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Evaluating Travelers Experience with Highway Advisory Radio (HAR) And Citizens Band Radio Advisory System (CBRAS) On Florida's Turnpike Enterprise Toll Roadways And Florida Interstate Highways

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EVALUATING TRAVELERS' EXPERIENCE WITH HIGHWAY ADVISORY RADIO (HAR) AND CITIZENS' BAND RADIO ADVISORY SYSTEM (CBRAS) ON FLORIDA'S TURNPIKE ENTERPRISE TOLL ROADWAYS AND FLORIDA'S INTERSTATE HIGHWAYS

by

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ABSTRACT

The goal of this thesis is to evaluate travelers' experience with Highway Advisory Radio (HAR) and Citizens' Band Radio Advisory System (CBRAS) technologies on both Florida Interstate Highway system (FIH) and the Florida Turnpike Enterprise (FTE) toll roads. To achieve this goal, two different survey tools were used. The first tool is a random digit dialing phone survey known as CATI (Computer-Assisted Telephone Interviewing). The second tool is a field survey that intercepts travelers at the Florida Turnpike Enterprise (FTE) service plazas and the Florida Interstate Highway (FIH) rest areas.

HAR and CBRAS are traditional components of the Advanced Traveler Information Systems (ATIS). This thesis pays special attention to the effectiveness of HAR and CBRAS in improving travelers' experience. Feedback to analyze these two technologies was collected via a telephonic survey and a field survey. Two different field surveys (one for HAR and one for CBRAS) were designed and implemented to obtain feedback on these technologies. The field survey for CBRAS is unique and has never been done before for this purpose.

A sample size of 1000 HAR surveys was collected through the CATI phone survey. Field surveys were collected at five locations across the state, including central, southeast, and southwest regions of Florida. The HAR field survey sample size was 1610 and the CBRAS field survey sample size was 613. All field surveys were conducted by UCF students at each of the five locations, over a 13-week data collection period. The HAR messages were designed to alert drivers of any adverse roadway traffic or weather conditions. The CBRAS is limited to truck

drivers with the closed system radio pre-installed in their vehicles. However, truck drivers were also asked some questions on HAR if they do not use CBRAS.

Basic statistical analysis was used to determine a number of performance indicators which include system's use and awareness, usability of provided information, route diversion, and travelers' demographics. In addition, the two HAR phone and field samples were combined together and examined using a decision tree model. Target questions were selected from the survey to build the tree network. The tree model aimed at identifying trends between categorical differences of travelers with respect to specific questions. Understanding travelers' satisfaction with HAR is critical to knowing its benefits. The ending results indicated that both basic statistical analysis and the decision tree model are in agreement. A comparison between HAR phone and field surveys indicates the following. Travelers interviewed for the HAR field survey were more aware of the HAR than travelers surveyed by phone. A small portion of the surveyed samples used HAR (22% and this was consistent between the phone and the field surveys). Also, 80% or more were satisfied with HAR for both phone and field samples and the majority (85% or more) supported its continuation as an indication of willingness to use it in the future, especially in emergency conditions. In terms of the types of messages they want to hear from HAR, traffic congestion was the most common. Dynamic Message Signs (DMS) were the most preferred source of travel information and were the alternative for HAR, if HAR gets terminated. This was followed by smartphone applications which received twice as much support from field surveyed travelers (28%) when compared to phone surveyed travelers (15%).

The CATI Phone Survey was biased towards elderly people (60% of the sample) and mainly females (58%) that use the FTE roadway system. Users satisfied with the system are those who only use these roadways once per week or less. The survey ultimately shows that travelers rely

on modern modes of obtaining traffic information than traditional ones, such as HAR. DMS, and smart phone applications are leading communication tools among all type of travelers. The HAR field survey was less biased with respect to age and gender distribution (56% were under 50 and 62% were males). Both surveys indicate that the sample is well educated (about 60% have an associate degree or higher).

CBRAS serves a small segment of commercial truck drivers (only 12% out of 613 used CBRAS). However, this small segment used it heavily (84% used it sometimes, often, or always). And 92% of CBRAS users were satisfied or strongly satisfied with it. CBRAS was used mostly for route divergence, with 72% of the drivers relying on it for this purpose.

Truck drivers who never used CBRAS (88% of the sample) were asked questions about HAR. Only 27% of them used HAR and 57% of these used it sometimes, often, or always with 72% of the truck users being satisfied with HAR compared to the 92% satisfied with CBRAS. The most common complaint about HAR by truck drivers was that it is not easy to access or understand.

Based on responses of truck drivers for both HAR and CBRAS field surveys above, it seems that GPS navigation was the most preferred source of travel information (28%). In addition to the basic statistics, a decision tree model, using SAS Enterprise Miner was performed. The statistical analysis results indicated satisfaction of travelers. The decision tree model was used to predict and profile responses to all answered questions that each survey shared. Training data was included in the model and the model was able to leverage the questions. Results of the decision tree model predicted high user satisfaction rates.

Analyses of the three implemented surveys show that HAR and CBRAS technologies are not used by a large proportion of travelers, but their users are typically satisfied with these technologies. A

small portion of the surveyed sample of truck drivers uses CBRAS but they use it heavily and were very satisfied with it. The travelers' satisfaction level with HAR was high. The HAR and CBRAS systems are in the middle of a heated competition lead by digital communication, it may be a sign of the time to create HAR/CBRAS smart phone applications for the longevity of these traditional technologies.

I dedicate my thesis to my late sister Amal A. Muhaisen, who passed away during the time of this research. As an instructor at UCF, she has helped many students to a path of success. She was a person who never paid attention to faults but was rather the thriving force that pushed everyone to success. Her strong well for helping others never hampered her unmatched touch of kindness. She was known to open her heart to accommodate feelings of happiness, sympathy and concern for all those who sought her for comfort. Her time, resources and her home were always available to share with others. Amal's patience, courage and determination have been the drive that provided me with strength to stay the course and succeed. Her flame of strength has kept my path let during the most difficult times. Although she is no longer with us, her passionate spirit will always be with me, may God bless her sweet soul.

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LIST OF ACRONYMS/ABBREVIATIONS

ATIS	Advanced Traveler Information Systems
CBRAS	Citizens' Band Advisory Radio System
CATI	Computer Assisted Telephone Interviewing
DMS	Dynamic Message Signs
FDOT	Florida Department of Transportation
FIH	Florida Interstate Highway
FTE	Florida Turnpike Enterprise
HAR	Highway Advisory Radio
IRB	Institutional Review Board
ITS	Intelligent Transportation Systems
TMC	Traffic Management Center
TSP	Turnpike Service Plaza

CHAPTER ONE: INTRODUCTION

1.1 Background

Traffic information is considered one of the most important factors affecting travel today. Location specific, accurate, and timely traffic information are essential factors to ensure safe, efficient, and convenient travel for all types of road users. In today's world of high speed communication, travelers have a host of options through which they are able to receive traffic information. These options vary from traditional modes, such as radio stations, all the way to the highly advanced Intelligent Transportation System (ITS). Advanced Traveler Information Systems (ATIS) are critical ITS elements providing essential travel information to travelers. Two ATIS technologies, currently exist on the Florida Turnpike Enterprise (FTE) toll roads and the Florida Interstate Highways (FIH). These ATIS are Highway Advisory Radio (HAR) and Citizens' Band Radio Advisory System (CBRAS). Evaluation of the use of these traditional technologies will prove to be essential in this continuously evolving communication age. FDOT has contracted with the University of Central Florida to evaluate these technologies and whether improvement or replacement is potentially needed.

Review of literature, shows that various types of HAR studies have been done nationwide. However, there was only one limited study on the Wizard CB alert system similar to the CBRAS performed by Iowa's DOT.

1.2 Research Scope

The HAR/CBRAS unique study described in this thesis focuses on travelers' feedback at five locations selected based on recommendations from FTE and FDOT. This thesis focuses on travelers' awareness of the system and their use of the provided information. Travelers' preferred

methods of obtaining traffic information is directly collected. Travelers' feedback can be analyzed by a number of methods; however this thesis focuses on two types of analyses:

- Evaluating the usage of HAR and CBRAS to understand the relationship between their frequency of use and several other important use related factors, such as HAR and CBRAS awareness, clarity and ease of use and understanding the message, location specific information, availability of other traffic information alternatives, age and gender of users, and their education level.
- Examining the effect of the HAR/CBRAS messages on the travelers' route choice and diversion, and their satisfaction with these technologies.

1.3 Organization of Thesis

This thesis is composed of the following chapters:

Chapter 1 is the introduction to the thesis to provide the reader with the study background. Chapter 2 discusses the research goal and objectives. Chapter 3 is literature review of previous research which focuses on HAR surveys as a main subject and other related survey studies. Chapter 4 is a description of the research methodology. Chapter 5 is analysis of data. Chapter 6 is statistical analysis. Chapter 7 is about the decision tree model. Chapter 8 is conclusion to the overall results of this thesis; it also provides recommendations and directions for future research.

CHAPTER TWO: GOAL AND OBJECTIVES

2.1 Research Goal

The goal of this thesis is toevaluate travelers' experience with Highway Advisory Radio (HAR) and Citizens' Band Radio Advisory System (CBRAS) technologies, on both Florida Interstate Highway system (FIH) and the Florida Turnpike Enterprise (FTE) toll roads. The evaluation includes measuring awareness of these technologies, their frequency of use, and user satisfaction with the information provided by these technologies. The evaluation also seeks to specifically learn traveler's favorite mode of receiving traffic information.

2.2 Research Objectives

In order to achieve the above goal, this thesis has identified the following objectives as priority for the HAR and CBRAS evaluation:

- Identify the proper method for survey tools.
- Select five field survey locations on the FTE and FIH systems to represent Florida.
- Assess travelers' extent of knowledge and familiarity and degree of their satisfaction with HAR.
- Assess truck drivers' knowledge and familiarity with the CBRAS.
- Quantify effects of HAR and CBRAS on travelers' route choice.
- Use comparison of other existing traffic information systems (or traffic information alternatives other than HAR and CBRAS).

CHAPTER THREE: LITERATURE REVIEW

3.1 Background

This literature review covers research that has been done in the United States that is directly related to HAR and citizen band (CB) radio systems and their efficacy against other traveler information systems (TIS) that are used to deliver critical traffic information to the roadway users. These TIS can include 511 calls, dynamic message signs (DMS), smartphone applications, and other various technologies.

Many studies have researched and evaluated the implementation of HAR systems in various states or surveyed drivers on the use of HAR and other TIS technologies. **Wolshon and Schwehm (1999)** studied the applications, equipment, installation, power, cost, and licensing requirements of implementing HAR in construction zones in Louisiana. The HAR system was mainly used to provide travel time information during the construction period. Limitations were found regarding the lack of infrastructure to collect and broadcast real-time traffic information and the amount of labor needed to operate the system. The total system cost was around $77,000 including "three pole mounted transmitter units, along with three accompanying sets of solar power supply systems, three tone-in-broadcast flash activation systems, and cellular telephone capability for all transmitters" (Wolshon and Schwehm, 1999). Operational costs were estimated to be $20 per month for electrical service and $30-$50 for cellular service, depending on the usage. It was concluded that the HAR system will not work properly and give the desired results that can satisfy travelers unless there is an established infrastructure that can collect and provide real-time traffic information.

3.2 Previous HAR Research

Havinoviski and Sutton (2006) analyzed whether the existing HAR system in the Hampton Roads area of Virginia should be upgraded or replaced. The existing HAR experienced transmission issues, especially during bad weather, and had a smaller broadcast radius than originally expected. The benefit-cost ratios were calculated for four possible alternatives: keeping HAR system as is, upgrading the HAR system to reduce transmission issues, purchasing an existing AM radio station to provide traveler information, or building a new FM radio transmitter to provide area-wide coverage. These benefit-cost ratios showed that upgrading the HAR system or having a new FM radio transmitter were the best options, indicating that HAR can be a cost-effective method to provide information to travelers over a large area. The FM transmitter could provide a larger coverage area, but would have more licensing and permitting issues and possible difficulty in obtaining a frequency in a crowded metropolitan area.

Smith et al. (1995) published an investigation about operational procedures for HAR systems. Interviews with both Virginia drivers and key transportation personnel from other states were performed to obtain information on the public image of HAR systems. Conclusions indicated that data for TIS must be gathered/updated from many agencies in order to give a clear picture to motorists, which shows that the operation of HAR systems is personnel-intensive. Also, most of the motorists listened to the traffic reports from commercial radio; therefore, there is a need to use DMS with specific messages telling drivers to tune into the HAR broadcast when they are in a covered area. Tables 1, 2 and 3 below show some of the survey results; these results show that many people think HAR should broadcast congestion and incident information, that a low percentage of participants use HAR compared to commercial and CB radio, and that drivers often

did not feel a need to tune in to HAR or were familiar enough with the area to not need to use HAR.

TABLE 1 PREFERRED TYPE OF INFORMATION FOR HAR BROADCASTS (SMITH ET AL., 1995)

What type of information do you think should be broadcast on HAR?	**I-81 (28 subjects)**	**I-66 (24 subjects)**
Location of work zones	61%	19%
Incident information	**75%**	**33%**
Tourist information	18%	0%
Congestion information	**68%**	**70%**
Weather information	61%	26%
Alternate routes	36%	26%
Special event information	18%	0%
Location of motorist services	11%	0%

TABLE 2 USUAL SOURCES OF TRAFFIC INFORMATION (SMITH ET AL., 1995)

What is your usual source of traffic information?	I-81 (29 subjects)	I-66 (27 subjects)
Commercial radio	21%	59%
Television	3%	0%
HAR	**10%**	**0%**
CB radio	**24%**	**11%**
Other	3%	7%
None	38%	22%

TABLE 3 REASONS FOR NOT TUNING IN TO HAR (SMITH ET AL., 1995)

Was there a particular reason that you did not tune in?	Blacksburg (68 responses)	I-81 (19 subjects)	I-66 (17 subjects)
Perceived no reason to seek information	23%	37%	23%
Listening to music/other audio	9%	21%	23%
Familiar with area	**45%**	**16%**	**18%**
Prior bad experience with HAR	6%	5%	18%
Other	16%	21%	18%

Salazar (2002) studied the application of HAR in transmitting information to road users in San Antonio, Texas. Interviews with agencies, design concepts, and analysis of the system architecture provided a better understanding of this type of ATIS. A text-to-speech technology was applied to the HAR system so that the local traffic management center (TMC) could broadcast written messages on air. Many other important points on HAR are summarized below:

- The Federal Communication Commission (FCC) licenses the use of HAR systems; governmental agencies, as well as other non-governmental organizations can use such systems under the FCC's license, guidelines and regulations.
- HAR equipment consists of an audio source, transmitter, antenna, and ground system.
- It is recommended to install flashing beacons for HAR signage. Signage can be either static or dynamic.
- The HAR radio frequency is controlled by the FCC in the range of 530 kHz to 1700 kHz.
- A HAR system can broadcast information on road closures and detours, traffic restrictions, parking situations, traffic conditions, special events, or other traffic related information.
- A HAR system cannot be used to broadcast "music or to identify the commercial name of any business establishment whose services may be available within or outside the coverage area of the station" (Salazar, 2002).
- Many roadway Agencies with HAR experience were interviewed, including Minnesota Department of Transportation (DOT), New Jersey Turnpike Authority, Texas DOT, Washington State DOT, and Wyoming DOT. These agencies discussed important limitations of HAR, including the lack of updated transmitted information and interference from topography or geography as well as other radio frequencies.

- The length of HAR messages should be as short as possible while delivering clear message containing information on "attention, problem, effect, and taking action" (Salazar, 2002).

3.3 HAR Component Cost and Technical Specifications

Walton et al. (2009) published a report describing arterial intelligent transportation systems. According to this report, there are almost 4004 miles of US freeways and 2,453 miles of arterials covered by HAR system (based on ITS Joint Programs Office's (JPO) 2006 Metropolitan Summary). Various advantages of HAR were mentioned, including a considerable amount of information that can be broadcast, reduced delay and a low number of information stops, considerable range (up to 6 miles), ease of accessibility (radio available in almost all vehicles), and no commercial disruption. A range of HAR component costs, including both capital and operation & maintenance (O&M) costs, were also calculated, based on the 2007 ITS Cost Database (http://www.itscosts.its.dot.gov); these costs are shown in Table 4.

TABLE 4 HAR COMPONENT COSTS (WALTON ET AL., 2009 BASED ON 2007 ITS COST DATABASE)

Element	Life	Capital Cost		O&M Cost	
	Years	$K, 2007 Dollars		$K/year, 2007 Dollars	
		Low	High	Low	High
Highway Advisory Radio	20	15.00	35.00	0.60	1.00
Highway Advisory Radio Sign	10	5.00	9.00	0.25	0.25
Roadway Probe Beacon	5	5.00	8.00	0.50	0.80

Athey Creek Consultants (2014) discussed HAR system technical specifications and regulations, best practices, values, current usage and future. The FCC regulates various aspects of HAR systems. Some of these regulations are the following: frequency is available on AM and Low-power FM (LPFM) frequencies, transmitter output power (10 Watts), antenna height (15 meters = 49.2 feet), coverage radius (3 km = 1.86 miles), and first license is active for ten years and renewable. Additionally, HAR systems can only broadcast information related to "travel, imminent danger, emergencies, emergency points of assembly, traffic conditions, weather information, information regarding motor vehicle crashes, road closures and construction, parking, current driving travel times, air flight status, truck weigh stations, driver rest areas, locations of truck services, and road closures" (Athey Creek Consultants, 2014).

3.4 HAR Use by State

Table 5 on the next page summarizes HAR use by state. HAR is used in 19 states, with the most sites in Pennsylvania and Washington. This table will be useful when implementing the state DOT Current Practice Survey to allow the UCF research team to know what DOTs have experience with HAR.

TABLE 5 HAR USE BY STATE (ATHEY CREEK CONSULTANTS, 2014)

States	Deployment Descriptions
>50 HAR Sites	
Pennsylvania	Pennsylvania DOT operates 92 HAR towers. HAR use in Pennsylvania varies by district, with District 6 (around Philadelphia) operating no HAR, while District 2 operations multiple HAR along the I-80 corridor.
Washington	Washington State DOT operates close to 90 sites throughout the state, primarily at locations near key decision points, mountain passes, or areas prone to major events. Several of these sites also support the state's ferry operations.
10-50 HAR Sites	
Colorado	Colorado DOT operates 16 HAR sites (nine AM broadcasts on the East Slope of the Rocky Mountains and seven FM broadcasts on the west slope).
Connecticut	Connecticut operates 14 HAR (eight along the Connecticut Turnpike).
Florida	The Florida Turnpike operates 10 HAR along the Turnpike.

States	Deployment Descriptions
Idaho	Idaho Transportation Department identified that they will deploy 25 HAR in southern Idaho by summer 2014.
Illinois	Illinois DOT operates 10 HAR sites in the Chicago metropolitan area and nine sites in the East St. Louis area to advise of travel times, lane closures and weather conditions affecting travel.
Indiana	Indiana DOT operates 23 towers throughout the state.
Iowa	Iowa DOT operates 10 HAR towers, three of which are FM broadcasts, and one location utilizes Super HAR broadcast that extends the coverage area.
New Jersey	New Jersey has 13 HAR operational throughout the state, and they previously relied on these HAR more for traveler information before the 511 phone system was launched.
New York	New York State DOT operates 15 HAR throughout the state.
	The New York State Thruway Authority (NYSTA) operates more than 20 HAR along the Thruway.
Ohio	Ohio DOT operates 26 HAR towers clustered around the largest cities (seven near Cleveland, six near Columbus, four in Dayton, three in Cincinnati, and one in Akron).
Oregon	Oregon DOT operates approximately 24 HAR towers in key locations throughout Oregon.

States	Deployment Descriptions
Utah	Utah DOT operates about 12 HAR towers, primarily in the Salt Lake City valley and on roads to remote ski destinations.
<10 HAR Sites	
Alabama	Alabama DOT operates four mobile HAR units, primarily for hurricanes, incidents, and winter weather reports.
Montana	Montana DOT operates five HAR on mountain passes, typically one HAR on each side of the mountain pass.
New Hampshire	New Hampshire DOT operates two HAR towers along the Turnpike.
Tennessee	Tennessee DOT operates three HAR towers.
Texas	Texas DOT operates 21 HAR towers around San Antonio, Austin, El Paso and Amarillo to advise of lane closures, events and extreme weather conditions.

This study mentioned major uses of HAR, including emergencies associated with weather, overlong and complex information that is difficult to broadcast through other tools (such as DMS), the unavailability of other tools in emergency situations, traffic warnings about particular corridors, and travel time information broadcasting. Travelers can be alerted that there is important HAR information via static roadside signs with beacons, portable DMS, and websites; Figure 1 below shows the New York State Thruway Authority (NYSTA) website which contains live "updated" HAR locations and messages.

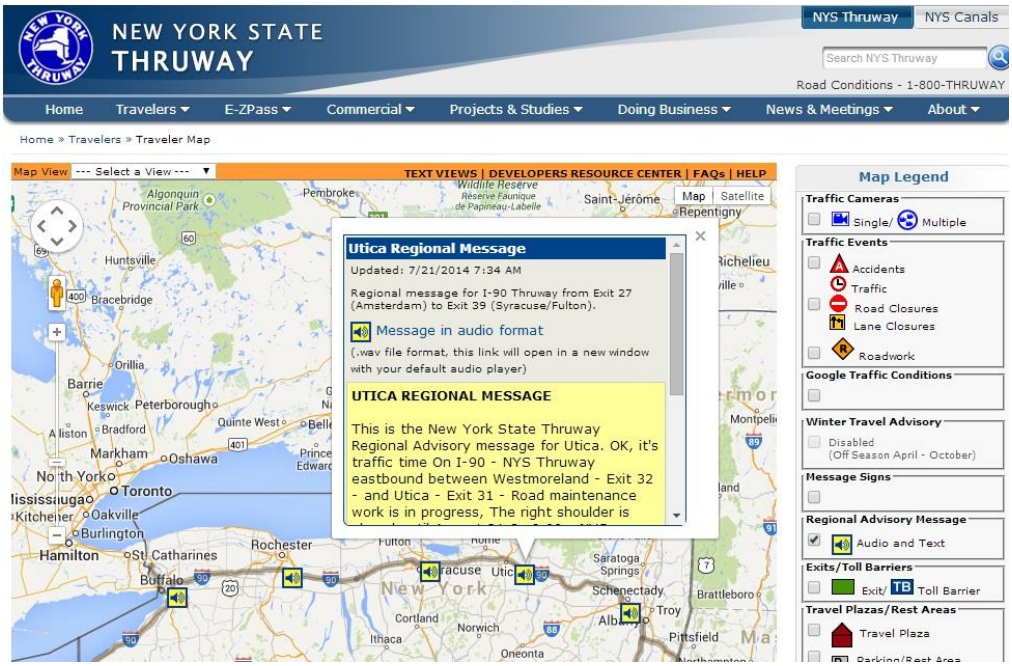


FIGURE 1 NYSTA HAR LOCATIONS AND BROADCASTS ONLINE (NYSTA WEBSITE, 2014)

Pricing was also discussed in this report; the price varies depending on the type of HAR system. The cost for portable HAR with mobile operations ranges from $35,000-$50,000 and the cost for permanent HAR with frequent information at major areas ranges from $25,000-$55,000.

3.5 HAR as a Component of ATIS

Eidswick et al. (2009) evaluated the deployment of Portable Dynamic Message Sign (PDMS)/Highway Advisory Radio (HAR) in Grand Canyon National Park (Figure 2) to increase transit usage, improve parking management, and reduce congestion. Data collection and surveys were implemented, along with a general plan on how to design, run, and maintain DMS/HAR systems.

HAR in Tusayan PDMS in Tusayan

FIGURE 2 HAR AND PDMS IN TUSAYAN, GRAND CANYON NATIONAL PARK (EIDSWICK ET AL., 2009)

Results showed that modal share of shuttle buses increased by 32 to 46 percent due to the deployment of PDMS/HAR causing people to shift from driving their private automobile to using the shuttle buses. This reduction in private vehicles usage led to a fuel savings of over 10,000 gallons. Also, congestion inside park roads and parking areas was reduced, with people stating that the parking was smoother than previous years, even though demand did not decrease. Finally, guests' experience was improved due to better traveler information, with 94% stating that the PDMS were accurate and 86% stating that the HAR was accurate. Based on this test, **Eidswick et al. (2009)** recommended installing a permanent traveler information system containing both HAR and PDMS systems with real-time (not static) information. It was also recommended to establish a partnership with Arizona DOT to apply HAR, DMS, and 511 in other areas outside the park.

Another plan study (operational and maintenance guidelines) done by **Villwock-Witte et al. (2011)** studied the use of DMS and HAR as ITS solutions to the congestion problems in Bear Lake Corridor in Colorado (Figure 3). These tools aimed to increase the use of public transport (shuttle buses), reduce emissions, and manage parking issues. Using these devices in tandem is

beneficial, as the DMS gains the attention of travelers to alert them that there is a HAR message and the HAR allows for more information to be transmitted to the travelers than DMS allows.

FIGURE 3 HAR TRAILER (VILLWOCK-WITTE ET AL., 2011)

Caltrans (2011) studied the performance of HAR and how to improve it. They conducted a survey on state DOTs to see their experience with HAR. Six state transportation agencies (Louisiana, Maryland, Missouri, New Jersey, Oregon and West Virginia) responded completing this survey. Survey results stated that Maryland, Oregon, and New Jersey actively use HAR, with New Jersey having 13 HAR stations in use. Louisiana and Missouri have few HAR stations in place with inactive HAR programs, and West Virginia has a few HAR stations in place, but these are all county-operated and not operated by the state. Many of these states had concerns about HAR, with Louisiana describing HAR effectiveness as less than satisfactory, New Jersey complaining about weak signals and radio interference at most HAR sites, and West Virginia having issues with topography. Louisiana, Missouri, and West Virginia preferred using 511 phone systems instead of using HAR stations. HAR users and experts, including HAR vendors, were also interviewed to obtain information on the best practices nationwide; these interviews showed that HAR efficiency is difficult to obtain since it is hard to find the ideal location to place HAR

stations to ensure high signal quality without negative effects from other radio signals from commercial stations.

Martin et al. (2011) studied the use of various TIS as tools for traffic incident management. HAR was one of these tools; compared to VMS, HAR is more useful, provides a larger amount of information, and can be accessed by all users (depending on the covering area and signal quality) by just tuning the radio to a specific frequency. Signage advertising HAR is important to tell users/drivers that they are in a HAR zone and what frequency to tune their radio to. Flashing beacons should be used to let users know when there is a message being broadcast. Some disadvantages mentioned in this study include the bad effect on signals by tall buildings, especially where the 50 foot antenna height is restricted by Federal Communication Commission (FCC), and the harmful impact by high-power electric lines on broadcast quality.

Neudorff et al. (2003) discussed HAR as one of various traveler information delivery methods that can be used to manage/operate traffic on the freeway. HAR can spread more information (live and recorded messages) to a wider range of travelers than VMS and many other methods. However, because of its limited distribution range of no more than 3-4 miles from the transmitter, which is restricted by the FCC (unlike commercial stations), poor signal quality is expected for HAR. Figure 4 shows a HAR station along a freeway.

FIGURE 4 HAR STATION ALONG FREEWAY (NEUDORFF ET AL., 2003)

HAR systems can be either fixed or portable/mobile systems and can be deployed in two major ways: point coverage (to cover a specific localized area) and wide-range coverage (with multiple synchronized transmitters). HAR signing (static or dynamic) with flashing beacons to alert travelers if there is a message being transmitted is important to notify travelers that they are in an HAR broadcast area (Figure 5). Also mentioned was the Automatic Highway Advisory Radio (AHAR) system in Europe, which automatically tunes the radio to the particular HAR station frequency and mutes all other broadcasts until the message is finished.

FIGURE 5 HAR SIGNS (NEUDORFF ET AL., 2003)

Maccubbin et al. (2003) discussed the unit costs of various ITS units, as of September 2002; Table 6 shows the costs for VMS and HAR components. Both the capital and O&M costs are much lower for HAR than for VMS systems.

