface streets, and 2 portable VMS units (*3*). Figure 1.1 shows a typical VMS.

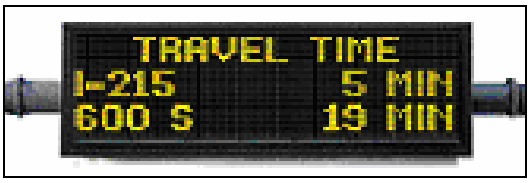

Figure 1.1: Variable Message Sign

1.2.2 Highway Advisory Radio

HAR is an Amplitude Modulation (AM) radio station that broadcasts traffic information. Roadside signs flash when urgent messages are being broadcast (*3*). Travelers tuned to the appropriate station can receive audio information concerning construction activities, road conditions and closures, special events, traffic information, weather and, in some cases, tourist information. Figure 1.2 shows a sign which informs drivers when to use HAR.

Figure 1.2: Highway Advisory Radio

1.2.3 Phone-based Traveler Information: 511

A toll-free phone service called 511 is tied into CommuterLink's network of information resources (*3*). Callers to 511 use a voice-operated menu to access information about traffic, public transit, road conditions, and Lake Powell ferry services. Figure 1.3 shows the logo for the 511 traveler information system.

Figure 1.3: 511 Toll-free Phone System

1.2.4 Web-based Traveler Information: CommuterLink

The CommuterLink website is a web-based information service that provides pre-trip information concerning construction activities, road conditions, and incident locations (*3*). The CommuterLink website provides estimated travel speeds for the interstate corridors. CommuterLink website users can access still motion photographs of current driving conditions from any one of the 265 closed circuit televisions installed throughout the network. Recently, CommuterLink website users have been able to view VMS messages in real time. Figure 1.4 shows the CommuterLink logo which will be used in the public survey questionnaire.

Figure 1.4: CommuterLink Website **(www.commuterlink.utah.gov)**

1.3 Research Goal and Objectives

The goal of this study is to evaluate UDOT's ATISs. This study assesses the effectiveness of four ATISs in Utah: VMS, HAR, 511, and the CommuterLink website.

This study's research objectives are to:

1. Determine the level of public awareness of ATISs in Utah.
    - The level of awareness of each of the four ATISs helps to compare the systems and identify those that need more publicity.

2. Assess the usefulness of UDOT's ATIS.
    - The use and effectiveness of each of the four ATISs have been determined. This information was gathered through both specific and open-ended questions in the public surveys. Furthermore, respondents were asked about the type of information they seek from ATIS.

3. Investigate the effect of ATIS on driving habits.
    - It was researched how ATIS affects a driver's decisions, both pre-trip and en-route.

4. Determine the influence of demographic factors on ATIS use.
    - It was determined whether the level of impact of traveler information is dependent on the driver's travel pattern flexibility, years of driving experience, and miles driven each week.

The research tasks were as follows:

1. Design an ATIS evaluation.
2. Design questionnaires for public interviews.
3. Conduct public surveys.
4. Evaluate responses and trends.
5. Analyze data from UDOT access logs for the CommuterLink website and 511.
6. Recommend improvements.

7. Develop a scope on how to directly and accurately measure the effectiveness of ATIS using VISUM-online.
8. Meet with UDOT's Technical Advisory Committee (TAC) and present findings.
9. Deliver report.

2. LITERATURE REVIEW

Different agencies have come up with interesting findings from their ATIS evaluations. Some of the evaluations have been described in the following sections.

2.1 Likely Users of ATIS

Males and younger drivers have been found to be more likely to divert (that is, use ATIS) than females and older drivers, respectively, under similar conditions (*4*). This is because females and older drivers are, on average, more risk averse than males and younger drivers. Additionally, well-educated individuals exhibit greater compliance with VMS messages. This is supported by the findings of the University of California researchers (*5*). They found that women were less likely to divert than men. The probability of making route adjustments was higher for drivers with longer trips, those who believe the information to be accurate, those with the most variable conditions, and better educated drivers. Furthermore, Northwestern University researchers found that commuters were most willing to divert when the alternate route was a familiar one, when the driver was under time pressures, when the congestion was a non-recurring rather than a chronic problem, and when the information was confirmed by another source, such as a radio. A study in Seattle found that non-changers appreciated receiving traffic information, even if their travel behavior was not influenced by it (*5*).

Another Seattle study found that an ATIS user is likely to be wealthier, more educated, younger, with a longer commute, and more conversant with technology than an average member of the general population (*6*). It was also found that interests in traveler information vary according to travel behavior, demographics, and factors related to attitude and interest in technology. This study identified between four and eight apparent user groups using the cluster method. It was found that likely ATIS user groups included mainly middle aged men (aged 35-55 years), high-income and high-mileage commuters, and those with a high level of comfort with technology. The study found that ATIS users generally have favorable opinions of the systems, while non-users are somewhat skeptical. It was also found that the ATIS benefits are often not enough to induce non-users to actively seek out information. Non-users generally accept traffic congestion as the norm, and are most likely to make decisions based on inertia and experience. This study recommended that more aggressive marketing designed to promote first-time use is the necessary first step in realizing the full benefits of ATIS (*6*).

2.2 Traveler Response

A San Francisco-based study identified the value of traveler information in terms of reduction of anxiety and frustration during congestion (*7*). Even when traveler information does not affect route choice, it can be used to confirm the present route choice. The decision making process for travelers occurs in four steps; recognizing the need for a decision based on apparent uncertainty, gathering information that contributes to perception, making the decision and acting accordingly, and evaluating the outcome of the decision. This four-step process involves identifying what information to access, where to obtain it, and how to use the information. Over time this experience creates an individual perception of the reliability and usefulness of each information source. Moreover, the perceptions and attitudes about the transportation network and the desirability of certain transportation modes influence the type of travel information sought. These perceptions and attitudes are also influenced by social, cultural, and

psychological factors. This is why knowledge of user demographics helps to successfully disseminate useful information.

A survey was conducted as a part of the study. Half of the people who do not use traveler information indicated that their travel routes are not specifically addressed by the reports (*7*). Roughly two-thirds of all travelers receive updated travel information in some form. Although radio was identified as the predominant source of travel information, more detailed information sources are attracting interest. Traffic information on the radio is sparse, inconsistent, and is generally limited to interstate routes. As enhanced information services become available, long freeway commuters and high-mileage drivers who previously relied on radio readily adjust to web or phone-based services. Web and phone information services are perceived to be more detailed, reliable, accurate, and superior to radio and television reports. Travelers expected that accessing information would help reduce trip time, assist in route planning, and reduce travel-related anxiety. Based on traveler information, motorists were generally more likely to modify their route choice as opposed to changing their departure time. Only a few respondents were found to change travel mode or cancel trips.

Another study determined the degree of alternative route selection from a rural freeway caused by a traffic-responsive VMS system in a work zone (*8*). The VMS displayed real-time estimates of travel time to the end of the work zone. Alternative route selection was measured through extensive volume counts on the freeway and on parallel arterial streets, both before and after implementation of the VMS system. Additionally, traffic volumes were measured at a variety of locations. Analysis of peak period data found that alternative route selection rates were between 7 percent and 10 percent of the freeway traffic, depending on the location and the day of the week (*8*).

The Virginia 511 telephone service evaluation surveyed residents, tourists, and Commercial Vehicle Operators (CVOs). Additionally, telephone and online surveys gathered data concerning ATIS' effect on travel behavior and the levels of satisfaction with ATIS (*9*). An online survey was posted on the 511Virginia.org website for six months. The telephone survey was marketed through an automated message on the global portion of the 511 message service informing users of the $10 incentive for participating in the survey. Respondents were asked to leave their name and phone number so they could be contacted later. The message was posted for two 20-day periods. The majority of respondents used 511 Virginia for emergency services, accidents/construction, and road conditions. The awareness survey also found that 19 percent of participants had heard of 511 Virginia. Of those who had heard of the 511 service, 8 percent had used the service. Of those who had heard of the 511 service, 32 percent were familiar with the services 511 Virginia provides (*9*).

The Washington State Department of Transportation (WSDOT) Traffic and Weather Information on the Web examined the user experience associated with retrieving traveler information, such as road conditions, traffic congestion, pass information, construction and weather, from the WSDOT Traffic and Weather site (*10*). The methodology involved an evaluation of web logs, a 1,700-participant online survey to develop an understanding of audience expectations and experience with WSDOT online ATIS, and a usability experiment involving 16 people. The research team reviewed computer-generated analysis of website server logs for the WSDOT Weather web portal to understand the typical visitor's usage patterns. After analyzing these data, the research team conducted detailed usability testing to investigate the use of the WSDOT website more thoroughly. The usability study and analysis of the WSDOT Traffic and Weather site revealed that participants found the WSDOT Traffic and Weather to be a valuable resource. The usability experiment tested participants' abilities to acquire specific information from the website, and included a labeling exercise and an interview about traveling. The study identified aspects of the website that people liked and disliked and recommended improvements on several issues. It was suggested that the website should be more user-friendly, allowing anyone to be able to access the information they need without training (*10*).

3. PUBLIC SURVEY

Public surveys were conducted randomly in the Salt Lake Valley which included personal interviews with 201 licensed drivers. Personal interviews are better than alternative methods (telephonic surveys, mail-out surveys, web-based surveys) in many ways. The researcher can interact directly with the respondent and ask followup questions. Moreover, the respondents find it easier because mainly opinions are sought and they can clarify their doubts (*11*). It was verified whether there were comparable samples from different demographic groups so that different viewpoints and unbiased opinions could be obtained. Respondents were also asked open-ended questions to obtain their views on and suggestions for ATIS.

3.1 Sample Size Calculation

The number of participants needed for statistically significant results is found by using the formula (*12*):

$$n = \frac{(4*Z^2*p*q)}{B^2} \qquad (2)$$

where:
n = sample size required to estimate p
Z = test statistic for a standard normal distribution.
p = either .5 (conservative value) or the proportion favoring ATIS in any previous research surveying the same population. Here p = 0.5 is considered to give the highest value of n.
q = (1.00 - p) the best estimate that can be made of the proportion opposed to ATIS
B = bound on the error of estimation or the confidence interval (two times the confidence interval for two tailed tests). It has been assumed that the actual value may be ±7% from the true value. Since it is a two tailed test, B=2*(±7%) = ±0.14

A 95% confidence level was assumed. Hence, Z = 1.96 and $Z^2 = 3.84$

$$n = \frac{(4*1.96^2*.5*.5)}{(.14)^2}$$
$$\approx 200$$

This sample size of 200 is statistically valid with an error margin of +/-7% with a 95% confidence level.

3.2 Questionnaire Design

A questionnaire is a tool that draws forth, collects and records information. Well-framed questionnaires start off a process of analysis and discovery in the respondent's mind (*13*). Questionnaire design, unlike sampling and data analysis, is not guided by rules. It is best guided by intuition about how to script a natural conversation between a researcher and a respondent. If a questionnaire is reliable, then the feedback from a population sample can be considered a reflection on the attitudes of the entire population. Furthermore, questionnaires are usually quick and much data can be gathered. The main disadvantage, however, is that a questionnaire tells only the respondent’s reaction as the respondent perceives the situation (*13*).

There is generally a tendency of respondents to try to please an interviewer by answering "yes" whenever possible. Moreover, there is a tendency to prefer answers listed earlier (or later) or to number the options serially. Most of these problems were overcome by rotation, that is, by changing the order in which the questions and options were presented to the respondents. Also, the questionnaire was pre-tested to detect misleading or confusing questions. The questions were kept simple and short. Complex symbols and terminology were avoided.

