

The Impact of Real-Time and Predictive Traffic Information on Travelers' Behavior in the I-4 Corridor

FINAL REPORT



FDOT-UCF Contract No.: **BC355 RPWO# 3**

Submitted by
The Impact of I-4 Traffic Information Project Research Team

**The I-4 Traffic Information Project Principal Investigator and Contact Person:
Haitham Al-Deek, Ph.D., P.E.**

Professor of Civil & Environmental Engineering, Director of the Transportation Systems Institute, and CATSS Program Director of Advanced Management Traffic Systems and Data Warehouse Research
Department of Civil and Environmental Engineering
University of Central Florida
P.O. Box 162450
Orlando, Florida 32816-2450
Phone (407) 823-2988, Fax (407) 823-3315
E-mail: haldeek@mail.ucf.edu

The UCF I-4 Project Research Team Members: Haitham Al-Deek (Team Leader), Morgan Wang (Co-Principal Investigator), Mohamed Abdel-Aty (Co-Principal Investigator), Patrick Kerr, Emam Emam, Hatem Abou-Senna, Yueliang Zuo, and Sherif Ishak (Principal Investigator of Louisiana State University Subcontract)

Submitted to
The Florida Department of Transportation

July 2003

TECHNICAL REPORT DOCUMENTATION PAGE

| | | | | | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|-----------|
| 1. Report No. | | 2. Government Accession No. | | 3. Recipient's Catalog No. | |
| 4. Title and Subtitle The Impact of Real-Time and Predictive Traffic Information on Travelers' Behavior in the I-4 Corridor | | | | 5. Report Date July 2003 | |
| | | | | 6. Performing Organization Code | |
| 7. Author (s) Haitham Al-Deek, Morgan Wang, Mohamed Abdel-Aty, Patrick Kerr, and Sherif Ishak | | | | 8. Performing Organization Report No. | |
| 9. Performing Organization Name and Address Center for Advanced Transportation Systems Simulation (CATSS) Dept. of Civil & Environmental Engineering University of Central Florida 4000 Central Florida Boulevard Orlando, FL 32816-2450 | | | | 10. Work Unit No. (TRAIS) | |
| | | | | 11. Contract or Grant No. BC355 RPWO# 3 | |
| 12. Sponsoring Agency Name and Address Florida Department of Transportation Research Center 605 Suwannee Street Tallahassee, FL 32399-0450 | | | | 13. Type of Report and Period Covered Final Report | |
| | | | | 14. Sponsoring Agency Code | |
| 15. Supplementary Notes Prepared in cooperation with the Florida Department of Transportation. | | | | | |
| 16. Abstract Real time and predicted traffic information plays a key role in the successful implementation of advanced traveler information systems (ATIS) and advanced traffic management systems (ATMS). Traffic information is essentially valuable to both transportation system users and providers. In addition to monitoring the operational performance of traffic on freeway facilities, real time information is now communicated to the traveling public by the concerned agencies in order to keep the public informed of the latest conditions and to provide opportunities for better travel decisions. Although real time advisory information on traffic conditions is currently widely available to the public via the Internet and other media sources, such information is of less use at the pre-trip planning stage since traffic conditions are dynamically changing over time. This created the need and the motivation to synthesize predictive information as well. Such predictive information can be effectively used to provide the public with the expected traffic conditions within short-term horizons during which their trip is expected to begin. Using predictive information, travelers can make better future trip decisions either at the pre-trip planning stage or en-route via onboard wireless communication devices. Decisions that are likely to be impacted by predictive information include departure time, travel mode, route selection, and possibly trip destination. This study presents the full scale implementation of a short-term traffic prediction model that was developed by the University of Central Florida's Transportation Systems Institute (UCF-TSI) to assist I-4 travelers with trip-making decisions along the 40-mile I-4 corridor in Orlando, Florida. This report presents the results of two pilot surveys of the impact of traffic information on travelers' behavior in the I-4 corridor. One pilot survey was conducted via telephone and the other was conducted using the Internet. | | | | | |
| 17. Key Words Traffic Information, Traffic Prediction, Web Site, Internet, Traveler Information Surveys, Traveler Behavior. | | | 18. Distribution Statement No restriction - this report is available to the public through the National Technical Information Service, Springfield, VA 22161 | | |
| 19. Security classif. (of this report) Unclassified | | 20. Security Class. (of this page) Unclassified | | 21. No. of Pages 117 | 22. Price |

DISCLAIMER

The opinions, findings and conclusions in this publication are those of the authors and not necessarily those of the Florida Department of Transportation or the US Department of Transportation. This report does not constitute a standard specification, or regulation. This report is prepared in cooperation with the State of Florida Department of Transportation.

ACKNOWLEDGEMENT

This report has been prepared as part of Contact No.: BC355 RPWO# 3, "The Impact of Real-Time and Predictive Traffic Information on Travelers' Behavior in the I-4 Corridor". The report has been prepared by the the University of Central Florida's research team.

The authors would like to acknowledge the financial support of the Florida Department of Transportation (FDOT) Research Center and the help of the Traffic Engineering Central Office in Tallahassee, Florida. In particular, the authors would like to thank Mr. Lap T. Hoang, State Traffic Operations Engineer, and Ms. Elizazbeth Birriel of the Traffic Engineering Central Office for their important role in supporting and managing this research project. Special thanks go to Mr. Richard C. Long for encouraging the initial research idea of this project and providing the financial support through his center.

EXECUTIVE SUMMARY

The primary goal of this research project is to enhance the short-term traffic prediction model previously developed and tested by the UCF Transportation Systems Institute (UCF-TSI), and implement this model online of the 40-mile corridor of I-4 in Orlando, Florida. The model was originally developed using non-linear time series approach in a previous research study that was sponsored by the FDOT Traffic Engineering Central Office. In this project the implementation phase was directed towards making the real-time and predicted information accessible to the traveling public via a user-friendly interactive interface on the Internet. I-4 travelers now have easy access to travel time information between on- and off-ramps along the corridor in both directions and in both real-time and predictive modes. At the pre-trip planning stage, travelers can now query the system before departure to determine the predicted travel times and delays along the segment of the corridor they are about to travel. The interactive web-based system also provides travelers with predicted travel time information at different prediction horizons, ranging from 10 to 30 minutes.

A secondary goal of this project is to test travelers response to real time and predictive traffic information in the Interstate-4 corridor. There are three sequential parts in this process: conducting the pilot surveys, followed by a marketing campaign of the web site, and finally conducting a large scale random survey of travelers living and/or commuting in the I-4 corridor.

A pilot CATI (Computer-Aided Telephone Interview) survey was conducted to measure the level of familiarity with the present I-4 web site and also the 511 telephone service. The research team at UCF designed the survey. Western Watts marketing

research company was used to conduct the interview and was compensated for their service. The desired complete sample was 400. Among the significant results was that about 25% of the sample use I-4 for commute, and about 20% use it for work related trips. The remaining percentage use I-4 for other trip purposes. About 28% of the sample use I-4 five or more times per week. About 26% of the sample use I-4 both in the morning and afternoon peak periods, 14% use it only in the morning peak, and 16% use it only in the afternoon peak. Surprisingly about 30% of the respondents use I-4 on weekends.

As for traffic information, only 7 respondents indicated that they use the present web site, and also only 7 indicated that they use the 511 phone service. However 48 respondents (12% of the sample) indicated that they are familiar with the present I-4 web site. Also, 120 respondents (30% of the sample) indicated that they are familiar with the 511 Phone traveler information service. In general, respondents indicated that the information they need the most is related to the locations of incidents and the expected delay.

A web-based pilot survey was conducted to measure the level of familiarity with I-4 web site and also the 511 telephone service. The research team at UCF designed and implemented the web-based survey with SAS/IntraNet software. Although the design sample size is 400, the web-based survey was so popular and it reached the sample size of 439 in the first few days of the survey period. Since the design of this web-based survey included automatic validating capability, the data quality for the web-based survey is much higher than the traditional phone based survey system with relatively low cost. The screening questions were that the respondents have to be I-4 users and live and/or

work in Central Florida. Note that the internet survey was restricted only to UCF students, staff, and faculty (the pool size is about 43,000 individuals).

Among the significant results was that about 35% of the sample use I-4 for commute, and about 12% use it for work related trips. The remaining percentage use I-4 for other trip purposes. About 33% of the sample use I-4 five or more times per week. About 29% of the sample use I-4 both in the morning and afternoon peak periods, 9% use it only in the morning peak, and 15% use it only in the afternoon peak. Surprisingly, about 29% of the respondents use I-4 on weekends and that is similar to the finding through regular phone based survey.

As for traffic information, there are 34 respondents (9%) indicated that they use the web site that is much higher than 7 respondents found in phone survey. This is an indicator that web-based survey can reach web surfers much more effectively than regular residents. In general, the respondents indicated that the information they needed the most is related to the locations of incidents and the expected delay.

Presently, UCF has a contract with FDOT District-5 to conduct the marketing campaign and the large scale random survey in the I-4 corridor. Since the new Central Florida Regional Transportation Operations Consortium's web site will be launched in Fall 2003, both the marketing campaign and the large scale random survey will be conducted after the new web site is launched.