TABLE 6 SOME ITS UNIT COSTS (MACCUBBIN ET AL., 2003)

Subsystem/Unit Cost Element	Lifetime (years)	Capital Cost ($K)		O&M Cost ($K/year)		Notes
		Low	High	Low	High	
Variable Message Sign	20	48	120	2.4	6	Low capital cost is for smaller VMS installed along arterial. High capital cost is for full matrix, LED, 3-lines, walk-in VMS installed on freeway.

Subsystem/Unit Cost Element	Lifetime (years)	Capital Cost ($K)		O&M Cost ($K/year)		Notes
Variable Message Sign Tower	20	25	125	-	-	Low capital cost is for cantilever structure. High capital cost is for a truss structure that will span across 3-4 lanes. VMS tower structure requires minimal maintenance.
Variable Message Sign - Portable	14	21.5	25.5	1.2	2	Trailer-mounted VMS (3-lines, 8-inch character display): includes trailer, solar, or diesel powered.
Highway Advisory Radio	20	16	32	0.6	1	Capital cost is for a 10-watt HAR. Includes processor, antenna, transmitters, battery back-up, cabinet, rack mounting, lighting, mounts, connectors, cable, and license fee. Super HAR costs an additional $9-10K (large antenna). Primary use of the super HAR is to gain a stronger signal.

Subsystem/Unit Cost Element	Lifetime (years)	Capital Cost ($K)		O&M Cost ($K/year)		Notes
Highway Advisory Radio Sign	10	5	-	0.25	-	Cost is for an HAR sign with flashing beacons and variable message capability. Includes cost of the controller.

A study on incident management strategies performed by **Ozbay et al. (2005)** evaluated the costs/benefits of various incident management strategies including CCTVs, police patrols, VMS, and HAR. The major HAR benefits mentioned were the instant traffic reports it provides and the widespread availability of this information to the travelers when they need it. Disadvantages included the need for accurate timely data to ensure these messages are reliable, as well as ensuring the HAR messages are not constantly repeated, causing drivers to ignore these repetitious/boring messages.

3.6 Other Advanced Travel Information Systems

3.6.1 Florida HAR Surveys

Florida's Turnpike Enterprise (2004) surveyed their customers about their use and opinions on HAR. 90% of the respondents were positively satisfied with HAR. Only 11% of respondents reported that they used HAR often; however, 51% stated they tuned into the HAR station when the lights were flashing. 89% of respondents who listened to HAR felt that the HAR information was accurate and 87% used the HAR information to change their route. Overall, 92% of respondents thought that HAR was important on Florida's Turnpike.

3.6.2 ITS Operations

A report prepared by **Battelle Memorial Institute and Meyer, Mohaddes Associates, Inc. (2004)** discussed the installation and operation of ITS information systems along U.S. 395 north of Spokane, Washington. This ITS system includes: "road weather information system environmental sensor stations, mobile Highway Advisory Radio systems, and Closed Circuit Television (CCTV) cameras." (Battelle Memorial Institute and Meyer, Mohaddes Associates Inc., 2004). A before and after phone survey was conducted on Commercial Vehicle Operators (CVOs) that traveled through the project corridor; this showed that 56% used the HAR stations and 51% found HAR messages "somewhat useful" or "very useful" (Figure 6).

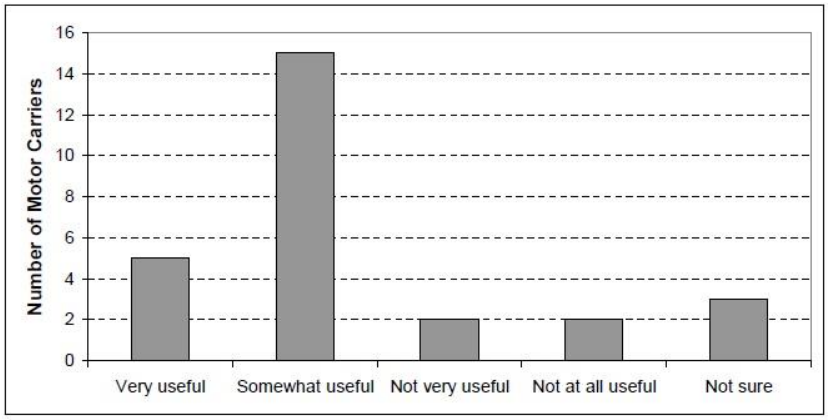


FIGURE 6 REPORTED USEFULNESS OF HAR MESSAGES BY CVOS (BATTELLE MEMORIAL INSTITUTE AND MEYER, MOHADDES ASSOCIATES INC., 2004)

The use of various TIS by CVOs before and after ITS information systems implementation was also analyzed, as shown in Figures 7 and 8. These figures show that there is high use in the new HAR program (almost 56% of the CVOs report using HAR "sometimes" or "often") and that cell phones and CB radios are still used frequently by CVOs compared to the other information sources. Therefore, it appears that the new ITS sources do not replace the traditional ITS sources used by CVOs, but are instead used to enhance these traditional sources. It is important to note that these CVOs' responses may differ from agencies' and normal drivers' responses.

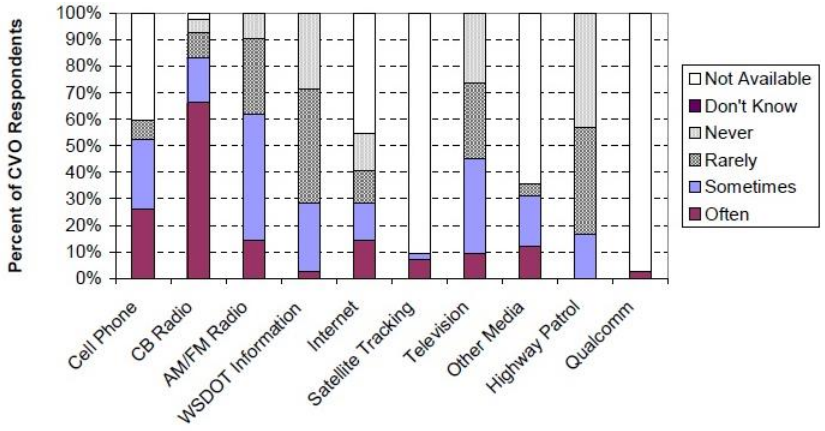


FIGURE 7 REPORTED BASELINE (BEFORE SYSTEM DEPLOYMENT) USE OF VARIOUS INFORMATION SOURCES (BATTELLE MEMORIAL INSTITUTE AND MEYER, MOHADDES ASSOCIATES INC., 2004)

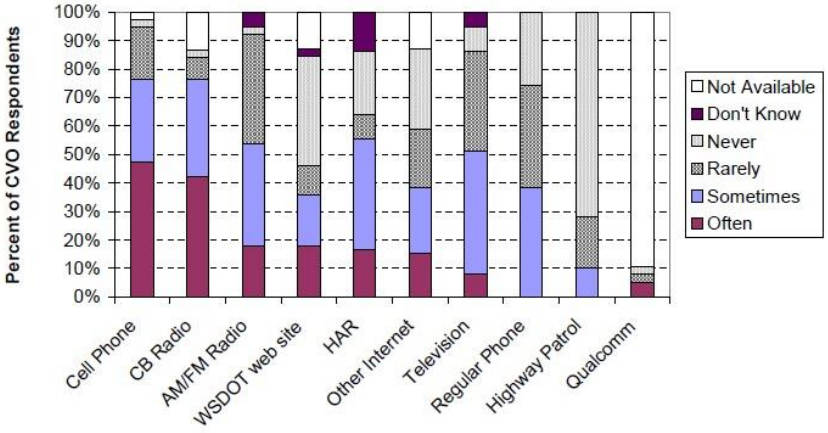


FIGURE 8 REPORTED POST SYSTEM-DEPLOYMENT USE OF VARIOUS INFORMATION SOURCES (BATTELLE MEMORIAL INSTITUTE AND MEYER, MOHADDES ASSOCIATES INC., 2004)

Some studies have also been done concerning the use of CB radios as TIS technologies. **Ullman et al. (2002)** conducted research in Texas exploring the use of CB wizard technology. This technology was used to "provide pre-recorded information regarding highway or work zone conditions, much like a highway advisory radio (HAR)" (Ullman et al., 2002) for work zone safety enhancement at late-merge lane closures. A CB wizard warning unit is shown in Figure 9. This study provided general guidelines and found that CB wizard technology can improve lane choices and speed (in addition to queue length and delay) for trucks approaching work zones.

FIGURE 9 CB WIZARD ADVANCED WARNING UNIT (ULLMAN ET AL., 2002)

Kamyab and Maze (2013) published a paper assessing the Wizard CB Alert System in Iowa that regularly transmits warning messages around work zones area to manage traffic speed. This study recommended using such a system in the future to warn truck operators of maintenance and construction crews. It was found that 63% of truck operators heard the alert message through their CB radio and that 41% stated that the Wizard CB alert was the first notification they had that they were nearing a maintenance crew. Data collection was performed by listening to truck operators' comments on the radio (both positive and negative) and conducting a rest area survey near work zones. Some of the survey results are summarized below:

- Of the 94 truck operators interviewed, 94% owned CB radio.
- 80% of the operators who owned a CB radio turned their radio to the appropriate channel to receive the Wizard CB alerts.
- 84% of the operators who were on the appropriate channel noticed the maintenance crew on the interstate; 75% of these heard the Wizard CB message, 98% felt the message was not annoying, and 100% thought the system should continue to be used in the future.
- 89% of the operators who heard the Wizard CB message felt the message was an effective warning of the maintenance crew.

Gass et al. (1979) developed a simulation model to assess the effects of CB radios in improving highway safety in New York. They showed how direct reporting of accidents by citizens using CB radios to emergency response units of highway patrol (HP) significantly decreased response time, making this technology a better reporting alternative to phone calls and direct observation of accidents and roadway hazards.

This developed mathematical model considered the geography, dynamics and emergency response under a given set of assumed conditions. The simulation exercise involved various traffic systems, from simple highway traffic systems to more complex systems. The following are some of the statistics and results of the simulation:

- CB radios allowed HP to respond to 4.2% of accidents before any other form of reporting was completed. Also, reporting of accidents to HP centers by citizens using CB radios, before any other link could report, accounted for 29.6 % of the total reported accidents.
- Approximately 90% of the time (in the last six test data points), direct reporting by CB radios resulted in the minimum detection and notification time.
- Response time using direct HP reporting (notification and response times) in the experimental area was less than five minutes compared with the control area, where response times were more than ten minutes.
- Time saved upon the occurrence of an accident using HP reporting via CB radios was 3.88 minutes in notification time, and 2.45 minutes saved in response time.

Many studies also evaluated various TIS technologies, often including HAR and CB radio, and compared them to each other. **Deeter (2009)** summarized the state-of-the-practice in the United States on real-time traveler information delivery, mainly focusing on 511 phone systems and websites. This study consisted of an online survey on TIS sent to 51 public private agencies,

to which there were 34 unique responses (67% response rate); observation and testing of various TIS in use throughout the nation; review of previous studies on TIS; and interviews with various transportation professionals. There are a variety of TIS currently in use, including 511 phone systems, traveler information websites, DMS, and HAR; these are all available to drivers at no cost. Additional information can also be obtained from private sector websites, phones, TV news, and media outlets.

Suggestions made in this report included to have more cooperation and communication between public, private, operating, and expert agencies, as well as the consumers/users, to increase the consciousness, usefulness, and accessibility of TIS technologies at all levels; more effort to achieve uniformity between agencies nationwide on the use of these technologies; enhancing of 511 call systems to provide more accurate information to callers; and conducting of more surveys to obtain a better understanding of what consumers need from TIS technologies and how they feel about these technologies.

Details were also discussed about 511 phone systems nationwide; these systems are very widespread, with 42 systems in 33 states providing coverage to 47% of Americans. Figure 10 shows the deployment status of 511 nationwide as of February 21, 2008. Around 100 million 511 calls had been made as of the date of this research; almost 30% of these calls had been made from either the San Francisco Bay area or the state of Florida. Figure 11 shows the 511 call volumes from April 2007 to March 2008.

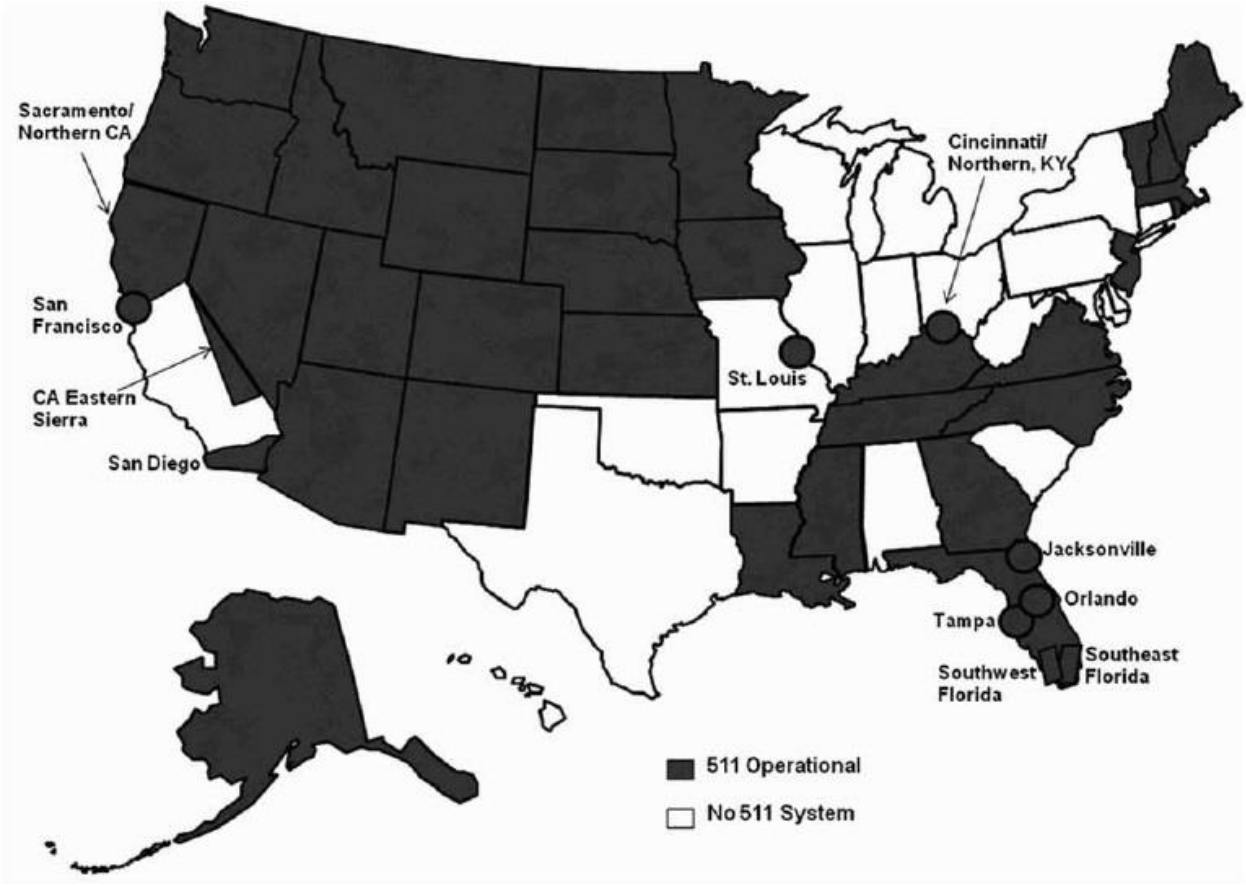


FIGURE 10 CURRENT 511 PHONE SYSTEM DEPLOYMENT STATUS AS OF FEBRUARY 21, 2008 (DEETER, 2009)

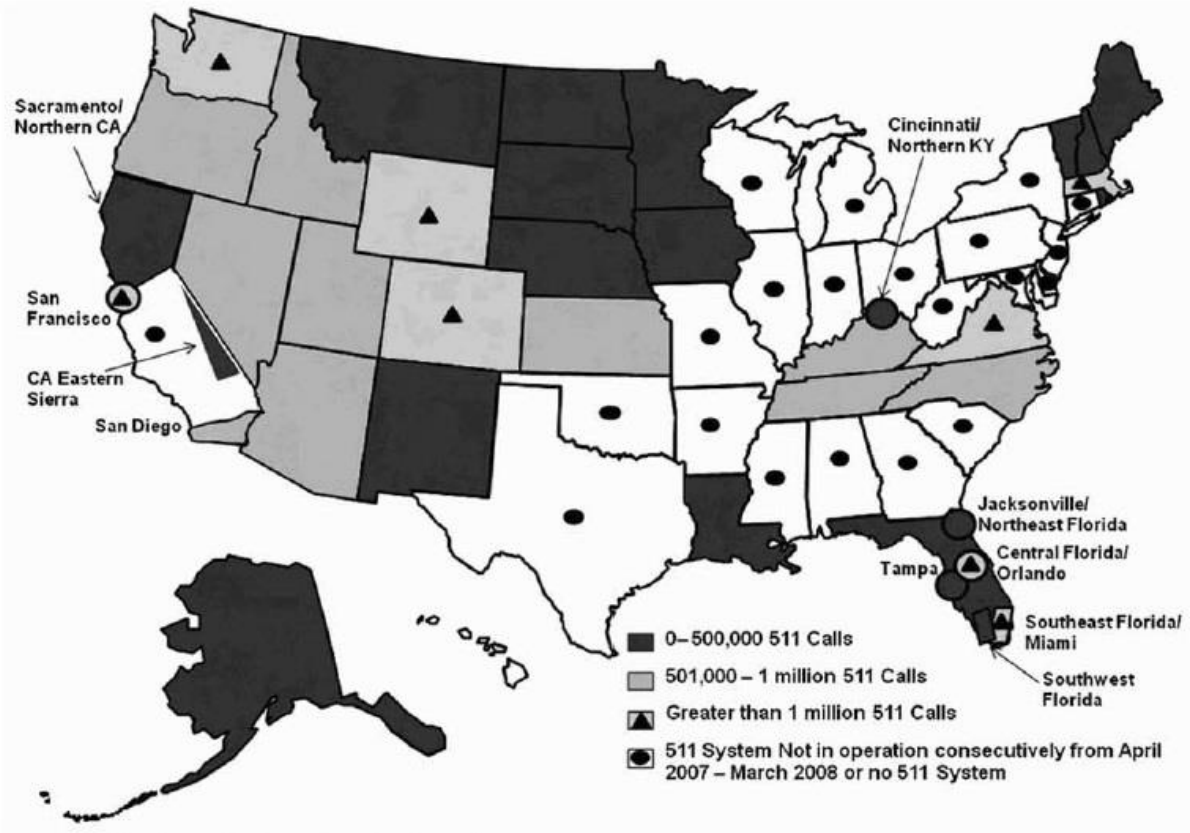


FIGURE 11 TOTAL 511 CALL VOLUMES FROM APRIL 2007 – MARCH 2008 (DEETER, 2009)

Noyce et al. (2009) studied TIS through literature review and web/telephone-based surveys on the motor carrier industry in the Ten-State Mississippi Valley Region (Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Ohio, and Wisconsin). Two main surveys were conducted: a Motor Carrier Representatives Survey and a Planners and Regulators Survey. Some results from the Motor Carrier Representatives Survey are shown in Figures 12 and 13, and in Table 7. Figure 12 shows the usage of TIS by dispatchers and truck drivers to obtain current traffic and weather information; 79.6% use CB radio reports from other drivers and 59.3% use HAR. Figure 13 shows what TIS methods the dispatchers and truck drivers would prefer to receive various types of information; this shows that they would prefer the use of changeable message signs (CMS) for traffic information and commercial radio reports for weather information. Table

7 shows the various responses that fall under the "Other" category in Figure 13. These responses indicate that the internet is also a preferred way to obtain travel information.

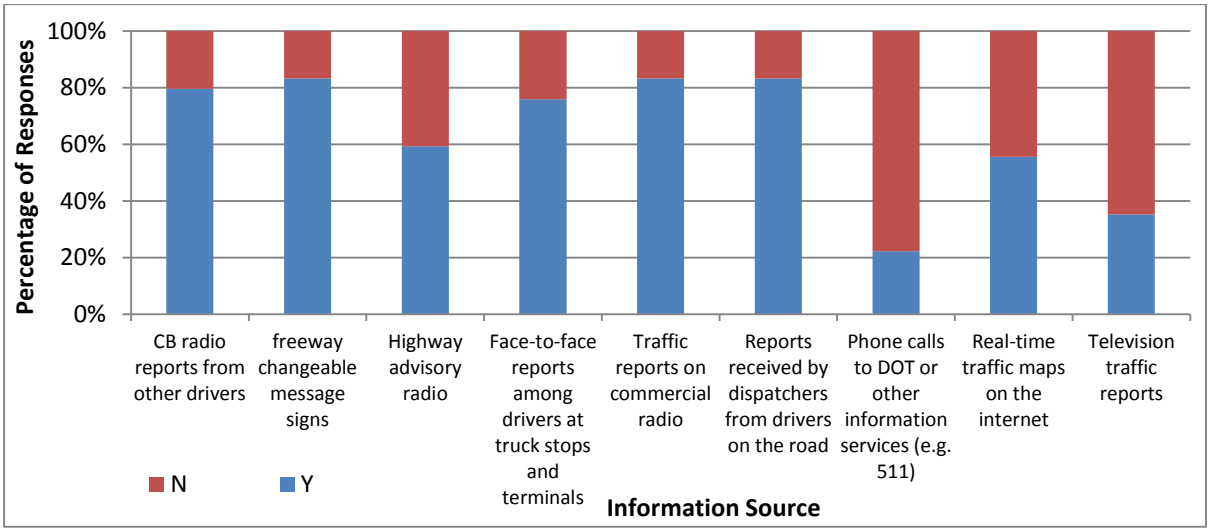


FIGURE 12 CURRENT USAGE OF INFORMATION DELIVERY METHODS (NOYCE ET AL., 2009)

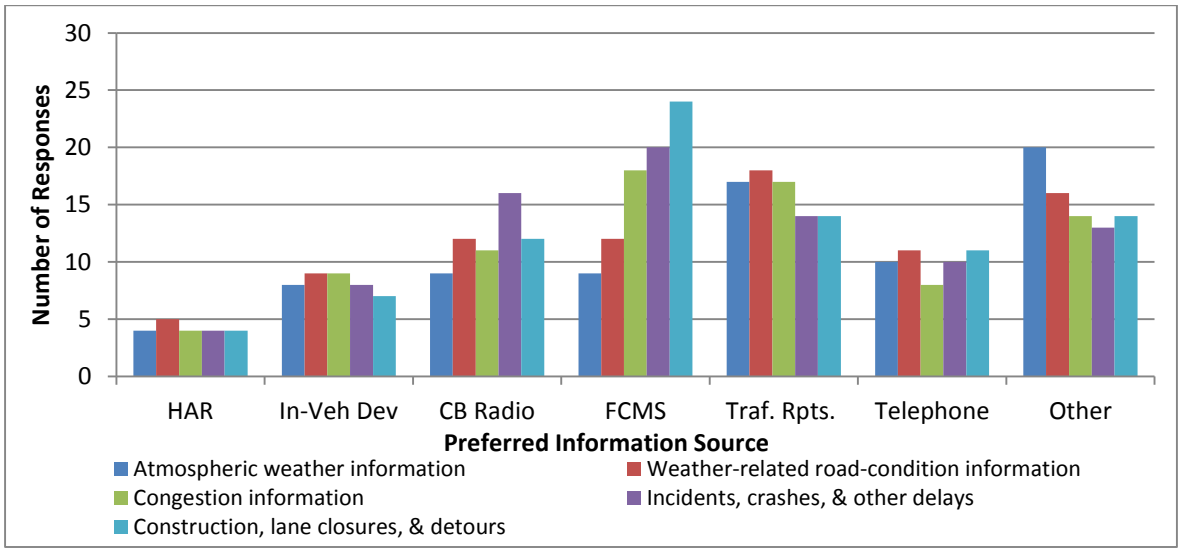


FIGURE 13 PREFERRED DELIVERY METHODS FOR INFORMATION TYPES (NOYCE ET AL., 2009)

TABLE 7 THE "OTHER" SUGGESTED DELIVERY METHODS FOR INFORMATION TYPES - FROM FIGURE 13 (NOYCE ET AL., 2009)

Delivery Method	Count
Internet	15
Dispatch push to drivers	7
Weather band radio	2
No need for weather info	1
GPS	1
Satellite radio	1
E-mail	1
Weather Channel (TV)	1

The Planners and Regulators Survey was given to variety of agencies, including state DOTs, Federal Highway Administration (FHWA) personnel, and regional planning offices. Figure 14 shows how useful these agencies felt a variety of TIS technologies were to motor carriers; this indicates that agencies felt that CMS were the most useful TIS technology and that HAR was not very useful. These survey questions will be useful to help the UCF research team design the state DOT Current Practices survey.

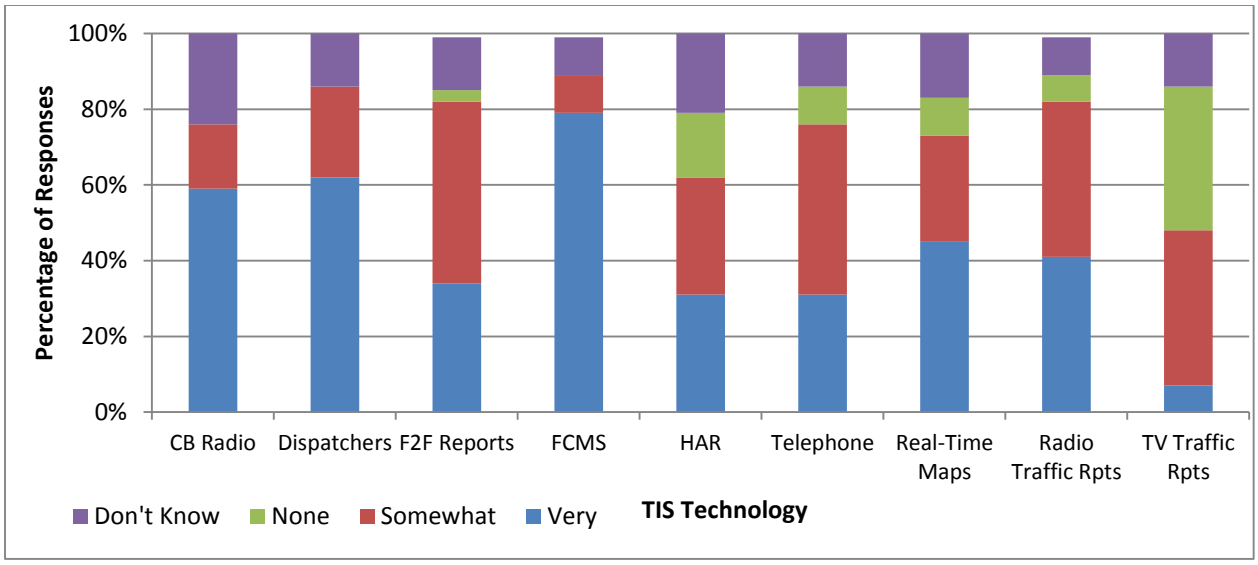


FIGURE 14 AGENCY OPINIONS ON INFORMATION DELIVERY METHODS FOR THEIR USEFULNESS TO MOTOR CARRIERS (NOYCE ET AL., 2009)

Walton et al. (2006) studied the enhancement of a toll road network in Austin, Texas by using traveler information to increase toll roads' usage, divert traffic from non-toll roads, and reduce travel time. A commuter survey was performed and the results used to build a simulation DYNASMART-P model (developed by the Center for Transportation Research at the University of Texas and the Federal Highway Administration) in order to analyze various ATIS implementation strategies. Results showed that toll road usage and revenue were positively affected by ATIS, with a reduction in congestion on non-toll roads. Table 8 shows how the 706 participants in the online survey currently receive and would prefer to receive local traveler information; a vast majority currently uses radio and would prefer to continue using radio. Note that the term "radio" can include both commercial radio and HAR.