Mainly opinion-type questions were asked in the questionnaire. The filter question was that the respondents should have a valid driving license. The questions were then grouped by content, namely VMS, HAR, 511 phone system, CommuterLink website, use and opinions of ATIS, and questions about the respondent. The respondents were shown pictures of the four ATISs being evaluated. They were then asked if they were aware of that system. If the respondents were aware of the system, they were asked questions about whether they had used the system, how frequently they had used it and whether it was useful. The respondents were asked what UDOT could do to increase the effectiveness of each system. Moreover, the respondents were given the opportunity to provide comments about ATIS in general. If a respondent was not aware of a particular system, that respondent was interviewed about the other ATISs. If a respondent was not aware of any of the four ATISs, that respondent was screened out.

There were general questions on ATIS. The respondents were asked about the information they generally seek from ATIS (accidents/construction, road conditions, travel time, emergency services, alternative routes, others). The effect of ATIS on driving habits was also investigated. The respondents were asked about the changes they make as a result of using ATIS (cancel trip, change departure time, take a different route from the normal one, make minor changes to the normal route to avoid a congested area, change mode of transport, other changes, and no changes). Moreover, the respondents were asked about their level of agreement with a set of opinions on ATIS. Users' expectations of the performance and benefits of ATIS were collected.

The last section of the survey asked respondents to provide information about themselves. The demographic data that was collected helped to develop a profile of the region's commuters and to control potential differences among respondents. In other words, it enabled the comparison of responses based on demographic data such as gender, age, education level, and travel schedule flexibility. It was determined whether the degree of impact of traveler information is dependent on the driver's travel pattern flexibility, years of driving experience, and miles driven each week. The questionnaire is presented in Appendix A.

4. DATA ANALYSIS AND RESULTS

Responses of Salt Lake Valley commuters were obtained through public opinion surveys. The surveys complemented the findings from the analysis of UDOT logs for 511 and the CommuterLink website. The 201 respondents were randomly selected, mainly in the downtown malls in Salt Lake City and at the University of Utah. Results in which the respondents expressed their degrees of agreement to a particular view were presented as scores on a certain scale. The other results were expressed as percentages of those who responded "yes" or "no" to a particular question. The results were then analyzed.

4.1 Analysis of UDOT's logs for 511 and the CommuterLink website

UDOT's logs for 511 and the CommuterLink website were obtained from UDOT's Traffic Operations Center's monthly reports. It was found from the analysis that since July 2002, the 511 calls showed little increase in demand from April to September. However, 511 calls have grown markedly during winter from 2003 to 2005. The spike starts in October, peaks in December and January, and ends in March. This is because in winter, when the road conditions are not predictable, people actively seek out more information. Overall 511 use dropped from around 70,000 calls per month from November to February to about 20,000 calls per month during the rest of the year. There were as many as 140,000 511 calls in December 2003 when there was a severe snowstorm.

The CommuterLink website visitor sessions show an increasing trend from 2003 to 2005. The increase in website visitor sessions during winter is consistent with people seeking more pre-trip information during inclement weather conditions such as snowstorms. Overall CommuterLink website visitor sessions from 2003 to 2005 dropped from around 150,000 sessions per month from November to February to about 75,000 sessions per month during the rest of the year.

4.2 Public Survey Results

4.2.1 ATIS Awareness and Use

Figure 4.1 shows the level of awareness and use of each of the four ATISs evaluated. There is a higher level of awareness and use associated with en-route ATISs, such as VMS and HAR when compared to pre-trip ATISs, such as the 511 phone system and the CommuterLink website. This is probably because the en-route systems are visible to drivers as they travel and they do not have to actively seek them out. This also indicates that pre-trip ATISs should be popularized by various awareness and educational programs.

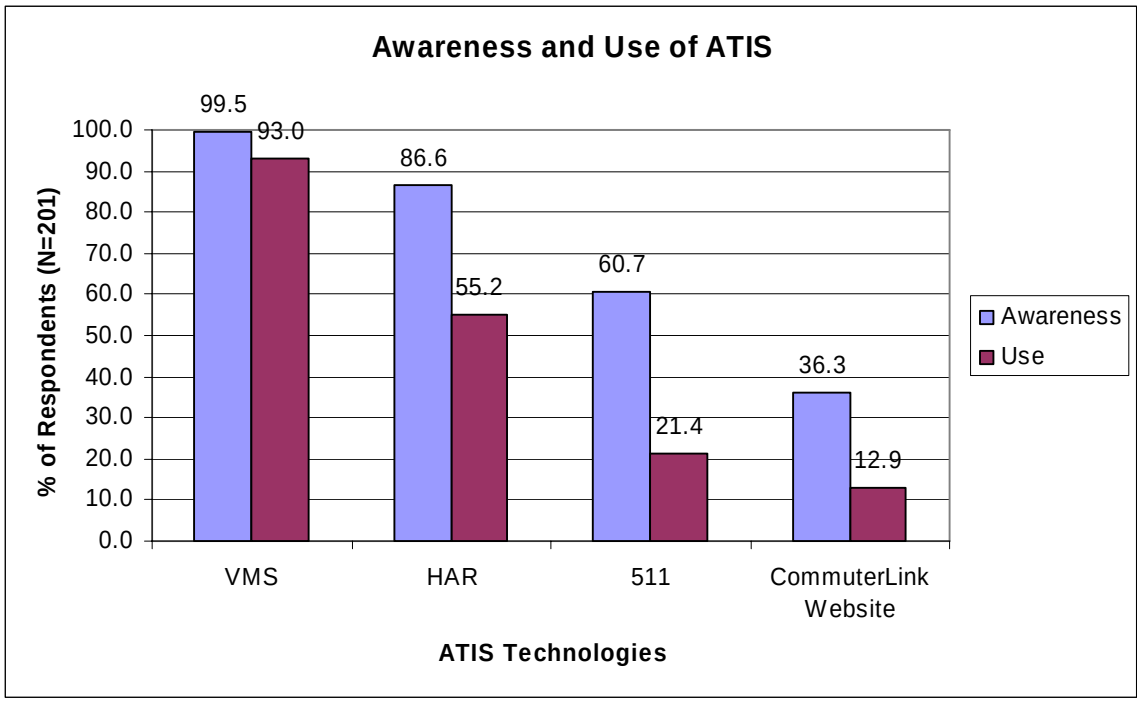

Figure 4.1: Awareness and Use of ATIS

Of the 200 survey respondents who have seen the VMS, 187 (93.5%) indicated that they have read the messages posted on VMS. Figure 4.2 shows the frequency of response to VMS, expressed in percentages. The majority of survey respondents indicated that they often or sometimes respond to weather, safety, or traffic alerts when they are posted on VMS. It should be noted that not all message types warrant a response; travel time messages are purely informational.

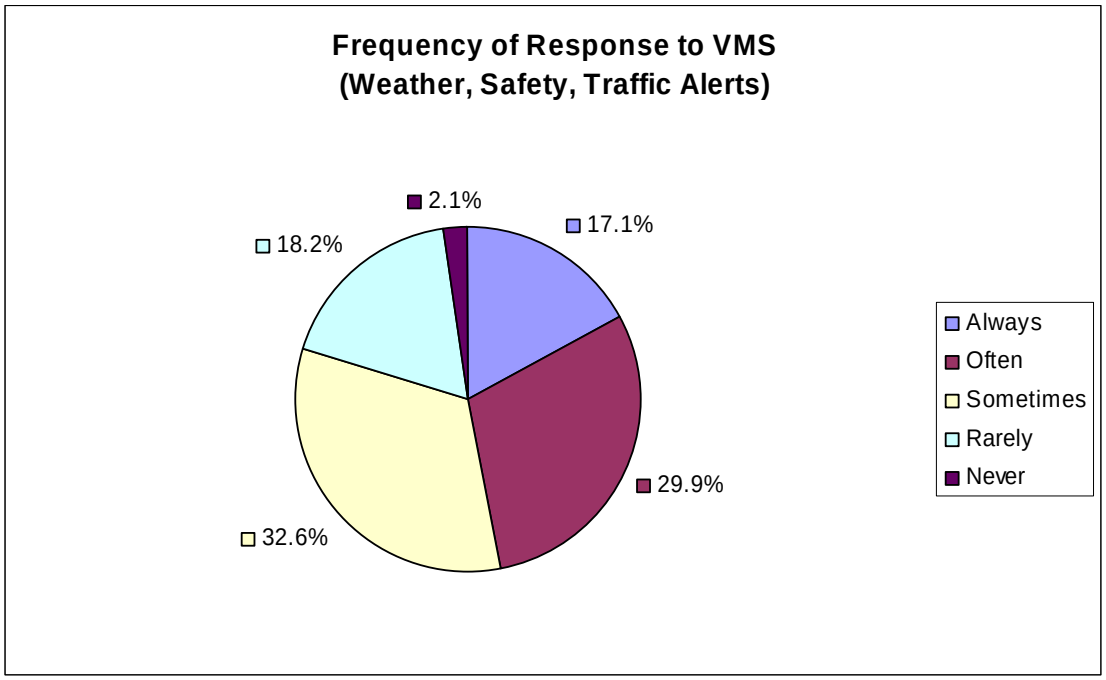

Figure 4.2: Frequency of Response to VMS

Figure 4.3 presents the frequency of response to activated HARs. Of the 174 survey respondents who were aware of HAR, 111 stated that they have used the system to obtain information. The results indicate that 71.1 percent of the respondents access the HAR systems "sometimes" or "rarely," suggesting that HAR is not a primary source of traveler information. Although the question specifically asked for response rates when flashers are activated, it is possible that many survey respondents associate the frequency of HAR use with the frequency that they encounter with an activated HAR station.

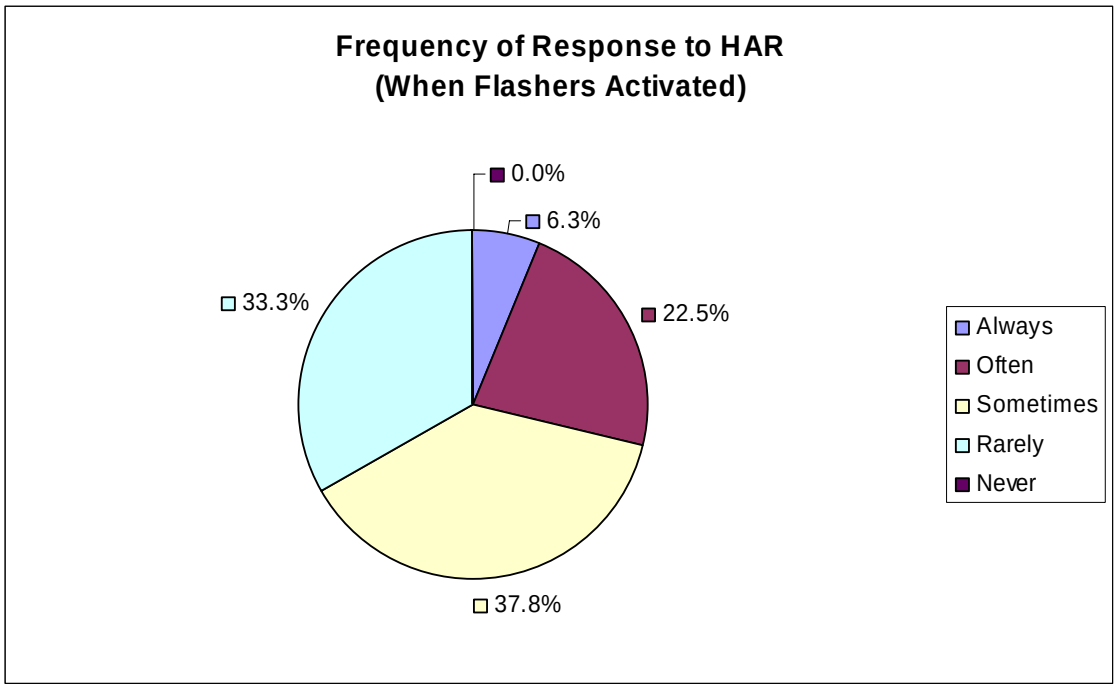

Figure 4.3: Frequency of Response to HAR (when flashers are activated)

Of the 122 survey respondents who were aware of the 511 phone service, 43 (35.2%) stated that they have accessed the information system. Figure 4.4 presents the frequency of 511 use. The survey results indicate that 58.1 percent of 511 users are most likely to access the system during periods of inclement weather or severe congestion. Another 34.9 percent rarely use it. Results from other studies indicate that drivers generally rely on their experience, subjective evaluation, and intuition while planning or making trips and usually do not seek information during normal conditions (*6*, *7*).