TABLE OF CONTENTS

TECHNICAL REPORT DOCUMENTATION PAGE..... i

INTRODUCTION 6

BACKGROUND ON SHORT TERM TRAFFIC PREDICTION MODELS..... 8

EVALUATION OF THE I-4 SHORT TERM TRAFFIC PREDICTION SYSTEM..... 9

 Description of the Non-Linear Time Series Model 10

 Study area and Data collection 12

 Model parameters..... 14

 Prediction Horizon 15

 Prediction Step 15

 Rolling Horizon 15

 Rolling Step 15

 Number of Alpha Intervals 16

 Effect of Traffic Conditions..... 17

 Prediction Performance Evaluation 17

 Statistical analysis..... 18

 Effect of Congestion Index (CI) 19

 Effect of Prediction Horizon (PH) 20

 Effect of Rolling Horizon (RH) 21

 Interaction between Prediction Horizon and Congestion Index (PHxCI) 22

 Interaction between Rolling Horizon and Congestion Index (RHxCI) 23

 Path-Based Analysis 24

 Summary of the Evaluation Phase 26

CONVERSION OF THE SHORT-TERM TRAFFIC PREDICTION MODEL INTO A PUBLICLY ACCESSIBLE WEB APPLICATION..... 28

 Description of the Web Application 28

 Mapping Loop Detector Stations to Entry and Exit Points..... 32

MODIFICATION OF THE WEB-BASED TRAFFIC PREDICTION SYSTEM..... 34

LONG TERM TRAFFIC PREDICTION MODULE 41

REFERENCES 47

SURVEY RESULTS 52

SURVEY RESULTS 76

DESIGN OF THE WEB-BASE SURVEY..... 106

LIST OF TABLES AND FIGURES

| | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Table 1 Results of the GLM Statistical Procedure | 19 |
| Table 2: Mapping Loop Detector Stations to Entry and Exit Points Along I-4 | 34 |
| Figure 1 Snapshot of the I-4 traffic prediction system | 14 |
| Figure 2 Schematic representation of the time series operation | 16 |
| Figure 3 Effect of congestion index on relative travel time prediction error | 20 |
| Figure 4 Effect of prediction horizon on relative travel time prediction error | 21 |
| Figure 5 Effect of rolling horizon on relative travel time prediction error | 22 |
| Figure 6 Effect of interaction between prediction horizon and congestion index on relative travel time prediction error | 23 |
| Figure 7 Effect of interaction between rolling horizon and congestion index on relative travel time prediction error | 24 |
| Figure 8 Distribution of prediction errors using path-based approach | 26 |
| Figure 9: Snapshot of the I-4 Traffic Information Main Web Page | 29 |
| Figure 10: Snapshot of the Short Term Traffic Forecasting Page | 30 |
| Figure 11: Sample of a User's Request for Predicted Travel Time | 31 |
| Figure 12: 15-Minute Forecasted Information from SR 482 to Exit 48 | 32 |
| Figure 13: Snapshot of the I-4 Traffic Information Main Web Page | 36 |
| Figure 14: Snapshot of the Eastbound Real-Time Traffic Information Page | 37 |
| Figure 15: Snapshot of the Westbound Real-Time Traffic Information Page | 38 |
| Figure 16: Historical Travel Time in the Eastbound Direction on Friday, March 8 th , 2002 at 8:000 AM over the Entire 40-Mile Corridor | 39 |
| Figure 17: Historical Travel Time in the Westbound Direction on Friday, March 8 th , 2002 at 8:000 AM over the Entire 40-Mile Corridor | 40 |
| Figure 18: Snapshot of the long term traffic prediction application | 42 |
| Figure 19: Snapshot of the average and cumulative long term traffic prediction in the eastbound of I-4 from West of Lake Buena Vista to Fairbanks (Exit 87) | 43 |

INTRODUCTION

Traffic information plays a key role in the successful implementation of advanced traveler information systems (ATIS) and advanced traffic management systems (ATMS). The current nationwide instrumentation of freeway systems continues to provide traffic management centers and other transportation agencies with a wealth of real time information on traffic conditions at critical locations. This information is essentially valuable to both transportation system users and providers. For transportation agencies, traffic information is critical to the effective management of traffic under both recurrent and non-recurrent conditions. Decision making processes are also critically influenced by the availability of such information. In addition to monitoring the operational performance of traffic on freeway facilities, real time information is now communicated to the traveling public by the concerned agencies in order to keep the public informed of the latest conditions and to provide opportunities for better travel decisions. Although real time advisory information on traffic conditions is currently widely available to the public via the Internet and other media sources, such information is of less use at the pre-trip planning stage since traffic conditions are dynamically changing over time. This created the need and the motivation to synthesize predictive information as well. Such predictive information can be effectively used to provide the public with the expected traffic conditions within short-term horizons during which their trip is expected to begin.

Using predictive information, travelers can make better future trip decisions either at the pre-trip planning stage or en-route via onboard wireless communication devices. Decisions that are likely to be impacted by predictive information include departure time, travel mode, route selection, and possibly trip destination. As predictive information

becomes more available to the traveling public, better decisions can be made that will help spread travel demand over time and space, and thus reducing the amount of congestion in urban areas. This report presents a thorough statistical analysis of the short-term traffic prediction model that was developed by Al-Deek et al. (2001) and is currently implemented on the 40-mile I-4 corridor in Orlando, Florida, as part of an ongoing research study by the Transportation Systems Institute at the University of Central Florida. The emphasis of the study is on identifying the factors that can significantly influence the performance of the adopted non-linear time series model, rather than on the model development procedure itself. In other words, the report presents the results of the extensive experimentation with the model under various model parameters and traffic conditions to identify the factors affecting the predictive performance and the magnitude of their influence on the prediction errors.

The testing phase of the model was conducted using data compiled from a wide range of operating traffic conditions including both recurrent and non-recurrent conditions. This variation was necessary to study the behavior of the model under all traffic conditions. While prediction can be made for any of the three traffic parameters: speed, lane occupancy, and traffic volume, the study emphasized the prediction of speed for its explicit use to derive travel time and subsequently delay, which are commonly perceived by most travelers. Point predictions of speed were directly translated to travel times by dividing the distance between two consecutive sensor stations by the average predicted speed at both stations. The total predicted trip travel time can then be estimated using either a link-based or path-based approach.

BACKGROUND ON SHORT TERM TRAFFIC PREDICTION MODELS

Several research efforts were conducted in the area of short-term traffic prediction in the last few years to support ITS applications and provide the travelers with travel time information at the pre-trip planning stage and en-route. Kaysi et al. (1993) and Ben-Akiva et al. (1991) recommended that traffic routing strategies under recurring and non-recurring congestion be based on forecasting of future traffic conditions rather than historical and/or current traffic conditions. This is because travelers' decisions are affected by future traffic conditions rather than current traffic conditions. Several prediction methods have been implemented in research in the past two decades. Ben Akiva et al. (1992) grouped those methods into three categories: (a) statistical models, (b) macroscopic models, and (c) route choice models based on dynamic traffic assignment. Time series models have been used in traffic forecasting for their strong potential for on-line implementation; see, for example, Stamatiadis and Taylor (1994), Ahmed and Cook (1982), Gazis and Knapp (1971), Kyte et al. (1989), Lu Jian (1990), Nihan and Davis (1989), Okutani and Stephanades (1984), Vojak et al. (1994), Lee and Fambro (1999), Jiang (1999), and Iwasaki and Shirao (1996).

Recently, Chen and Chien (2001) conducted a study using probe vehicle data to compare the prediction accuracy under direct measuring of path-based travel time versus link-based travel times. The study showed that under recurrent traffic conditions, path-based prediction is more accurate than link-based prediction. The study used Kalman filtering technique to carry out the dynamic travel time prediction. The study also attempted to explore the relationship between the probe vehicle percentage and the prediction error. Another study by Kwon et al. (2000) used an approach to estimate

travel time on freeways using flow and occupancy data from single loop detectors and historical travel time information. Forecasting ranged from a few minutes into the future up to an hour ahead. The study showed that current traffic conditions are good predictors for the near future, up to 20 minutes, while long-range predictions need the use of historical data.

Other approaches were based on artificial neural networks. Park and Rilett (1998) proposed two modular Artificial Neural Networks (ANN) models for forecasting multiple-period freeway link travel times. One model used a Kohonen Self Organizing Feature Map (SOFM) while the other utilized a fuzzy c-means clustering technique for traffic patterns classification. Rilett and Park (2001) proposed a one-step approach for freeway corridor travel time forecasting rather than link travel time forecasting. They examined the use of a spectral basis neural network with actual travel times from Houston, Texas. Later, Park et al. (2001) conducted a study to identify the optimal aggregation interval sizes as a function of the traffic dynamics and frequency of observations for different scenarios. Another study by Abdulhai et al. (1999) used an advanced time delay neural network (TDNN) model, optimized using a Genetic Algorithm, for traffic flow prediction. The results of the study indicated that prediction errors were affected by the variables pertinent to traffic flow prediction such as spatial contribution, the extent of the loop-back interval, resolution of data, and others.

EVALUATION OF THE I-4 SHORT TERM TRAFFIC PREDICTION SYSTEM

Before explaining the implementation efforts of the I-4 traffic prediction system on the web, a brief description is provided in this report, along with the statistical evaluation of the implemented model under various traffic conditions.

Description of the Non-Linear Time Series Model

The statistical analysis of the prediction performance is conducted for the model that was developed and evaluated in an earlier study by Al-Deek et al. (2001). However, the performance evaluation in the previous study was limited to the central corridor of I-4 with a total of 25 sensor stations. Based on the limited testing results, the model showed relatively accurate predictions. In this study, the model is extensively evaluated for the entire 40-mile corridor of I-4 with a total of 70 sensor stations. The primary objective of this study is to assess the model performance prior to the full-scale implementation and final release to the public. In doing so, the model is examined under different traffic conditions and parameters to quantify the magnitude of prediction errors associated with different possible scenarios and the operating conditions that require further prediction improvements.