TABLE 8 AUSTIN COMMUTERS' CURRENT USAGE AND PREFERENCE IN THE MANNERS OF RETRIEVING TRAVELER INFORMATION (WALTON ET AL., 2006)

Question	Radio	TV	Local Newspaper	DMS	Internet
How do you currently receive traveler information on the local roadway system?	89%	36%	4%	12%	15%
Which of the following would you prefer to use to receive traveler information on the local roadway system?	78%	19%	2%	37%	18%

Patten et al. (2003) studied the use of ATIS by road users (motorists and truckers) on the Pennsylvania Turnpike. A mail survey was sent to 5,510 motorists and 3,584 truckers; 1,528 motorists (27.7%) and 889 truckers (24.8%) responded. Results are summarized below:

- Almost 33% of motorists and over 50% of truckers use VMS information in their trips.
- Almost 5% of motorists and around 15% of truckers use HAR information in their trips.
- Almost 45% of motorists obtained travel information before heading on their trip.
- Almost 45% of motorists used communications device(s) during their trip.

Cortelazzi et al. (2006) studied the expansion of the Pennsylvania Turnpike Commission's ATIS statewide; the ATIS included HAR, VMS, CCTV cameras, and many other technologies. This expansion allowed greater effectiveness in managing traffic and incidents, greater driver access to traveler information, a reduction in truck rollovers, as well as both economic and environmental benefits.

Martin et al. (2005) studied four major ATIS technologies (VMS, HAR, 511 calls, and CommuterLink website) in Utah. A survey was performed on 201 random respondents in Salt

Lake Valley; only 28.9% recognized these four ATIS technologies and only 4% used all of them. HAR was the second most known and used system after VMS. These results show that users of HAR usually found it helpful; a majority of HAR users did not often tune into HAR when the beacons were flashing; and that a lot of participants were aware of HAR, but did not necessarily use it. Recommendations focused on the advertisement and public education of ATIS technologies and how to integrate the various systems with each other.

Robinson et al. (2012) studied the deployment, use and efficiency of real-time TIS in six major cities (Rockville MD, Orlando FL, San Francisco CA, Teaneack NJ, Detroit MI, and Salt Lake City UT). A variety of data was collected via trip logs, focus groups, and surveys, amongst other methods. About 70% of agencies use HAR as a TIS, but many users had negative impressions of HAR due to the poor sound quality and lack of usefulness and updated information. These negative impressions led users to not use HAR and recommend others to not use it. However, about 18% of travelers used HAR while in transit to make trip decisions.

Young et al. (2009 and 2010) published a two phase report on evaluating the usefulness of TIS, focusing on DMS, on a 40 mile corridor of Interstate 80 in Wyoming. Surveys on both frequent and random travelers, as well as statistical analysis were used for this evaluation. Some results of the frequent traveler online survey showed that many people did not use any information source during their trips and only learned about incidents by encountering them while they were driving and that drivers felt DMS were the most important TIS technology.

Results from the 42 collected random traveler surveys conducted at travel plazas concerning the use of TIS technologies showed that DMS had the highest percentage of use (72% for trucks and 17% for non-trucks), then 511 (42% for trucks and 50% for non-trucks), then flashing caution signs (39% for trucks and 0% for non-trucks), then HAR (33% for trucks and 17%

for non-trucks), and then others including broadcast radio, CB radio, and TV. Also, results from the 147 random traveler surveys conducted at rest areas showed that HAR (8% for trucks and 14% for non-trucks) is less used than DMS (37% for trucks and 40% for non-trucks) and 511 (33% for trucks and 25% for non-trucks) for both truck drivers and regular motorists.

The University of South Florida (USF) (1993) prepared a report for FDOT that discussed integrated transportation information (real-time traffic information) applications in Tampa Bay. Data collection techniques used to gather real-time traffic information can be summarized in seven major methods: "inductance detectors, piezoelectric sensors, roadside detectors, video-based surveillance, fleet vehicles as probes, aerial surveillance, and citizen call-in" (USF, 1993). The use of CB radio by citizens was considered as a citizen call-in technique used for on-site incidents and congestion situations. The collected information was distributed to roadway users through many methods including "broadcast media such as TV and radio, inquiry-based media such as telephone, highway-based media such as HAR and VMS, and finally subscription-based media" (USF, 1993). The HAR system was considered as both broadcast and highway-based media.

Golob and Regan (2002) interviewed nearly 1200 trucking companies' managers to determine their experience with, usefulness of, and potential improvements for traffic information regarding trucking operations in California. Results showed that CMS (57%) and CB radio (56%) reports from other drivers were considered to be the most useful, then commercial radio (47%), and face-to-face drivers' reports (40%), with dedicated highway advisory radio (35%) being the least useful.

The usefulness of various improved TIS was also asked; these results showed that dedicated highway advisory radio had the highest percentage (64.7%) of drivers who thought it would be "very useful" in the future. CMS came in second with 56%, and then in-vehicle

navigation systems with 50%. This surprising result indicated that the drivers/managers see the current HAR in place at the time of study as not very useful, but they think with improvements it can be very useful.

Higgins et al. (2003) published a paper for improving communication with travelers in Wisconsin. The Wisconsin Department of Transportation (WisDOT) developed alternative route systems to relieve congestion during highway construction. After learning that these alternative systems were underused, WisDOT performed a study to examine the decision-making processes of their drivers regarding diversion to alternate routes. Media-specific strategies used by other agencies, including websites, smartphone applications, social media, text messages, e-mail lists, commercial radio, television, HAR, and DMS were discussed. A survey conducted at three driver license offices (total of 287 usable responses) found that the travel information sources most mentioned by commercial drivers were radio (56%), road signs (47%), WisDOT/Wi511 websites (39%), and other commercial drivers or dispatchers (39%). The following recommendations were made to WisDOT regarding the alternative route system:

- Encourage the use of the existing alternate route system by improving communications with travelers.
- Continue to educate drivers on the available traveler information website (www.511Wi.gov) by increasing promotional efforts.
- Provide drivers with additional messages, via DMS, concerning delays and alternate routes.
- Consider improvements to the existing HAR system such as use of clear computer-generated messages or personalized messages whenever possible to improve on the existing audio message quality.

- Make specific alternate route recommendations when feasible and supply drivers with information about the expected time when a delay-causing event will end.

Shaheen et al. (2014) published a paper about ITS deployment, including the use of some TIS technologies. A survey was conducted on stakeholders to determine the status of ITS deployment regionally and to identify future ITS testing locations and integration strategies. Key survey questions were associated with ITS status, transportation management center (TMC) status, factors that may slow development of infrastructure and technology deployment, and the relative status of 10 to 20 year ITS plans within the surveyed regions.

Survey results regarding deployment rates of various ITS technologies showed that 88% of responding stakeholders used CMS and 56% used HAR. It was also shown that 57% of TMCs are involved in incident management, 55% of TMCs are involved in coordination with emergency information agencies, and 52% of TMCs are involved with the distribution of public information.

A new, emerging TIS technology is the use of smartphone applications (apps) to obtain traffic information. Previous studies have not thoroughly investigated this technology, so the UCF research team performed some preliminary research regarding traffic information smartphone apps. **Kentucky Transportation Cabinet's (KYTC)** official website (http://511.ky.gov/) offers smartphone apps for iPhone and Android operating systems to help Kentucky roadway users obtain real-time traffic and travel information. **Virginia DOT (VDOT)** also has 511 systems that provide traveler information through a website, telephone, and smartphone apps. These apps allow users to obtain information on incidents and construction projects, in addition to access to live traffic cameras. Figure 15 shows a sample of the VDOT traffic app for iPhones.

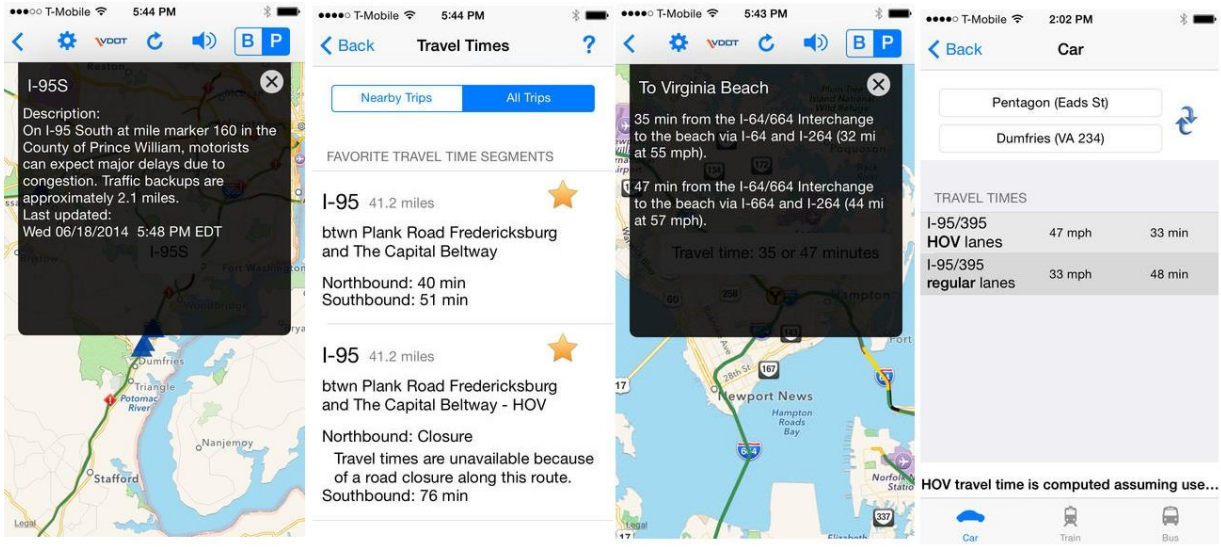


FIGURE 15 VDOT 511 VIRGINIA TRAFFIC APP ON IPHONE (SOURCE: APPLE ITUNES WEBSITE)

3.7 Literature Review Summary

This literature review shows that many states have evaluated various TIS technologies, including HAR and CB radios. No studies have been done on the CBRAS technology, although one study mentioned the Wizard CB alert system, which is similar to CBRAS. Many states found that HAR was not very useful for regular motorists, but that it was more useful for truck drivers. The main complaints about HAR were poor signal quality and the need to have a strong data collection infrastructure to provide real-time traffic information through HAR messages. New TIS technologies, including 511 phone systems, websites, and smartphone applications, have become more prevalent recently; however, these are often used to supplement the existing information that can be obtained from HAR or CB radio. The use of DMS has become very widespread in recent years, but this covers a smaller area and provides less information than HAR can. DMS is also more expensive than HAR, regarding equipment costs and operations and maintenance costs. For all the TIS technologies, it was found that advertising and promotion were necessary to ensure travelers understood these technologies were available and how to effectively use them.

Many of the previous studies conducted agency and/or traveler surveys regarding the use of various TIS technologies. However, there is no time to conduct agency surveys as part of this thesis. This is a future research work that is needed. Since Florida has a large proportion of out-of state travelers, it is important to conduct field surveys to determine if travelers from other areas are aware of and use HAR. Previous studies found that local travelers were less likely to use HAR than travelers from other areas; these field surveys will help to see if this is true for HAR in Florida as well. Knowing how the various traveler populations (local travelers, tourists, and truck drivers) view and use HAR and CBRAS, along with other TIS technologies, will allow agencies in charge to effectively decide whether these systems are useful and how to proceed with them in the future. No matter what technologies are used, it is important to educate the public about these technologies and ensure real-time data can be collected and distributed to travelers to ensure these systems are as beneficial as possible.

CHAPTER FOUR: METHODOLOGY

Proper development of the methodology is essential to ensure the surveys in this thesis obtain the desired information as efficiently as possible. The methodology includes design of surveys, selecting the method of survey implementation, determining sample sizes for each survey, and number and type of questions. This methodology will incorporate ideas from previous surveys that were analyzed in Chapter 3, Literature Review, but modify these to best fit the objectives of this thesis. This chapter discusses the methodology developed for each of these surveys. While certain aspects of the methodology overlap between some of the surveys, each survey has a unique feature that makes it beneficial to this thesis.

4.1 **Design of Surveys**

To obtain accurate and representative travelers' feedback on HAR and CBRAS, a unique tool for each of the three surveys is needed. Planning of the three survey tools also involves selecting the method by which the surveys will be implemented, the desired sample size, and amount of information needed. The survey tool design includes modification of previous survey ideas to fit the objectives of this project (ideas discussed in the Literature Review, Chapter 3 of this study).

The three surveys developed and implemented in this thesis are:

- HAR CATI Phone Survey (Computer-Assisted Telephone Interviewing)
- CBRAS/HAR Field Survey for Truck Drivers
- HAR Field Survey for Travelers/Tourists

The CATI Phone survey questions and the field questions were similar with respect to gender questions, HAR awareness and preferred method of receiving traffic information. There were, however specific questions that can be asked to the field traveler but may not necessary apply to the telephone respondents. HAR Field questions, for instance, included specific questions about trip purpose, trip origin and destination. CATI Phone survey was primarily focused on getting HAR awareness information, alternative methods of receiving traffic information and travelers delay threshold for making a route diversion. Since the CBRAS was limited to commercial truck drivers, feedback questions were generally specific to this system. The CBRAS survey tool was tailored to collect information on the usability, clarity and accuracy of the service. Reliability on the CBRAS was another important parameter which needed to be measured.

A number of the CBRAS questions focused on route diversion as a scale to quantify the reliability of this system. All surveys sought travelers' stated preference with regards to hypothetical situations, especially those relating to the emergency evacuation situations. It is worth mentioning that open-ended questions were limited in all three surveys. This was purposely done to ensure accuracy and consistency of collected data. As it is policy of the University of Central Florida, all surveys collected for research must be preapproved by its Institutional Review Board (IRB), see Appendix F. All three surveys were thoroughly reviewed and modified to secure final approval from the UCF IRB. Prior to implementation, the three surveys were also reviewed and approved by project managers with the sponsors of this study, FTE and FDOT.

4.2 HAR CATI Survey

The purpose of the HAR CATI survey is to obtain information from Florida Turnpike travelers on their knowledge, use, and satisfaction with HAR, as well as information on other traffic information sources they use. This survey utilizes the "Computer-Assisted Telephone Interviewing" (CATI) survey method, which employs random digit dialing to call potential survey participants from a target audience. This ensures a random sample of the target audience is obtained without wasting excess resources calling people who do not meet the survey requirements. The target audience for this survey is frequent Turnpike travelers, so only phone numbers of people who live in zip codes close to the Turnpike were randomly called. A sample size of 1000 completed surveys was chosen for this survey in order to provide enough information for statistical modeling.

For this survey, it was important to include questions regarding the participant's awareness of HAR, use of HAR, and satisfaction with HAR if he or she has ever used it. Diversion questions relating to HAR were also important to indicate how travelers respond to HAR delay messages. There were also questions on the participant's use of other traffic information sources and demographic questions relating to age and education level to provide FTE and FDOT with additional information about traveler's preferences and characteristics. Screening questions were also needed to ensure the participant was a member of the target audience; if the participant was not a Turnpike traveler, the survey was terminated and not counted as a complete survey. Since the survey is implemented over the phone, only multiple choice questions were used; no free response questions were included in the survey. Additionally, the number of questions was selected to provide as much information as possible while still keeping the length of the entire

survey at ten minutes or below to prevent participants from stopping in the middle of the survey. The survey contains a total of 28 questions, which are summarized in Table 9. However, there are many paths of the survey, which can cause the length to vary from a minimum of 14 to a maximum of 28 questions. The detailed design of this survey, as well as all of the other field surveys, are shown in Appendices 1-3 (Design of Surveys) of this thesis. The HAR CATI Phone survey design is shown in Appendix A.

TABLE 9 SUMMARY OF QUESTIONS IN HAR CATI SURVEY

Question Type	Number of Questions
General Information	4
Diversion	7
Traffic Information Sources	4
HAR Awareness	3
HAR Use	6
HAR Satisfaction	2
Demographic	2

4.3 CBRAS/HAR Field Survey for Truck Drivers

The purpose of the CBRAS/HAR field survey is to obtain information from freight truck drivers that travel on the Florida Turnpike or Florida interstates regarding their knowledge, use, and satisfaction with CBRAS and/or HAR, as well as information on other traffic information sources they use. Since it is difficult to target truck drivers over the phone or online, it was deemed necessary to travel to service plazas along the Turnpike, as well as rest areas on interstates, to survey these truck drivers.

Based on the suggestions of the FTE and FDOT management teams who sponsored this study, these surveys have been collected at three FTE service plazas (Okahumpka, Turkey Lake, and Canoe Creek) and two FDOT rest areas (I-95 rest area in St. Lucie and I-75 rest area in Charlotte). The five selected locations were considered priority as they were thought to provide most practical coverage of travelers within the state. A map of these locations is provided Figure 17 below.

FIGURE 16 FDOT REST AREA AND SERVICE PLAZA INFORMATION

Student research assistants equipped with iPads have been sent to each of these locations and surveyed truck drivers. The survey has been programmed on a server and is accessed via a website on the iPad. This implementation method is innovative and allows for the completed surveys to be stored on the server so they can be accessed and analyzed at a later date. A target sample size was established at 500 completed surveys. The target audience for this survey is commercial freight truck drivers who frequently utilize FIH's and FTE service plazas. The 500 survey sizes sample originally intended was exceeded by more than 22% (a total of 613 truck driver surveys were collected). This survey was unique in its focus on the CBRAS, which is only available to truck drivers with CBRAS units installed in their trucks. For this survey, it was important to include questions regarding the truck driver's awareness, use, and satisfaction with CBRAS and/or HAR (full CBRAS survey design is provided in Appendix B). In order to prevent the survey from being too lengthy, it was decided to only ask a participant about either CBRAS or HAR. If the participant has ever used CBRAS, he or she will be asked questions pertaining to the use and satisfaction with CBRAS and not asked questions about HAR. If the participant is not aware of or has never used CBRAS, he or she will be asked questions about HAR. Splitting the survey in this manner provides the desired information while still keeping the survey's length at a minimum Since this is the only survey that asks about CBRAS, the CBRAS questions were chosen to have priority over the HAR questions in regard to the order asked. The survey also contains diversion questions relating to CBRAS and HAR, questions about the participant's use of other traffic information sources, and demographic questions. Only multiple choice questions were used to keep the survey short and provide the capability for statistical modeling. The survey contains a total of 22 questions (summarized in Table 10) However, since a participant is only asked either the CBRAS or HAR questions (or neither if he or she has never used either technology), the

maximum number of questions a participant will be asked is 16 questions, with a minimum of 6 questions.

TABLE 10 SUMMARY OF QUESTIONS IN CBRAS/HAR FIELD TRUCK DRIVER SURVEY

Question Type	Number of Questions
General Information	3
Traffic Information Sources	3
CBRAS Awareness	1
CBRAS/HAR Use	4
CBRAS/HAR Satisfaction	4
Diversion	4
Demographic	3

Similar to the CATI Phone Survey, it was important to include questions regarding gender, the participant's awareness of HAR, use of HAR, and satisfaction with HAR if he or she has ever used it.

4.4 HAR Field Survey for Travelers/Tourists

The purpose of the HAR survey for travelers/tourists is to obtain information from Florida Turnpike and interstate drivers regarding their knowledge, use, and satisfaction with HAR, as well as information on other traffic information sources they use. To obtain a more thorough understanding of travelers' opinions relating to HAR, both Florida residents and tourists should be surveyed. Tourists will be hard to survey over the phone or online, so it was decided to perform these surveys at service plazas along the Turnpike, as well as rest areas on interstates, similar to the CBRAS/HAR survey for truck drivers. These surveys were collected at the same three FTE

service plazas (Okahumpka, Turkey Lake, and Canoe Creek) and two FDOT rest areas (I-95 rest area in St. Lucie and I-75 rest area in Charlotte) as the CBRAS/HAR field truck driver survey. The field surveys were programmed on a server which was accessed via a website. The iPads used for the field truck driver survey were programmed to access this HAR field survey as well. Student research assistants who conducted the survey in the field, are therefore, able to choose the appropriate survey (CBRAS/HAR for truck drivers or HAR for travelers/tourists) and ultimately be linked to the question set associated with that survey.

The design of this HAR field survey is very similar to the design of the HAR CATI survey (see full design of this survey in Appendix C). However, some questions were removed, such as the diversion questions, as they might be confusing for tourists who do not use these roads frequently. The survey contains a total of 20 multiple choice questions, which are summarized in Table 3. Due to the multiple paths, the length of the survey can vary from 13 to 20 questions.

TABLE 11 SUMMARY OF QUESTIONS IN HAR TRAVELER/TOURIST SURVEY

Question Type	Number of Questions
General Information	2
Traffic Information Sources	4
HAR Awareness	3
HAR Use	6
HAR Satisfaction	2
Demographic	3

The target sample size was 1500 units. The target audience for HAR survey were all travelers who utilize the FTE and FIH roadway systems. The collected sample of 1610 surveys exceeded the

originally intended sample size by more than 7%. The HAR field survey also shared basic questions with the both CATI HAR survey and the field CBRAS-HAR survey. Common questions among the three surveys include traveler gender, HAR awareness, HAR satisfaction, and frequency of use.

CHAPTER FIVE: DATA COLLECTION

The field surveys were innovative in that they were performed using iPads to conduct live, on-site interviews with tourists and truck drivers. Completed surveys were instantly submitted to a web server that hosts this data for future use and analysis. UCF has daily access to collected surveys to monitor data collection quality and efficiency. The live monitoring ability has played a significant part in ensuring high quality reliable data collection. The execution of the field survey required use of 6 to 8 iPads on each of the collection dates. These units were purchased and used for both HAR and CBRAS surveys. Switching between the two different surveys (HAR/CBRAS) was easily done as these surveys were hosted on the web server. This ability allowed users to streamline the survey process and collect the maximum possible surveys in a reasonably short time period. It is worth mentioning, however, that hard copies of both survey types were kept at hand as backup, in the unforeseeable event that any of the survey iPads seizes to operate due to issues with the cellular carrier network.

FIGURE 17 LEFT: A SINGLE IPAD SHOWING APPLICATIONS IN GENERAL. RIGHT: IPADS USED FOR FIELD DATA COLLECTION

5.1 Survey Team Selection, Training and Certification

Based on the sample sizes and the selection of a number of the survey locations, twelve UCF students were carefully selected for the task. The selected twelve-student team included undergraduate and graduate students. The majority of the team members were civil engineering seniors, however, a few of them were from other majors. Team members majoring in the fields of Psychology as well as Business Administration were intentionally selected, for their presumed experience in research and marketing. These skills have proved to be essential to the team's ability to perform well and interact with the public sample being surveyed. The team has also made use of the multi-lingual ability of some of its members and interviewed non English drivers in four other languages. These languages included Arabic, French, Portuguese, and Spanish.

In order for team members o be able to work for a UCF sponsored research with surveys on behavior of human subjects, each of the team members had to receive human behavior research training, through UCF's Institutional Review Board (IRB). The IRB consists of a committee established (http://www.research.ucf.edu/Compliance/irb.html) to "advocate for the protection of the rights and welfare of human participants involved in research". A certification process followed the training, was also required under the IRB's Collaborative Institutional Training Initiative (CITI) Program. The certification required that each team member completes training and passes a test on the material that he or she have received his or her training on. Figure 19 depicts a picture of few team members along with Professor Al-Deek and FDOT project manager, Eric Gordin.

FIGURE 18 TEAM MEMBERS AND PROFESSOR HAITHAM AL-DEEK (UCF INCIPAL INVESTIGATOR) AND FDOT PROJECT MANAGER (ERIC GORDIN)

The team members started early on all survey days to take advantage of day light and to offset any unforeseeable delay. On one occasion the team has planned to arrive early at FTE's Okahumpka

Service Plaza, (this was a revisit to the same plaza they surveyed several weeks before), only to find out that it has been completely demolished for the purpose of renovation. Their early start served them well that day as they were able to make it to the nearest service plaza where they were able to start interviewing travelers by 9-am that same morning. Other logistics such as separating team members in groups to provide coverage for travelers in the north and south bound directions of service plazas, worked well. In addition to cars and commercial fright trucks, the team interviewed other types of highway users. Polled users included recreational vehicles (RV's), maintenance vehicles, service vehicles, and motorcycles. Implementation of both field surveys for data collection started on November 15, 2014 and ended in February, 2015. As of February 22, 2015, a total of 13 trip-days were completed at the FTE service plazas and FDOT rest areas (4 trip-days to Canoe Creek Plaza, 4 trip-days to Turkey Lake Plaza, 1 trip-day to Okahumpka Plaza, and 4 trip-days total or 2 trip-days per each of the interstate rest areas). From these, a total of 613 HAR/CBRAS truck driver surveys and 1610 HAR traveler/tourist surveys were collected.

Figure 20 (on the following Page) shows the boundaries Florida Department of Transportation seven geographical districts. The seven districts include the Florida Turnpike Enterprise as an independent district. The map is color coded, for ease of identification of the boundaries of each of the districts. The five field survey locations selected for this study, were divided among three of the seven Districts. The Florida Turnpike Enterprise service plaza locations (Canoe Creek TSP, Okahumpka TSP and Turkey Lake TSP) were all encompassed by District 5. St Lucie's (along I-75) Rest Area was encompassed by District 4, while District 1 encompassed Charlotte County Rest Area (along I-95).

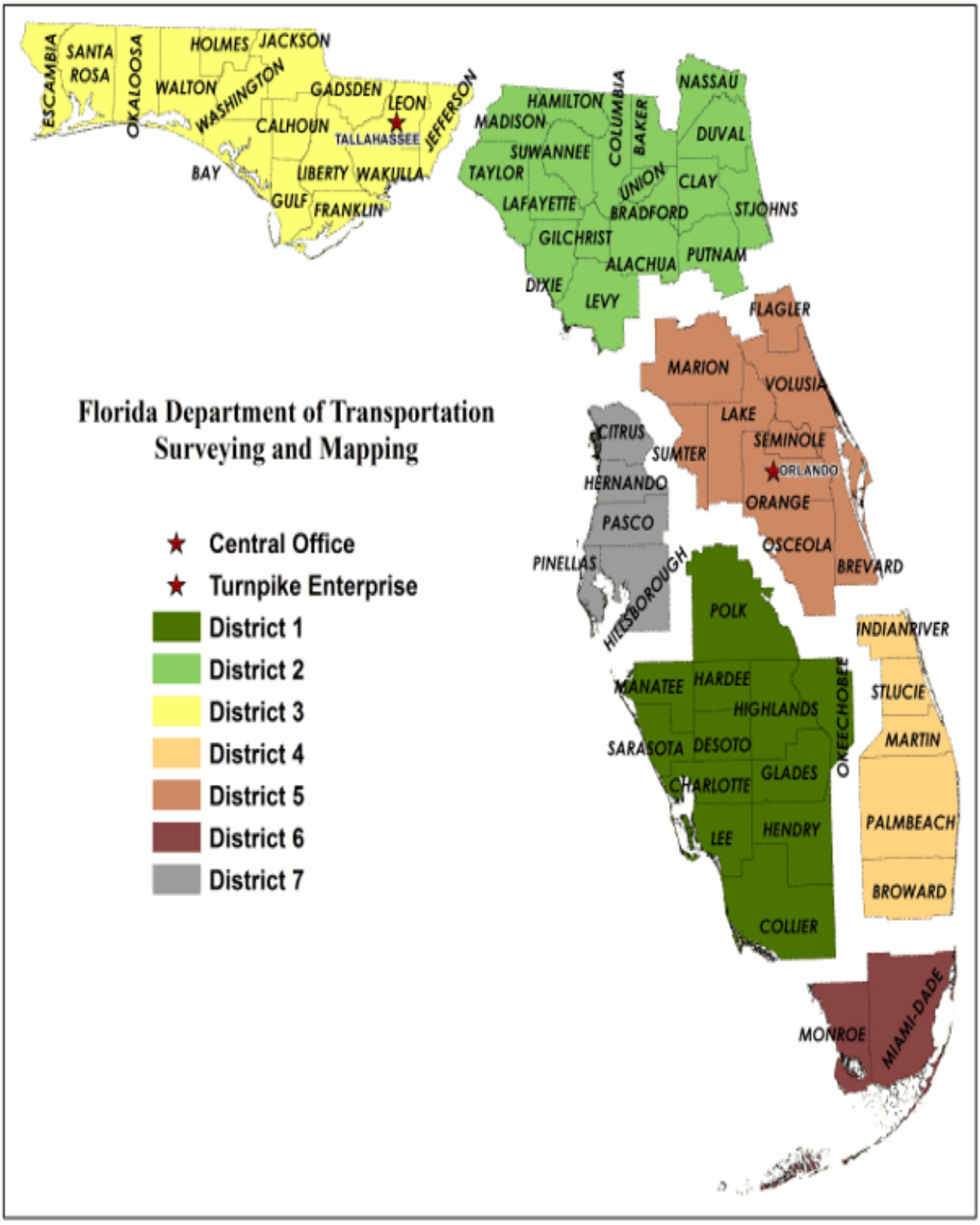


FIGURE 19 FLORIDA DOT REGIONAL DISTRICTS

CHAPTER SIX: DATA COLLECTION

6.1 HAR CATI Survey Statistics

The results of the survey are provided in frequency tables in Appendix G. The following provides detailed discussion of these simple statistical results. A target sample of 1000 was collected using the CATI method. Approximately half of the survey participants knew about HAR, a few have used it but most of them have not. Five hundred twenty-seven (527) of the 1000 participants (53%), were aware that HAR is available on the Florida Turnpike. Four hundred twenty-five (425) became aware of HAR via the signs along the Florida Turnpike (81%), 42 became aware of HAR via a friend or relative (8%), 12 became aware of HAR from the Florida Turnpike website (2%), and 48 became aware of HAR via other methods (9%). HAR use among the Florida Turnpike travelers who (out of the 527, 221 aware-individuals) have previously used it are classified as follows; Rare use at 46% and 35% use it occasionally, 10% use it often, and 9% use it on regular basis, HAR messages about roadway congestion was heard among users 62% of HAR users, while 61% of these users diverted off the Florida Turnpike to avoid the this congestion announced in these message. Delays of 15 or 30 minutes broadcast over HAR will potentially cause 70% of respondents to divert off the Florida Turnpike. When asked about their satisfaction with the HAR service, 83% of the HAR users were "Satisfied" or "Strongly Satisfied" with HAR. Traffic congestion information being the most important type of information to be broadcast over HAR, was concluded by 53% of the users, and 85% of respondents said HAR should be continued. The percent of respondents who said that they would use HAR in the future was 83% of respondents and 79% of respondents would use HAR in an emergency, with an additional 12% that would use HAR after consulting other information sources. When HAR users were asked about their reasons for service satisfaction 34% indicated that their satisfaction was due to accuracy of information

and information being up-to-date. The ease of understanding HAR messages caused 26% satisfaction among its users. HAR's ability to provide location specific messages message resulted in 22% user satisfaction. Ease of access to HAR message resulted in 19% user of satisfaction. On the other hand, the main reasons for dissatisfaction were due to HAR message being difficult to understand (43%), and having limited coverage area. In an effort to potentially increase the awareness of HAR all 1000 participants were asked their opinions on how to promote it. Their feedback varied, with 31% choosing highway DMS, 24% choosing popular radio stations, and a minimal 6% choose the FTE or FDOT website.