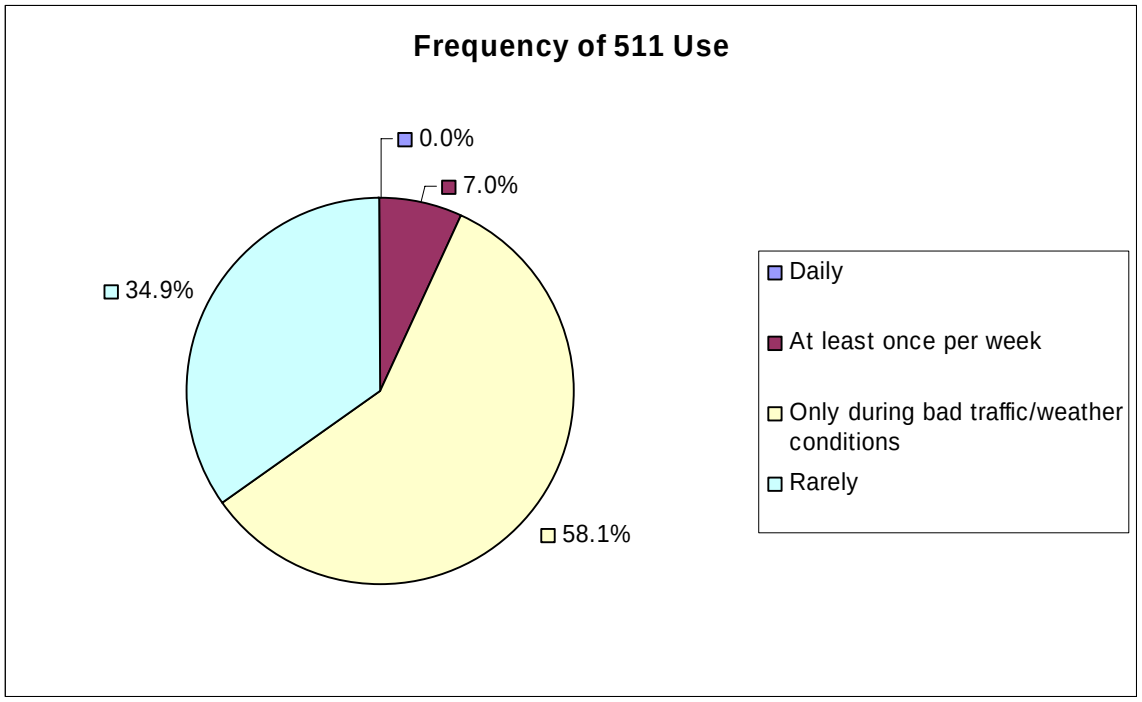

Figure 4.4: Frequency of 511 Use

Of the 73 survey respondents who were aware of the CommuterLink website, 26 (35.6%) stated that they had accessed the website. Figure 4.5 illustrates the frequency of the CommuterLink website use. Of those who had accessed the CommuterLink website, 69.2 percent stated that they do so rarely. Another 19.2 percent use it only during bad traffic or weather conditions and the remaining 11.5 percent use it at least once per week.

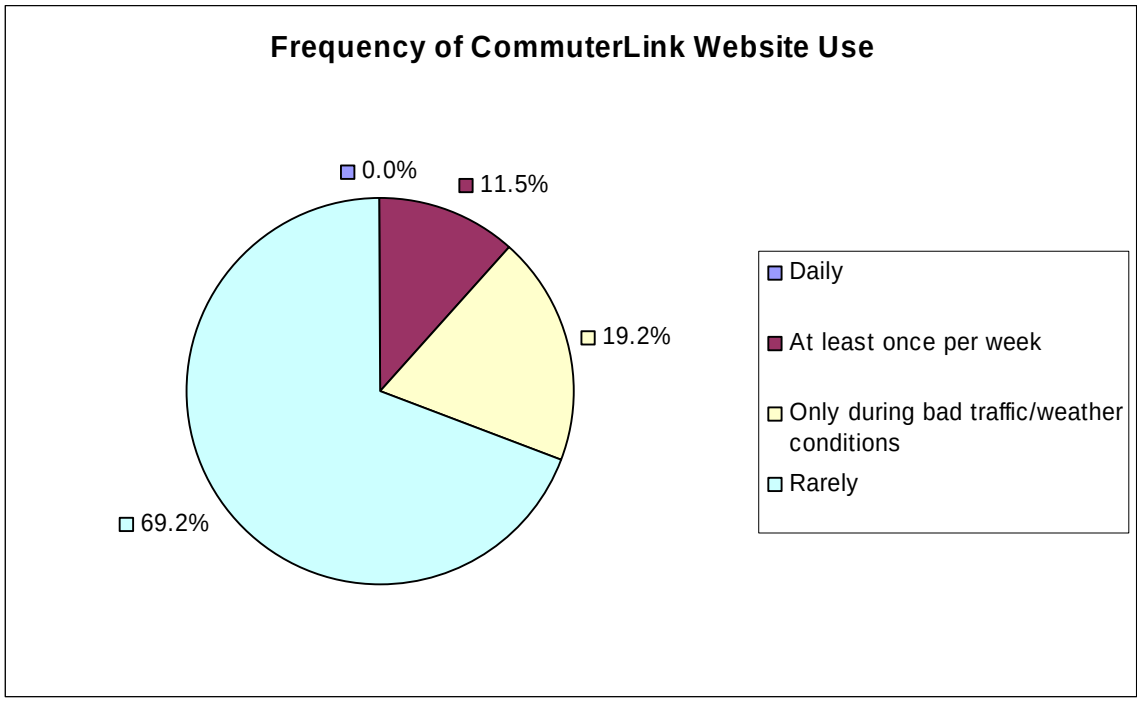

Figure 4.5: Frequency of the CommuterLink Website Use

4.2.2 ATIS Effect on Driving Habits

Figure 4.6 presents the effect of ATIS on driving habits. The survey results indicate that changing trip departure time and making minor changes to a pre-planned route are the most popular forms of trip changes that are made based on traveler information. This is probably because these two options do not considerably impact a trip. Making a major route change or canceling a trip were less appealing, while even fewer respondents would change their mode of transport. It should be noted that the respondents were allowed to select more than one option that applied to them. Only 4 percent of those interviewed said that they would not modify their travel at all on the basis of traveler information. This implies that most people make changes to their trips to some extent when it saves time.

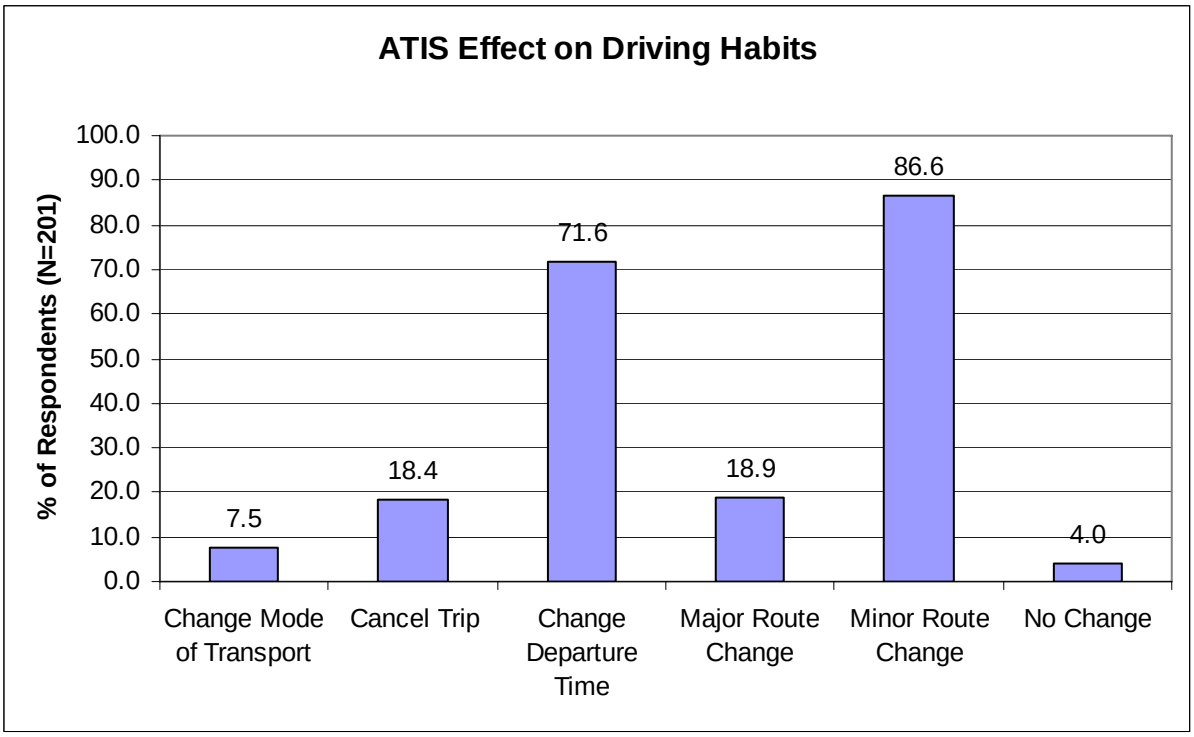

Figure 4.6: ATIS Effect on Driving Habits

4.2.3 ATIS Usefulness

Figure 4.7 illustrates the use and helpfulness of ATIS. The survey results indicate that nearly all of the respondents who have used HAR, 511, and the CommuterLink website have found them useful. This reflects the high quality of information UDOT is disseminating and implies that those who have accessed the system will likely access it again because they perceive ATIS to be helpful. It should be noted that the usefulness of VMS systems was evaluated separately because some of the VMS messages are informational.