In this section the theoretical basis of the model is presented with a brief description of the model parameters. For a more detailed description, the reader is encouraged to refer to the earlier study report by Al-Deek et al. (2001). In simple terms the model follows a non-linear time series approach with a single variable to make short-term predictions of speed using the most recent speed profile at a specific location. In mathematical terms, given a time series V_1, \dots, V_n , the objective is to predict the value of V_{n+1} using data collected from point 1 to n on the time series. For instance, if V_{n+1} represents the required predicted speed at a specific location at time interval $n+1$, then the model takes the form:

$$V_{n+1} = (3^{\alpha_n} - 1)V_n - V_{n-1} \quad [1]$$

Where α is referred to as the local Hölder exponent, as explained by Tong (1993). The variable α describes the concavity or convexity of the data set such that when $\alpha = 1$, the time series represents a perfectly stable situation in which the forecast speed will maintain the same rate of change as the previous two speeds. Therefore, the time series exhibits a linear trend. If $\alpha < 1$, then the forecast speed will be calculated as a fraction of the current speed plus the difference between the current speed and the previous speed on the time line. The opposite holds true for $\alpha > 1$. In other words, the predicted value for α determines if the three local speeds can be represented by a stable, concave, or convex data set. The local Hölder exponent, α , is the non-linear operation performed on each speed value, and has the following form:

$$\alpha_n = \log_3 \left(\frac{V_{n-1} + V_n + V_{n+1}}{V_n} \right) \quad [2]$$

It is obvious from the previous equation that the value of α for a point n on the time series requires knowledge of speed values at the points $n-1$, n , and $n+1$. Speed at point $n+1$ is to be predicted though and is, therefore, unknown. In essence, the value of α at point n must be predicted first before predicting the speed at point $n+1$, as explained in detail by Al-Deek et al. (2001). The performance of prediction models is usually evaluated using relative errors between the observed and predicted values. For speed predictions, the relative error is calculated as the absolute difference between observed and predicted speeds divided by the observed speed. In mathematical forms,

$$E_i = \frac{|(V_o)_i - (V_p)_i|}{(V_o)_i} \quad [3]$$

Where,

E_i = Relative speed prediction error for observation i .

$(V_o)_i$ = Actual speed for observation i .

$(V_p)_i$ = Predicted speed for observation i .

Given the upstream and downstream point measurements of speed for a section j of length L_j , the travel time can be estimated as

$$T_j = \frac{L_j}{\bar{V}_j} \quad [4]$$

Where:

T_j = the estimated travel time on section j

L_j = the length of section j

\bar{V}_j = average speed of upstream and downstream stations for section j

Study area and Data collection

The model was developed and tested using data collected from the 40-mile corridor of I-4 in Orlando, Florida. The corridor is instrumented with a total of 70 dual loop detector stations that are spaced at nearly half a mile in both directions. Each station collects traffic information in the form of counts, lane occupancy, and speed at 30-second intervals. The I-4 traffic surveillance system also includes a set of closed circuit TV cameras and several changeable message signs that are controlled by the Orlando Regional Traffic Management Center. The real time traffic data is transmitted via a high speed link to a database server at the University of Central Florida. The collected data is used to support the operation of the short-term traffic prediction system that is evaluated in this study. The prediction system is accessible to all freeway users via the web site:

<http://www.trafficinfo.org> . The system provides travel time predictions between user-selected origins (on-ramps) and destinations (off-ramps). The user may also select prediction horizons in the range of 10 to 30 minutes. The prediction system then provides the user with the cumulative forecasted travel times, the cumulative forecasted delay, and the average forecasted speed along the links constituting the trip path, from the selected on-ramp and to every off-ramp along the path. Figure 1 shows a sample snapshot of the forecasted information provided by the system for a trip that begins at the junction of State Road 528 and International Drive and ends at Ivanhoe Road (Exit 84). The figure shows that total forecasted travel time is estimated as 14.39 minutes, with delay of 2.18 minutes over a section that is 12.35 miles long.

- Trip Date: 10/30/2002
- Current Time: 3:50:31 PM
- Forecasting Time: 4:00:31 PM
- Trip Origin: SR 528 - International Drive
- Trip Destination: Ivanhoe Rd. (Exit 84)-old 42
- Total Forecasted Travel Time: 14.39 Minutes
- Total Forecasted Delay: 2.18 Minutes
- Total Traveled Distance: 12.35 Miles
- Your Forecasting Horizon: 10 Minutes
- Refresh rate: Manual

Detailed Travel Time Information on your Trip Segments from Origin to Destination
[Change my trip information](#)

| From: SR 528 - International Drive To | Cumulative Forecasted Travel Time | Cumulative Forecasted Delay | Average Forecasted Speed (mph) |
|----------------------------------------------------|-----------------------------------|-----------------------------|--------------------------------|
| Sand Lake Rd. (Exit 74A)-old 29 | 1 min. 8 sec. | 0 min. 0 sec. | 65 |
| I-Dr/Universal/Kirkman Rd-South (Exit 75A)-old 30A | 2 min. 37 sec. | 0 min. 1 sec. | 61 |
| Kirkman Rd-North (Exit 75B)-old 30B | 3 min. 13 sec. | 0 min. 3 sec. | 60 |
| Florida Turnpike (Exit 77)-old 31 | 4 min. 13 sec. | 0 min. 4 sec. | 60 |
| Conroy Road (Exit 78)-old 31A | 4 min. 47 sec. | 0 min. 6 sec. | 59 |
| John Young Parkway (Exit 79)-old 32 | 7 min. 9 sec. | 0 min. 7 sec. | 59 |
| US 441 - Orange Blossom Tr.-S (Exit 80A)-old 33A | 8 min. 12 sec. | 0 min. 15 sec. | 59 |
| US 441 - Orange Blossom Tr.-N (Exit 80B)-old 33B | 8 min. 42 sec. | 0 min. 17 sec. | 58 |
| Kaley (Exit 81BC)-old 35 | 9 min. 46 sec. | 0 min. 26 sec. | 58 |
| SR 408 E/W Expwy (Exit 82A)-old 36 | 10 min. 38 sec. | 0 min. 47 sec. | 56 |
| East Anderson St. (Exit 82C)-old 38 | 11 min. 56 sec. | 1 min. 35 sec. | 52 |
| Robinson (Exit 83A)-old 40 | 13 min. 10 sec. | 1 min. 55 sec. | 51 |
| US 17/92, SR 50, Amelia St. (Exit 83B)-old 41 | 13 min. 49 sec. | 2 min. 5 sec. | 51 |
| Ivanhoe Rd. (Exit 84)-old 42 | 14 min. 23 sec. | 2 min. 10 sec. | 51 |

Figure 1 Snapshot of the I-4 traffic prediction system

Model parameters

The traffic prediction model used in this study is affected by several parameters that could significantly impact the performance of the model. For illustration, Figure 2 shows the layout of the model parameters on the time scale for two different scenarios. Each parameter is defined as follows:

Prediction Horizon

Prediction Horizons is defined as the time window after which prediction is made. For instance, 5-minute prediction horizons result in predicting speed 5 minutes away from the present time.

Prediction Step

The time window at which prediction is executed or updated. For instance, a one-minute prediction step results in prediction updates every minute.

Rolling Horizon

Rolling horizon is defined as the time window defining the prediction history in the past. For instance, 30-minute rolling horizons assume that the next prediction value is affected only by traffic conditions observed within the past 30 minutes. Since the predicted speed values represent average predicted conditions over the specified prediction horizon, it is necessary to average speed values in the rolling horizon over intervals of the size of the prediction horizons. For example, if the prediction horizon is selected as 5 minutes, then rolling horizon must also be divided into five-minute speed intervals.

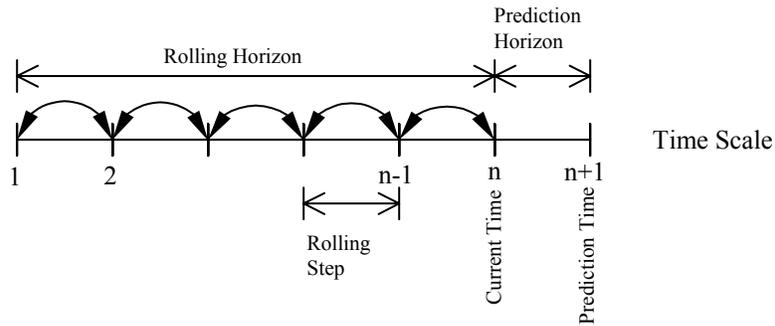
Rolling Step

The time interval that determines how the rolling horizon is divided to generate average values for the time series model. When set equal to the prediction horizon, the number of average values generated will be equal to the rolling horizon divided by the prediction horizon, as shown in Figure 2(a). If the rolling step is set to a value smaller

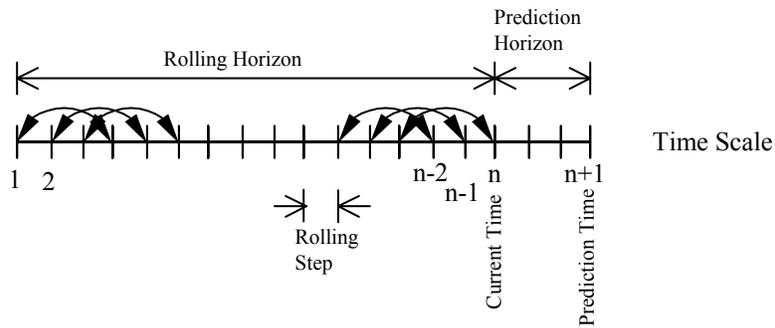
than the prediction horizon, time windows will overlap as shown in Figure 2(b), producing smoothed moving averages, rather than discrete independent averages.

Number of Alpha Intervals

Represents the number of intervals used to construct the histogram for Alpha values.



(a): Rolling step equal to prediction horizon



(b): Rolling step smaller than prediction horizon

Figure 2 Schematic representation of the time series operation

Effect of Traffic Conditions

The effect of the traffic conditions on the prediction performance was also investigated in this study using a congestion index (CI) in the range from 0 to 7. The index is estimated from the observed speeds by dividing the speed range into 10-mph intervals, with 0 indicating a speed range from 0 to 10 mph, 1 for the range from 11 to 20 mph, and so on. As such, an index of 0 reflects the most congested conditions, while an index of 7 represents the free-flow conditions. The congestion index was considered one of the factors affecting the prediction performance due to the variation in the dynamics of traffic conditions.