6.2 Summary of HAR CATI Survey Analysis

The HAR Phone Survey showed that a majority of the sampled Turnpike customers thought HAR was good and should be continued. People who had used HAR generally had positive experiences and trusted the accuracy of HAR congestion messages. A majority of the participants, however, were elderly and infrequent users of the Turnpike and had never used HAR. The survey also showed that people like to use DMS for travel information and do not prefer to use Florida 511 or CB radios. The results from this phone survey makes a good first-step user assessment of the HAR. The field HAR surveys, the planned online HAR and public agencies' opinions on HAR technology, however, are important supplemental elements to a more accurate assessment of the service. These surveys can collectively provide feedback from younger, more frequent Turnpike travelers. Looking at all of these surveys together will allow for a more accurate assessment of Turnpike users' opinions and experiences regarding HAR. It is important to point out that the HAR online and agency surveys are not part of this thesis due to time constraints but will be pursued by the project and continuation of this study.

6.3 CBRAS ANALYSIS

The results of the survey are provided in frequency tables in Appendix H. The following provides detailed discussion of these simple statistical results. A total of 613 truck driver CBRAS surveys were completed. Of which 54% of the truck drivers had CB radios in their trucks and 44% of the truck drivers who had CB radios were aware of CBRAS. Fifty two percent (52%) of these had used CBRAS (12% of total 613 truck drivers) and 84% of CBRAS users used it "Sometimes," "Often," or "Always." The vast majority (92% of CBRAS users) were "Satisfied" or "Strongly Satisfied" with CBRAS. Truck drivers who used CBRAS were mostly satisfied with accurate up-to-date information and ease of access. A majority of 68% of CBRAS users have heard a message over CBRAS concerning congestion. A significant finding is that 71% CBRAS users, who had heard the traffic congestion message (on CBRAS) have diverted off of the Turnpike. Truck Drivers who had never used CBRAS (88%) were then asked about HAR and 27% of these truck drivers had used HAR. The CBRAS Survey indicated that 57% of these truck drivers were not using CBRAS, have used HAR "Sometimes," "Often," or "Always." User satisfaction levels were at 72% of the "Satisfied" or "Strongly Satisfied" with HAR. The most common complaints were that HAR is not easy to access or understand. HAR message concerning congestion were heard by 44% of the HAR users, and 55% of them diverted off the Turnpike to avoid congestion. Truck drivers' demographics indicated that 97% of them were males, 59% lived in Florida. Florida's Turnpike/I-75/I-95 were traveled once a week or less by 45% of the surveyed truck drivers, 23% traveled these roads more than 5 times per week. The survey results also indicated that 78% of the truck drivers who used HAR or CBRAS had more than 10 years professional truck driving experience.

GPS Navigation devices were the most preferred travel information source, selected by 28% of the surveyed truck drivers. The second most preferred source for the information was smartphone applications, selected by 22% truck drivers and 69% of theses drivers used Google Maps. Truck drivers also indicated they received travel information sources as follows; 16% from CB radio, 15% from DMS, 9% from commercial radio, 5% from their dispatcher, 3% from Florida 511, and 2% from HAR

6.4 CBRAS Field Traveler Survey Summary

A total sample size of 613 surveys with over 50% of truck drivers having access to some type of CB radios completed. A quarter of this sample was aware of CBRAS and about a little over ten percent have actually used it. Almost all CBRAS users were satisfied with its use, and a quarter of truck drivers in the sample who had no CBRAS experience have used HAR. The majority of the HAR users were satisfied, truck drives preferred source to receive traffic information was GPS navigation device. The survey sample indicated a majority experienced truck drivers with daily use of FTE and FIH.

6.5 HAR Field Survey for Travelers and Tourists, Statistical Analysis

The results of the survey are provided in frequency tables in Appendix I. The following provides detailed discussion of these simple statistical results. Design of this HAR field survey was very similar to the design of the HAR CATI survey. A total of 1610 surveys were completed for tourists and commuters traveling on the FTE and FIH roadway systems that were also non-truck drivers. Their awareness of HAR was sought early on in the survey. A majority of 61% of respondents were aware that HAR is available on Florida Turnpike, and Florida Interstate Highways (I-75/I-

95). HAR roadway signs were most informing, as 57% travelers became aware by reading these signs. Respondents who had used the HAR on the Florida Turnpike/ I-75/I-95 were 22% of the sample size. The resulting frequencies for this user segment are; 12% used it "Rarely," 6% used it "Sometimes," 3% used it "Often," and 1% used it "Always." Field survey results confirmed travelers' satisfaction levels received earlier from the CATI phone survey with 80% of HAR users were "Satisfied" or "Strongly Satisfied" with HAR. Satisfaction reasons were contributed to HAR providing accurate, up-to-date information by 36%, and 64% users felt that traffic congestion information is the most important type of information to be broadcast on HAR. When asked if HAR should be continued or not, 89% of respondents said HAR should be continued and 84% of respondents said they would use HAR in the future. Emergency HAR users formed 44% of respondents, with an additional 38% that would use HAR after consulting other information sources. Feedback on most preferred method of receiving travel information, 34% preferred DMS for travel information respondents, 28% preferred smartphone applications, 23% preferred GPS navigation devices. Remaining percentages were 14% preferring commercial radio reports, 2% preferring HAR, and 1% preferred Florida 511. The most preferred smartphone application was Google Maps which was preferred by 16% of travelers. If HAR was discontinued, 72% of respondents would use DMS for travel information, 58% would use smartphone apps, and 56% would use commercial radio reports. Note that these percentages will not add to 100% because for Question 16 in the HAR field survey it says check all that apply, so some travelers checked more than one answer which is allowed in this question. Compared with CATI phone survey demographics, the HAR field respondents were significantly younger with 54% of the respondents were under 50 years old. Female respondents were comparatively lower at 38%. The HAR field survey was less biased and more representative of the population. Most travelers taking the field

survey (74%) traveled on the Florida Turnpike/I-75/I-95 once a week or less, and 10% traveled on these roads more than 5 times per week. A majority travelers of 64% were using the Florida Turnpike/I-75/I-95 for leisure or vacation and 71% of them lived in Florida. Another point of consistency with the CATI phone survey is that the higher majority of travelers surveyed in the field were college graduates holding an associate degree or higher (61%).

6.6 HAR Field Traveler Survey Summary

Total sample of 1610 completed surveys. HAR percent usage among travelers was relatively small although the majority of the respondents were aware of the HAR service. High satisfaction levels were reported among the users (290 out of the 362 who said they were aware of HAR were either satisfied or strongly satisfied, see Question 10 of the HAR field survey). A higher number indicated desire for the service to continue even though most of them were not even aware of it and have never used it before (1429 out of the entire 1610 sample, see Question 15 in the HAR field survey). Although most of travelers indicated intent for future use, DMS still topped respondents' list as most preferred choice of travel information. The HAR sample in the field survey mainly consisted of Florida Turnpike/I-75/I-95 users who used the road for leisure and used it once per week or less.

6.7 CATI Phone Survey and HAR Field Survey Comparisons

6.7.1 HAR Awareness and Use: HAR CATI and HAR Field Comparison:

TABLE 12 HAR AWARENESS AND USE: HAR CATI AND HAR FIELD SURVEY COMPARISON

Question	Answer	Phone Survey Results	Field HAR Survey Result
HAR Awareness	Yes	53%	61%
HAR Usage	yes	22%	22%
HAR Satisfaction	"Satisfied" or "strongly Satisfied"	83%	80%
HAR Continuation	continued	85%	89%
Future use of HAR	Yes	83%	84%
Emergency use of HAR	Yes (including after checking w/ other information sources first)	90%	82%

As seen in the above Table 6.1, the comparison between the field and the CATI survey shows close agreement between the two surveys in awareness levels, and levels of use and satisfaction. This consistency is observed throughout the table. The gab noticed between the parameters was 4% on average. The largest differences occurred in two out of the six parameters compared (awareness and emergency use of HAR). This indicates more awareness of HAR from the field survey, and more dependency on use during emergency events from the telephone.

6.7.2 Respondent Demographics (HAR Phone vs. HAR Field):

TABLE 13 HAR CATI AND HAR FIELD RESPONDENT DEMOGRAPHICS

Question	Answer	HAR Phone Survey Results	HAR Field Survey Results
Age	Over 50 years old	60%	46%
Gender	Male	42%	62%
Trip Purpose	Work or school	23%	17%
Trip Purpose	Leisure/Vacation	42%	64%
Trip Frequency	Once per week or less	70%	74%
Trip Frequency	More than five times per week	9%	10%
Educational Level	Associate Degree or higher	59%	61%

Examination of the above table comparisons of demographics between the telephone and field surveyed travelers shows a wider gab than the HAR awareness and use table. It is worth noting that the largest difference between the two surveyed groups appears in the age category. The field sample includes a significant number of users who are younger than 50-years old, in comparison with the telephone sample. The field sample also shows significant shift towards having more male respondents than the telephone sample. A third area showing notable variation between the respondents whose trip purpose is for leisure (significantly larger portion in the field compared to the phone survey).

6.7.3 Preferred ATIS Information Sources (HAR Phone vs. HAR Field):

TABLE 14 PREFERRED ATIS TRAFFIC INFORMATION SOURCE COMPARISON

Question	Answer	HAR Phone Survey Results	HAR Field Survey Results
Preferred Type of HAR Message	Traffic Congestion Locations & Durations	58%	64%
Preferred Travel Information Source	DMS	31%	34%
Preferred Travel Information Source	HAR	7%	2%
Preferred Travel Information Source	Smartphone Applications	15%	28%
Alternative if HAR was Discontinued	DMS	83%	72%
Alternative if HAR was Discontinued	Smartphone Applications	53%	58%

This table compares preferences of field and telephone survey respondents with regards to the traffic information message type, travel information source and HAR alternatives. Both categories elect traffic congestion location and duration as most important. The two groups also agree on DMS as their alternative source of traffic information if HAR was to be discontinued, closely followed by smartphone applications. A small percent of each sampled group selects HAR as a favorite source of travel information.

CHAPTER SEVEN: SAS DECISION TREE MODEL

7.1 Introduction

The purpose of this document is to examine the two samples of HAR phone and HAR field surveys using more advanced statistical analysis, namely building a tree model. This document also explains how the model was built when the two samples (field and phone) were combined together. The combination was necessary to get sufficient sample size for the tree model based on the responses of travelers.

The combined sample decision tree model is influenced by a neural network model that is built first to understand the important parameters needed for the tree model and to minimize the number of trials and errors to get to the best tree model.

The HAR satisfaction question "How would you rate your experience with HAR and the travel information it provides?" from both the field and phone surveys were used as the target variable. Matching questions were used from each survey. No non-matching questions were used.

Steps to build the Tree Model

- Target HAR Satisfaction Questions and Simple Results
- Matching Survey Questions for Modeling Field and CATI
- Survey Question Plots with Binary Satisfaction
- Statistical Exploration
- Modeling Set Up
- The Combined Sample Tree Model Results

7.2. Survey Target Satisfaction Questions & Simple Results

Below are the two questions and their simple statistical results (see Appendices 7 and 8).

The Field Survey Results

Table 15 hq10 How would you rate your experience with HAR and the travel information it provides?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Satisfied	54	3.4	14.9	14.9
	2 Satisfied	236	14.7	65.2	80.1
	3 Dissatisfied	49	3.0	13.5	93.6
	4 Strongly Dissatisfied	23	1.4	6.4	100.0
	Total	362	22.5	100.0	
Missing	System	1248	77.5		
Total		1610	100.0		

The CATI (Phone) Survey Results

Table 16 Q14. How would you rate your experience with Highway Advisory Radio and the travel information it provides?

Value	Description	Counts	%
1	Strongly Satisfied	26	11.76
2	**Satisfied**	**158**	**71.5**
3	Dissatisfied	24	10.86
4	Strongly Dissatisfied	13	5.88
Answered		221	

From the phone survey 221 participants used HAR and could be asked about their satisfaction with HAR. Combined HAR CATI and field samples provide a total of 583 participants who were asked about their satisfaction with HAR. For the purpose of simplifying the modeling and understanding the results, all satisfaction responses are labeled as "1" and all dissatisfaction responses are labeled as "0." The table below simply explains these combined questions and combined responses.

TABLE 17 COMBINED HQ10 AND Q14

Q10 Field & Q14 CATI	Grand Total	%
Satisfied with HAR (labeled as "1" in model)	474	81.30%
Not Satisfied with HAR (labeled as "0" in model)	109	18.70%
Grand Total	583	100.00%

7.3. Survey Questions that Match in both Survey to Explore for Modeling

The following Table 15 shows the shared questions; the red cells represent filtering questions that were answered "yes" by all of the HAR users, so these questions were not included for modeling.

TABLE 18 SHARED QUESTIONS BETWEEN HAR CATI AND HAR FIELD SURVEYS

Match		
CATI	Field	Description
gender	qs4	Gender
q2	hq1	Trip Purpose
q6	hq2	Route Times-Week
q7	hq3	Preferred Travel Info
q9	hq5	Like about Preference
q10	hq6	Aware of HAR
q11	hq7	How Aware HAR
q12	hq8	Used HAR
q13	hq9	Freq HAR
q14	hq10	Rate Experience
q16	hq12	HAR most important Info
q22	hq13	Hurricane Evac. Use HAR
q23	qh14	Where increase aware HAR
q24	hq15	HAR continued or discontinued
q26	hq17	Continued use
q27	hq19	Age
q28	hq20	Education

7.4. Chi-square Table of HAR Experience & Other Questions

Table 16 compares the input questions with the target satisfaction question. Chi-Square test statistics are noted and degrees of freedom (DF) are shown. Significant probability less than 0.05 is highlighted yellow.

TABLE 19 CHI-SQUARE COMPARISON TABLE FOR QUESTION VS SATISFACTION

Input	Chi-Square	Df	Prob
HAR_continued_or_discontinued	77.929	2	<.0001
Continued_use	62.1994	1	<.0001
Hurricane_Evac__Use_HAR	59.8826	2	<.0001
Freq_HAR	14.165	3	0.0027
Age	11.791	4	0.019
How_Aware_HAR	10.2067	3	0.0169
Preferred_Travel_Info	8.8855	6	0.1801
Like_about_Preference	7.8329	6	0.2506
Where_increase_aware_HAR	6.8061	5	0.2355
Trip_Purpose	6.6489	3	0.084
Route_Times_Week	6.2315	3	0.1009
Gender	5.4963	1	0.0191
HAR_most_important_Info	4.7269	5	0.4501
Florida	2.9553	1	0.0856
Education	2.4488	4	0.6538

7.5. Categorical Bar Charts of Important Variables within the Models:

The following bar charts show the questions that were important from the modeling results.

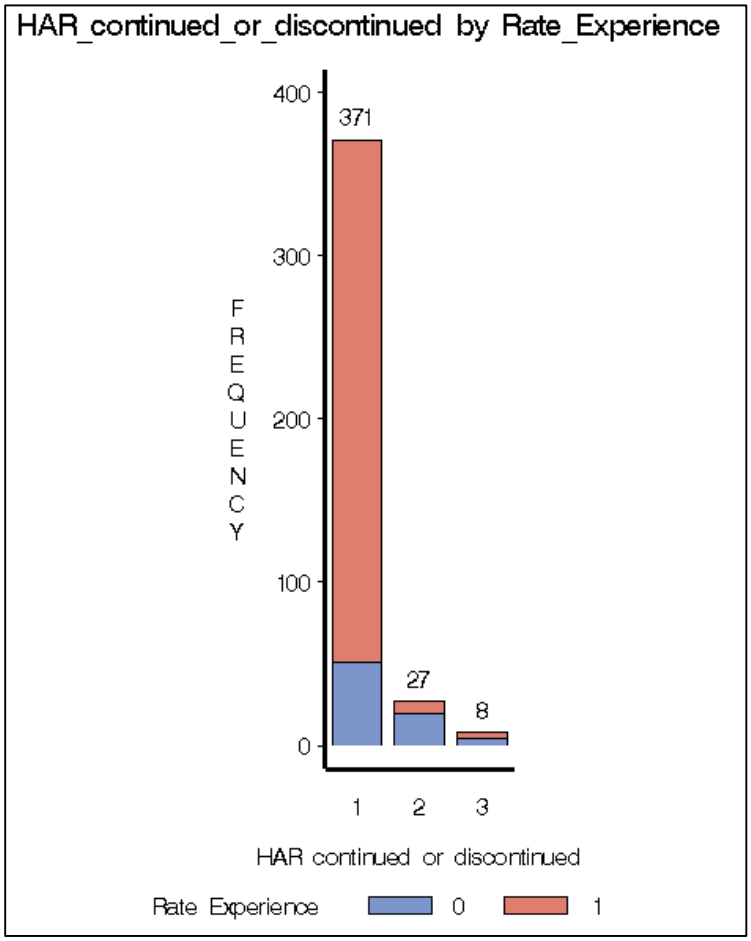


FIGURE 20 HAR CONTINUED VS. DISCONTINUED OPINION

(Continued=1, Discontinued=2, Impartial=3)

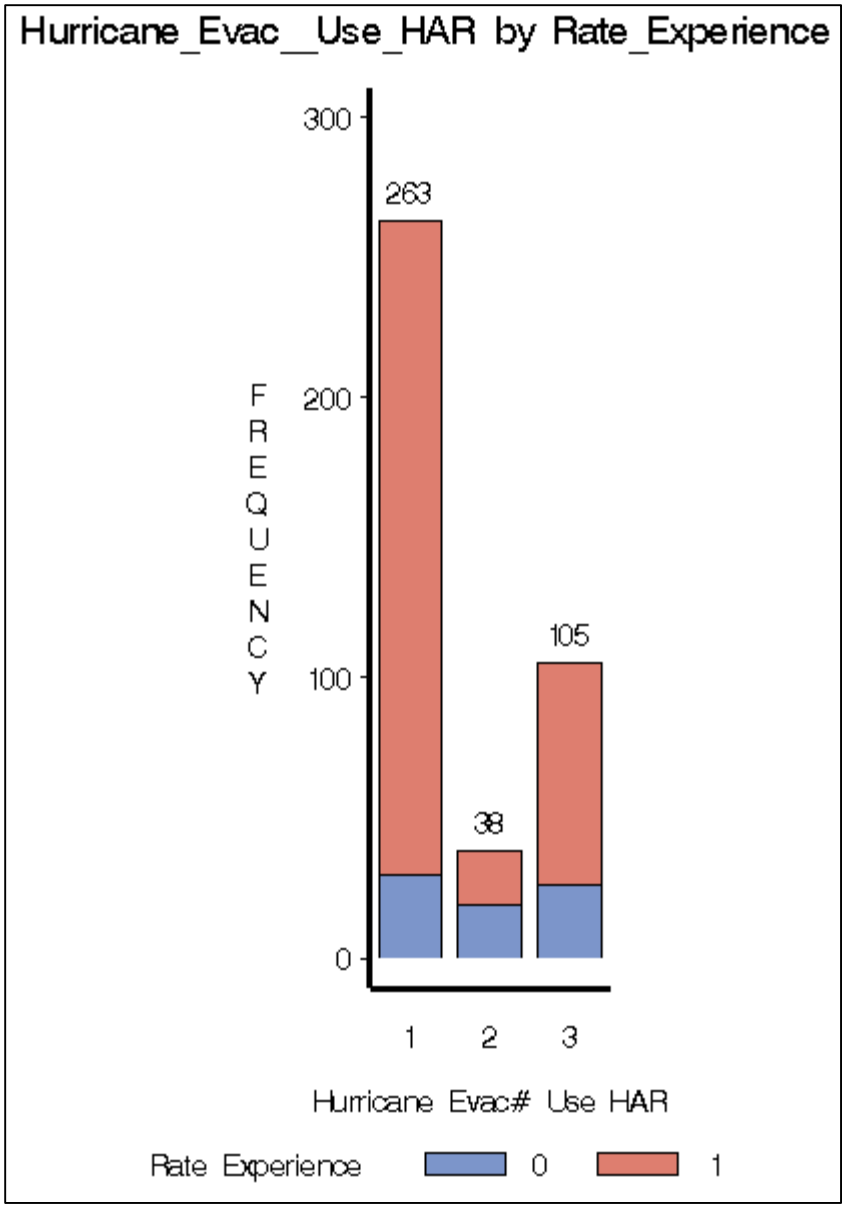


FIGURE 21 HAR USE DURING HURRICANE EVACUATION

(Will use=1, Will not use=2, Use but seek other information sources first=3)

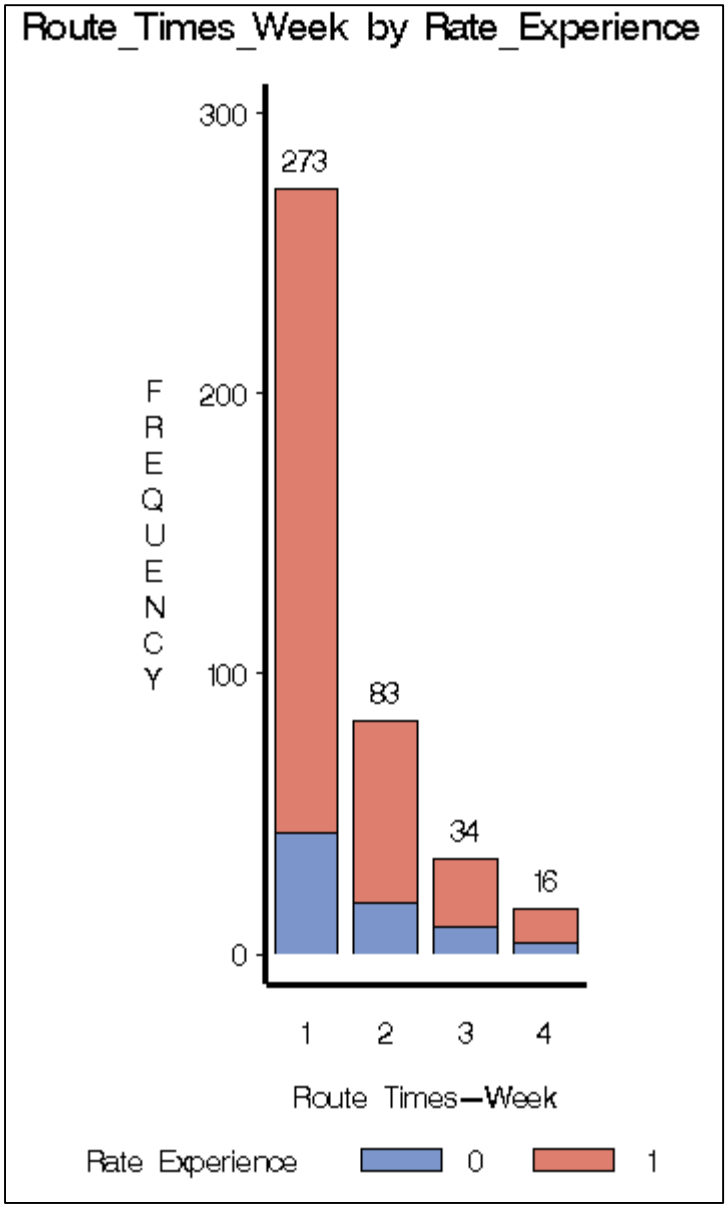


FIGURE 22 WEEKLY UTILIZATION OF ROUTE

(Rout travel once or less/week =1, Route travel 2 to 5 times a week=2, Route travel 6 to 10 times a week=3, Route travel more than 10 times a week=4)

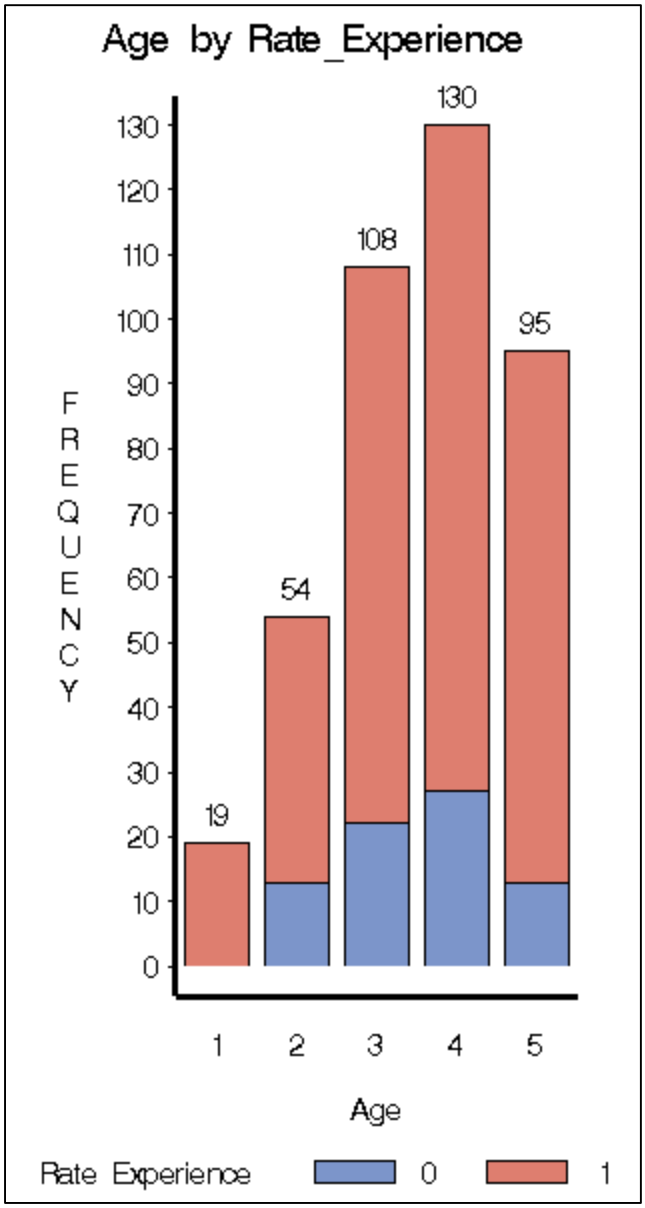


FIGURE 23 AGE BY RATE EXPERIENCE

(18 to 25=1, 26 to 35=2, 36 to 50=3, 51 to 65=4, over 65=5)