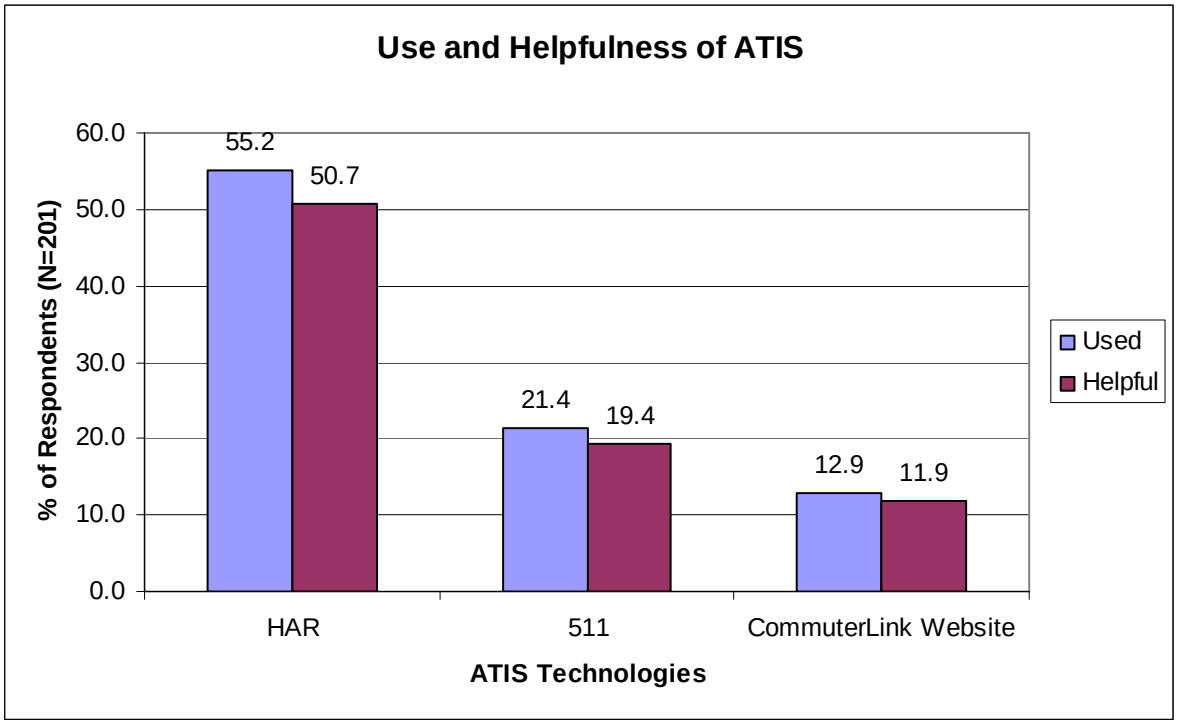

Figure 4.7: Use and Helpfulness of ATIS

The 187 respondents who had read VMS messages were asked about the type of information they seek from VMS. They were allowed to select multiple information types. Figure 4.8 presents the VMS information preferences. Information concerning weather and road conditions topped the list (82%), followed by travel time and delays (80%), amber alerts (67%), construction and maintenance activities (60%), and, finally, traffic incidents and safety-related warnings (51%).

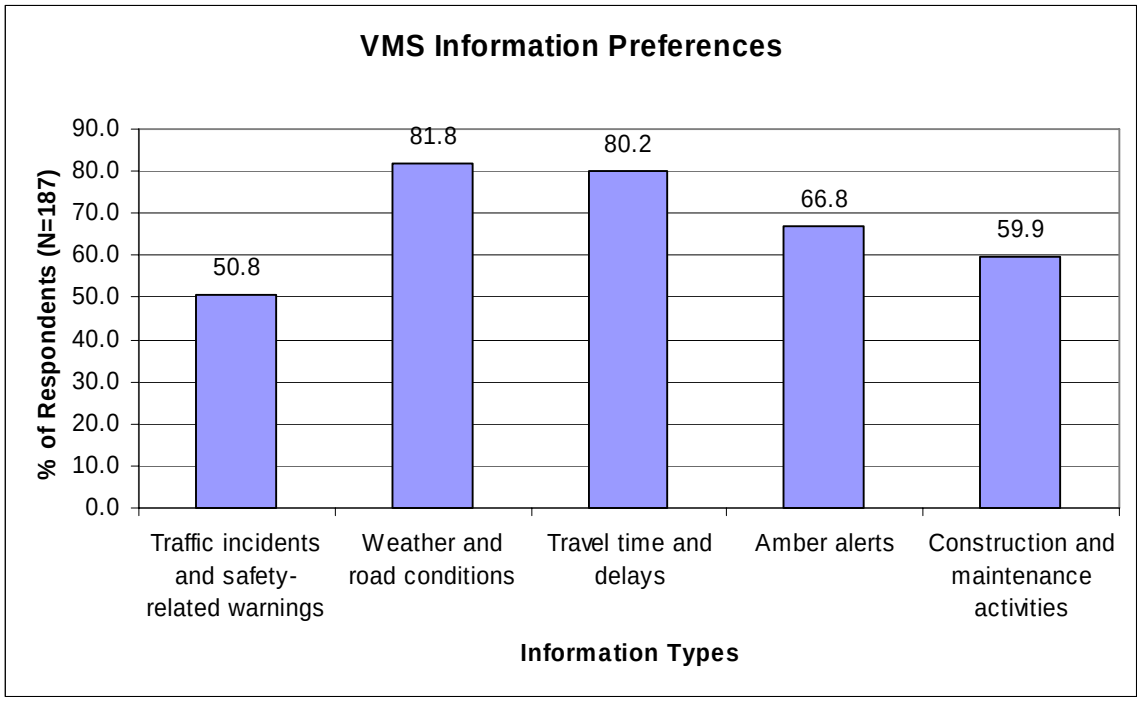

Figure 4.8: VMS Information Preferences

Figure 4.9 presents general ATIS information preferences. Most of the respondents use ATISs to get road condition information (86%), followed by information on travel time (65%), accidents or construction (64%), emergency services (46%), and alternate routes (39%).

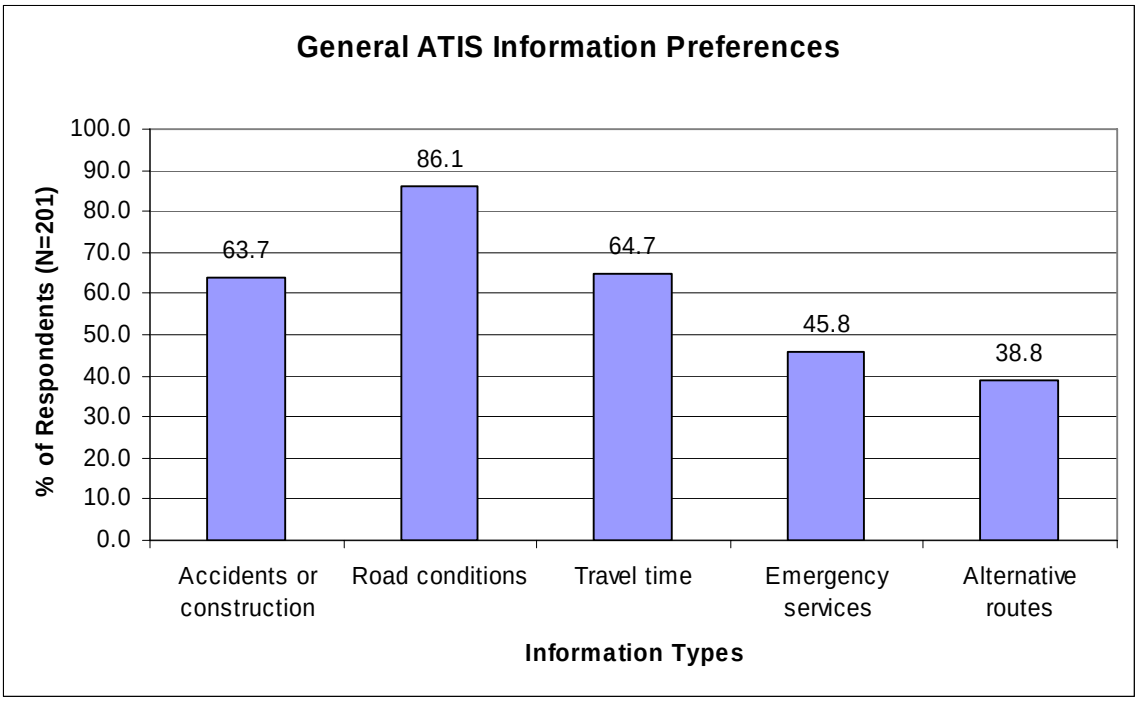

Figure 4.9: General ATIS Information Preferences

4.2.4 Opinions about ATIS

Figure 4.10 illustrates responses to the opinion "ATIS is unnecessary." 90.1 percent of survey respondents expressed various levels of disagreement to this statement. In the analysis, various levels of agreement and disagreement were assigned distinct values. The rating scale was from 1 to 7, where 1 meant "strongly agree" and 7 meant "strongly disagree." Using this scale, an overall score was determined for each opinion. A higher score (maximum possible overall score of 7) meant strong disagreement. The overall score determined for the opinion "ATIS is unnecessary" was 5.7, which implies disagreement.

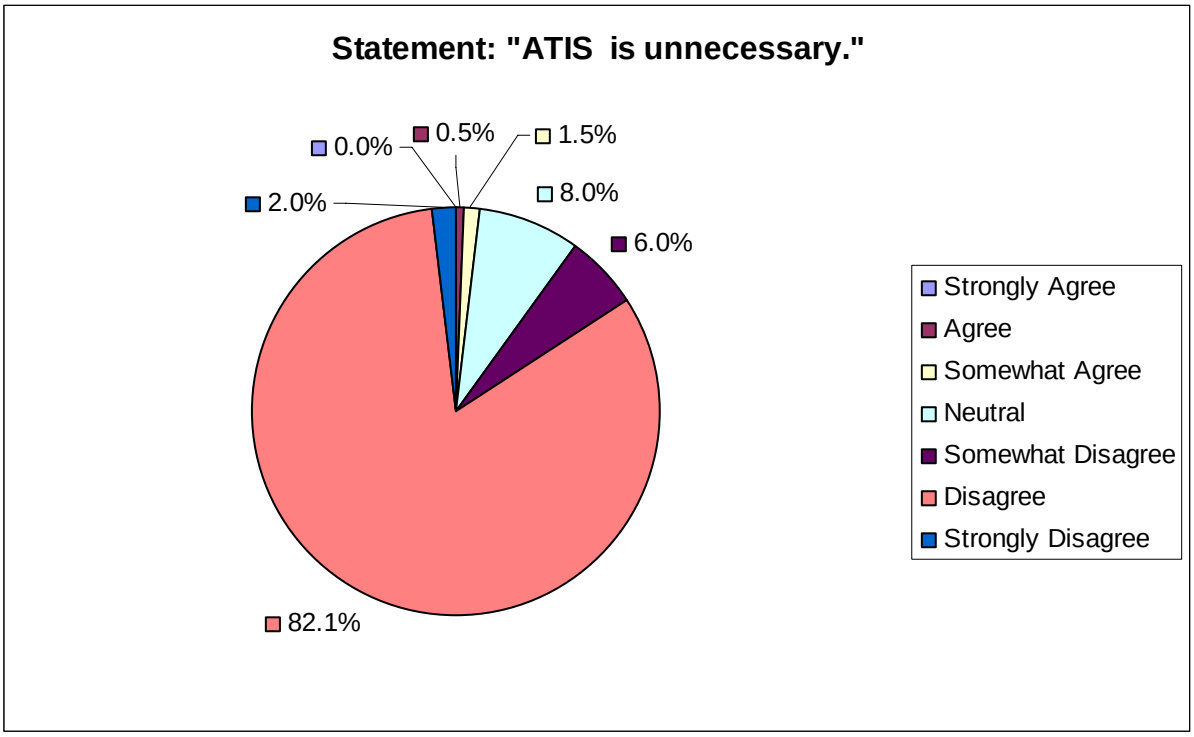

Figure 4.10: Response to "ATIS are unnecessary"

Figure 4.11 illustrates responses to the opinion "ATISs help reduce anxiety, stress, and surprise because travelers are warned beforehand." About 94 percent of survey respondents generally agree that ATISs reduce anxiety, stress, and surprises associated with driving. This means that the majority of respondents value information about driving conditions. The overall score determined for this opinion was 2.4, which implies agreement.