Prediction Performance Evaluation

To expedite the evaluation process of the model, a special module was developed to perform prediction runs for all scenarios that result from different combinations of parameter values. The controlled parameters and the various levels are prediction horizon (5, 10, and 15 minutes), rolling horizon (15, 20, 25, 30 minutes), and rolling step (1, 3, and 5 minutes). Each combination of the previous factors generated one scenario that was tested under different traffic conditions, ranging from free-flow to heavy congestion. The testing period extended over five different weekdays from 6:00 AM to 10:00 AM for the morning peak, 10:00 AM to 3:00 PM for the off peak, and 3:00 PM to 7:00 PM for the evening peak. The total number of predictions generated from all possible scenarios was 863,310. The distribution of prediction errors showed that the majority of observations produced errors less than or equal to 0.1 (10%) while the overall mean and standard error of estimate were 0.0616 (6.16%) and 0.000079, respectively.

Statistical analysis

To examine the effect of the model parameters and the traffic condition settings, a multivariate general linear model (GLM) was developed to determine the significance of each factor. The percent relative prediction error was estimated from the GLM as follows:

$$E = 25.603 + 0.480(CI)^2 - 6.861(CI) + 0.216(PH) + 0.036(RH) - 0.051(PH)(CI) - 0.007(RH)(CI) \quad [5]$$

Where

E = Percent relative prediction error

CI = Congestion index

PH = prediction horizon in minutes

RH = rolling horizon in minutes

(PH)(CI) = interaction term between prediction horizon and congestion index

(RH)(CI) = interaction term between rolling horizon and congestion index

Table 1 shows the statistical results of the GLM procedure. The factors that were identified as significant in the GLM (P-value < 0.05) are the congestion index (CI), the prediction horizon (PH), the rolling horizon (RH), the interaction terms between the prediction horizon and congestion index (PHxCI), and the interaction terms between the rolling horizon and congestion index (RHxCI). The selection of each of those factors was determined by the tolerance threshold in the stepwise regression procedure. The tolerance value determines whether or not a specific factor should be retained in the model or removed. The table also shows the coefficients, standard errors, and

standardized coefficients associated with each factor. Also, the t-value and the P-value are shown in the table. A discussion on the effect of each term is presented next.

Table 1 Results of the GLM Statistical Procedure

| Effect | Coefficient | Std Error | Std Coefficient | Tolerance | T | P (2-Tail) |
|----------|-------------|-----------|-----------------|-----------|----------|------------|
| Constant | 25.603 | 0.184 | 0.000 | | 138.920 | 0.000 |
| CIxCI | 0.480 | 0.004 | 0.555 | 0.049 | 136.036 | 0.000 |
| CI | -6.861 | 0.042 | -0.986 | 0.023 | -163.901 | 0.000 |
| PH | 0.216 | 0.014 | 0.106 | 0.018 | 15.683 | 0.000 |
| RH | 0.036 | 0.007 | 0.024 | 0.037 | 4.966 | 0.000 |
| PHxCI | -0.051 | 0.002 | -0.142 | 0.037 | -30.146 | 0.000 |
| RHxCI | -0.007 | 0.001 | -0.033 | 0.022 | -5.388 | 0.000 |

Effect of Congestion Index (CI)

The statistical analysis shows that the first and second order terms of the congestion index (CI) were significant. This shows that the effect of traffic conditions on the prediction performance is not linear. With all other factors held constant, the analysis shows that the congestion index and the percent relative errors are inversely proportional. Higher errors are associated with lower congestion indexes (heavy congestion) and vice versa. This effect is clearly demonstrated in Figure 3, which shows the mean percent relative error with the 95% confidence bounds. The figure shows that the highest prediction errors (25% to 30%) were observed during congested conditions, when traffic is likely to exhibit unsteady state conditions with high random fluctuations in speed, and consequently, unfavorable conditions for making relatively accurate predictions. It can also be noted from the figure that the highest relative error was observed at congestion index equal to 1, which corresponds to speeds in the range of 11 to 20 mph. This may suggest that such range exhibits the highest random variations in traffic conditions and thus the most adverse impact on the traffic prediction performance. The prediction

performance improves significantly as traffic conditions evolve from congestion to free-flow conditions.

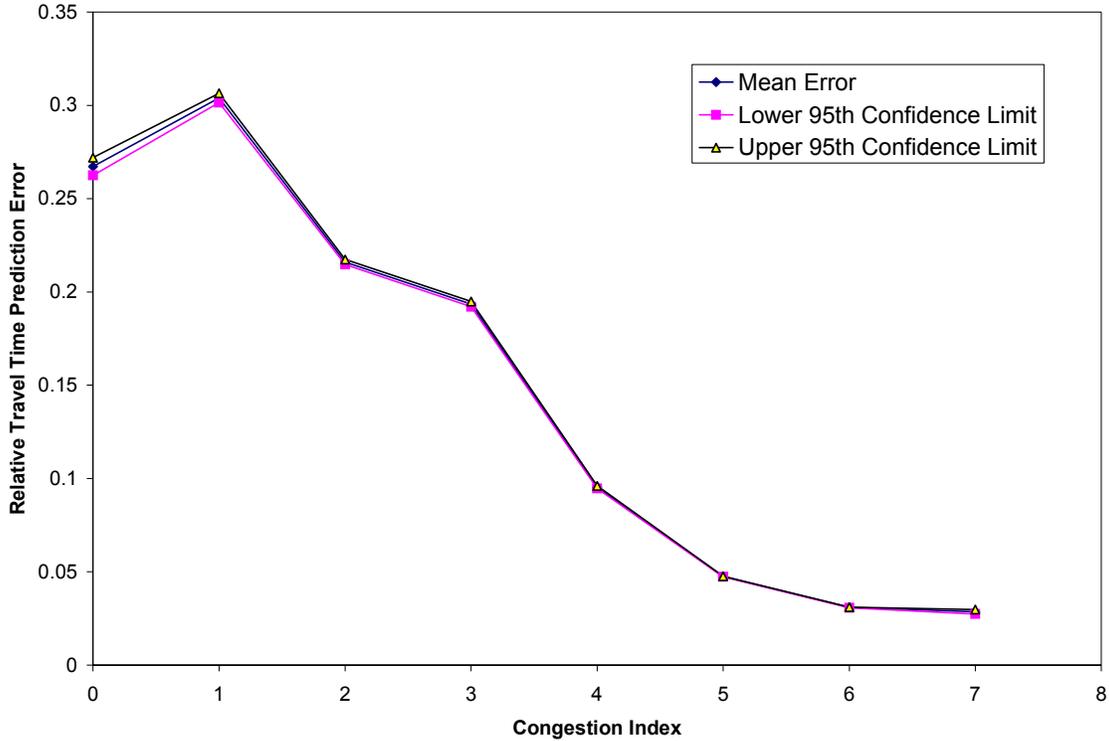


Figure 3 Effect of congestion index on relative travel time prediction error

Effect of Prediction Horizon (PH)

The prediction horizon in this study was varied in the range of 5 to 15 minutes in 5-minute increments. The statistical analysis shows the percent relative errors consistently increase with the length of the prediction horizon. Such observation is intuitive since longer predictions are harder to make given the dynamic nature of traffic conditions. As shown in Figure 4, smaller errors are associated with 5-minute predictions than those with 15-minute predictions. The 95% confidence bounds show that the differences are statistically significant.

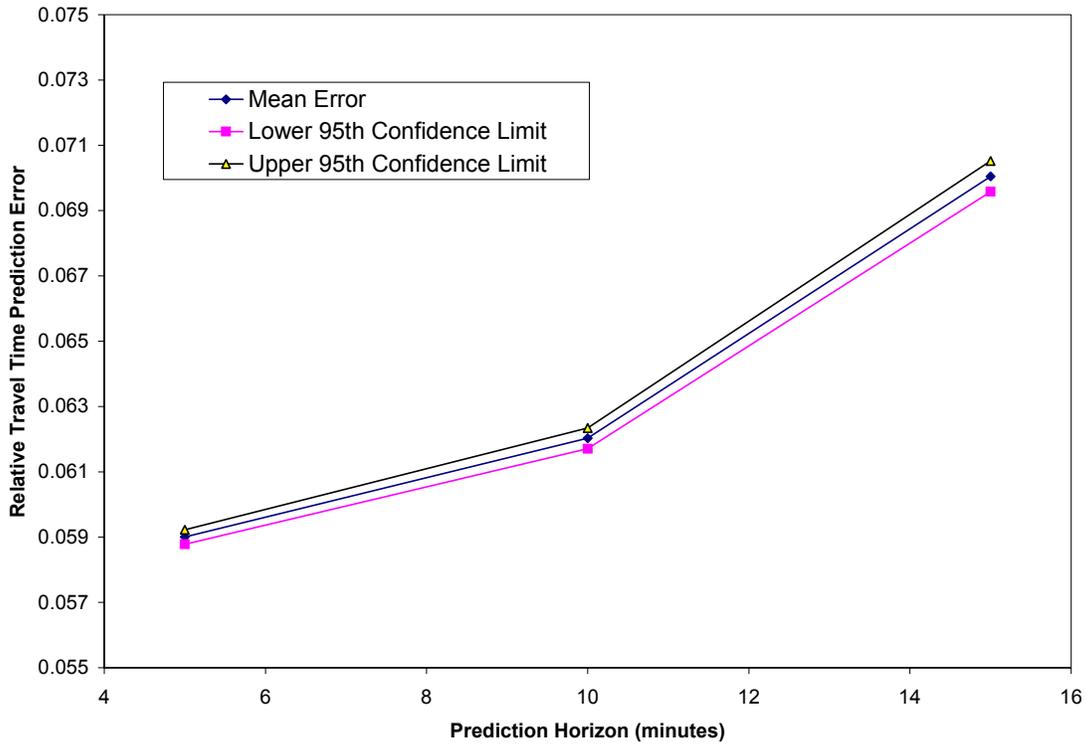


Figure 4 Effect of prediction horizon on relative travel time prediction error

Effect of Rolling Horizon (RH)

The rolling horizon defines the time period in the recent past where forecasted traffic conditions are based on. Such period is critical in determining the trend of the change in traffic conditions. This parameter proved to have a statistically significant impact on the predictive performance of the model. The GLM analysis suggests that longer rolling horizons appear to have an adverse impact on the model performance. A possible explanation for this is that current and forecasted traffic conditions are less likely to be affected by conditions observed farther in the past. This is clearly shown by comparing the performance derived from 30-minute rolling horizons with that from 20-minute horizon. It is recommended, however, that the rolling horizon should not be

reduced to less than 15 minutes to provide the model with sufficient information for detecting the changing trend of traffic conditions. Figure 5 shows the effect of the rolling horizon on the prediction errors.