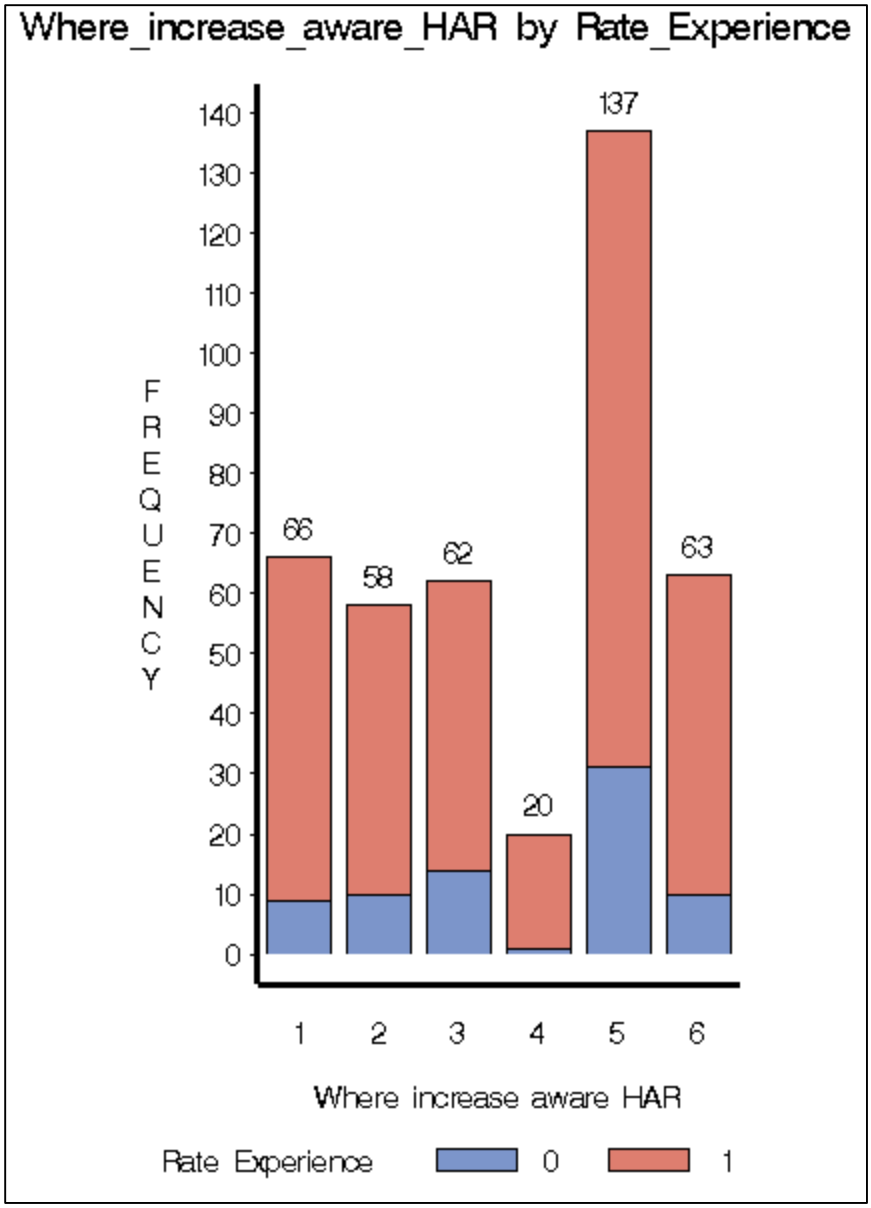


FIGURE 24 HAR ADVERTISEMENT METHODS

(TV=1, Popular radio stations=2, Social media websites =3, FTE/FDOT websites=4, DMS=5, Billboard signs=6)

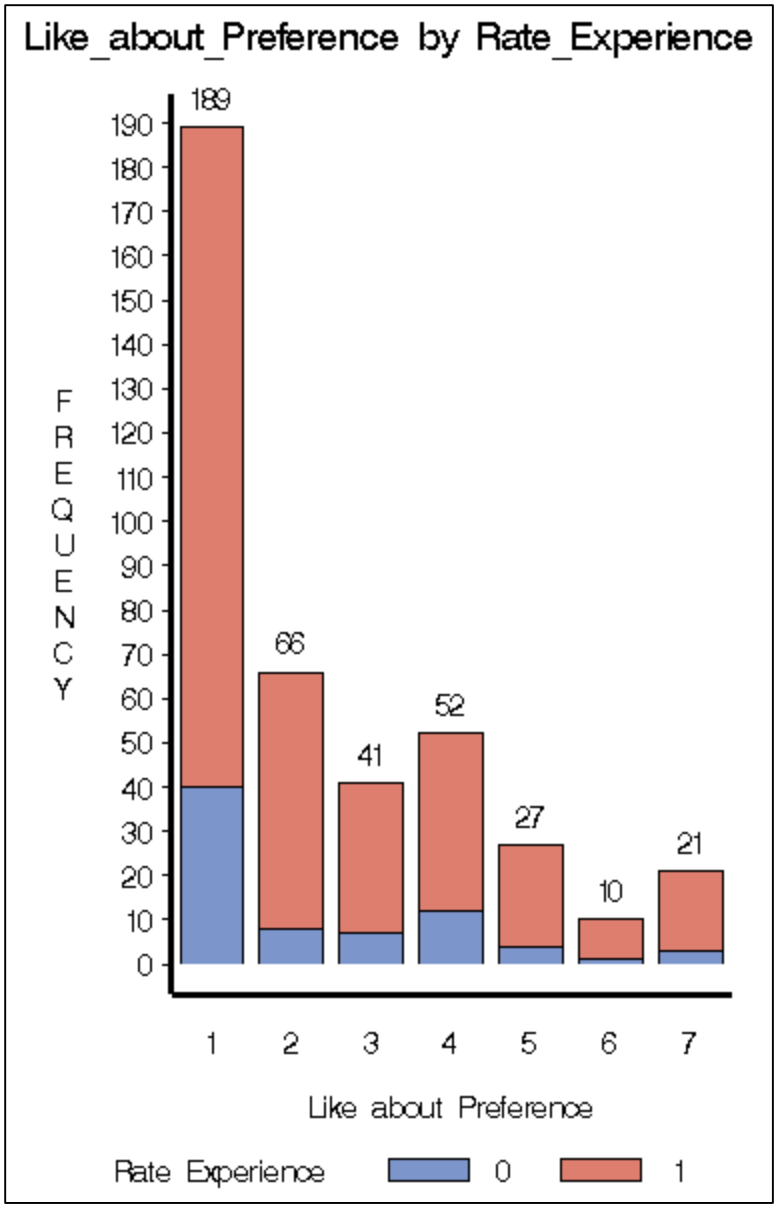


FIGURE 25 REASON FOR OF CHOICE OF TRAVEL INFORMATION SOURCE

(Ease of use=1, Information accuracy=2, Timely information=3, Location specific information=4, Safety information=5, Special event information=6, Other reasons=7)

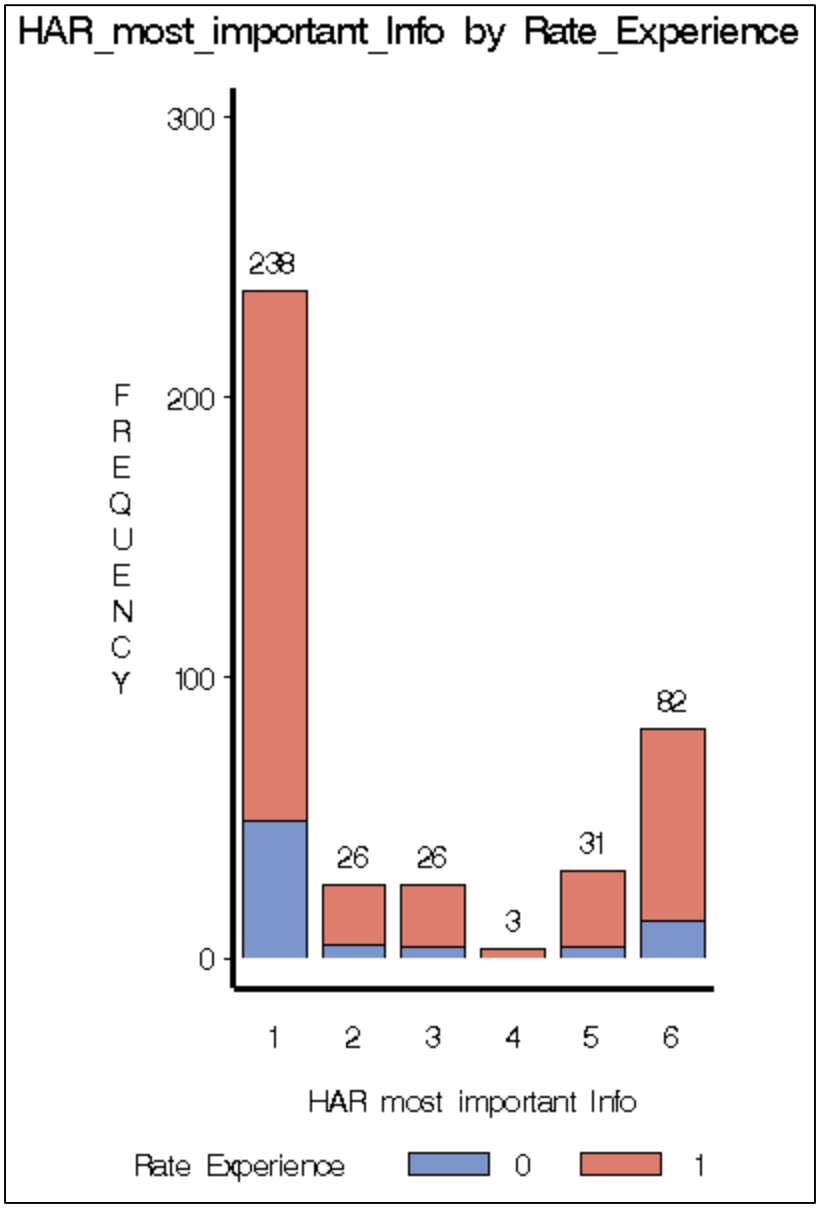


FIGURE 26 PRECEIVED MOST IMPORTANT TYPE OF INFORMATION BROADCAST ON HAR

(Congestion information=1, Weather conditions=2, Roadway construction=3, Special events=4, Alternate route information=5, Safety information=6)

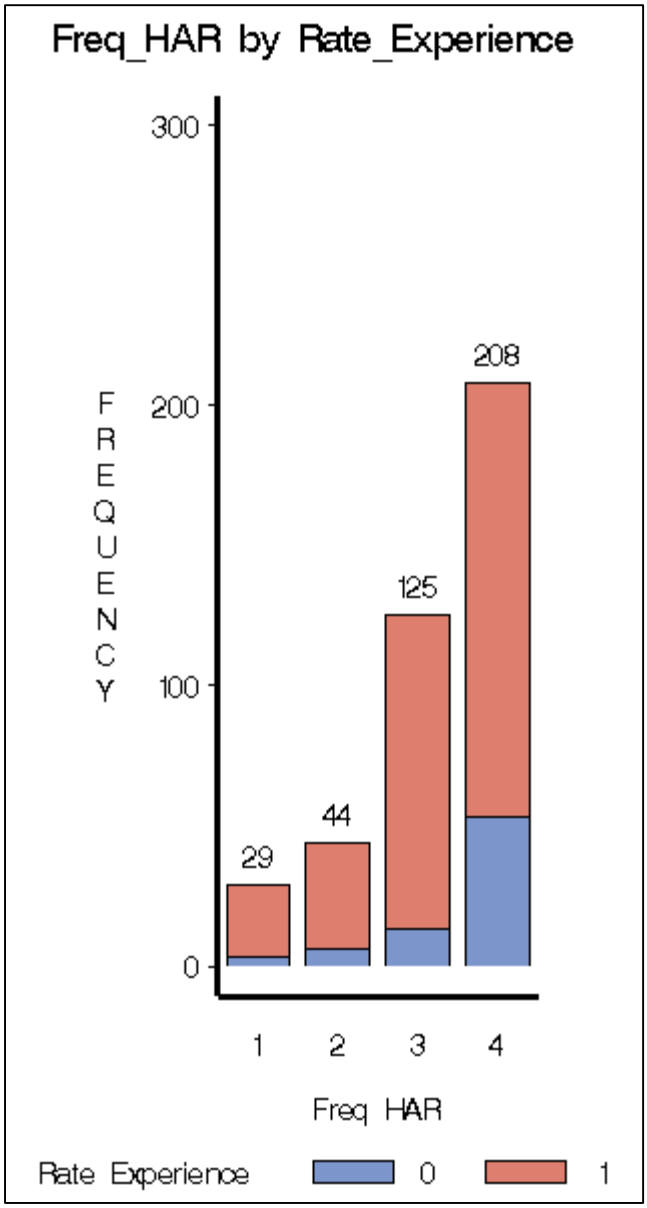


FIGURE 27 HAR USE FREQUENCY

(Always=1, Often=2, Sometimes=3, Rarely=4)

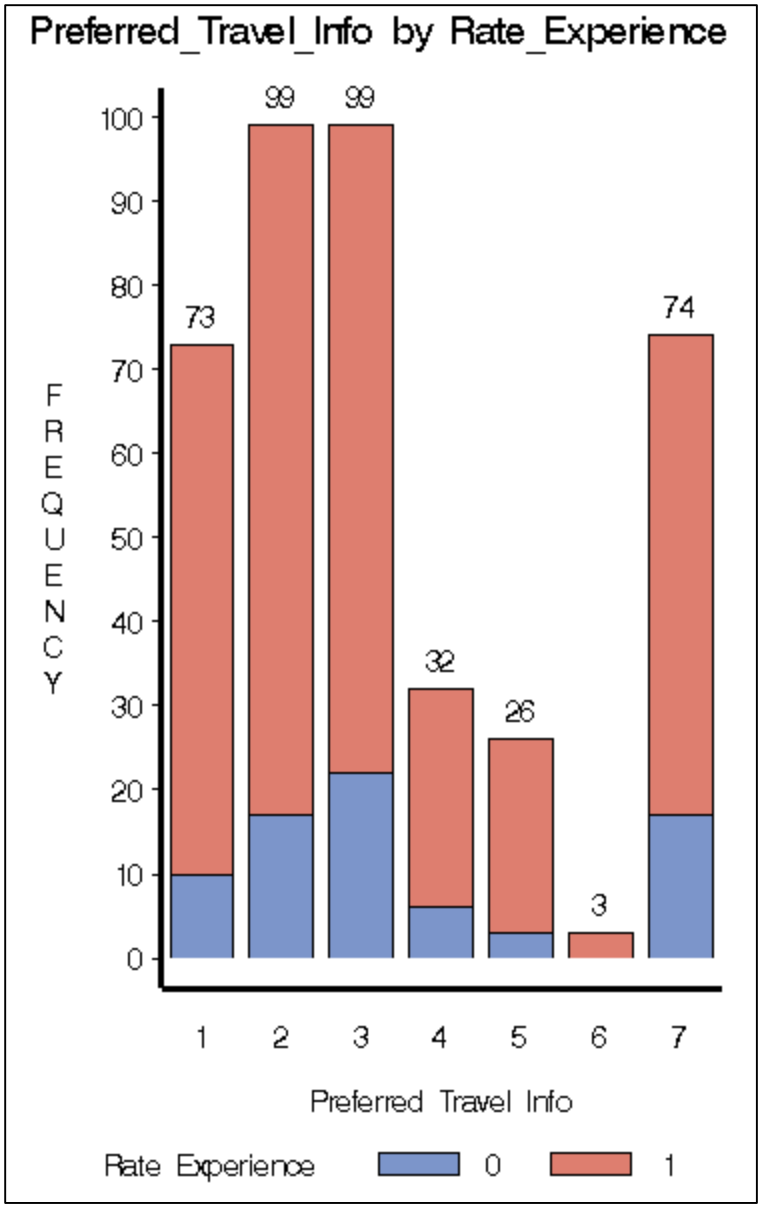


FIGURE 28 PREFERRED TRAFFIC INFORMATION METHOD

(Commercial radio=1, FL-511=2, DMS=3, Smart phone apps.=4, HAR=5, CBRAS=6, GPS navigation=7)

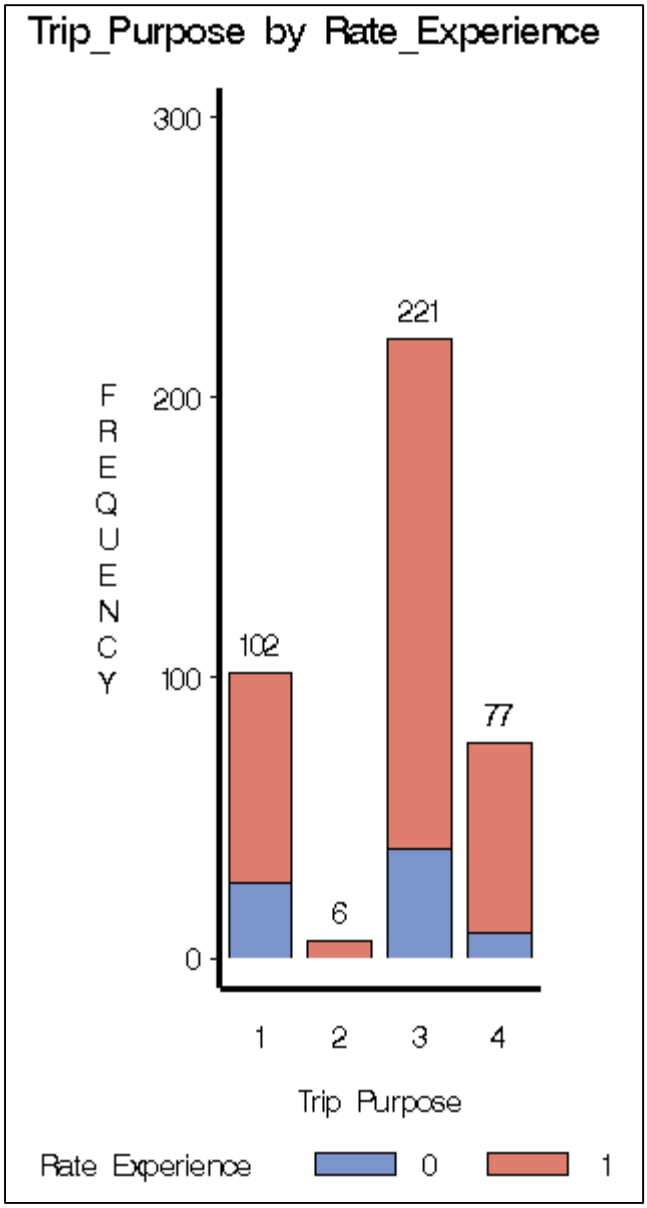


FIGURE 29 TRIP PURPOSE

(From/to work/school=1, Shopping=2, leisure/vacation=3, Other=4)

7.6. Modeling Set Up SAS Enterprise Miner

Figure 30 below shows the modeling set up that was used in SAS Enterprise Miner. The first box on the left is the combined satisfaction data set where the targeting question for modeling was noted. Since this was a survey with only categorical variables, nominal variables and ordinal variables were also noted in this data box. The Data Partition box explains the training and the validation portion segmented for measuring the performance of the models. The third box is the neural network model which is then synced into the decision tree model which does a better job explaining the relationships of the target variables and their relationships with input variables in comparison to the black box neural network model which provides little explanation.

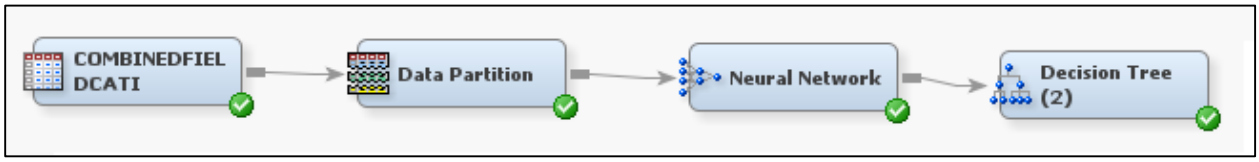


FIGURE 30 SAS ENTERPRIZE IN MINOR MODELING DIAGRAM

The Data box is already explained in the prior section.

7.6.1. Data Partition

The following data partition details show that the default method that was selected for partitioning, 70% of the data was used for training models, and 30% of the data was used for validating the models. This translates to 406 observations used for training and 177 observations used for validation.

TABLE 20 DATA PARTITIONING TABLE

.. Property	Value
General	
Node ID	Part
Imported Data	...
Exported Data	...
Notes	...
Train	
Variables	...
Output Type	Data
Partitioning Method	Default
Random Seed	12345
Data Set Allocations	
Training	70.0
Validation	30.0
Test	0.0
Report	
Interval Targets	Yes
Class Targets	Yes
Status	
Create Time	3/23/15 2:36 PM
Run ID	ba99f84f-e4cc-4e3c-a859-f5d5fc1d055
Last Error	
Last Status	Complete
Last Run Time	3/23/15 2:37 PM
Run Duration	0 Hr. 0 Min. 8.44 Sec.
Grid Host	
User-Added Node	No

7.7. Artificial Neural Networks (ANNs)

Artificial neural networks (ANNs) have attracted considerable attention in recent years. ANNs are statistical models that are very flexible and highly parameterized which enables them to model relatively small irregularities and still be highly accurate. However, this could lead to the risk of over fitting.

It is best to think about ANNs in terms of layers. The outputs from one layer can serve as inputs to the next layer and so on. Mathematically, for a network with just one layer of transformations between x (input variables) and y (output variables) with one hidden layer (Breiman et al. ,1998):

$$y = \sum_k w_k^{(2)} f_k(\sum_j w_j^{(1)} x_j) \quad (1)$$

Here the *w* parameters are the weights in the linear combinations and f_ks are the non-linear transformations. The nonlinearity of these transformations is essential. The term network derives from a graphical representation of this structure in which the predictor variables and each weighted sum are nodes, with edges connecting the terms in the summation of the node. There is no limit to the number of layers that could be used in an ANNs. See the Figure 31 below

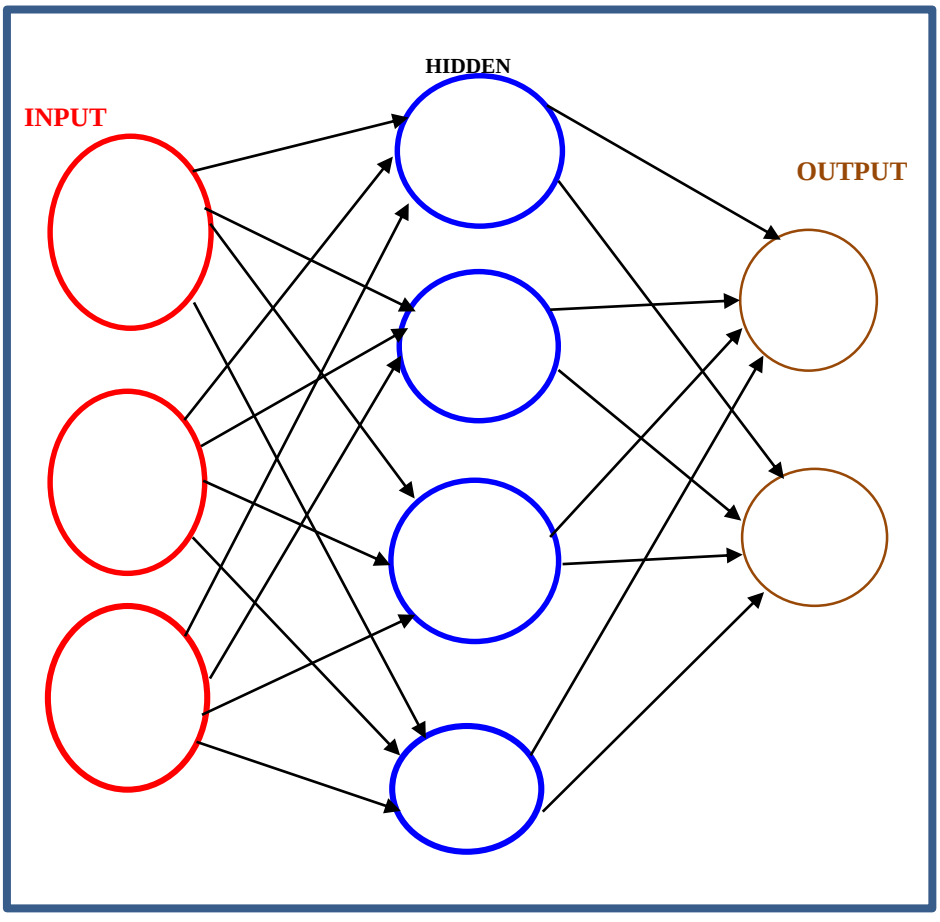


FIGURE 31 GRAPHICAL PRESENTATION OF ARTIFICIAL NEURAL NETWORKS INPUT, OUTPUT, AND LAYERS.

Artificial Neural Networks (ANN) are artificial networks inspired by the biological neural networks, found in the human brain. These networks consist of collections of cells, made from individual cells known as “Neurons”. A neuron, living within the network, is one cell that has the ability to process received input, and generates output based on the processed input. Neural network first came to light in a 1943 paper by W. McCulloch, and W. Pitts. The two scientists developed the first conceptual model of an artificial neural network. Their work as well as the work of their successors was focused on designing a computational model to solve certain types of problems based on the brain. The neural network is a “connectionist” computational system. In that, it does not process instruction in a linear progression. It rather combines the information as whole, and processes it in parallel throughout a network of nodes. A network of many neurons, therefor, has the ability to produce complicated intelligent behavior. The significance of the neural network lays in its ability to “learn”. This does not just make it a complex system, but rather, a complex and an adaptive system. It is for the neural networks unique abilities to change its internal structure, based on the received input that makes it hard to decipher (Shiffman D., The Nature of Code: Simulating Natural Systems With Processing, Oreilly And Associate, Inc., January, 2012).

The following Table 18 shows the default set up that was used for the neural network model that fed into the decision tree model:

TABLE 21 ANN MODEL DEFAULT SETUP

.. Property	Value
General	
Node ID	Neural
Imported Data	...
Exported Data	...
Notes	...
Train	
Variables	...
Continue Training	No
Network	...
Optimization	...
Initialization Seed	12345
Model Selection Criterion	Profit/Loss
Suppress Output	No
Score	
Hidden Units	No
Residuals	Yes
Standardization	No
Status	
Create Time	3/25/15 5:47 PM
Run ID	e42ea6e2-887e-4950-95eb-1fb90da83
Last Error	
Last Status	Complete
Last Run Time	3/25/15 5:48 PM
Run Duration	0 Hr. 0 Min. 26.44 Sec.
Grid Host	
User-Added Node	No

7.7.1. ANN Output

The results of the neural network model is shown below. Neural networks can be confusing to describe as they are like a black box. They can sometimes lead to over fitting the data. The total number of parameters listed with this model are 154, see Table 19. This is also reflected in the Number of Estimated Weights. It is too difficult to simplify and understand the theory behind all these parameters so the tree model leveraging off the ANN will help explain the parameters better. The results of the ANN model are shown in Tables 20 and 21 and Figure 32.