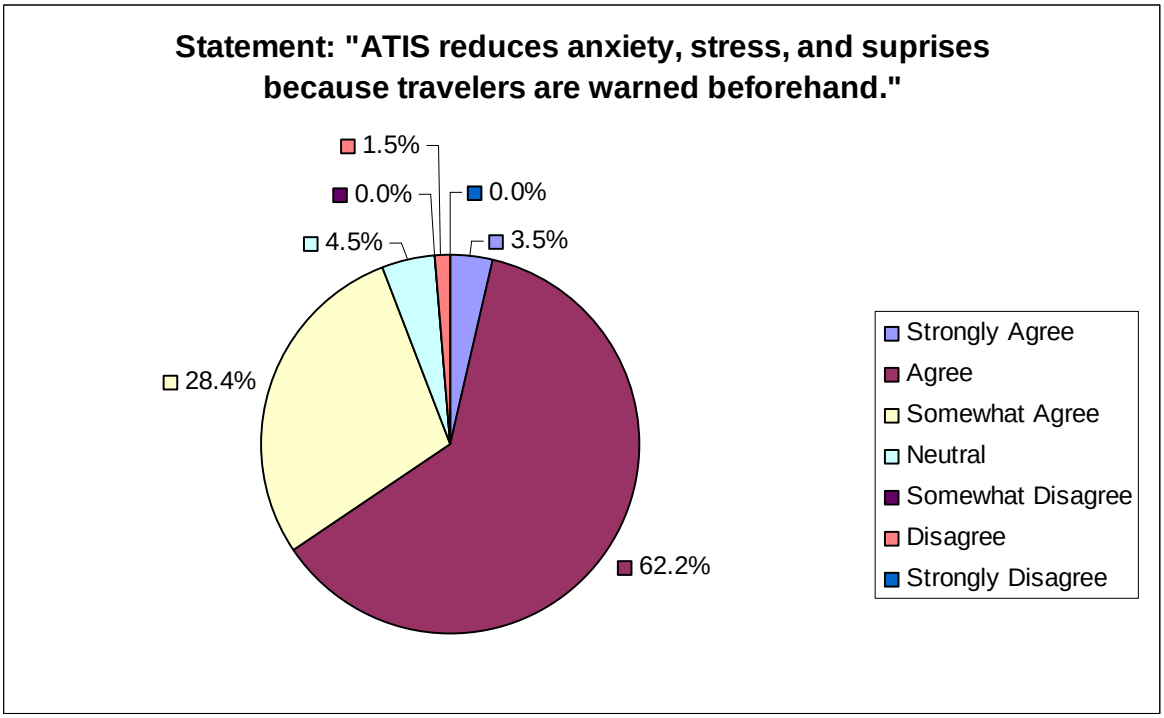

Figure 4.11: Response to "ATIS reduce anxiety, stress, and surprise"

Figure 4.12 illustrates responses to the opinion “ATIS is a reliable and useful service.” Approximately 92 percent of those surveyed agreed with the statement. This implies that, although not everyone uses ATIS, most people feel that ATIS is a worthwhile investment. The overall score determined for this opinion was 2.3, which implies agreement.

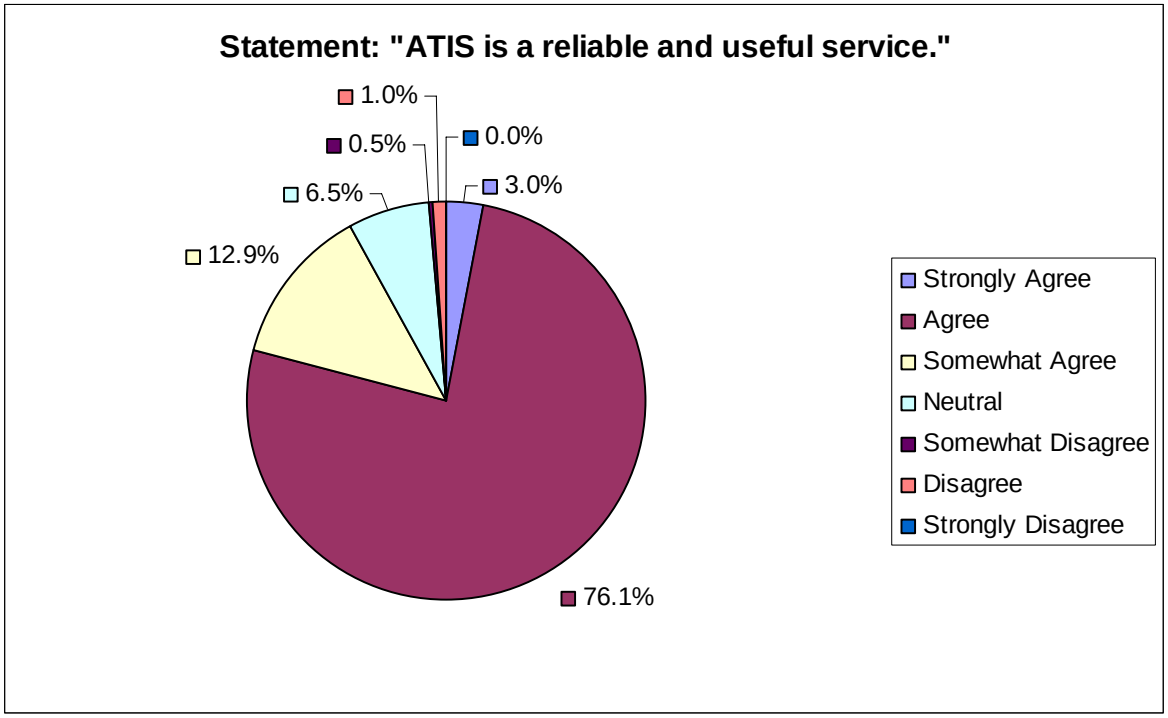

Figure 4.12: Response to “ATIS is reliable and useful”

Figure 4.13 illustrates responses to the opinion “ATISs help reduce delay by making us more aware of reliable travel routes.” About 94 percent of those surveyed agreed with this statement. The overall score determined for this opinion was 2.4, which implies agreement.

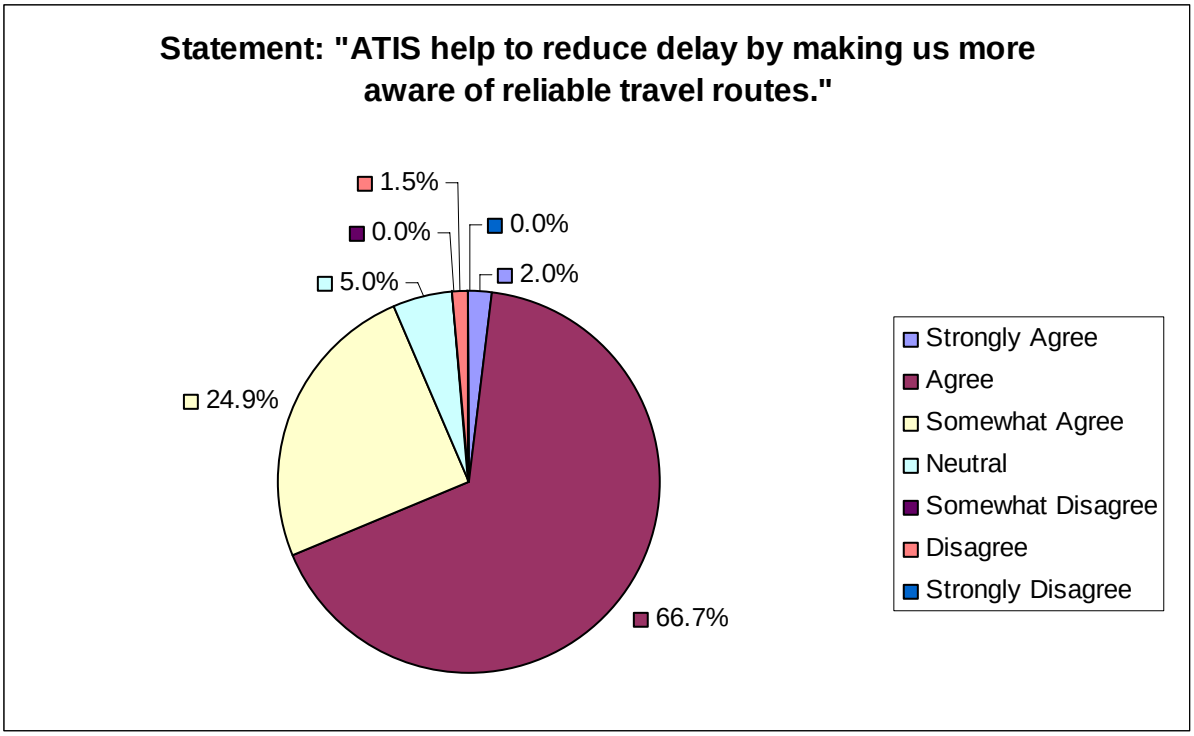

Figure 4.13: Response to “ATISs help reduce delay”

4.2.5 Demographics

Figure 4.14 shows that there were more male respondents (55%) than female respondents (45%) in the random public survey.

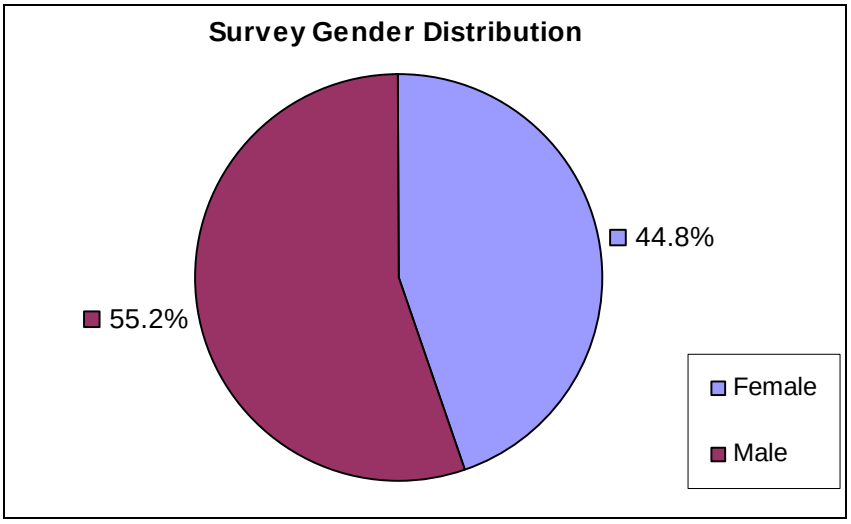

Figure 4.14: Gender Distribution of Respondents

Figure 4.15 presents the split of respondent age into various age groups. There were representatives from all age groups. The dominant age group was 26-35 years (32%), followed by 18-25 years (24%), 36-45 years (17%), 46-55 years (16%), 56-65 years (10%) and over 65 years (0.5%). The reason for about 90% of the respondents being between the ages of 18 and 55 is that people who belong to these groups are more mobile because they own vehicles and drive to school, work, business etc.