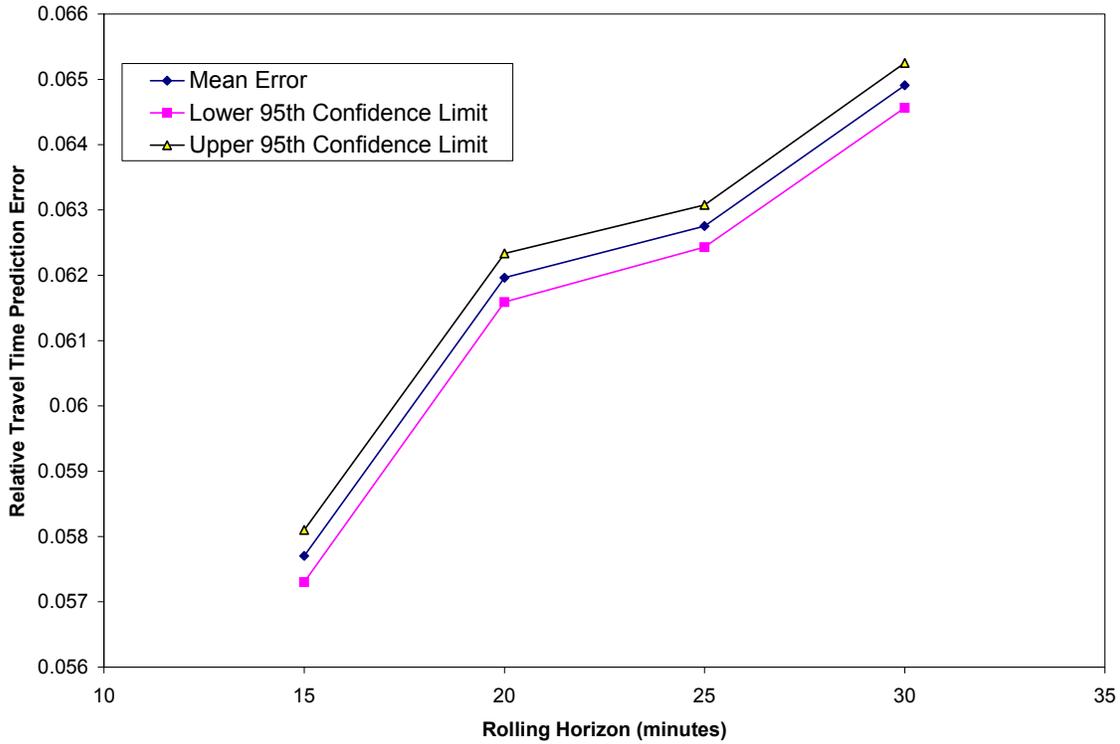


Figure 5 Effect of rolling horizon on relative travel time prediction error

Interaction between Prediction Horizon and Congestion Index (PHxCI)

The interaction term between the prediction horizon and the congestion index was introduced to detect if the effect of the prediction horizon is sensitive to variations in traffic conditions. The statistical analysis shows that the interaction term has a negative coefficient, which implies that the effect of prediction horizon increases as congestion develops. In other words, the prediction performance under free-flow traffic conditions is not as sensitive to the prediction horizon as it is under congested conditions. This

suggests that longer prediction horizons are likely to produce more accurate predictions under light or moderate traffic conditions. Congested conditions, however, are very sensitive to prediction horizons as shown in Figure 6. The figure clearly shows that the slope of the lines representing the relationship between the prediction error and prediction horizon is steeper during congested conditions than it is during low or moderate congestion.

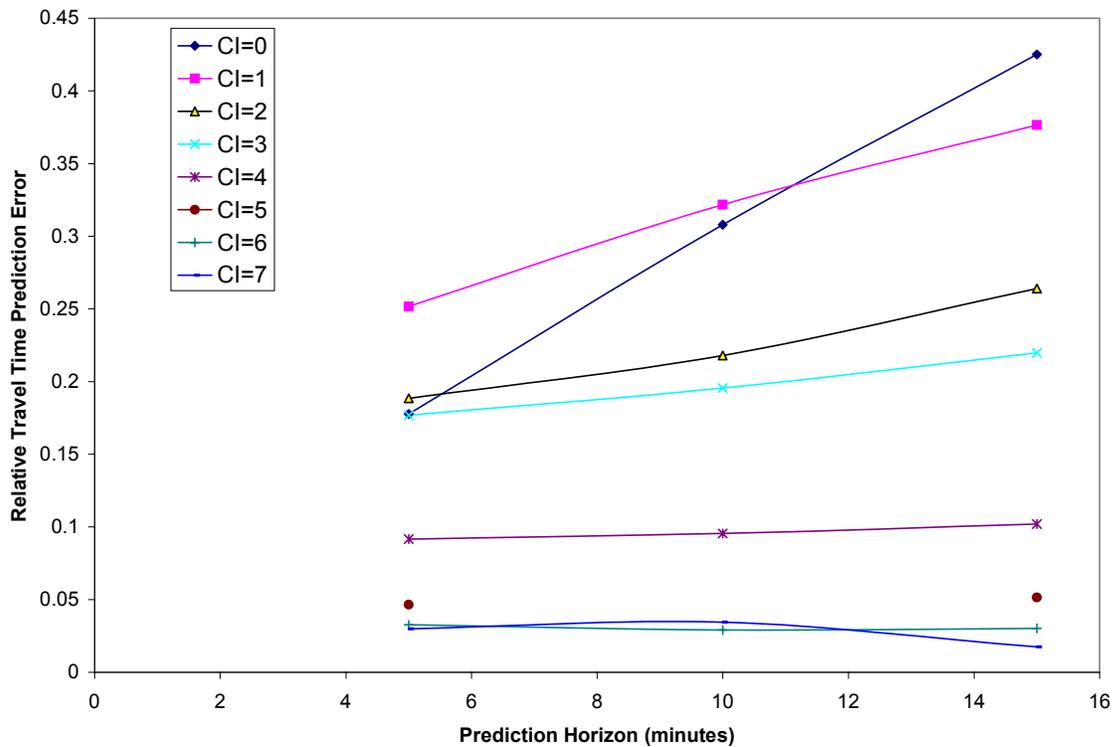


Figure 6 Effect of interaction between prediction horizon and congestion index on relative travel time prediction error

Interaction between Rolling Horizon and Congestion Index (RHxCI)

The effect of interaction term between the rolling horizon and congestion index on the prediction performance was also statistically significant. The term coefficient is negative, indicating that the effect of rolling horizon decreases during free-flow conditions and increases during congested conditions. This can be clearly seen in

Figure 7. A possible interpretation is that congested conditions are characterized with rapid changes and high fluctuations in speeds that result in variations that are much more difficult to capture from the information relayed in the rolling horizon. As such, shorter rolling horizons may be considered more appropriate under congested conditions since past information becomes less relevant than most recent information. This explains why the prediction performance during congested conditions improves with 15-minute rolling horizons as compared to 30-minute horizons.

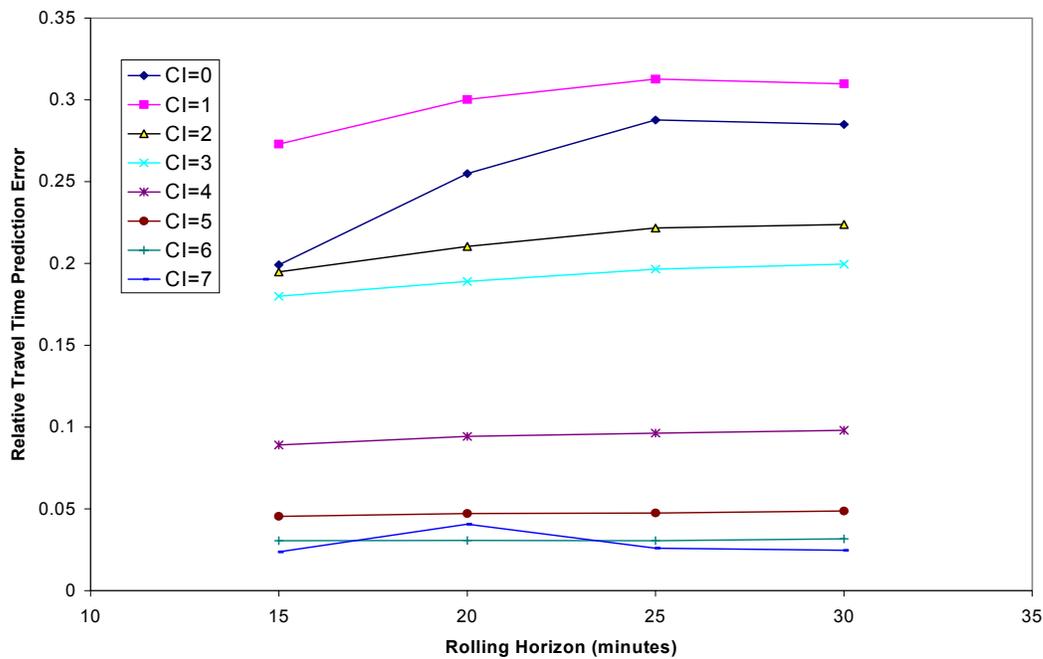


Figure 7 Effect of interaction between rolling horizon and congestion index on relative travel time prediction error