TABLE 22 PERFORMANCE OF NEURAL NETWORK MODEL

Fit Statistics	Statistics Label	Train	Validation
DFT	Total Degrees of Freedom	406	.
DFE	Degrees of Freedom for Error	252	.
DFM	Model Degrees of Freedom	154	.
_NW_	Number of Estimated Weights	154	.
AIC	Akaike's Information Criterion	603.36	.
SBC	Schwarz's Bayesian Criterion	1220.34	.
ASE	Average Squared Error	0.11	0.126
MAX	Maximum Absolute Error	0.95	0.939
DIV	Divisor for ASE	812	354
NOBS	Sum of Frequencies	406	177
RASE	Root Average Squared Error	0.33	0.356
SSE	Sum of Squared Errors	88.41	44.761
SUMW	Sum of Case Weights Times Freq	812	354
FPE	Final Prediction Error	0.24	.
MSE	Mean Squared Error	0.18	0.126
RFPE	Root Final Prediction Error	0.49	.
RMSE	Root Mean Squared Error	0.42	0.356
AVERR	Average Error Function	0.36	0.424
ERR	Error Function	295.36	150.024
MISC	Misclassification Rate	0.15	0.158
WRONG	Number of Wrong Classifications	59	28

TABLE 23 DETAILS ON THE NEURAL NETWORK TRAINING MISCLASSIFICATION

		Target	Outcome	Frequency	Total	
Target	Outcome	Percentage	Percentage	Count	Percentage	
0 (TRUE)	0 (Negative)	83.3333	26.6667	20	4.9261	
1 (False)	**0 (Negative)**	**16.6667**	**1.2085**	**4**	**0.9852**	**Misclass.**
0 (False)	**1 (Positive)**	**14.3979**	**73.3333**	**55**	**13.5468**	**14.532**
1 (TRUE)	1 (Positive)	85.6021	98.7915	327	80.5419	

TABLE 23 DETAILS ON THE NEURAL NETWORK VALIDATION MISCLASSIFICATION

		Target	Outcome	Frequency	Total	
Target	Outcome	Percentage	Percentage	Count	Percentage	
0 (TRUE)	0 (Negative)	68.75	32.3529	11	6.2147	
1 (False)	**0 (Negative)**	**31.25**	**3.4965**	**5**	**2.8249**	**Misclass.**
0 (False)	**1 (Positive)**	**14.2857**	**67.6471**	**23**	**12.9944**	**15.8193**
1 (TRUE)	1 (Positive)	85.7143	96.5035	138	77.9661	

FIGURE 32 CUMULATIVE LIFT PERFORMANCE WITH DEPTH OF NEURAL NETWORK MODEL

The ANN Cumulative Lift vs. Sample Size (Depth) is shown in Figure 32 (above) for both Train (model set of data) and the Validation samples. The X-axis represents the sample size or "Depth" (in percentage form) and the Y-axis represents the Lift performance in cumulative format. The sample size is divided into a 70-30 split for the purpose of constructing the ANN model for input in the decision tree model.

The Lift is the percent of the gain in accuracy resulting from the ANN (or decision tree) model output whichever is applicable, compared with the calculated percent from the sample size (based of the 70/30 sample split). In other words, Lift is the gain in prediction accuracy of the analysis sample. Examining the cumulative Lift percentage, in the Train and Validation Lift curves in this graph, it is noted that the Lift declines with the increased sample percentage. In most of the ANN modeling, the model's Lift declines as the Depth approaches 100%. The validation Lift starts at the highest level, above 1.2, but rapidly drops below 1.1 at 20%, bottoms at 30% and then slightly increases. The validation Lift does not appear to follow the same trend as the training Lift. This trend of inconsistency may be attributed to the fact that neural networks model have over fitted

itself within training. Making the hybrid model with the classification tree should help. The tree model shown in the next section almost has the same validation misclassification rate as well (Breiman et al. ,1998).

7.8. Classification Modeling

One purpose of the classification models is to map an X-variable vector of measurements to a Y variable, which is a categorical variable.

For the purpose of convenience of notation, an observation class variable is referred to as the prediction variable. Variable C is used here as the class variable for observation, and the set of values $\{c_1,\ldots,c_m\}$ are used to describe the categorical variable Y. Measured variables $X_1,\ldots\ldots,X_p$ are referred to in a number of ways, including observed variables, input variables, the features, explanatory variables, attributes and so on.. The "x" denotes a *p*-dimension vector which can be designated as real value, ordinal or categorical, etc. for its components. In this model x is limited to ordinal or categorical values. As an illustration, $x_j(i)$ is the ith input vector for the *j*th component, given that $1 \leq i \leq n$, $1 \leq j \leq p$. Only one of the two views of classification is analyzed in the case of this model. This case is a discriminative viewpoint or a decision boundary as opposed to being a probabilistic viewpoint (Berry and Linoff, 2004).

7.9. Tree Models

The term class purity used in the tree models indicates that the majority of points represented in each cell along with the chosen class score are of the same classification. Tree models effectively maximize purity of class purity by partitioning the space used for input layout.

As an illustration, dealing with a number of input variables x, y, and z, the variable x can be divided so that a single input cell space is be divided in two cell spaces. Further splitting of the initial

divided cells can continue to take place until reaching a threshold on y or z. The nodes of the tree are created as a result of each of the branching points.

Splitting of the input space of each input cell recursively is the basis for building the tree model. Cell-splitting involves evaluating each of the given thresholds; so that the optimal split leading to the highest value of the specified score function is achieved. The criterion is designated as entropy for ordinal variables, Chi-Square is for nominal variables, and the score assessment is based on the validation set for data. The model goal is to produce an output showing the percentage of correctly identified variables.

The following equation shows Entropy Criterion for real-valued threshold test T (where T stands for a threshold test Xj > T on one of the variables) is defined as the average entropy after the test is performed (Breiman et al. ,1998):

$$H(C|T) = p(T = 0)\, H(C|T = 0) + p(T = 1)\, H(C|T = 1) \quad (2)$$

where the conditional entropy H (C|T = 1) is defined as

$$-\sum_{c_k} p(c_k|T = 1)\, log_2\, p(c_k|T = 1) \quad (3)$$

Entropy average over the probability of descending through each of the decision tree branches is uncertain (T=1 or T=0). The analysis goal aims at identifying the single test T, among all variables, which would produce the minimum average entropy after the binary split.

A comparison between the training data set and the validation date set is the intended outcome of the splitting procedure. Having similar nodes in the tree is an indication that nodes share both similar and identical proportions.

7.10. Tree Model Combination with input from a ANN (Hybrid Approach)

A hybrid model in SAS Enterprise model results from understanding the ANN model and from developing the best tree model. This hybrid model intermixes the two models, which allows for a more accurate capturing of their operational process, combining the ease of understating of one (tree model) with the strength of the other (neural network). The decision tree model obtained from the neural network model is shown in the table below (Table 22). All implemented model settings were obtained from the default selection with the exception of the tree depth, which was set at 12. Model report outputs are set to the percentage of correct classification, resulting from the model.

TABLE 25 ANN MODELS AND TREE MODEL COMBINATION (HYBRID MODEL)

.. Property	Value
General	
Node ID	Tree2
Imported Data	...
Exported Data	...
Notes	...
Train	
Variables	...
Interactive	...
Import Tree Model	No
Tree Model Data Set	...
Use Frozen Tree	No
Use Multiple Targets	No
Splitting Rule	
Interval Target Criterion	ProbF
Nominal Target Criterion	ProbChisq
Ordinal Target Criterion	Entropy
Significance Level	0.2
Missing Values	Use in search
Use Input Once	No
Maximum Branch	2
Maximum Depth	12
Minimum Categorical Size	5
Node	
Leaf Size	5
Number of Rules	5
Number of Surrogate Rules	0
Split Size	.
Split Search	
Use Decisions	No
Use Priors	No
Exhaustive	5000
Node Sample	20000
Subtree	
Method	Assessment
Number of Leaves	1
Assessment Measure	Decision
Assessment Fraction	0.25

TABLE 246 COMBINED TREE MODEL RESULTS

Property	Value
Cross Validation	
Perform Cross Validation	No
Number of Subsets	10
Number of Repeats	1
Seed	12345
Observation Based Importance	
Observation Based Importance	No
Number Single Var Importance	5
P-Value Adjustment	
Bonferroni Adjustment	Yes
Time of Bonferroni Adjustment	Before
Inputs	No
Number of Inputs	1
Depth Adjustment	Yes
Output Variables	
Leaf Variable	Yes
Interactive Sample	
Create Sample	Default
Sample Method	Random
Sample Size	10000
Sample Seed	12345
Performance	Disk
Score	
Variable Selection	Yes
Leaf Role	Segment
Report	
Precision	4
Tree Precision	4
Class Target Node Color	Percent Correctly Classified
Interval Target Node Color	Average
Node Text	...
Status	
Create Time	3/25/15 5:49 PM
Run ID	3399ce19-625b-4308-840e-d314d867
Last Error	
Last Status	Complete
Last Run Time	3/25/15 5:55 PM
Run Duration	0 Hr. 0 Min. 31.16 Sec.

7.11. The Combined Tree Model and Results

The following are the results of the tree model and the diagram of the leaf/splits (see Figure 33). 70% of the data was used for training (total of 406) and 30% of the data was used for validation (total of 177). The tree model predicts the users' satisfaction and shows which variable influenced satisfaction. Note that there were no missing values in the data.

First Level

First Split

Should HAR service be continued or discontinued?

Left

2, 3 – Discontinued or impartial – Higher % of dissatisfaction

Right

1 – Continued – Higher % of satisfaction

Second Level

First Split (Left hand side)

What is the most important type of traffic information you think should be broadcast on HAR?

Left

1, 6 – Traffic congestion and safety information – Higher % of dissatisfaction

Right

All other responses – More even split between dissatisfaction and satisfaction

Second Split (Right hand side)

If you were required to evacuate the area of Florida that you reside in because of a hurricane and HAR was available for emergency broadcasts, would you use HAR?

Left

2 & 3 – No & Yes but would seek out other sources of information first – Higher % of satisfaction

Right

1 – Use HAR in Evac. – Even higher % of satisfaction

Third Level

First Split (Left hand side)

If you were required to evacuate the area of Florida that you reside in because of a hurricane and HAR was available for emergency broadcasts, would you use HAR?

Left

1 – Use HAR in Evac. – Even split in training, higher level of satisfaction in validation

Right

2 & 3 – No & Yes but would seek out other sources of information first – Higher % of dissatisfaction

Second Split (right hand side)

How frequently do you use HAR?

Left

1, 2, 3 – Always, Often, or Sometimes – Higher % of satisfaction

4 – Rarely – Not as high % of satisfaction

Fourth Level

First Split (Left hand side)

What do you like most about your preferred source of travel information you selected?

Left

1 – Ease of Use – Higher % of satisfaction

Right

All other responses – Higher % of dissatisfaction in training, even split in validation.

Second Split (Right hand side)

What do you like most about your preferred source of travel information you selected?

Left

2 – Information Accuracy – 100% satisfaction

Right

All other responses – Higher % of satisfaction

Fifth Level

First Split (Right hand side)

To increase awareness of HAR, where do you think is the best place to promote or advertise HAR?

Left

1, 3, 5 – Television, Social Media Websites, DMS – Higher % satisfaction in training, higher % dissatisfaction in validation

Right

All other responses – Higher % of satisfaction

Sixth Level

First Split (Right hand side)

How many times per week do you travel on this route?

Left

1 – Once a week or less – Higher % satisfaction in training, higher % dissatisfaction in validation

Right

2, 3, 4 – More than once a week – Higher % dissatisfaction in training, higher % satisfaction in validation

Seventh Level

First Split (Right hand side)

What is the purpose of your most common trip?

Left

3 – Leisure/vacation – Higher % satisfaction in training, higher % dissatisfaction in validation

Right

All other responses – Higher % satisfaction in training, higher % dissatisfaction in validation

Second Split (Right hand side)

Which of the following best describes your age?

Left

1, 2, 3 – 18-50 years old – Higher % satisfaction

Right

4, 5 – Greater than 50 years old – 100% dissatisfaction in training, even split in validation

Eighth Level

First Split (Right hand side)

How do you prefer to receive travel information, such as traffic conditions, road closures, and special events information while traveling?

Left

7 – GPS Navigation Device – Higher % satisfaction

Right

All other responses – Higher % of dissatisfaction

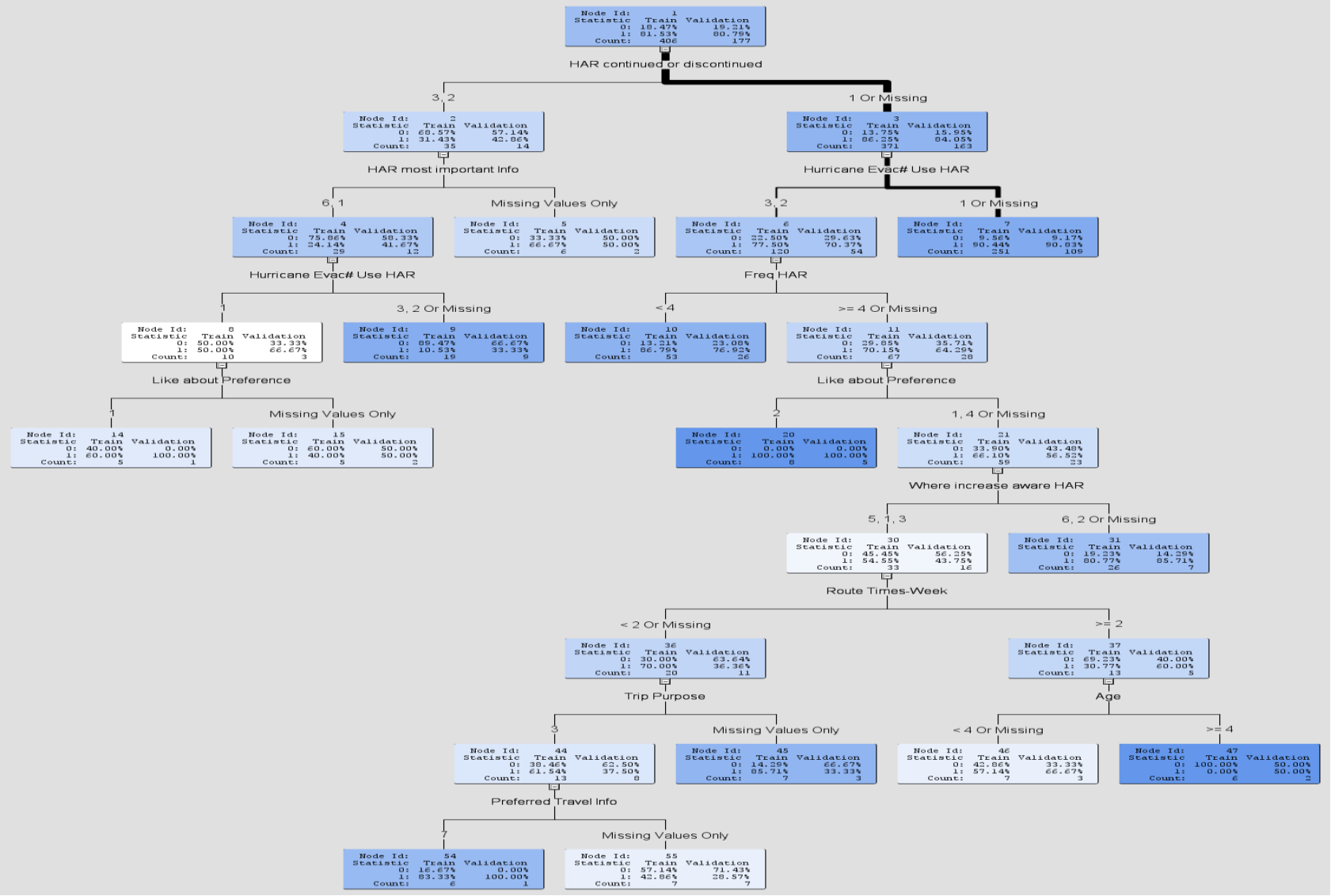


FIGURE 33 DECISION TREE MODEL RESULT DIAGRAM

TABLE 27 PERFORMANCE OF TREE MODEL

Target	Target Label	Fit Statistics	Statistics Label	Train	Validation	Test
Rate_Experience	Rate Experience	_NOBS_	Sum of Frequencies	406	177	NaN
Rate_Experience	Rate Experience	_MISC_	Misclassification Rate	0.128078818	0.1581921	NaN
Rate_Experience	Rate Experience	_MAX_	Maximum Absolute Error	0.90438247	1	NaN
Rate_Experience	Rate Experience	_SSE_	Sum of Squared Errors	84.92193431	46.6273626	NaN
Rate_Experience	Rate Experience	_ASE_	Average Squared Error	0.104583663	0.13171571	NaN
Rate_Experience	Rate Experience	_RASE_	Root Average Squared Error	0.323393975	0.36292659	NaN
Rate_Experience	Rate Experience	_DIV_	Divisor for ASE	812	354	NaN
Rate_Experience	Rate Experience	_DFT_	Total Degrees of Freedom	406	NaN	NaN

The critical component highlighted is the misclassification rate. From the simple statistics the ratio of dissatisfied respondents is 16.70% (see Appendix G for HAR CATI survey). The training misclassification is 12.81% and the validation misclassification is 15.82%. These values are lower than 18.70%, showing the model is better than random guessing at predicting responses and classifications.

TABLE 28 DETAILS ON THE TREE MISCLASSIFICATION

		Target	Outcome	Frequency	Total	
Target	Outcome	Percentage	Percentage	Count	Percentage	
0 (TRUE)	0 (Negative)	81.1	40.0000	30	7.3892	
1 (False)	**0 (Negative)**	18.9	2.1148	7	1.7241	Misclass.
0 (False)	**1 (Positive)**	12.2	60.0000	45	11.0837	12.8078
1 (TRUE)	1 (Positive)	87.8	97.8852	324	79.8030	

TABLE 29 DETAILS ON THE TREE VALIDATION MISCLASSIFICATION

		Target	Outcome	Frequency	Total	
Target	Outcome	Percentage	Percentage	Count	Percentage	
0 (TRUE)	0 (Negative)	65.0	38.2353	13	7.3446	
1 (False)	**0 (Negative)**	35.0	4.8951	7	3.9548	Misclass.
0 (False)	**1 (Positive)**	13.4	61.7647	21	11.8644	15.8192
1 (TRUE)	1 (Positive)	86.6	95.1049	136	76.8362	

TABLE 30 VARIABLE IMPORTANCE

Variable Name	Label	Number of Splitting Rules	Validation Importance	Ratio of Validation to Training Importance	Importance
HAR_continued_or_discontinued	HAR continued or discontinued	1	1.0000	1.0000	1.0000
Hurricane_Evac__Use_HAR	Hurricane Evac# Use HAR	2	0.4976	0.8448	1.6980
Route_Times_Week	Route Times-Week	1	0.3552	0	0
Age	Age	1	0.3313	0	0
Where_increase_aware_HAR	Where increase aware HAR	1	0.3225	0.6686	2.0729
Like_about_Preference	Like about Preference	2	0.3076	0.6149	1.9990
HAR_most_important_Info	HAR most important Info	1	0.3058	0	0
Freq_HAR	Freq HAR	1	0.2920	0.2692	0.9220
Preferred_Travel_Info	Preferred Travel Info	1	0.2346	0.6176	2.6319
Trip_Purpose	Trip Purpose	1	0.1663	0	0

Table 27 shows that the tree model captured the most important question for satisfaction of users "Should HAR be continued or discontinued?". This is indicated by the ratio of validation to training at 1 or 100%. The questions are listed in order of importance. They also indicate the number of splits that they were included in within the models and the match between the training and validation ratios are noted.

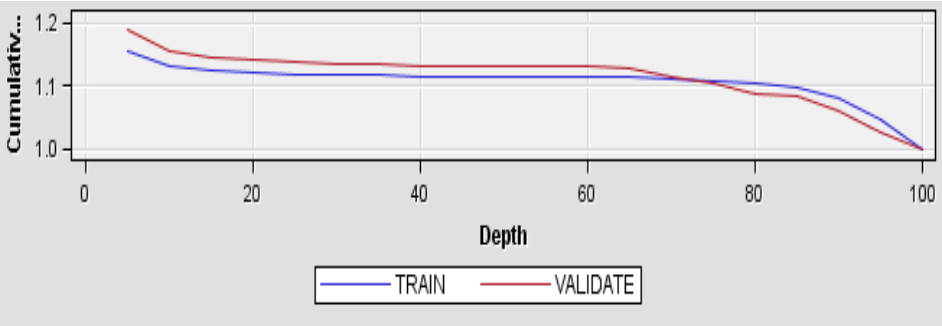


FIGURE 34 VALIDATION LIFT CURVE COMPARED TO TRAIN CURVE

The training Lift starts at 1.15398 from 5% and the validation Lift starts 1.18729.Although the Lift drops for both training and validation, it is not until 80% that the validation Lift drops below 1.1. Furthermore, the training and validation Lift appears to follow the same trend line. This indicates that the model has a more consistent performance compared to the neural networks model Lift which seemed unstable and over fitted itself, see Figure 32.

Summary of Tree Model

The neural networks model was utilized to help better understand the deep interactions with how respondents answer the survey questions with the target variable of the satisfaction question. These respondents are the FTE/FDOT's traveling customers, and understanding their satisfaction with HAR is critical to knowing its benefits. Modeling provides a greater insight to this satisfaction and dissatisfaction. Neural networks can be difficult to understand and it is

challenging to trust the black box result without explanation. Creating the hybrid tree model from the neural networks model output helps leverage that model while having the capability of understanding and describing the results. The important top four variables from the tree model for predicting classification of satisfaction were the following questions and their responses:

- How the respondents answered, “Should HAR be continued or discontinued?.”
- How the respondents answered, “In the event of a Hurricane Evacuation would they use HAR?.”
- How many times a week the respondents traveled the Route with HAR.
- The age category within which the respondent was classified.

The misclassification rates within the validation in the neural networks and the tree models were almost the same value. The tree model appeared to have a more consistent Lift with its training curve and hence appeared to avoided over fitting as much as the neural networks model did. In prediction of satisfaction, the tree model provides a benefit and better insight into understanding of the respondents’ satisfaction.

The misclassification rates within the validation in the neural networks and the tree models were almost the same value. The tree model appeared to have a more consistent Lift with its training curve and hence appeared to avoided over fitting as much as the neural networks model did. In prediction of satisfaction, the tree model provides a benefit and better insight into understanding of the respondents’ satisfaction.

Implementation of this model assumes a hypothesis that traveler satisfaction with HAR was the cause for participants of the survey to select "continued" for HAR. It is worth mentioning, however, that it could be the other way around. The opposite hypothesis that respondent selection

of "continued" for HAR was causing their satisfaction with the technology, may also be a valid hypothesis. Better understanding of what made customers to state that they are “satisfied” or “dissatisfied” may be needed to decide on either of the two opposing hypotheses. In addition, future analysis of increased satisfaction with customers can be targeted in the model. The fact is that the decision to continue or discontinue the HAR ultimately rests on the agencies funding and operating this technology.

CHAPTER EIGHT: CONCLUSIONS AND FUTURE RECOMMENDATIONS

8.1 Conclusions

This thesis provides an overview of the current operation of the HAR and CBRAS services within the coverage area of the survey locations. The results of these three surveys were examined, and interactions among them were considered. The findings contribute to the understanding of the effect of the two ATIS technologies, and the value given to them by travelers. Simple statistical analysis of the results indicates that CBRAS serves a small segment of commercial truck drivers; however, CBRAS is not used by a large proportion of the truck driver population surveyed. Truck drivers are typically satisfied with travel information services provided by CBRAS. This travel information source was heavily relied upon, for the purpose of route diversion. GPS navigation was the most preferred source of travel information for truck drivers, with a 28% use share. The CATI phone survey was biased towards older segment of the travelers, about 60% and mainly females (58%) who use the FTE roadway system. Its results, however, were consistent with the two other surveys conducted in this study. The HAR field survey had less bias in terms of age and gender distribution (54% under 50 and 62% males). Both surveys indicate that the sample is well educated with about 60% having an associate degree or higher. Users satisfied with the system are those who only use these roadways once per week or less. The surveys ultimately show that travelers rely on modern modes of obtaining traffic information than traditional ones, such as HAR. Dynamic Message Signs (DMS), and smart phone applications are leading communication tools among all types of travelers. As was the case with CBRAS, HAR was also not used by a large proportion of travelers, but HAR users are typically satisfied with it. This was confirmed by

the results of the SAS Minor decision tree model which combined the HAR and CATI survey samples. After successful profiling, a hybrid model was developed which was able to predict responses to answered questions shared between the CATI and the field HAR surveys. The hybrid model was able to connect user satisfaction with the HAR in relation to the use of the HAR system. On the other hand, the hybrid model was able to correlate dissatisfied customers as the least users, confirming results of the simple statistical data analysis. However, the hybrid decision tree model has an edge over the simple statistical analysis. It was able to predict dissatisfaction better than a simple guess as its validation results indicated, and it was able to point out what is relevant out of the questions asked in the HAR CATI phone and HAR field surveys. This important outcome can provide guidance to agencies in charge of the HAR technology to know what to focus on so as to improve their customer service and customers' usage of their systems which are purchased and maintained by the users' taxes.

In summary, the HAR and CBRAS systems are in the middle of a heated competition lead by digital communication. As seen from the study results, survivability of HAR systems may hinge on their ability to adapt to the changing traffic information landscape. HAR/CBRAS must bridge the technology gab, stemming from the razor sharp clarity, timeliness and speed by which traffic information can conveniently be delivered by these competitors.

8.2 Future Recommendations

The following is recommended for future research:

- Implementation of additional types of surveys designed and conducted through different modes of communication, in order to capture other types of user segments may provide a more gender and age balanced sample size. Examples of these surveys can be a HAR

Internet survey with the smartphone application options.

- Seeking HAR experience feedback from State DOTs, Local District and Emergency Management government type organizations throughout the state of Florida, can provide an invaluable source and feedback on the future use of HAR technology. Such survey can provide an "operation and maintenance" prospective on existing HAR systems, to help direct the HAR service in a most useful and cost efficient way.
- Seeking feedback from other HAR systems currently in use in other states across the US can be a reliable source on HAR feedback that is based on a practical experience.
- Enhancing the existing HAR and CBRAS systems to provide more coverage areas than is currently provided. This will increase the number of customers currently being served and provide them more time (and perhaps more options) to avert congestion and adverse weather conditions.
- As the research study indicates a clear trend to drivers favoring use of smartphones, it is inevitable that a HAR message becomes integrated in smartphone applications to accommodate the growing number of smart phone users.
- Upgrading the technology may be warranted based on the fact that a good percentage of the unsatisfied users had complained about existing HAR message clarity.
- HAR message should focus more on traffic information.
- HAR service needs more marketing by FTE and FDOT as the majority of the interviewed survey participants had not heard of it.

APPENDIX A: HAR CATI SURVEY DESIGN

HAR CATI SURVEY DESIGN (VERSION 8.0) (12/3/2014)

THE UNIVERSITY OF CENTRAL FLORIDA IS CONDUCTING A SURVEY OF PEOPLE WHO USE THE FLORIDA'S TURNPIKE ENTERPRISE TOLL ROADS. WE ARE NOT SELLING OR MARKETING YOU ANYTHING. WE ARE SIMPLY TRYING TO GET YOUR UNDERSTANDING AND OPINIONS ABOUT TRAFFIC INFORMATION AND HIGHWAY ADVISORY RADIO. YOUR RESPONSES ARE VERY IMPORTANT AS THEY WILL HELP US IMPROVE THE QUALITY OF TRAFFIC INFORMATION ON THESE ROADS. YOU ARE FREE TO TERMINATE THIS SURVEY AT ANY TIME. IF YOU CHOOSE TO TERMINATE THIS SURVEY AT ANY TIME, DATA COLLECTED FROM YOUR RESPONSE WILL NOT BE USED UNLESS YOU EXPLICITLY ALLOW US TO USE IT. ALL ANSWERS ARE STRICTLY CONFIDENTIAL AND THE SURVEY WILL ONLY TAKE A FEW MINUTES OF YOUR TIME.