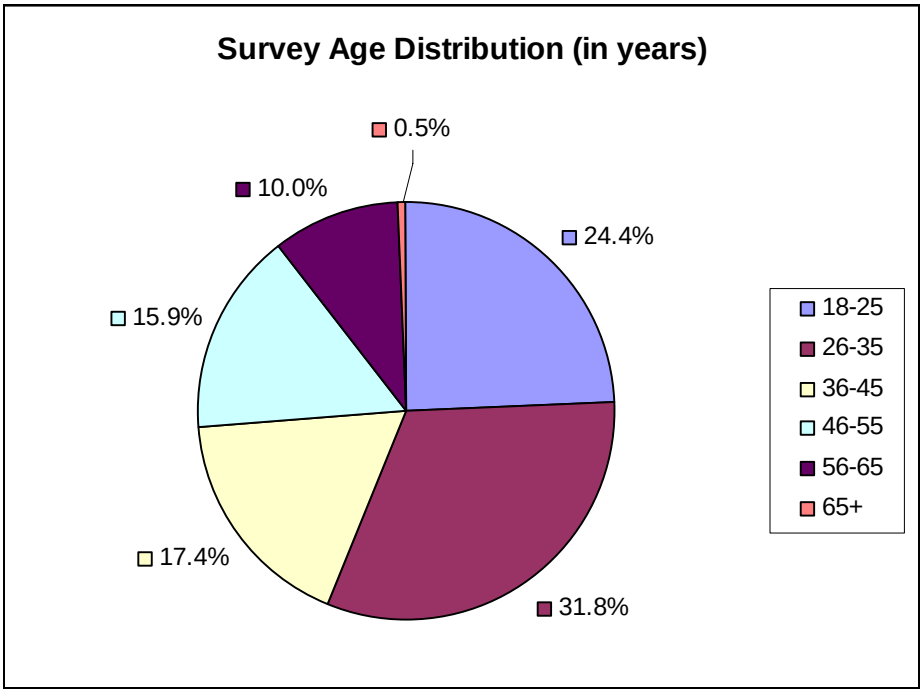

Figure 4.15: Age Distribution of Respondents

Figure 4.16 shows the split of marital status. The majority of respondents were married (59%).

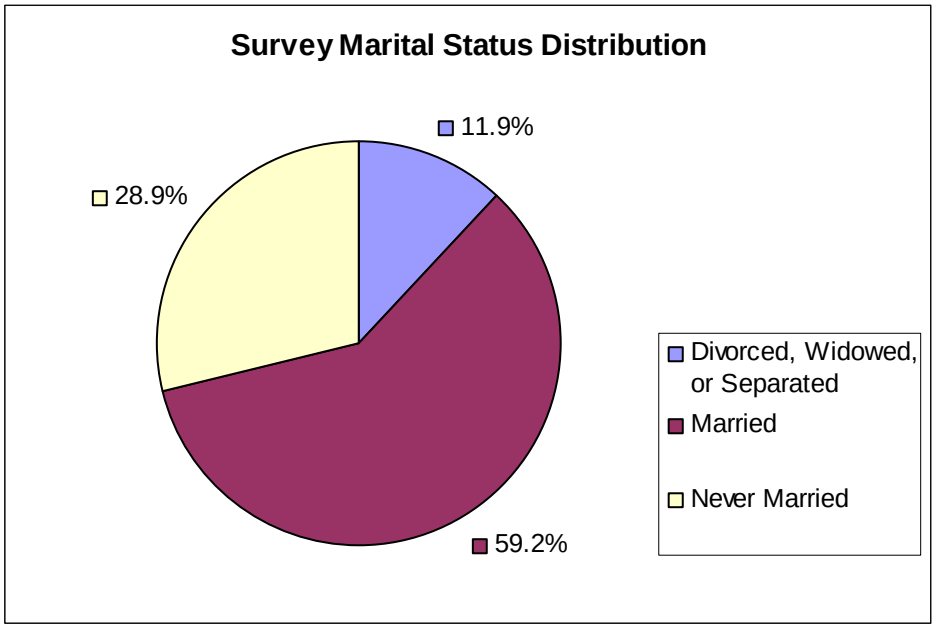

Figure 4.16: Marital Status Distribution of Respondents

Figure 4.17 shows that most of the respondents had a college education (54%), followed by those who finished high school/diploma (32%), and those with a post-graduate degree (13%). In other words, the majority of the respondents (68%) were well-educated with either a college or a post-graduate degree.

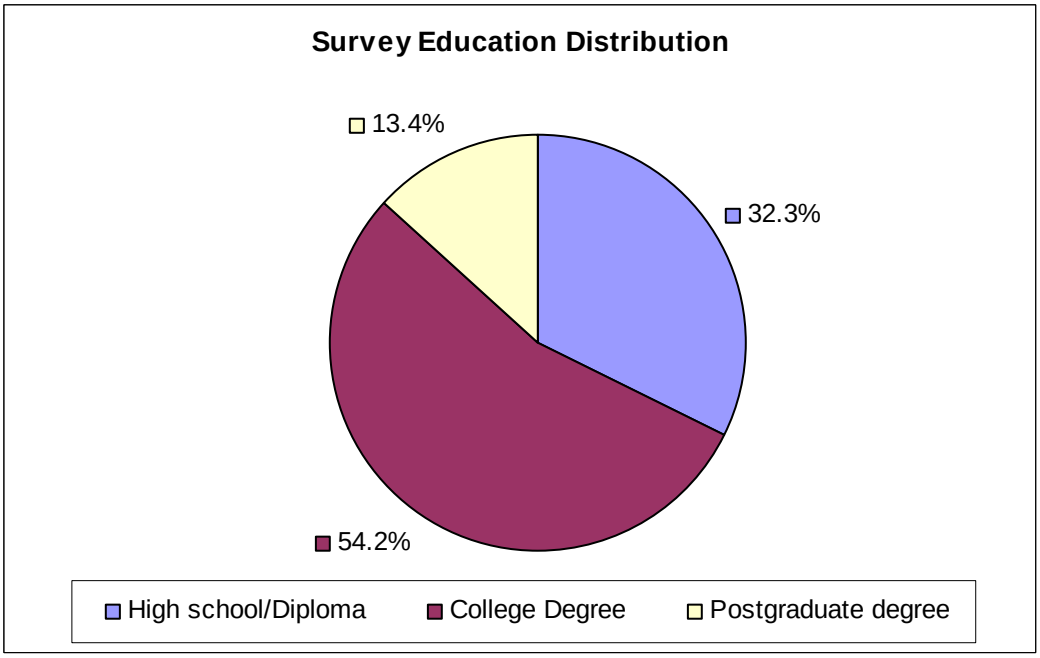

Figure 4.17: Education Distribution of Respondents

Figure 4.18 shows that most of the respondents had less than 15 years of driving experience (68%) while the remaining 32 percent had more than 15 years of driving experience.

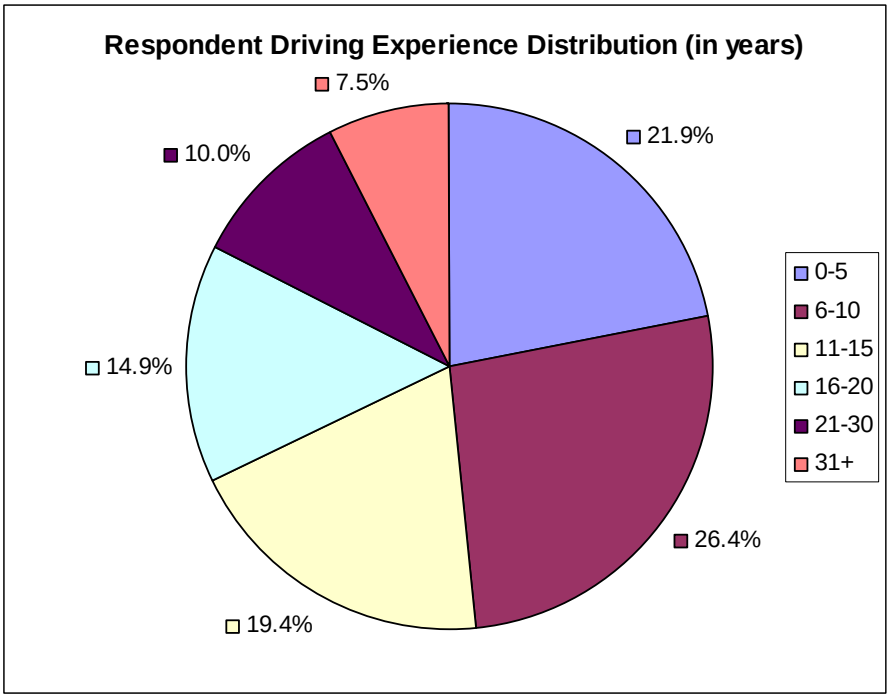

Figure 4.18: Driving Experience Distribution of Respondents

Figure 4.19 illustrates the travel schedule flexibility of the respondents. About 60 percent of the respondents had a flexible travel schedule, whereas the remaining 40 percent had an inflexible travel schedule.

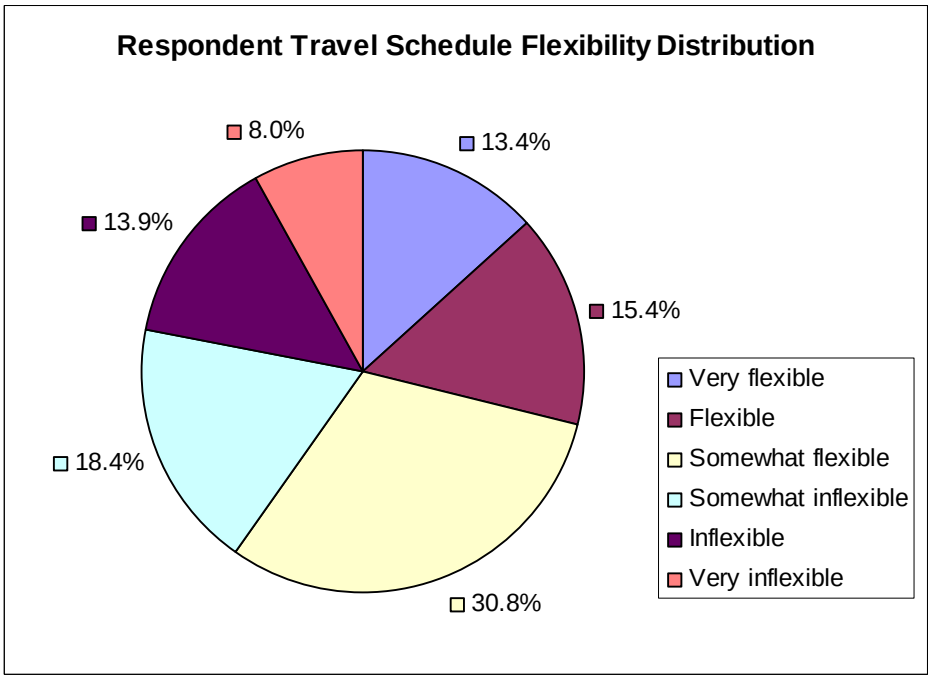

Figure 4.19: Travel Schedule Flexibility Distribution of Respondents

Figure 4.20 shows the weekly driving distribution of the various respondents. About 50% of the respondents drive less than 100 miles per week, whereas 34% of the respondents drive more than 100 miles per week. Some of the respondents (16%) could not specify the category to which they belonged.