Path-Based Analysis

The statistical analysis of the predictive errors presented thus far was link-based. In order to evaluate the prediction errors associated with individual trips, path-based analysis should be conducted along the trip using the predicted information. In this case,

the total predicted travel time for a particular trip should be based on the cumulative link-based travel time predictions using variable future arrival times at each link along the trip path. In other words, the prediction horizon for any link will be based on the predicted arrival time at this link. Since the maximum prediction horizon in this study was limited to 15 minutes, the path-based approach was examined for trips whose travel times do not exceed the maximum prediction horizon. The prediction errors were then estimated from all trips that can be generated along the corridor with duration of 15 minutes or less. The difference in travel times (minutes per mile) was then calculated from both predicted and actual conditions. For nearly 3500 trips generated from different points along the corridor during one day (6:00 AM to 6:00 PM), the distribution of path-based prediction errors was drawn as shown in Figure 8. The figure shows that the prediction errors for the majority of generated trips were observed in the range of -0.25 to +0.50 minutes per mile with a mean of -0.042 and standard deviation of 0.253. The 95% confidence bounds for the observations were -0.050 and -0.034, indicating that the model has a slight tendency to underestimate the travel times.

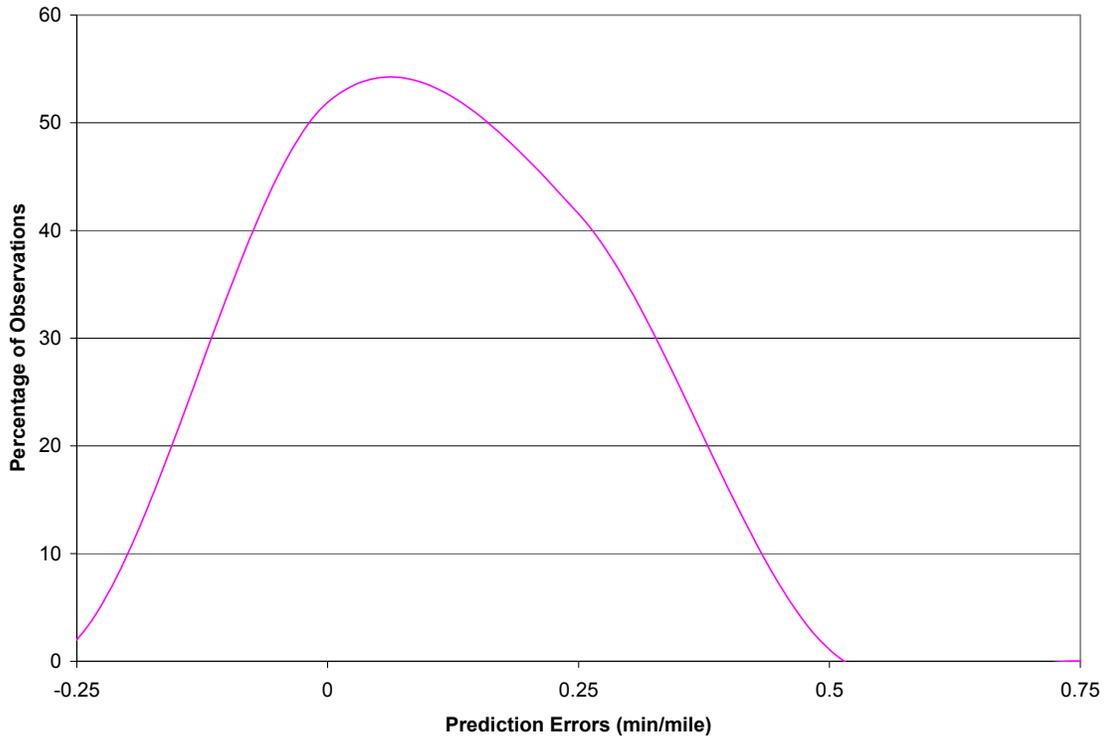


Figure 8 Distribution of prediction errors using path-based approach

Summary of the Evaluation Phase

This section of the report presented the statistical analysis of the I-4 traffic prediction system that is currently implemented on the 40 mile corridor in Orlando, Florida. The performance evaluation was conducted using data from five weekdays. Several factors were examined to identify their effect on the overall performance of the system. A general linear model was developed and showed that the prediction performance is influenced by the prevailing level of congestion, the prediction horizon, the rolling horizon, and their interaction. A congestion index was defined based on the prevailing speed at the time of prediction and was found to have the most significant effect on the model performance. The results showed that the performance deteriorates

rapidly as congestion develops, causing errors as high as 25 to 30% under heavy congested conditions.

Other factors were found to be significant as well such as the prediction horizon, the rolling horizon, and their interaction terms with the congestion index. The effect of the prediction horizon was also statistically significant, indicating that longer prediction horizons lead to higher prediction errors. The statistical analysis also revealed that long rolling horizons have a negative impact on the performance of the model. The interaction terms of the prediction horizon and the rolling horizon with the congestion index were both significant. This suggests that the effect of the prediction horizon on the model performance increases under congested conditions as a result of the high level of instability in traffic conditions. This implies that short prediction horizons are more favorable under congested conditions. Likewise, the interaction term between the rolling horizon and the congestion index was also significant, implying that shorter rolling horizons are more favorable during congested conditions.

The performance of the system was also examined using a path-based approach with variable prediction horizons. Trips were generated along the corridor with duration up to the maximum prediction horizon used in the study (15 minutes). The analysis showed that the errors in minutes per mile were in the range of -0.25 to +0.5, which appears to be satisfactory. Current research efforts are underway to further improve the prediction performance by integrating memory-based approaches into a more comprehensive hybrid traffic prediction system that supports longer prediction horizons.

CONVERSION OF THE SHORT-TERM TRAFFIC PREDICTION MODEL INTO A PUBLICLY ACCESSIBLE WEB APPLICATION

The objective of this task is to carry out a full conversion of the previously developed short-term traffic prediction model into a web application accessible by the traveling public. The short-term traffic prediction application offers the I-4 travelers an opportunity to project travel times and delays along the corridor between specific entry and exit points. The conversion process was successfully completed and the web application is now fully operational and accessible by the traveling public. In this section we explain in detail how an I-4 traveler can access the web application online to receive predicted travel time and delay information on his/her trip. Also, we explain how the loop detector stations were mapped to the corridor's entry and exit points.

Description of the Web Application

The time series model developed and implemented by TSI at UCF was converted into a web application, giving the public access to predictive travel time and delay information on I-4. This section introduces the web interface and explains the main functions as well as the user input requirements. Figure 9 shows a snapshot of the I-4 traffic information main page with links to predicted, real-time, and historical information. This section will explain the steps involved in predicting point-to-point travel times along the I-4 corridor. By following the link "Point-to-Point Travel Time", the users will proceed to the short-term traffic forecasting page, shown in Figure 10. The figure shows a list of origins and destinations along the corridor in each direction. Origins are identified as on-ramps and destinations as off-ramps. The figure shows that the user may also specify the time horizon for the prediction results. A range from 10

minutes to 30 minutes is allowed. The method of updating the predicted travel time information can also be selected by the user as “manual” or “automatic”. Automatic updates are obtained by refreshing the results page periodically.