WOULD YOU LIKE TO PARTICIPATE IN THIS SURVEY? (Yes, No) **(if "No", terminate survey)**

Are you 18 years old or older? (Yes, No) **(if "No", terminate survey)**

1. Have you traveled on the Florida Turnpike in the past year?
    a. Yes
    b. No **(if "No", terminate survey)**

(If participant does not terminate, operator should note participant's gender)

Gender: (Male, Female)

2. What is the purpose of your most common trip on the Florida Turnpike?
    a. Travel to/from work or school **(if "Travel to/from work or school", proceed to question 3, otherwise proceed to question 6)**
    b. Shopping
    c. Leisure/vacation
    d. Other

3. Excluding intermediate stops, how long does this trip on the Florida Turnpike typically take?
    a. Less than 15 minutes
    b. 15-30 minutes
    c. 31-45 minutes
    d. 46-60 minutes
    e. More than 60 minutes

4. Excluding the Florida Turnpike, how many other routes have you ever taken for this trip?
    a. None **(if "None", proceed to question 6; otherwise proceed to question 5)**
    b. One
    c. Two

d. Three

e. Four or more

5. Excluding intermediate stops, how long does this trip typically take using the best alternate route?

    a. Less than 15 minutes

    b. 15-30 minutes

    c. 31-45 minutes

    d. 46-60 minutes

    e. More than 60 minutes

6. How many times per week do you travel on the Florida Turnpike?

    a. Once a week or less

    b. 2-5 times a week

    c. 6-10 times a week

    d. More than 10 times a week

7. How do you prefer to receive travel information, such as traffic conditions, road closures, and special events information while traveling?

    a. Commercial Radio Reports

    b. Florida 511

    c. Highway Electronic Message Signs

d. Smartphone Applications **(if "Smartphone Applications", proceed to question 8)**

e. Highway Advisory Radio (HAR)

f. Citizens' Band (CB) Radio

g. GPS Navigation Device

(For all answer choices except "Smartphone Applications", proceed to question 9)

8. What is your preferred smartphone application?

    a. Vehicle Navigation Smartphone Apps (TomTom, Garmin, Magellan, etc...)

    b. Waze Social GPS Maps

    c. Google Maps

    d. Apple Maps

    e. Other

9. What do you like most about your preferred source of travel information you selected?

    a. Ease of use

    b. Information accuracy

    c. On-time delivery of information

    d. Location-specific information

    e. Availability of safety or security information

    f. Availability of special event information

g. Other reasons

10. Highway Advisory Radio (HAR) is a radio station (AM 1640) dedicated to 24-hour highway travel information. Are you aware that Highway Advisory Radio is available on the Florida Turnpike?
    a. Yes **(if "Yes", proceed to question 11)**
    b. No **(if "No", proceed to question 20)**

11. How did you first become aware that Highway Advisory Radio is available on the Florida Turnpike?
    a. Signs along Florida Turnpike
    b. Friend or relative
    c. Florida Turnpike website
    d. Other

12. Have you ever used Highway Advisory Radio while traveling on the Florida Turnpike?
    a. Yes **(if "Yes", proceed to question 13)**
    b. No **(if "No", proceed to question 20)**

13. How frequently do you use Highway Advisory Radio during your trips on the Florida Turnpike?
    a. Always
    b. Often

c. Sometimes

d. Rarely

14. How would you rate your experience with Highway Advisory Radio and the travel information it provides?

    a. Strongly Satisfied

    b. Satisfied

    c. Dissatisfied

    d. Strongly Dissatisfied

(if "Strongly Satisfied" or "Satisfied", proceed to question 15.A; if "Dissatisfied" or "Strongly Dissatisfied", proceed to question 15.B)

15. A. Which answer best describes your strongest opinion on Highway Advisory Radio and the travel information it provides?

    a. Information is accurate and up-to-date

    b. Easy to access

    c. Easy to understand

    d. Provides location-specific information

(Proceed to question 16)

15. B. Which answer best describes your strongest opinion on Highway Advisory Radio and the travel information it provides?
    a. Information is not accurate and up-to-date
    b. Not easy to access
    c. Not easy to understand
    d. Does not provide location-specific information
    e. Needs a wider coverage area

16. What is the most important type of traffic information you think should be broadcast on Highway Advisory Radio?
    a. Traffic congestion locations and durations
    b. Weather conditions
    c. Roadway construction
    d. Special events
    e. Alternate route information
    f. Safety information

17. While traveling on the Florida Turnpike, have you ever heard a message on Highway Advisory Radio that informed you of congestion?
    a. Yes **(if "Yes", proceed to question 18)**
    b. No **(if "No", proceed to question 20)**

18. Did you exit off the Florida Turnpike to avoid this congestion?

a. Yes **(if "Yes", proceed to question 20)**

b. No **(if "No", proceed to question 19)**

19. Why did you stay on the Florida Turnpike?

a. Unfamiliar with alternate routes

b. Did not trust accuracy of Highway Advisory Radio message

c. Alternate route would still take more time

d. No alternate routes available

e. Other

20. While traveling on the Florida Turnpike, what amount of delay broadcast on Highway Advisory Radio would make you exit off the Florida Turnpike?

a. 15 minutes

b. 30 minutes

c. 45 minutes

d. More than 45 minutes

e. Would not exit off the Florida Turnpike

(if "Would not exit off the Florida Turnpike", proceed to Question 21; otherwise proceed to Question 22)

21. What is the main reason you would stay on the Florida Turnpike?

a. Unfamiliar with alternate routes

b. Would not trust accuracy of Highway Advisory Radio message

c. Alternate route would likely take more time

d. No alternate routes available

e. Other reasons

22. If there was an emergency, such as a hurricane, that required you to evacuate your area of residence in Florida and Highway Advisory Radio was available for emergency broadcasts, would you use Highway Advisory Radio?

    a. Yes

    b. No

    c. Yes, but would seek out other sources of information first

23. To increase awareness of Highway Advisory Radio, where do you think is the best place to promote or advertise Highway Advisory Radio?

    a. Television

    b. Popular Radio Stations

    c. Florida Turnpike and/or Florida Department of Transportation Website

    d. Social Media Website

    e. Highway Electronic Message Signs

    f. Billboard

24. Should Highway Advisory Radio service be continued or discontinued?

    a. Continued

b. Discontinued

c. Impartial

25. If Highway Advisory Radio service is discontinued, what alternatives would you use to obtain travel information? (select all that apply)

    a. Commercial Radio Reports

    b. Florida 511

    c. Internet

    d. Highway Electronic Message Signs

    e. Smartphone Applications

    f. Citizens' Band (CB) Radio

    g. Other alternative

26. If Highway Advisory Radio service is continued, would you use Highway Advisory Radio in the future?

    a. Yes

    b. No

27. Which of the following best describes your age?

    a. 18-25 years

    b. 26-35 years

    c. 36-50 years

    d. 51-65 years

e. Over 65 years

28. What is your highest level of education reached?

a. High School Diploma or less

b. Some College

c. Associate Degree

d. Bachelor Degree

e. Post Graduate Degree

APPENDIX B: FIELD CBRAS SURVEY DESIGN

FIELD CBRAS SURVEY DESIGN

Student Full Name: _____

CBRAS Survey Sequence Number for this Student:_____

Date of CBRAS TRUCK Driver Survey_____

Time of CBRAS TRUCK Driver Survey:_____

CBRAS/HAR TRUCK DRIVER FIELD SURVEY Version 5A (11-14-14)

Student should select Survey Roadway: Florida Turnpike

I-75 (Charlotte Rest Area)

I-95 (St. Lucie Rest Area)

[Student must select appropriate roadway and then appropriate roadway (Florida Turnpike, I-75, or I-95) will be selected automatically in questions that have roadway names in them.]

If student selects Florida Turnpike above then the student must select one of the three service plazas on Florida Turnpike: **(Student must select one of the following three service plazas)**

1) Turkey Lake Service Plaza
2) Okahumpka Service Plaza
3) Canoe Creek Service Plaza

If student selects I-75 (Charlotte Rest Area) or I-95 (St. Lucie Rest Area) then there are no more choices since it is only one location for each of these two interstates. In other words, the service plaza selection (one of the three is only if the student selects the Florida Turnpike as the roadway for the survey).

Hello, my name is ____ and I am an undergraduate student researcher with the University of Central Florida. We are conducting a survey on your understanding and opinions about traffic information systems such as Citizens' Band Radio Advisory System or Highway Advisory Radio. Your responses are very important as they will help improve the quality of traffic information on Florida Turnpike Enterprise roadways and interstates. We are not selling or marketing you anything. You are free to terminate this survey at any time. If you choose to terminate this survey, data collected from your responses will not be used without your explicit permission. All responses are strictly confidential. This survey will only take a few minutes of your time.

Would you like to participate in this survey? (Yes, No) **(if "No", terminate survey)**

[If participant does not terminate, student should note participant's gender (Male, Female)]

Gender: (Male, Female)

16. Do you have a Citizens' Band (CB) radio in your truck?
    a. Yes **(if "Yes", proceed to question 2)**
    b. No **(if "No", proceed to question 3)**

17. How often do you use CB radio for travel information?

    a. Always
    b. Often
    c. Sometimes
    d. Rarely
    e. Never

18. Do you live in Florida?

    a. Yes
    b. No

19. How many times per week do you travel on the Florida Turnpike/I-75/I-95? (note that only one road should show in the question not all three depending on selection of student for roadway location at the start of the survey)

    a. Once a week or less
    b. 2-5 times a week
    c. 6-10 times a week
    d. More than 10 times a week

20. How do you prefer to receive travel information, such as traffic conditions, road closures, and special events information while traveling?

a. CB Radio

b. Information from your dispatcher

c. Highway Advisory Radio (HAR)

d. Highway Electronic Message Signs

e. Smartphone Applications **(if "Smartphone Applications", proceed to question 6)**

f. Commercial Radio

g. Florida 511

h. GPS Navigation Device

(For all answer choices except "Smartphone Applications", proceed to question 7)

21. What is your preferred smartphone application?

a. Vehicle Navigation Smartphone Apps (TomTom, Garmin, Magellan, etc...)

b. Waze Social GPS Maps

c. Google Maps

d. Apple Maps

e. Other

22. What do you like most about your preferred source of travel information you selected?

a. Ease of use

b. Information accuracy

c. On-time delivery of information

d. Location-specific information

e. Availability of safety or security information

f. Availability of special event information

(Participants who answered "Yes" to Question 1 should be asked Set A questions next; participants who answered "No" to Question 1 should be asked Set B questions next)

Set A Questions

(only asked to participants who answered "Yes" to Question 1)

These questions concern CBRAS.

1A. Citizens' Band Radio Advisory System (CBRAS) is a traffic information channel (channel 19) broadcasted over CB radios. Are you aware that CBRAS is available on the Florida Turnpike?

a. Yes **(if "Yes", proceed to question 2A)**

b. No **(if "No", proceed to Set B questions)**

2A. Have you ever used CBRAS while traveling on the Florida Turnpike?

a. Yes **(if "Yes", proceed to question 3A)**

b. No **(if "No", proceed to Set B questions)**

3A. How frequently do you use CBRAS during your trips on the Florida Turnpike?

a. Always

b. Often

c. Sometimes

d. Rarely

4A. How would you rate your experience with CBRAS and the travel information it provides?

a. Strongly Satisfied

b. Satisfied

c. Dissatisfied

d. Strongly Dissatisfied

(if "Strongly Satisfied" or "Satisfied", proceed to question 5A.A; if "Dissatisfied" or "Strongly Dissatisfied", proceed to question 5A.B)

5A. A.Which answer best describes your strongest opinion on CBRAS and the travel information it provides?

a. Information is accurate and up-to-date

b. Easy to access

c. Easy to understand

d. Provides location-specific information

(Proceed to question 6A)

5A. B. Which answer best describes your strongest opinion on CBRAS and the travel information it provides?

f. Information is not accurate and up-to-date
g. Not easy to access
h. Not easy to understand
i. Does not provide location-specific information
j. Needs a wider coverage area

6A. While traveling on the Florida Turnpike, have you ever heard a message on CBRAS that informed you of congestion?

a. Yes **(if "Yes", proceed to question 7A)**
b. No **(if "No", proceed to question 8A)**

7A. Did you divert off the Florida Turnpike to avoid this congestion?

a. Yes
b. No

8A. How many years of professional truck driving experience do you have?

a. Less than five years
b. 5-10 years
c. 11-15 years
d. 16-20 years
e. More than 20 years

(End of Survey)

Set B Questions

(only asked to participants who answered "No" to Questions 1, 1A, or 2A)

These questions concern HAR.

1B. Have you ever used Highway Advisory Radio (HAR) while traveling on the Florida Turnpike/I-75/I-95? (note that only one road should show in the question not all three depending on selection of student for roadway location at the start of the survey)

a. Yes **(if "Yes", proceed to question 2B)**
b. No **(if "No", end survey)**

2B. How frequently do you use HAR during your trips on the Florida Turnpike/I-75/I-95? (note that only one road should show in the question not all three depending on selection of student for roadway location at the start of the survey)

a. Always
b. Often
c. Sometimes
d. Rarely

3B. How would you rate your experience with HAR and the travel information it provides?

a. Strongly Satisfied
b. Satisfied
c. Dissatisfied
d. Strongly Dissatisfied

(if "Strongly Satisfied" or "Satisfied", proceed to question 4B.A; if "Dissatisfied" or "Strongly Dissatisfied", proceed to question 4B.B)

4B. A.Which answer best describes your strongest opinion on HAR and the travel information it provides?

a. Information is accurate and up-to-date
b. Easy to access
c. Easy to understand
d. Provides location-specific information

(Proceed to question 5B)

4B. B. Which answer best describes your strongest opinion on HAR and the travel information it provides?

a. Information is not accurate and up-to-date
b. Not easy to access
c. Not easy to understand

d. Does not provide location-specific information

e. Needs a wider coverage area

5B. While traveling on the Florida Turnpike/I-75/I-95, have you ever heard a message on HAR that informed you of congestion? (note that only one road should show in the question not all three depending on selection of student for roadway location at the start of the survey)

a. Yes **(if "Yes", proceed to question 6B)**

b. No **(if "No", proceed to question 7B)**

6B. Did you divert off the Florida Turnpike/I-75/I-95 to avoid this congestion? (note that only one road should show in the question not all three depending on selection of student for roadway location at the start of the survey)

a. Yes

b. No

7B. How many years of professional truck driving experience do you have?

a. Less than five years

b. 5-10 years

c. 11-15 years

d. 16-20 years

e. More than 20 years

(End of Survey)

APPENDIX C: FIELD HAR SURVEY DESIGN

FIELD HAR SURVEY DESIGN

Student Full Name: _____

HAR Survey Sequence Number for this Student:_____

Date of HAR Survey_____

Time of HAR Survey:_____

HAR FIELD SURVEY Version 5A (11-14-14)

Student should select Survey Roadway: Florida Turnpike

I-75 (Charlotte Rest Area)

I-95 (St. Lucie Rest Area)

[Student must select appropriate roadway and that roadway (Florida Turnpike, I-75, or I-95) will be selected automatically in questions that have roadway names in them.]

If student selects Florida Turnpike above then the student must select one of the three service plazas on Florida Turnpike: **(Student must select one of the following three service plazas)**

4) Turkey Lake Service Plaza
5) Okahumpka Service Plaza

6) Canoe Creek Service Plaza

If student selects I-75 (Charlotte Rest Area) or I-95 (St. Lucie Rest Area) then there are no more choices since it is only one location for each of these two interstates. In other words, the service plaza selection (one of the three is only if the student selects the Florida Turnpike as the roadway for the survey).

Hello, my name is ____ and I am an undergraduate student researcher with the University of Central Florida. We are conducting a survey on your understanding and opinions about traffic information and Highway Advisory Radio. Your responses are very important as they will help improve the quality of traffic information on Florida toll roads and interstates. We are not selling or marketing you anything. You are free to terminate this survey at any time. If you choose to terminate this survey, data collected from your responses will not be used without your explicit permission. All responses are strictly confidential. This survey will only take a few minutes of your time.

Would you like to participate in this survey? (Yes, No) **(if "No", terminate survey)**

Are you 18 years old or older? (Yes, No) **(if "No", terminate survey)**

(only asked to participants who could possibly be under 18)

[If participant does not terminate, student should note participant's gender (Male, Female)]

Gender: (Male, Female)

23. What is the purpose of your current trip on the Florida Turnpike/I-75/I-95? (note that only one road should show in the question not all three depending on selection of student for roadway location at the start of the survey)

    a. Travel to/from work or school
    b. Shopping
    c. Leisure/vacation
    d. Other

24. How many times per week do you travel on the Florida Turnpike/I-75/I-95? (note that only one road should show in the question not all three depending on selection of student for roadway location at the start of the survey)

    a. Once a week or less
    b. 2-5 times a week
    c. 6-10 times a week
    d. More than 10 times a week

25. How do you prefer to receive travel information, such as traffic conditions, road closures, and special events information while traveling?

    a. Commercial Radio Reports

b. Highway Electronic Message Signs

c. Smartphone Applications **(if "Smartphone Applications", proceed to question 4)**

d. Highway Advisory Radio (HAR)

e. Citizens' Band (CB) Radio

f. Florida 511

g. GPS Navigation Device

(For all answer choices except "Smartphone Applications", proceed to question 5)

26. What is your preferred smartphone application?

a. Vehicle Navigation Smartphone Apps (TomTom, Garmin, Magellan, etc...)

b. Waze Social GPS Maps

c. Google Maps

d. Apple Maps

e. Other

27. What do you like most about your preferred source of travel information you selected?

a. Ease of use

b. Information accuracy

c. On-time delivery of information

d. Location-specific information

e. Availability of safety or security information

f. Availability of special event information

28. Highway Advisory Radio (HAR) is a radio station (AM 1640) dedicated to 24-hour highway travel information. Are you aware that HAR is available on the Florida Turnpike/I-75/I-95? (note that only one road should show in the question not all three depending on selection of student for roadway location at the start of the survey)

    a. Yes **(if "Yes", proceed to question 7)**
    b. No **(if "No", proceed to question 13)**

29. How did you first become aware that HAR is available on the Florida Turnpike/I-75/I-95? (note that only one road should show in the question not all three depending on selection of student for roadway location at the start of the survey)

    a. Signs along roadway
    b. Friend or relative
    c. Florida Turnpike or Florida Department of Transportation website
    d. Other

30. Have you ever used HAR while traveling on the Florida Turnpike/I-75/I-95? (note that only one road should show in the question not all three depending on selection of student for roadway location at the start of the survey)

a. Yes **(if "Yes", proceed to question 9)**

b. No **(if "No", proceed to question 13)**

31. How frequently do you use HAR during your trips on the Florida Turnpike/I-75/I-95? (note that only one road should show in the question not all three depending on selection of student for roadway location at the start of the survey)

    a. Always

    b. Often

    c. Sometimes

    d. Rarely

32. How would you rate your experience with HAR and the travel information it provides?

    a. Strongly Satisfied

    b. Satisfied

    c. Dissatisfied

    d. Strongly Dissatisfied

(if "Strongly Satisfied" or "Satisfied", proceed to question 11.A; if "Dissatisfied" or "Strongly Dissatisfied", proceed to question 11.B)

33. A. Which answer best describes your strongest opinion on HAR and the travel information it provides?

a. Information is accurate and up-to-date

b. Easy to access

c. Easy to understand

d. Provides location-specific information

(Proceed to question 12)

11. B. Which answer best describes your strongest opinion on HAR and the travel information it provides?

    k. Information is not accurate and up-to-date

    l. Not easy to access

    m. Not easy to understand

    n. Does not provide location-specific information

    o. Needs a wider coverage area

12. What is the most important type of traffic information you think should be broadcast on HAR?

    a. Traffic congestion locations and durations

    b. Weather conditions

    c. Roadway construction

    d. Special events

    e. Alternate route information

    f. Safety information

13. If you were required to evacuate the area of Florida that you reside in because of a hurricane and HAR was available for emergency broadcasts, would you use HAR?
    a. Yes
    b. No
    c. Yes, but would seek out other sources of information first

14. To increase awareness of HAR, where do you think is the best place to promote or advertise HAR?
    a. Television
    b. Popular Radio Stations
    c. Social Media Websites
    d. Florida Turnpike and/or Florida Department of Transportation Website
    e. Highway Electronic Message Signs
    f. Billboard

15. Should HAR service be continued or discontinued?
    a. Continued
    b. Discontinued

16. If HAR service is discontinued, what alternatives would you use to obtain travel information? (select all that apply)
    a. Commercial Radio Reports

b. Internet

c. Highway Electronic Message Signs

d. Smartphone Applications

e. Citizens' Band (CB) Radio

f. Florida 511

17. If HAR service is continued, would you use HAR in the future?

a. Yes

b. No

18. Do you live in Florida?

a. Yes

b. No

19. Which of the following best describes your age?

a. 18-25 years

b. 26-35 years

c. 36-50 years

d. 51-65 years

e. Over 65 years

20. What is your highest level of education reached?

a. High School Diploma or less

b. Some College

c. Associate Degree

d. Bachelor Degree

e. Post Graduate Degree

APPENDIX D: LIST OF ZIP CODES NEAR HAR BEACONS

List of Zip codes near HAR beacons

	Zip Code	Name	Population (2010)
1	33066	Pompano Beach	15760
2	33069	Pompano Beach	25749
3	33068	Pompano Beach	49824
4	33186	Miami	67162
5	33196	Miami	46282
6	33023	Hollywood	63661
7	33021	Hollywood	45851
8	33024	Hollywood	63855
9	33314	Fort Lauderdale	21638
10	33411	West Palm Beach	65284
11	33413	West Palm Beach	15322
12	33467	Lake Worth	49531
13	33434	Boca Raton	19238
14	33433	Boca Raton	41877
15	34739	Kenansville	806
16	34773	Saint Cloud	1856
17	34772	Saint Cloud	21959
18	34769	Saint Cloud	21893
19	34744	Kissimmee	42743
20	34743	Kissimmee	33632
21	32824	Orlando	37468
22	32837	Orlando	52132
23	32821	Orlando	20510
24	32819	Orlando	25057
25	32809	Orlando	25714
26	32839	Orlando	52019
27	32835	Orlando	40584
28	32811	Orlando	35094
29	34785	Wildwood	10973
30	34762	Okahumpka	1044
31	34945	Fort Pierce	5510
32	34951	Fort Pierce	14097
33	34947	Fort Pierce	12080
34	34981	Fort Pierce	4248
35	34983	Port Saint Lucie	38467
36	34986	Port Saint Lucie	23260
37	34953	Port Saint Lucie	61494
38	34984	Port Saint Lucie	13764
39	34997	Stuart	39542

APPENDIX E: MILE POST AND COUNTY

Location	Status	Milepost	County	Facility	Name	Direction
SW 8th - NB MP 19.5	Existing	19.5	Dade	HEFT	SW 8th	NB
Miramar NB MP 0	Existing	0	Dade	Golden Glades	Miramar	NB
Miramar SB MP 52.9	Existing	52.9	Broward	Southern Coin	Miramar	SB
Deerfield NB MP 66.9	Existing	66.9	Broward	Southern Coin	Deerfield	NB
Deerfield SB MP	Existing	75.5	Palm Beach	Southern Coin	Deerfield	SB
Lake Worth NB MP 92.1	Existing	92.1	Palm Beach	Ticket System	Lake Worth	NB
Lake Worth SB MP 98.6	Existing	98.6	Palm Beach	Ticket System	Lake Worth	SB
Stuart NB MP 129.3	Existing	129.3	Martin	Ticket System	Stuart	NB
Stuart SB MP 141	Existing	141	St. Lucie	Ticket System	Stuart	SB
Ft. Pierce NB MP	Existing	148	St. Lucie	Ticket System	Ft. Pierce	NB
Ft. Pierce SB MP 157	Existing	157	St. Lucie	Ticket System	Ft. Pierce	SB
Canoe Creek NB MP 224	Existing	224	Osceola	Ticket System	Canoe Creek	NB
Canoe Creek SB	Existing	234.5	Osceola	Ticket System	Canoe Creek	SB
Beachline E/W MP 3.7	Existing	3.7	Orange	Beachline	Beachline	E/W
I-4 NB MP	Existing	255.8	Orange	Northern Coin	I-4	NB
I-4 SB MP	Existing	262.5	Orange	Northern Coin	I-4	SB
Wildwood NB MP 301	Existing	301	Sumter	Northern Coin	Wildwood	NB
Wildwood SB MP 309	Existing	309	Sumter	Northern Coin	Wildwood	SB

APPENDIX F: UCF INSTITUTIONAL REVIEW BOARD (IRB) APPROVAL LETTERS

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Haitham M. Al-Deek**

Date: **October 02, 2014**

Dear Researcher:

On 10/02/2014, the IRB approved the following activity as human participant research that is exempt from regulation:

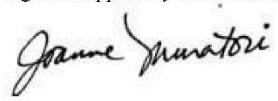
Type of Review:	Exempt Determination
Project Title:	Evaluating the Impact and Usefulness of Highway Advisory Radio (HAR) and Citizens' Band Radio Advisory Systems (CBRAS) in Providing Traveler Information and Improving the User Experience on the Florida Turnpike Enterprise's Toll Road Network and the Florida Interstate Highway (FIH) System
Investigator:	Haitham M Al-Deek
IRB Number:	SBE-14-10639
Funding Agency:	FL Department of Transportation
Grant Title:	
Research ID:	1057181

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 10/02/2014 09:41:00 AM EDT



IRB Coordinator

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Haitham M. Al-Deek**

Date: **October 29, 2014**

Dear Researcher:

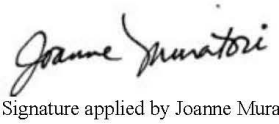
On 10/29/2014, the IRB approved the following minor modifications to human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Modification Type:	A revised phone survey has been uploaded in iRIS and a revised consent document has been approved for use.
Project Title:	Evaluating the Impact and Usefulness of Highway Advisory Radio (HAR) and Citizens' Band Radio Advisory Systems (CBRAS) in Providing Traveler Information and Improving the User Experience on the Florida Turnpike Enterprise's Toll Road Network and the Florida Interstate Highway (FIH) System
Investigator:	Haitham M Al-Deek
IRB Number:	SBE-14-10639
Funding Agency:	FL Department of Transportation
Grant Title:	
Research ID:	1057181

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:



Signature applied by Joanne Muratori on 10/29/2014 12:10:27 PM EDT

IRB Coordinator

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Haitham M Al-Deek**

Date: **November 03, 2014**

Dear Researcher:

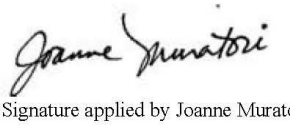
On 11/03/2014, the IRB approved the following minor modifications to human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Modification Type:	Two field surveys have been uploaded in iRIS and two consent scripts have been approved for use. In addition, the total number of study participants has been increased to 1,400 individuals. The following undergraduate research assistants have been added to the study: A. Borgmeier, J. Bruns, N. Crosby, D. Hufschmid, S. lamas, R. Mai, V. Martinez, T. McClure, F. Musmurati, S. Pope, A. Sandt, and N. Pepe. S. Aroui, J. Echevarria, and O. Mouri will be added when they activate their iRIS accounts.
Project Title:	Evaluating the Impact and Usefulness of Highway Advisory Radio (HAR) and Citizens' Band Radio Advisory Systems (CBRAS) in Providing Traveler Information and Improving the User Experience on the Florida Turnpike Enterprise's Toll Road Network and the Florida Interstate Highway (FIH) System
Investigator:	Haitham M Al-Deek
IRB Number:	SBE-14-10639
Funding Agency:	FL Department of Transportation
Grant Title:	
Research ID:	1057181

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:



Signature applied by Joanne Muratori on 11/03/2014 01:36:10 PM EST

IRB Coordinator

APPENDIX G: HAR CATI SURVEY FREQUENCY TABLES

Total Respondents: 1000
Export Date: January 31, 2015 08:48:40 am

QGENDER. Gender:

Value	Description	Counts	%
1	Male	422	42.2
2	**Female**	**578**	**57.8**
	Answered	1000	

Q2. What is the purpose of your most common trip on the Florida Turnpike?

Value	Description	Counts	%
1	Travel to/from work or school	234	23.4
2	Shopping	74	7.4
3	**Leisure/vacation**	**421**	**42.1**
4	Other	271	27.1
	Answered	1000	

Q3. Excluding intermediate stops, how long does this trip on the Florida Turnpike typically take?

Value	Description	Counts	%
1	Less than 15 minutes	37	15.81
2	**15-30 minutes**	**81**	**34.6**
3	31-45 minutes	55	23.5
4	46-60 minutes	21	8.97
5	More than 60 minutes	40	17.09
	Answered	234	

Q4. Excluding the Florida Turnpike, how many other routes have you ever taken for this trip?

Value	Description	Counts	%
1	None	39	16.67
2	**One**	**77**	**32.9**
3	Two	47	20.09
4	Three	31	13.25
5	Four or more	40	17.09
	Answered	234	

Q5. Excluding intermediate stops, how long does this trip typically take using the best alternate route?