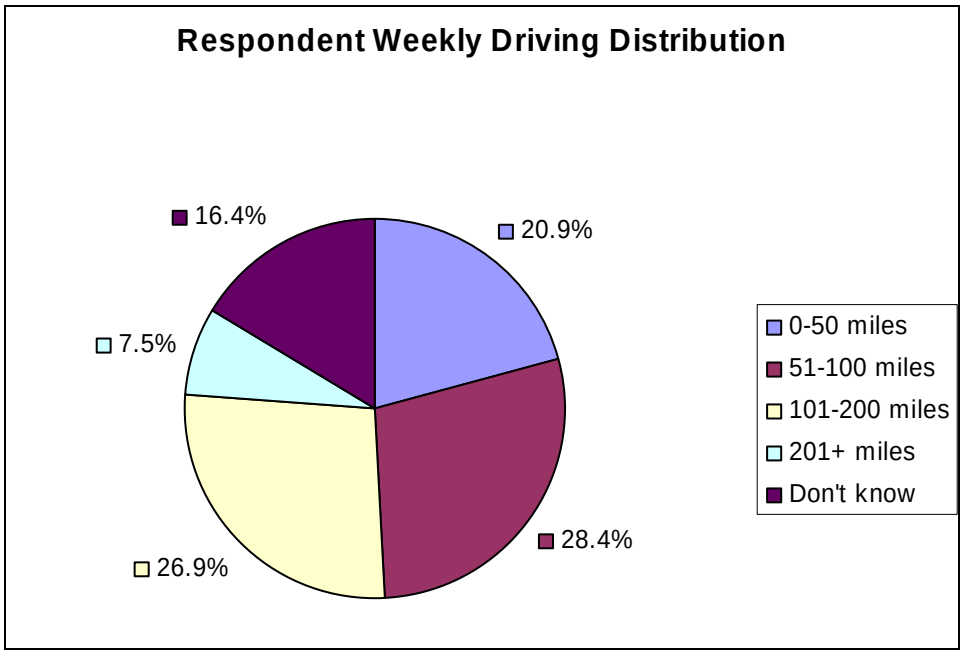

Figure 4.20: Weekly Driving Distribution of Respondents

4.2.6 Demographic Trends and ATIS Use

The percentage of survey respondents who were aware of all the ATISs (VMS, HAR, 511, and the CommuterLink website) have been termed as "All System Awareness." Of the 201 surveyed respondents, 58 (28.9%) were aware of all four systems. Of the 58 survey respondents who were aware of all ATISs, 24 (41.4%) were 36-55 years old. Of those 24 respondents:

- 23 (95.8%) had flexible travel schedules (flexible, somewhat flexible, or very flexible)
- 22 (91.7%) had a college degree or a postgraduate degree
- 22 (91.7%) were married
- 21(87.5%) were males
- 20 (83.3%) had more than 15 years driving experience
- 18 (75%) drove more than 100 miles per week

Combining these data, 36.2% of "All Systems Awareness" respondents were males between 36-55 years of age. Thus the profile of a potential market for ATIS technologies is an educated middle-aged man with a flexible schedule who drives at least 100 miles per week.

The percentage of survey respondents who have used all of the ATISs (VMS, HAR, 511, and the CommuterLink website) have been termed as "All System Users." Of the 201 surveyed respondents, 8 respondents (4.0%) had used all systems. Of those 8 respondents:

- 8 (100%) had a college degree or post-graduate degree
- 7 (87.5%) had flexible travel schedules (flexible, somewhat flexible, or very flexible)
- 7 (87.5%) were males
- 5 (62.5%) were 26-35 years old

Thus, educated young men with flexible schedules are the primary ATIS users. Education is associated with a higher level of comfort with technology as well as a higher value of time. The ability to modify trip planning using ATIS is directly related to the flexibility of travel schedules. The findings from the public survey in the Salt Lake Valley are consistent with the findings from studies in other parts of North America.

About 63 percent of the "All System Users" (those that have used all four ATISs) were between the ages 26 and 35, whereas 41.4 percent of "All System Awareness" respondents were between the ages 36 and 55. The lower use of ATISs by the middle-aged generation may be because they do not fully realize the benefits of ATISs. Based on this, it can be concluded that the two age groups need to be addressed differently. The 36-55 age group, with high ATIS awareness, needs to be educated about the uses and benefits of the four ATISs. Thus, marketing and educational programs might lead to increased ATIS awareness (especially the pre-trip ATISs, namely, the 511 phone system and the CommuterLink website) and use. The respondents' comments have been presented in Appendix B.

5. CONCLUSIONS AND FUTURE WORK

Of the 201 surveyed respondents, 58 (28.9%) were aware of all four systems. An educated middle-aged man with a flexible schedule, who drives at least 100 miles per week, is most likely to be aware of all four ATISs. Of the 201 surveyed respondents, 8 respondents (4.0%) had used all four ATISs. This indicates that there is a need to increase ATIS awareness and use. It was found that educated young men with flexible schedules are the primary ATIS users. Among those who used the ATIS services, users' satisfaction levels were consistently high and the users believed the information to be useful. There was a higher level of awareness and use associated with en-route ATISs, such as VMS and HAR when compared to pre-trip ATISs, such as the 511 phone system and the CommuterLink website. This indicates that pre-trip ATISs should be popularized by various outreach and educational programs to increase ATIS awareness and use. As acceptance of technology grows, the use of cell phones and web-based traveler information services is likely to increase.

Based on the findings from the public survey and from the analysis of UDOT's 511 and the CommuterLink website logs, it is apparent that ATIS use is increasing. The peak in the use of 511 and the CommuterLink website are associated with inclement weather conditions and holidays or special events that generate an increased number of trips. The findings from the ATIS public survey in the Salt Lake Valley are consistent with the findings from studies in other parts of North America.

Previous studies in other places have evaluated the effectiveness of ATISs based on diversion rates, change in mean speeds, influence on driver behavior, and driver perception of ATIS usefulness. Within the scale and scope of this study it was not possible to directly evaluate all but the latter of the measures of effectiveness. However, this study can be continued to accurately and directly measure ATIS performance using VISUM-online. VISUM-online is a tool to directly measure travelers' responses to ATIS messages. VISUM-online combines a transportation planning package, VISUM, with a series of state-of-the-art traffic flow models and database management tools to manage traffic in real time. The model uses historical and current traffic data to generate and display existing traffic conditions. The estimation of current and future traffic conditions typically relies on historical Origin-Destination (O-D) matrices and a statistical analysis of real-time traffic counts. A technique called Path-Flow Estimation is integrated within VISUM-online to update historical O-D matrices using current traffic counts and assignment modeling. The impedance of links is increased or reduced in a continuous, iterative process, as required by the deviations between assigned and counted volumes. The estimation may differ from the given O-D matrix within a scaleable range, in order to allow for a better solution for the overall network. Thus, tolerances may be applied to the traffic flow data obtained from UDOT to get an average value of vehicle volume. The benefit of this approach is in the integration of off-line planning information and information derived from the physics of traffic flow, in addition to the detector data. This system, when calibrated and fully deployed, will make ATIS evaluations more valuable.

6. RECOMMENDATIONS

Recommendations have been made based on the shortcomings identified from the respondents' answers and comments. Recommendations to improve ATIS in general have been grouped in "General," whereas the system-specific recommendations have been mentioned below each system name.

General:

1. Marketing and outreach programs should be focused on awareness as well as education.
2. Messages on one system need to be supplemented with messages on the other systems.
3. Commuter groups, tourists, and commercial vehicle drivers (especially on I-15) need to be better served.
4. Tourist awareness of the ATIS may be increased by focusing marketing on the top tourist origins and the top tourist destinations.
5. Implementing new changes during the winter should be avoided, as it corresponds to the highest use and demand for the ATIS. Changes may be introduced in April and September.

VMS:

1. More destinations may be included on travel time messages.
2. Maintenance frequency needs to be increased on message boards to minimize non-functioning units.
3. Travel time messages may also include HOV lane travel time savings (based on either real-time or historical data).

HAR:

1. The coverage range needs to be improved.
2. A broader-range radio station that frequently broadcasts traffic information during peak periods needs to be implemented. The current VMS and HAR locations in the Salt Lake Valley are presented in Appendix C.

511:

1. 511 may be advertised on weather forecasting, tourism, and UDOT's websites.
2. 511 should be differentiated from other n11 services through enhanced brand recognition.
3. A permanent feedback option on the phone system should be developed and monitored.
4. More usability research needs to be done regarding how to make 511 easier to navigate.
5. The phone tree structure and information format should provide more information on multiple alternate routes. More research should be done on travel information that callers might need if they do change their plans based on information they hear on 511.
6. Additional voice detection during processing needs to be prevented. Background noise has been found to interfere and interrupt information processing, resulting in repetitive requests that could frustrate users. Background noise is very common while driving and should not inhibit 511's effectiveness.

CommuterLink Website:

1. The CommuterLink website should be advertised on weather forecasting and tourism websites.
2. The direction of traffic on all CommuterLink camera images needs to be specified.
3. More Closed Circuit Television (CCTV) cameras need to be provided.
4. Big and Little Cottonwood Canyons' VMS messages should be made available online.
5. Links to improved email updates may be made on the CommuterLink website.

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APPENDIX A: ATIS PUBLIC SURVEY

We are conducting surveys as part of an evaluation of traveler information systems in Utah. The information you share will remain confidential.

Do you have a valid driver's license? Yes ____No____
If Yes, continue with the survey.
If No, thank you for your interest but the survey only applies to those who have a valid driver's license.

Variable Message Signs

Variable Message Signs are roadside boards that display text messages.

Have you ever seen these? Yes ____No____
If Yes, go to the next question.
If No, go to the next system.

Do you read them? Yes ___No___
If Yes, go to the next question.
If No, go to the next system.

How frequently do you generally respond to weather, safety, or traffic alerts when they are posted on VMS? Always ___ Often ___ Sometimes ___ Rarely ___ Never ___

Which of the following VMS message types do you find useful? (*Check all that apply*)
a. Traffic incidents and safety-related warnings ____
b. Weather and road conditions ____
c. Travel time and delays ____
d. Amber alerts ____
e. Construction and maintenance activities____

Could the Variable Message Signs be made more effective? Yes ____No____
If No, go to the next system.
If Yes, how?
_____
_____
_____

Highway Advisory Radio

Highway Advisory Radio is an AM radio station that broadcasts local traffic information on 1530 AM.

Did you know that the Highway Advisory Radio broadcasts traffic information? Yes ____No____
If Yes, go to the next question.
If No, go to the next system.

Have you ever used it? Yes ___No___
If No, go to the next system.
If Yes, does it help you? Yes ___No___

How frequently do you use it when the lights are flashing?
Always ___ Often ___ Sometimes ___ Rarely ___ Never ___

Could the Highway Advisory Radio system be made more effective? Yes ____No____
If No, go to the next system.
If Yes, how?
_____

_____

_____

511 toll-free phone service

511 is a toll-free phone service that tells you about traffic.