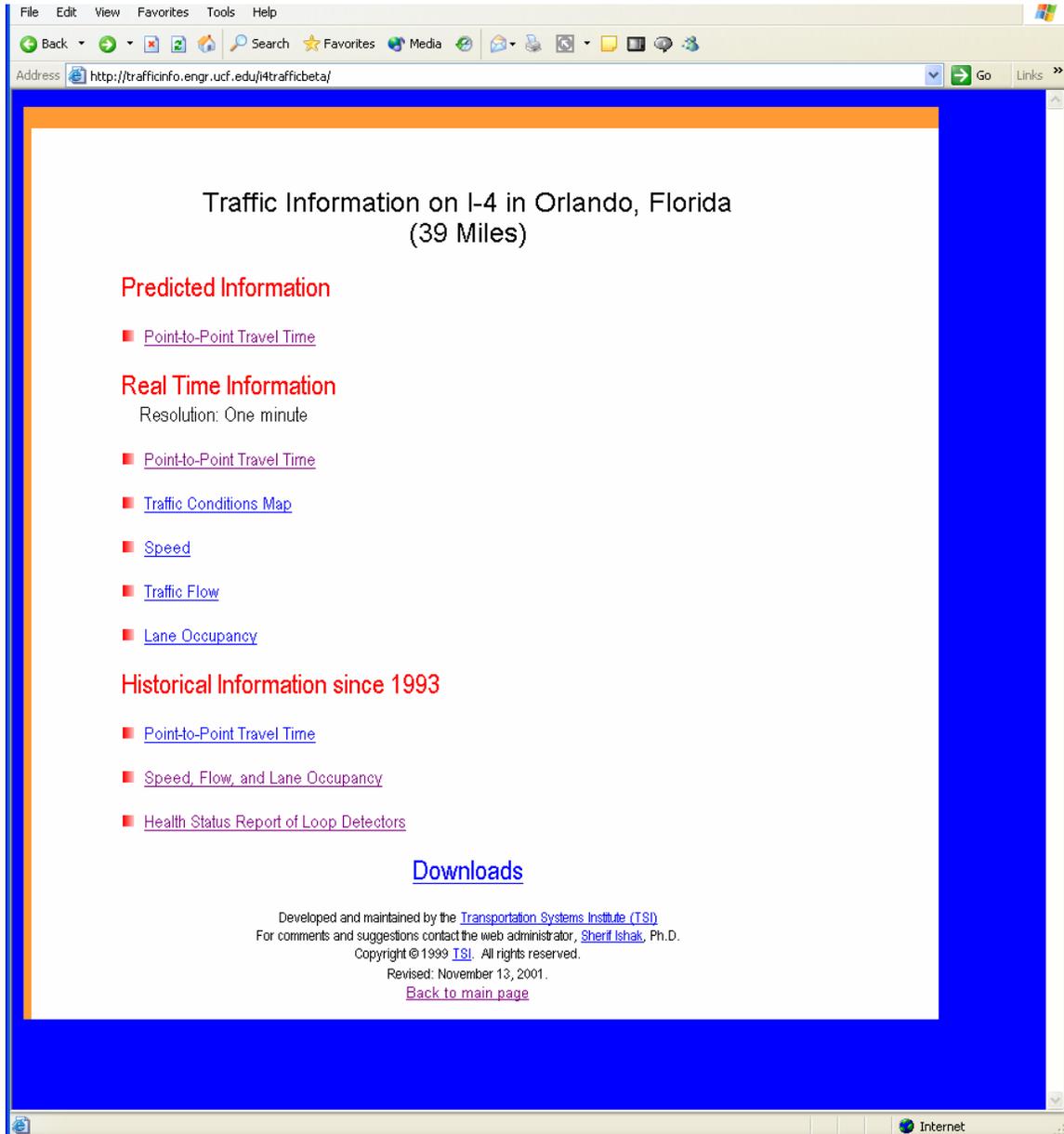


Figure 9: Snapshot of the I-4 Traffic Information Main Web Page

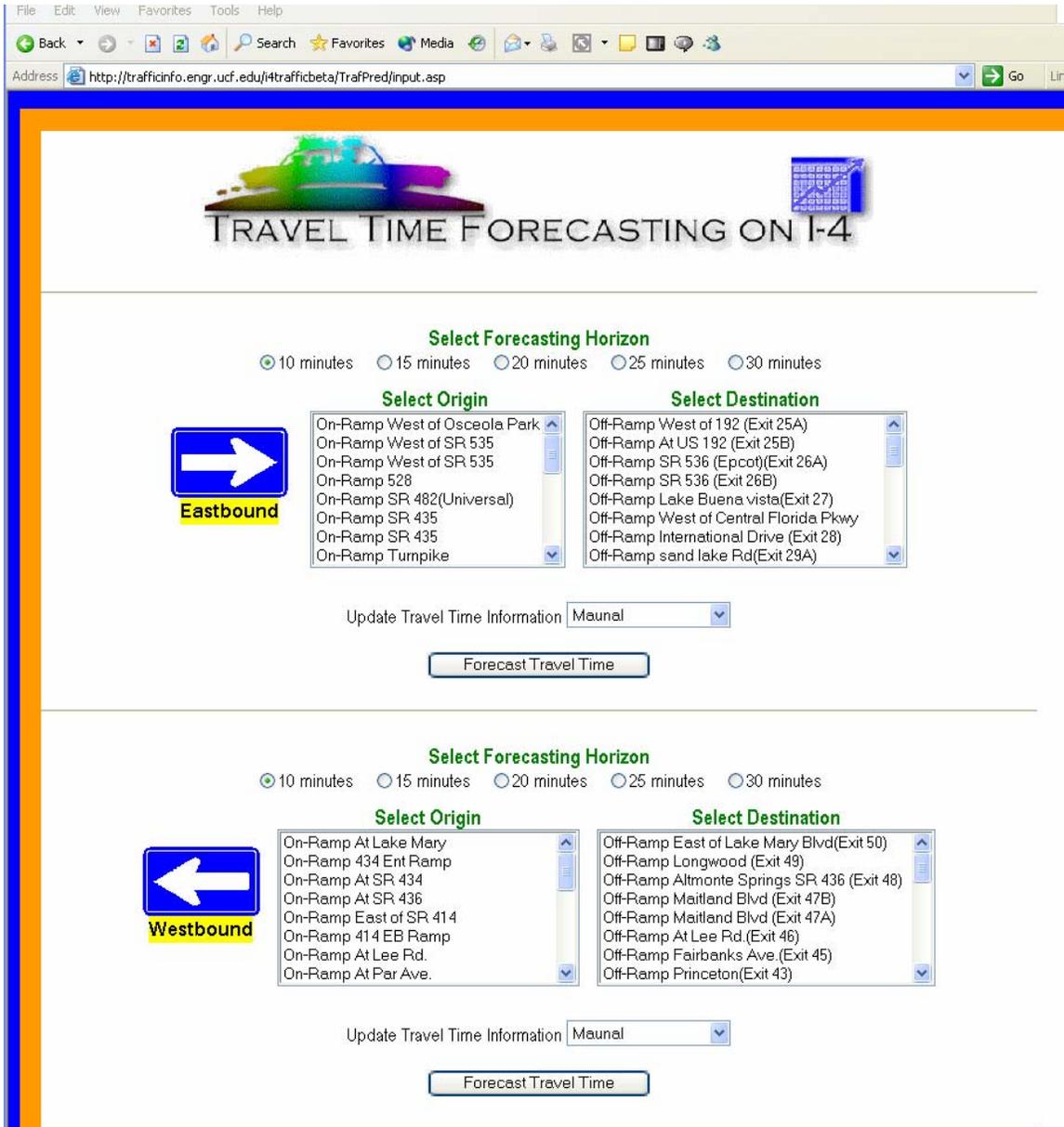


Figure 10: Snapshot of the Short Term Traffic Forecasting Page

An example is provided in Figure 11 where a user identifies the origin as “on-ramp SR 482 (Universal)”, the destination as “Off-ramp Altamonte Springs 436”, and the prediction horizon as 15 minutes. By clicking the “Forecast Travel Time” button, the user is presented with the results shown in Figure 12. The figure shows a summary of

information on the trip in the top portion of the screen including the trip date, the current and forecasting time, the trip origin and destination, the total forecasted travel time, the total forecasted delay, the total traveled distance, and the prediction horizon. Additionally, the user is provided with detailed information on the predicted travel time and delay from the origin to each exit (off-ramp) along the trip path. Such information helps the traveler identify potential section on the freeway where congestion develops and allows him/her to divert if necessary off the freeway before reaching congested sections. At each exit, the traveler is provided with the cumulative predicted travel time from the entry ramp, as well as the cumulative delay and average forecasted speed. In this example, the user's predicted travel time is nearly 25 minutes with expected delay of nearly 7 minutes.