Value	Description	Counts	%
1	Less than 15 minutes	11	5.64
2	15-30 minutes	54	27.69
3	**31-45 minutes**	**62**	**31.8**
4	46-60 minutes	26	13.33
5	More than 60 minutes	42	21.54
	Answered	195	

Q6. How many times per week do you travel on the Florida Turnpike?

Value	Description	Counts	%
1	**Once a week or less**	**700**	**70**
2	2-5 times a week	214	21.4
3	6-10 times a week	59	5.9
4	More than 10 times a week	27	2.7
	Answered	1000	

Q7. How do you prefer to receive travel information, such as traffic conditions, road closures, and special events information while traveling?

Value	Description	Counts	%
1	Commercial Radio Reports	237	23.7
2	Florida 511	28	2.8
3	**Highway Electronic Message Signs**	**314**	**31.4**
4	Smartphone Applications	152	15.2
5	Highway Advisory Radio (HAR)	66	6.6
6	Citizens' Band (CB) Radio	11	1.1
7	GPS Navigation Device	192	19.2
	Answered	1000	

Q8. What is your preferred smartphone application?

Value	Description	Counts	%
1	Vehicle Navigation Smartphone Apps (TomTom, Garmin, Magellan, etc...)	19	12.5
2	Waze Social GPS Maps	17	11.18
3	**Google Maps**	**79**	**52**
4	Apple Maps	15	9.87
5	Other	22	14.47
	Answered	152	

Q9. What do you like most about your preferred source of travel information you selected?

Value	Description	Counts	%
1	**Ease of use**	**348**	**34.8**
2	Information accuracy	97	9.7
3	On-time delivery of information	100	10
4	Location-specific information	126	12.6
5	Availability of safety or security information	101	10.1
6	Availability of special event information	40	4
7	Other reasons	188	18.8
	Answered	1000	

Q10. Highway Advisory Radio (HAR) is a radio station (AM 1640) dedicated to 24-hour highway travel information. Are you aware that Highway Advisory Radio is available on the Florida Turnpike?

Value	Description	Counts	%
1	**Yes**	**527**	**52.7**
2	No	473	47.3
	Answered	1000	

Q11. How did you first become aware that Highway Advisory Radio is available on the Florida Turnpike?

Value	Description	Counts	%
1	**Signs along Florida Turnpike**	**425**	**80.7**
2	Friend or relative	42	7.97
3	Florida Turnpike website	12	2.28
4	Other	48	9.11
	Answered	527	

Q12. Have you ever used Highway Advisory Radio while traveling on the Florida Turnpike?

Value	Description	Counts	%
1	Yes	221	41.94
2	**No**	**306**	**58.1**
	Answered	527	

Q13. How frequently do you use Highway Advisory Radio during your trips on the Florida Turnpike?

Value	Description	Counts	%
1	Always	20	9.05
2	Often	22	9.95
3	Sometimes	77	34.84
4	**Rarely**	**102**	**46.2**
	Answered	221	

Q14. How would you rate your experience with Highway Advisory Radio and the travel information it provides?

Value	Description	Counts	%
1	Strongly Satisfied	26	11.76
2	**Satisfied**	**158**	**71.5**
3	Dissatisfied	24	10.86
4	Strongly Dissatisfied	13	5.88
	Answered	221	

Q15A. Which answer best describes your strongest opinion on Highway Advisory Radio and the travel information it provides?

Value	Description	Counts	%
1	**Information is accurate and up-to-date**	**62**	**33.7**
2	Easy to access	35	19.02
3	Easy to understand	47	25.54
4	Provides location-specific information	40	21.74
	Answered	184	

Q15B. Which answer best describes your strongest opinion on Highway Advisory Radio and the travel information it provides?

Value	Description	Counts	%
1	Information is not accurate and up-to-date	5	13.51
2	Not easy to access	4	10.81
3	**Not easy to understand**	**16**	**43.2**
4	Does not provide location-specific information	4	10.81
5	Needs a wider coverage area	8	21.62
	Answered	37	

Value	Description	Counts	%
1	**Traffic congestion locations and durations**	**127**	**57.5**
2	Weather conditions	8	3.62
3	Roadway construction	17	7.69
4	Special events	2	0.9
5	Alternate route information	13	5.88
6	Safety information	54	24.43

Answered 221

Q17. While traveling on the Florida Turnpike, have you ever heard a message on Highway Advisory Radio that informed you of congestion?

Value	Description	Counts	%
1	**Yes**	**137**	**62**
2	No	84	38.01

Answered 221

Q18. Did you exit off the Florida Turnpike to avoid this congestion?

Value	Description	Counts	%
1	**Yes**	**84**	**61.3**
2	No	53	38.69

Answered 137

Q19. Why did you stay on the Florida Turnpike?

Value	Description	Counts	%
1	Unfamiliar with alternate routes	11	20.75
2	Did not trust accuracy of Highway Advisory Radio message	1	1.89
3	**Alternate route would still take more time**	**15**	**28.3**
4	No alternate routes available	13	24.53
5	Other	13	24.53
	Answered	53	

Q20. While traveling on the Florida Turnpike, what amount of delay broadcast on Highway Advisory Radio would make you exit off the Florida Turnpike?

Value	Description	Counts	%
1	15 minutes	344	34.4
2	**30 minutes**	**351**	**35.1**
3	45 minutes	96	9.6
4	More than 45 minutes	102	10.2
5	Would not exit off Florida Turnpike	107	10.7
	Answered	1000	

Q21. What is the main reason you would stay on the Florida Turnpike?

Value	Description	Counts	%
1	Unfamiliar with alternate routes	28	26.17
2	Would not trust accuracy of Highway Advisory Radio message	0	0
3	**Alternate route would likely take more time**	**37**	**34.6**
4	No alternate routes available	18	16.82
5	Other reasons	24	22.43
	Answered	107	

Q22. If there was an emergency, such as a hurricane, that required you to evacuate your area of residence in Florida and Highway Advisory Radio was available for emergency broadcasts, would you use Highway Advisory Radio?

Value	Description	Counts	%
1	**Yes**	**785**	**78.5**
2	No	96	9.6
3	Yes, but would seek out other sources of information first	119	11.9
	Answered	1000	

Q23. To increase awareness of Highway Advisory Radio, where do you think is the best place to promote or advertise Highway Advisory Radio?

Value	Description	Counts	%
1	**Television**	**289**	**28.9**
2	Popular Radio Stations	163	16.3
3	Florida Turnpike and/or Florida Department of Transportation Website	59	5.9
4	Social Media Website	98	9.8
5	Highway Electronic Message Signs	282	28.2
6	Billboard	109	10.9

Answered 1000

Q24. Should Highway Advisory Radio service be continued or discontinued?

Value	Description	Counts	%
1	**Continued**	**849**	**84.9**
2	Discontinued	59	5.9
3	Impartial	92	9.2

Answered 1000

Q25. If Highway Advisory Radio service is discontinued, what alternatives would you use to obtain travel information?

Value	Description	Counts	%
1	Commercial Radio Reports	726	72.6
2	Florida 511	388	38.8
3	Internet	509	50.9
4	**Highway Electronic Message Signs**	**828**	**82.8**
5	Smartphone Applications	525	52.5
6	Citizens' Band (CB) Radio	182	18.2
7	Other alternative	26	2.6

Answered 1000

Q26. If Highway Advisory Radio service is continued, would you use Highway Advisory Radio in the future?

Value	Description	Counts	%
1	**Yes**	**832**	**83.2**
2	No	168	16.8

Answered 1000

Q27. Which of the following best describes your age?

Value	Description	Counts	%
1	18-25 years	40	4
2	26-35 years	159	15.9
3	36-50 years	205	20.5
4	51-65 years	266	26.6
5	**Over 65 years**	**330**	**33**

Answered 1000

Q28. What is your highest level of education reached?

Value	Description	Counts	%
1	High School Diploma or less	224	22.4
2	Some College	189	18.9
3	Associate Degree	132	13.2
4	**Bachelor Degree**	**247**	**24.7**
5	Post Graduate Degree	208	20.8

Answered 1000

APPENDIX H: CBRAS SURVEY FREQUENCY TABLES

FREQUENCY TABLES FOR CBRAS SURVEYS

qversion Please choose what version of the survey.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 CBRAS	613	100.0	100.0	100.0

qroadway Survey Roadway:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Florida Turnpike	440	71.8	71.8	71.8
	2 I-75 (Charlotte Rest Area)	98	16.0	16.0	87.8
	3 I-95 (St. Lucie Rest Area)	75	12.2	12.2	100.0
	Total	613	100.0	100.0	

qroadpipe Pipe Roadway

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 the Florida Turnpike	440	71.8	71.8	71.8
	2 I-75	98	16.0	16.0	87.8
	3 I-95	75	12.2	12.2	100.0
	Total	613	100.0	100.0	

qs1 Survey Location:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Turkey Lake Service Plaza	234	38.2	53.2	53.2
	2 Okahumpka Service Plaza	57	9.3	13.0	66.1
	3 Canoe Creek Service Plaza	149	24.3	33.9	100.0
	Total	440	71.8	100.0	
Missing	System	173	28.2		
Total		613	100.0		

qs2 Would you like to participate in this survey?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	613	100.0	100.0	100.0

qs4 Gender:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Male	593	96.7	96.7	96.7
	2 Female	20	3.3	3.3	100.0
	Total	613	100.0	100.0	

q1 Do you have a Citizens' Band (CB) radio in your truck?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	329	53.7	53.7	53.7
	2 No	284	46.3	46.3	100.0
	Total	613	100.0	100.0	

q2 How often do you use CB radio for travel information?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Always	73	11.9	22.2	22.2
	2 Often	57	9.3	17.3	39.5
	3 Sometimes	77	12.6	23.4	62.9
	4 Rarely	83	13.5	25.2	88.1
	5 Never	39	6.4	11.9	100.0
	Total	329	53.7	100.0	
Missing	System	284	46.3		
Total		613	100.0		

q3 Do you live in Florida?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	362	59.1	59.1	59.1
	2 No	251	40.9	40.9	100.0
	Total	613	100.0	100.0	

q4 How many times per week do you travel on the Florida Turnpike/I-75/I-95?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Once a week or less	273	44.5	44.5	44.5
	2 2-5 times a week	200	32.6	32.6	77.2
	3 6-10 times a week	72	11.7	11.7	88.9
	4 More than 10 times a week	68	11.1	11.1	100.0
	Total	613	100.0	100.0	

q5 How do you prefer to receive travel information, such as traffic conditions, road closures, and special events information while traveling?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 CB Radio	95	15.5	15.5	15.5
	2 Information from your dispatcher	32	5.2	5.2	20.7
	3 Highway Advisory Radio (HAR)	13	2.1	2.1	22.8
	4 Highway Electronic Message Signs	92	15.0	15.0	37.8
	5 Smartphone Applications	134	21.9	21.9	59.7
	6 Commercial Radio	57	9.3	9.3	69.0
	7 Florida 511	20	3.3	3.3	72.3
	8 GPS Navigation Device	170	27.7	27.7	100.0
	Total	613	100.0	100.0	

q6 What is your preferred smartphone application?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Vehicle Navigation Smartphone Apps (TomTom, Garmin, Magellan, etc...)	6	1.0	4.5	4.5
	2 Waze Social GPS Maps	6	1.0	4.5	9.0
	3 Google Maps	93	15.2	69.4	78.4
	4 Apple Maps	11	1.8	8.2	86.6
	5 Other	18	2.9	13.4	100.0
	Total	134	21.9	100.0	
Missing	System	479	78.1		
Total		613	100.0		

q7 What do you like most about your preferred source of travel information you selected?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Ease of use	312	50.9	50.9	50.9
	2 Information accuracy	157	25.6	25.6	76.5
	3 On-time delivery of information	44	7.2	7.2	83.7
	4 Location-specific information	80	13.1	13.1	96.7
	5 Availability of safety or security information	13	2.1	2.1	98.9
	6 Availability of special event information	7	1.1	1.1	100.0
	Total	613	100.0	100.0	

q1a Citizens' Band Radio Advisory System (CBRAS) is a traffic information channel (channel 19) broadcasted over CB radios. Are you aware that CBRAS is available on the Florida Turnpike?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	144	23.5	43.8	43.8
	2 No	185	30.2	56.2	100.0
	Total	329	53.7	100.0	
Missing	System	284	46.3		
Total		613	100.0		

q2a Have you ever used CBRAS while traveling on the Florida Turnpike?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	75	12.2	52.1	52.1
	2 No	69	11.3	47.9	100.0
	Total	144	23.5	100.0	
Missing	System	469	76.5		
Total		613	100.0		

q3a How frequently do you use CBRAS during your trips on the Florida Turnpike?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Always	29	4.7	38.7	38.7
	2 Often	19	3.1	25.3	64.0
	3 Sometimes	15	2.4	20.0	84.0
	4 Rarely	12	2.0	16.0	100.0
	Total	75	12.2	100.0	
Missing	System	538	87.8		
Total		613	100.0		

q4a How would you rate your experience with CBRAS and the travel information it provides?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Satisfied	23	3.8	30.7	30.7
	2 Satisfied	46	7.5	61.3	92.0
	3 Dissatisfied	4	.7	5.3	97.3
	4 Strongly Dissatisfied	2	.3	2.7	100.0
	Total	75	12.2	100.0	
Missing	System	538	87.8		
Total		613	100.0		

q5aa Which answer best describes your strongest opinion on CBRAS and the travel information it provides?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Information is accurate and up-to-date	24	3.9	34.8	34.8
	2 Easy to access	23	3.8	33.3	68.1
	3 Easy to understand	17	2.8	24.6	92.8
	4 Provides location-specific information	5	.8	7.2	100.0
	Total	69	11.3	100.0	
Missing	System	544	88.7		
Total		613	100.0		

q5ab Which answer best describes your strongest opinion on CBRAS and the travel information it provides?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Information is not accurate and up-to-date	3	.5	50.0	50.0
	3 Not easy to understand	2	.3	33.3	83.3
	5 Needs a wider coverage area	1	.2	16.7	100.0
	Total	6	1.0	100.0	
Missing	System	607	99.0		
Total		613	100.0		

q6a While traveling on the Florida Turnpike, have you ever heard a message on CBRAS that informed you of congestion?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	51	8.3	68.0	68.0
	2 No	24	3.9	32.0	100.0
	Total	75	12.2	100.0	
Missing	System	538	87.8		
Total		613	100.0		

q7a Did you divert off the Florida Turnpike to avoid this congestion?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	36	5.9	70.6	70.6
	2 No	15	2.4	29.4	100.0
	Total	51	8.3	100.0	
Missing	System	562	91.7		
Total		613	100.0		

q8a How many years of professional truck driving experience do you have?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Less than five years	11	1.8	14.7	14.7
	2 5-10 years	11	1.8	14.7	29.3
	3 11-15 years	11	1.8	14.7	44.0
	4 16-20 years	10	1.6	13.3	57.3
	5 More than 20 years	32	5.2	42.7	100.0
	Total	75	12.2	100.0	
Missing	System	538	87.8		
Total		613	100.0		

q1b Have you ever used Highway Advisory Radio (HAR) while traveling on the Florida Turnpike/I-75/I-95?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	147	24.0	27.3	27.3
	2 No	391	63.8	72.7	100.0
	Total	538	87.8	100.0	
Missing	System	75	12.2		
Total		613	100.0		

q2b How frequently do you use HAR during your trips on the Florida Turnpike/I-75/I-95?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Always	9	1.5	6.1	6.1
	2 Often	30	4.9	20.4	26.5
	3 Sometimes	44	7.2	29.9	56.5
	4 Rarely	64	10.4	43.5	100.0
	Total	147	24.0	100.0	
Missing	System	466	76.0		
Total		613	100.0		

q3b How would you rate your experience with HAR and the travel information it provides?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Satisfied	11	1.8	7.5	7.5
	2 Satisfied	95	15.5	64.6	72.1
	3 Dissatisfied	35	5.7	23.8	95.9
	4 Strongly Dissatisfied	6	1.0	4.1	100.0
	Total	147	24.0	100.0	
Missing	System	466	76.0		
Total		613	100.0		

q4ba Which answer best describes your strongest opinion on HAR and the travel information it provides?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Information is accurate and up-to-date	31	5.1	29.2	29.2
	2 Easy to access	34	5.5	32.1	61.3
	3 Easy to understand	19	3.1	17.9	79.2
	4 Provides location-specific information	22	3.6	20.8	100.0
	Total	106	17.3	100.0	
Missing	System	507	82.7		
Total		613	100.0		

q4bb Which answer best describes your strongest opinion on HAR and the travel information it provides?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Information is not accurate and up-to-date	7	1.1	17.1	17.1
	2 Not easy to access	14	2.3	34.1	51.2
	3 Not easy to understand	10	1.6	24.4	75.6
	4 Does not provide location-specific information	3	.5	7.3	82.9
	5 Needs a wider coverage area	7	1.1	17.1	100.0
	Total	41	6.7	100.0	
Missing	System	572	93.3		
Total		613	100.0		

q5b While traveling on the Florida Turnpike/I-75/I-95, have you ever heard a message on HAR that informed you of congestion?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	65	10.6	44.2	44.2
	2 No	82	13.4	55.8	100.0
	Total	147	24.0	100.0	
Missing	System	466	76.0		
Total		613	100.0		

q6b Did you divert off the Florida Turnpike/I-75/I-95 to avoid this congestion?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	36	5.9	55.4	55.4
	2 No	29	4.7	44.6	100.0
	Total	65	10.6	100.0	
Missing	System	548	89.4		
Total		613	100.0		

q7b How many years of professional truck driving experience do you have?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Less than five years	8	1.3	5.4	5.4
	2 5-10 years	19	3.1	12.9	18.4
	3 11-15 years	27	4.4	18.4	36.7
	4 16-20 years	31	5.1	21.1	57.8
	5 More than 20 years	62	10.1	42.2	100.0
	Total	147	24.0	100.0	
Missing	System	466	76.0		
Total		613	100.0		

APPENDIX I: FREQUENCY TABLES FOR HAR FIELD SURVEY

FREEQUENCY TABLES FOR HAR FIELD SURVEYS:

qversion Please choose what version of the survey.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2 HAR	1610	100.0	100.0	100.0

qroadway Survey Roadway:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Florida Turnpike	1119	69.5	69.5	69.5
	2 I-75 (Charlotte Rest Area)	280	17.4	17.4	86.9
	3 I-95 (St. Lucie Rest Area)	211	13.1	13.1	100.0
	Total	1610	100.0	100.0	

qroadpipe Pipe Roadway

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 the Florida Turnpike	1119	69.5	69.5	69.5
	2 I-75	280	17.4	17.4	86.9
	3 I-95	211	13.1	13.1	100.0
	Total	1610	100.0	100.0	

qs1 Survey Location:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Turkey Lake Service Plaza	442	27.5	39.5	39.5
	2 Okahumpka Service Plaza	207	12.9	18.5	58.0
	3 Canoe Creek Service Plaza	470	29.2	42.0	100.0
	Total	1119	69.5	100.0	
Missing	System	491	30.5		
Total		1610	100.0		

qs2 Would you like to participate in this survey?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	1610	100.0	100.0	100.0

qs3 Are you 18 years old or older?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	1610	100.0	100.0	100.0

qs4 Gender:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Male	1002	62.2	62.2	62.2
	2 Female	608	37.8	37.8	100.0
	Total	1610	100.0	100.0	

hq1 What is the purpose of your current trip on Florida Turnpike/I-75/I-95?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Travel to/from work or school	268	16.6	16.6	16.6
	2 Shopping	37	2.3	2.3	18.9
	3 Leisure/vacation	1025	63.7	63.7	82.6
	4 Other	280	17.4	17.4	100.0
	Total	1610	100.0	100.0	

hq2 How many times per week do you travel on the Florida Turnpike/I-75/I-95?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Once a week or less	1194	74.2	74.2	74.2
	2 2-5 times a week	260	16.1	16.1	90.3
	3 6-10 times a week	96	6.0	6.0	96.3
	4 More than 10 times a week	60	3.7	3.7	100.0
	Total	1610	100.0	100.0	

hq3 How do you prefer to receive travel information, such as traffic conditions, road closures, and special events information while traveling?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Commercial Radio Reports	223	13.9	13.9	13.9
	2 Highway Electronic Message Signs	540	33.5	33.5	47.4
	3 Smartphone Applications	442	27.5	27.5	74.8
	4 Highway Advisory Radio (HAR)	29	1.8	1.8	76.6
	6 Florida 511	14	.9	.9	77.5
	7 GPS Navigation Device	362	22.5	22.5	100.0
	Total	1610	100.0	100.0	

hq4 What is your preferred smartphone application?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Vehicle Navigation Smartphone Apps (TomTom, Garmin, Magellan, etc...)	20	1.2	4.5	4.5
	2 Waze Social GPS Maps	64	4.0	14.5	19.0
	3 Google Maps	257	16.0	58.1	77.1
	4 Apple Maps	51	3.2	11.5	88.7
	5 Other	50	3.1	11.3	100.0
	Total	442	27.5	100.0	
Missing	System	1168	72.5		
Total		1610	100.0		

hq5 What do you like most about your preferred source of travel information you selected?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Ease of use	908	56.4	56.4	56.4
	2 Information accuracy	308	19.1	19.1	75.5
	3 On-time delivery of information	142	8.8	8.8	84.3
	4 Location-specific information	198	12.3	12.3	96.6
	5 Availability of safety or security information	46	2.9	2.9	99.5
	6 Availability of special event information	8	.5	.5	100.0
	Total	1610	100.0	100.0	

hq6 Highway Advisory Radio (HAR) is a radio station (AM 1640) dedicated to 24-hour highway travel information. Are you aware that HAR is available on the Florida Turnpike/I-75/I-95?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	993	61.7	61.7	61.7
	2 No	617	38.3	38.3	100.0
	Total	1610	100.0	100.0	

hq7 How did you first become aware that HAR is available on the Florida Turnpike/I-75/I-95?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Signs along roadway	921	57.2	92.7	92.7
	2 Friend or relative	22	1.4	2.2	95.0
	3 Florida Turnpike or Florida Department of Transportation website	5	.3	.5	95.5
	4 Other	45	2.8	4.5	100.0
	Total	993	61.7	100.0	
Missing	System	617	38.3		
Total		1610	100.0		

q8 Have you ever used HAR while traveling on the Florida Turnpike/I-75/I-95?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	362	22.5	36.5	36.5
	2 No	631	39.2	63.5	100.0
	Total	993	61.7	100.0	
Missing	System	617	38.3		
Total		1610	100.0		

hq9 How frequently do you use HAR during your trips on the Florida Turnpike/I-75/I-95?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Always	21	1.3	5.8	5.8
	2 Often	47	2.9	13.0	18.8
	3 Sometimes	99	6.1	27.3	46.1
	4 Rarely	195	12.1	53.9	100.0
	Total	362	22.5	100.0	
Missing	System	1248	77.5		
Total		1610	100.0		

hq10 How would you rate your experience with HAR and the travel information it provides?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Satisfied	54	3.4	14.9	14.9
	2 Satisfied	236	14.7	65.2	80.1
	3 Dissatisfied	49	3.0	13.5	93.6
	4 Strongly Dissatisfied	23	1.4	6.4	100.0
	Total	362	22.5	100.0	
Missing	System	1248	77.5		
Total		1610	100.0		

hq11a Which answer best describes your strongest opinion on HAR and the travel information it provides?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Information is accurate and up-to-date	105	6.5	36.2	36.2
	2 Easy to access	95	5.9	32.8	69.0
	3 Easy to understand	43	2.7	14.8	83.8
	4 Provides location-specific information	47	2.9	16.2	100.0
	Total	290	18.0	100.0	
Missing	System	1320	82.0		
Total		1610	100.0		

hq11b Which answer best describes your strongest opinion on HAR and the travel information it provides?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Information is not accurate and up-to-date	16	1.0	22.2	22.2
	2 Not easy to access	12	.7	16.7	38.9
	3 Not easy to understand	22	1.4	30.6	69.4
	4 Does not provide location-specific information	5	.3	6.9	76.4
	5 Needs a wider coverage area	17	1.1	23.6	100.0
	Total	72	4.5	100.0	
Missing	System	1538	95.5		
Total		1610	100.0		

hq12 What is the most important type of traffic information you think should be broadcast on HAR?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Traffic congestion locations and durations	230	14.3	63.5	63.5
	2 Weather conditions	26	1.6	7.2	70.7
	3 Roadway construction	19	1.2	5.2	76.0
	4 Special events	3	.2	.8	76.8
	5 Alternate route information	29	1.8	8.0	84.8
	6 Safety information	55	3.4	15.2	100.0
	Total	362	22.5	100.0	
Missing	System	1248	77.5		
Total		1610	100.0		

hq13 If you were required to evacuate the area of Florida that you reside in because of a hurricane and HAR was available for emergency broadcasts, would you use HAR?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	713	44.3	44.3	44.3
	2 No	284	17.6	17.6	61.9
	3 Yes, but would seek out other sources of information first	613	38.1	38.1	100.0
	Total	1610	100.0	100.0	

qh14 To increase awareness of HAR, where do you think is the best place to promote or advertise HAR?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Television	266	16.5	16.5	16.5
	2 Popular Radio Stations	278	17.3	17.3	33.8
	3 Social Media Websites	330	20.5	20.5	54.3
	4 Florida Turnpike and/or Florida Department of Transportation Website	12	.7	.7	55.0
	5 Highway Electronic Message Signs	466	28.9	28.9	84.0
	6 Billboard	258	16.0	16.0	100.0
	Total	1610	100.0	100.0	

hq15 Should HAR service be continued or discontinued?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Continued	1429	88.8	88.8	88.8
	2 Discontinued	181	11.2	11.2	100.0
	Total	1610	100.0	100.0	

hq16_1 If HAR service is discontinued, what alternatives would you use to obtain travel information? - Commercial Radio Reports

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	716	44.5	44.5	44.5
	1 Yes	894	55.5	55.5	100.0
	Total	1610	100.0	100.0	

hq16_2 If HAR service is discontinued, what alternatives would you use to obtain travel information? - Internet

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	783	48.6	48.6	48.6
	1 Yes	827	51.4	51.4	100.0
	Total	1610	100.0	100.0	

hq16_3 If HAR service is discontinued, what alternatives would you use to obtain travel information? - Highway Electronic Message Signs

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	455	28.3	28.3	28.3
	1 Yes	1155	71.7	71.7	100.0
	Total	1610	100.0	100.0	

hq16_4 If HAR service is discontinued, what alternatives would you use to obtain travel information? - Smartphone Applications

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	672	41.7	41.7	41.7
	1 Yes	938	58.3	58.3	100.0
	Total	1610	100.0	100.0	

hq16_5 If HAR service is discontinued, what alternatives would you use to obtain travel information? - Citizens' Band (CB) Radio

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	1534	95.3	95.3	95.3
	1 Yes	76	4.7	4.7	100.0
	Total	1610	100.0	100.0	

hq16_6 If HAR service is discontinued, what alternatives would you use to obtain travel information? - Florida 511

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	1394	86.6	86.6	86.6
	1 Yes	216	13.4	13.4	100.0
	Total	1610	100.0	100.0	

hq17 If HAR service is continued, would you use HAR in the future?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	1353	84.0	84.0	84.0
	2 No	257	16.0	16.0	100.0
	Total	1610	100.0	100.0	

hq18 Do you live in Florida?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	1150	71.4	71.4	71.4
	2 No	460	28.6	28.6	100.0
	Total	1610	100.0	100.0	

hq19 Which of the following best describes your age?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 18-25 years	175	10.9	10.9	10.9
	2 26-35 years	249	15.5	15.5	26.3
	3 36-50 years	441	27.4	27.4	53.7
	4 51-65 years	455	28.3	28.3	82.0
	5 Over 65 years	290	18.0	18.0	100.0
	Total	1610	100.0	100.0	

hq20 What is your highest level of education reached?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 High School Diploma or less	239	14.8	14.8	14.8
	2 Some College	392	24.3	24.3	39.2
	3 Associate Degree	190	11.8	11.8	51.0
	4 Bachelor Degree	456	28.3	28.3	79.3
	5 Post Graduate Degree	333	20.7	20.7	100.0
	Total	1610	100.0	100.0	

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