Did you know about it? Yes ____No____
If Yes, go to the next question.
If No, go to the next system.

Have you ever used it? Yes ___No___
If No, go to the next system.
If Yes, does it help you? Yes ___No___

How frequently do you use it?
Daily ___ At least once a week ___ Only during bad traffic/weather conditions ___ Rarely ___

Could the 511 phone system be made more effective? Yes ____No____
If No, go to the next system.
If Yes, how?
_____

_____

_____

CommuterLink Website (www.commuterlink.utah.gov)

The CommuterLink website is a web-based information service that provides pre-trip information concerning construction activities, road conditions, and incident location.

Did you know about it? Yes ____No____
If Yes, go to the next question.
If No, go to the next page.

Have you ever visited the website? Yes ____No____
If No, go to the next page.
If Yes, did it help you? Yes ____No____

How frequently do you use it?
Daily ___ At least once a week ___ Only during bad traffic/weather conditions ___ Rarely ___

Could the CommuterLink website be made more effective? Yes ____No____
If No, go to the next system.
If Yes, how?
_____
_____
_____

Section A: Use and Opinions

1. What information do you generally seek from these systems? (*Check all that apply)*
   a. Accidents/construction ____
   b. Road conditions ____
   c. Travel time ____
   d. Emergency services ____
   e. Alternative routes ____
   f. Others (Please Specify) _____

2. What changes do you make to your trip as a result of using these systems? (*Check all that apply*)
   a. Cancel your trip____
   b. Change your departure time____
   c. Take a completely different route from your normal one____
   d. Make minor changes to your normal route to avoid a congested area____
   e. Change your mode of transport____
   f. Other changes (Please specify) _____
   g. None of the above____

3. Please rate the following opinions as follows: strongly disagree, disagree, somewhat disagree, neutral, somewhat agree, agree, or strongly agree.

Advanced Traveler Information Systems:
   a. Reduce anxiety, stress, and surprises because travelers are warned beforehand. ____
   b. Help reduce delay by making us aware of reliable travel routes. ____
   c. Are a reliable and useful service. ____
   d. Are unnecessary. ____

Section B: About Yourself

4. Gender: Male ___ Female ___

5. Your age (in years): 18-25___26-35 ___ 36-45 ___ 46-55 ___56-65 ___ 66-75___76-85___86+ ___

6. Your marital status: Never Married____ Married ____Divorced/Widowed/Separated ____

7. Your highest level of education:
   Did not finish high school____High school/Diploma____College degree____Post graduate degree____

8. Your years of driving experience: 0-5___6-10 ___ 11-15 ___ 16-20 ___21-30 ___ 31+ ___

9. How would you rate your travel schedule flexibility?
   Very Flexible___Flexible___Somewhat Flexible___Somewhat Inflexible___Inflexible___
   Very Inflexible__

10. Approximately how far do you drive each week?
    0-50 miles ____51-100 miles ____101-200 miles ____201+ miles ____Don't Know ____

11. Comments/Suggestions:

_____

_____

Thank you for taking time to complete this survey!

APPENDIX B : RESPONDENTS' COMMENTS

Comments on VMS:

1. Additional public education/awareness.
2. Current, up-to-date messages.
3. Helps to know about road conditions and useful for safety but could more broadly be applied for weather conditions and how safe are roads ahead for driving.
4. I don't know if this really relates to how effective the signs are, but I would like to see local time and temperature displayed.
5. Improved advanced notice would give more time to respond.
6. Inaccurate travel times. They are the same no matter what the road conditions are.
7. Increased weather related messages.
8. It can save time and useful so should be more effective and accurate.
9. It would be nice if they were color-coded to differentiate between travel time verses incidents.
10. Make it more frequently updated.
11. Post the time of last update.
12. Put messages up prior to construction.
13. Reminding the speed limit; urging carpooling.
14. Should have signposts leading to the VMS because it props up suddenly.
15. The only thing I have noticed is they tend to slow traffic down because people need to read them! I don't know a way around this but it is interesting. Is there some study on size and message length vs. the time it takes to read them?
16. They are usually hard to see because they are dirty, they have lights out, they are not big enough so it's hard to read the complete message. They usually don't provide an adequate detour in time.
17. They should post things like "Do not slow down to read this sign."
18. Reminding the speed limit; urging carpooling.

Comments on HAR:

1. Additional public education/awareness
2. Could give more information on the road conditions and bad driving conditions.
3. Effectiveness could be improved with increased accuracy.
4. Good for alerts so should be more effective.
5. Is very dull, the information could be presented in an interesting way.
6. More of them.
7. More of them.
8. Put it on FM and Weatherband stations.
9. Should be more accurate.

Comments on 511:

1. Advertise it more. This is the first time I've heard about it.
2. It has a complicated menu system.
3. It has a confusing format.
4. More information on weather related road conditions.
5. Takes a lot of time to take out the relevant information.

Comments on the CommuterLink Website:

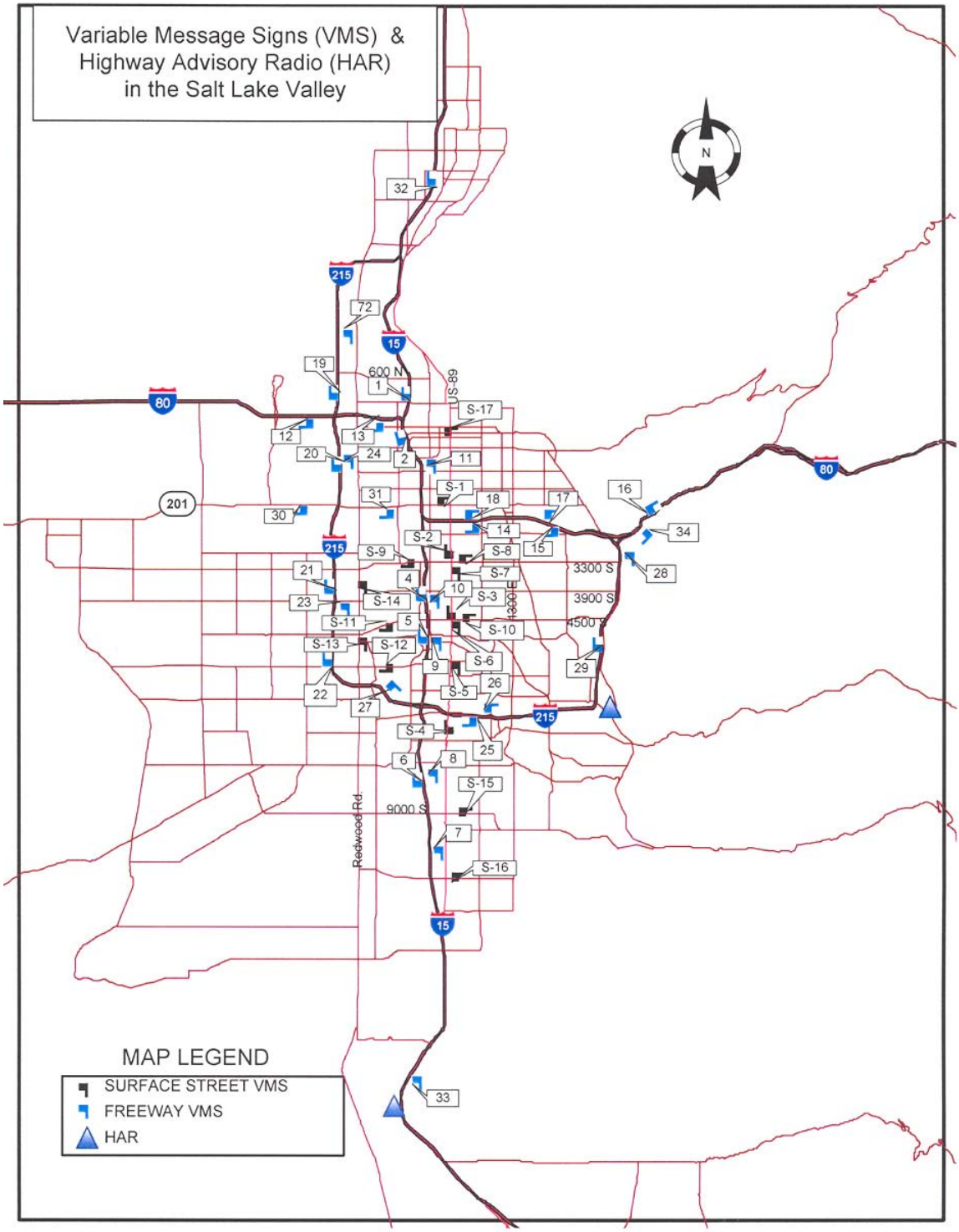
1. Faster uploads and quicker posting of traffic incidents.
2. Improved email updates.
3. Make it less cluttered; better images, especially the road maps, better cameras to capture traffic flows; show overall valley traffic patterns in a simulated graphic.
4. Should be more user-friendly.

General Comments at the End of Survey:

1. (ATIS are) great for safety.
2. (ATIS) can save time so it's really good.
3. (ATIS) help for safe travel and are good.
4. 511 not at all popular!
5. All [ATIS technologies] should be made more popular.
6. Could be made more popular, especially the website and phone service.
7. Could be more sociable, especially for young people.
8. Didn't know about most of these [systems]. Might be a good idea to popularize them.
9. Didn't know some of the things. You guys (are) doing a great job.
10. Fine
11. Fine.
12. Good job! Keep it up.
13. Good job, but very few people know about it.
14. Good work, keep it up!
15. Good work. More technology should be used.
16. Good! Very Informative.
17. Good, but should be made more popular through publicity.
18. Good, did not know of some of things, should be more advertised.
19. Great!
20. Great.
21. Helps a lot, doing a great job!
22. I didn't even know about the CommuterLink website.
23. I didn't know about the website until now.
24. If I'm going to make a trip, I'll do it no matter what. But sometimes it's nice to know if it's going to take longer than usual.
25. Improve awareness.
26. It's all useful and people should use it [ATIS] more and more.
27. It's fine.
28. It's great service.
29. It's great…helpful for safe traveling.
30. It's outstanding…everybody should use it.
31. It's really helpful.
32. It's useful and helpful.
33. Make a radio station like KRCL [plays variety of music] with traffic reports every 5 minutes during peak times.
34. More advertising needed.
35. More information could be used, 511 should be made user-friendly.
36. Most of the people don't know about all the traffic systems and rules, so [UDOT] should make it more popular and easy.
37. My only complaint regarding ATIS is that everyone slows down to read the VMS signs. It's not always a bad thing for people to slow down or decease their speed, however this often presents a traffic problem.
38. People slow down too much to read them [VMSs], but I still like them.

39. Really helps, informative!
40. Reliable and great service.
41. Requires more publicity, although good to use.
42. Should be more popular. Other cities have better systems.
43. Signboards should be more.
44. The signs are useful and helpful.
45. Very effective, good work.
46. Very instructive, but message boards should be more in numbers. Good.
47. Website needs to be more publicized and even 511.

APPENDIX C: VMS and HAR locations in the Salt Lake Valley


Variable Message Signs (VMS) &
Highway Advisory Radio (HAR)
in the Salt Lake Valley
N
MAP LEGEND
SURFACE STREET VMS
FREEWAY VMS
HAR
600 N
3300 S
3900 S
4500 S
9000 S
Redwood Rd.
US-89
I-80
I-15
I-215
SR-201