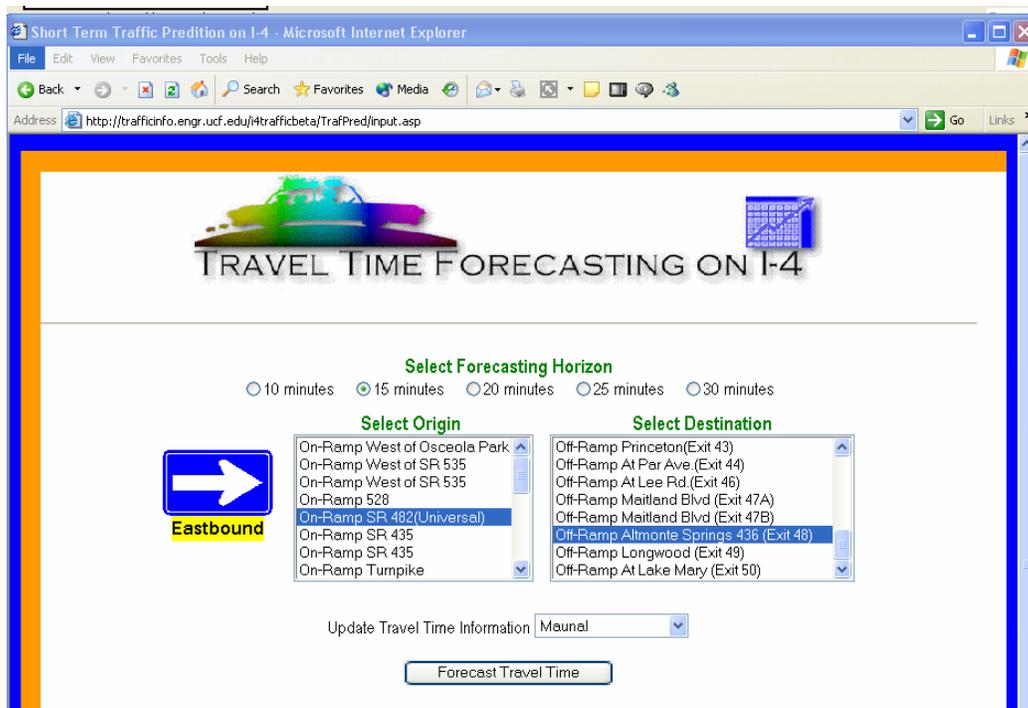


Figure 11: Sample of a User's Request for Predicted Travel Time

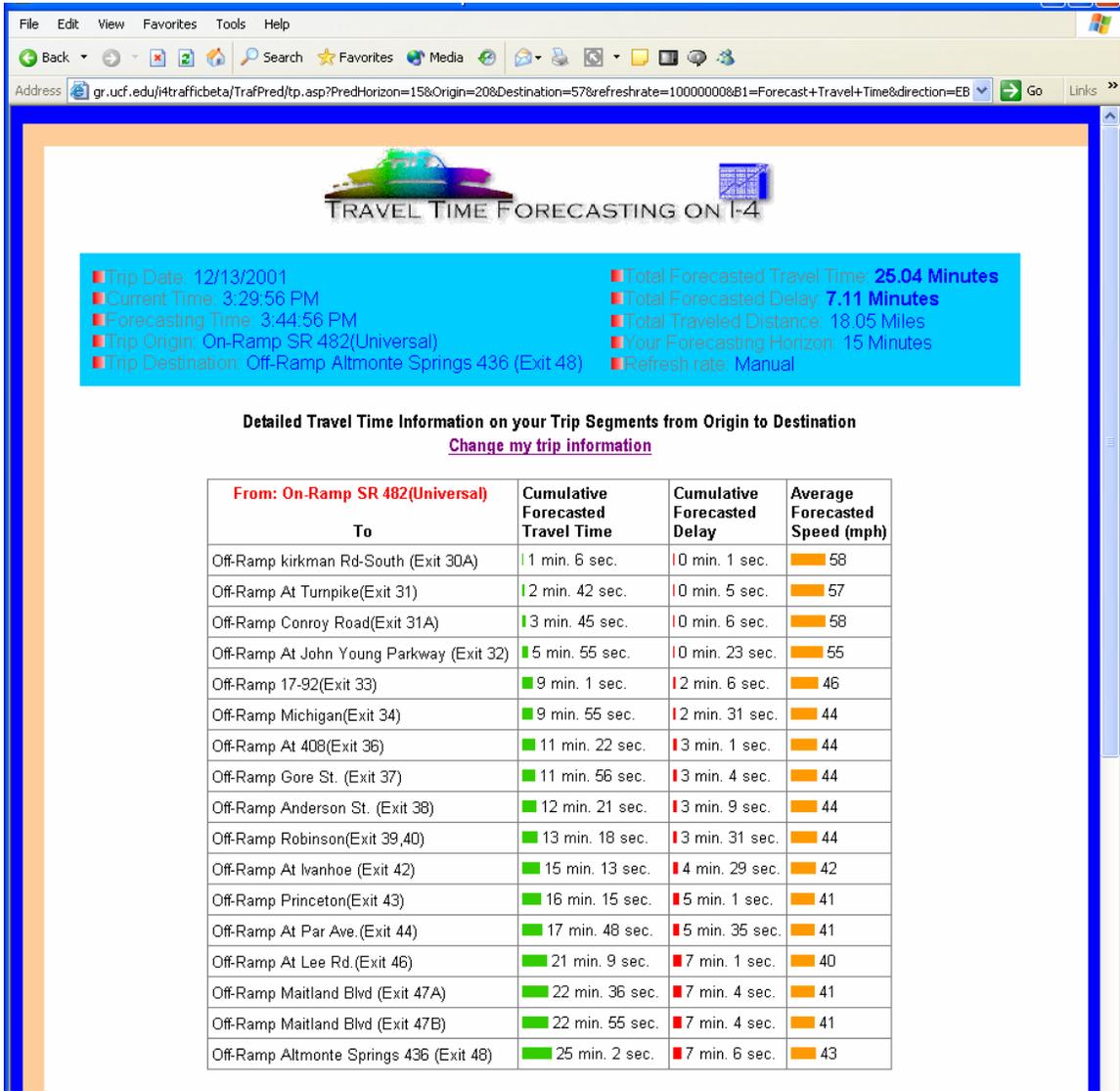


Figure 12: 15-Minute Forecasted Information from SR 482 to Exit 48

Mapping Loop Detector Stations to Entry and Exit Points

As explained earlier, traffic information on the I-4 corridor was provided for trips originating from on-ramps (entry points) and terminating at off-ramps (exit points). However, the information is collected from loop detector stations that may not be accurately aligned with entry and exit points. Therefore, it was essential to map the

detector stations to the location of on- and off-ramps. Table 2 shows the closest entry/exit points to each loop detector station in each direction.

Table 2: Mapping Loop Detector Stations to Entry and Exit Points Along I-4

| STATIONS | LOCATIONS | EASTBOUND-ON RAMP | EASTBOUND-OFF RAMP | WESTBOUND-ON RAMP |
|----------|---------------------------------------|------------------------------|------------------------------------------|--------------------------------------|
| 2 | West of 192 (116+00) | | | |
| 3 | West of 192 (142+00) | | Off-Ramp West of 192 (Exit 25A) | On-Ramp West of 192 |
| 4 | At US 192 (166+70) | | Off-Ramp At US 192 (Exit 25B) | On-Ramp At US 192 |
| 5 | West of Osceola Park (199+70) | On-Ramp West of Osceola Park | | |
| 6 | East of Osceola Park (235+00) | | | |
| 7 | SR 536 (268+30) | | Off-Ramp SR 536 (Epcot)(Exit 26A) | On-Ramp SR 536 |
| 8 | East of SR 536 (302+00) | | Off-Ramp SR 536 (Exit 26B) | |
| 9 | West of SR 535 (335+60) | On-Ramp West of SR 535 | | |
| 10 | West of SR 535 (368+00) | On-Ramp West of SR 535 | Off-Ramp Lake Buena vista(Exit 27) | On-Ramp Lake Buena vista |
| 11 | SR 535 (398+00) | | | |
| 12 | West of Rest Area (430+00) | | | |
| 13 | Rest Area (470+90) | | | |
| 14 | West of Central Florida Pkwy (501+10) | | Off-Ramp West of Central Florida Pkwy | On-Ramp West of Central Florida Pkwy |
| 15 | At Central Florida Pkwy (530+90) | | | |
| 16 | 528 EB Ramp (560+00) | | Off-Ramp International Drive (Exit 28) | On-Ramp International Drive |
| 17 | 528 WB Ramp (592+50) | On-Ramp 528 | | |
| 18 | West of 482 (623+50) | | | |
| 19 | West of 482 (658+00) | | Off-Ramp sand lake Rd(Exit 29A) | On-Ramp sand lake Rd |
| 20 | At SR 482 (678+00) | On-Ramp SR 482(Universal) | | |
| 21 | West of 435 (709+00) | | | |
| 22 | West of 435 (735+00) | | Off-Ramp kirkman Rd-South (Exit 30A) | |
| 23 | At SR 435 (765+00) | On-Ramp SR 435 | | On-Ramp At SR 435 |
| 24 | 435 WB Ramp (794+00) | On-Ramp SR 435 | | |
| 25 | At Turnpike (816+00) | | Off-Ramp At Turnpike(Exit 31) | On-Ramp At Turnpike |
| 26 | Turnpike WB Ramp (845+00) | On-Ramp Turnpike | | |
| 27 | Camera 21 (871+10) | | Off-Ramp Conroy Road(Exit 31A) | |
| 28 | West of John Young Parkway (900+00) | | | |
| 29 | West of John Young Parkway (929+00) | | | |
| 30 | At John Young Parkway (970+00) | | Off-Ramp At John Young Parkway (Exit 32) | On-Ramp At John Young Parkway |
| 31 | East of John Young Parkway (994+00) | | | |
| 32 | Rio Grande (1020+00) | | | On-Ramp Rio Grande |
| 33 | At Orange Blossom Trail (1044+00) | On-Ramp OBT | Off-Ramp 17-92(Exit 33) | |
| 34 | Michigan (1069+00) | On-Ramp Michigan | Off-Ramp Michigan(Exit 34) | |
| 35 | At Kaley (1093+00) | | | |
| 36 | Camera 28 (1120+00) | On-Ramp At 408 | Off-Ramp At 408(Exit 36) | On-Ramp At 408 |
| 37 | Camera 29 (1147+00) | | Off-Ramp Gore St. (Exit 37) | |
| 38 | Church St. (1165+00) | On-Ramp Church St. | Off-Ramp Anderson St. (Exit 38) | On-Ramp Church St. |
| 40 | Robinson (1195+00) | | Off-Ramp Robinson(Exit 39,40) | |
| 41 | At SR 50 (1220+00) | On-Ramp SR 50 | | On-Ramp SR 50 |
| 42 | At Ivanhoe (1246+00) | On-Ramp Ivanhoe | Off-Ramp At Ivanhoe (Exit 42) | |
| 43 | Princeton (1273+00) | | Off-Ramp Princeton(Exit 43) | On-Ramp Princeton |
| 44 | Winter Pk. (1299+00) | | | |
| 45 | At Par Ave. (1325+00) | | Off-Ramp At Par Ave.(Exit 44) | On-Ramp At Par Ave. |
| 46 | Minnesota (1355+00) | | | |
| 47 | At SR 426 (1377+00) | On-Ramp Fairbanks Ave. | | |
| 48 | Site 1393 (1400+00) | | | |
| 49 | At Lee Rd. (1426+00) | On-Ramp Lee Rd | Off-Ramp At Lee Rd.(Exit 46) | On-Ramp At Lee Rd. |
| 50 | East of Lee Rd. (1443+00) | | | |
| 51 | At Kennedy (1471+00) | | | |
| 52 | 414 EB Ramp(1501+00) | | Off-Ramp Maitland Blvd (Exit 47A) | On-Ramp 414 EB Ramp |
| 53 | East of SR 414 (1519+00) | On-Ramp SR 414 | Off-Ramp Maitland Blvd (Exit 47B) | On-Ramp East of SR 414 |
| 54 | At Wymore (1552+00) | | | |
| 55 | East of Wymore (1579+75) | | | |
| 56 | West of SR 436 (1608+00) | | | |
| 57 | At SR 436 (1632+50) | On-Ramp SR 436 | Off-Ramp Almonte Springs 436 (Exit 48) | On-Ramp At SR 436 |
| 58 | West of SR 434 (1670+15) | | | |
| 59 | West of SR 434 (1699+00) | | | |
| 60 | At SR 434 (1734+00) | On-Ramp SR 434 | Off-Ramp Longwood (Exit 49) | On-Ramp At SR 434 |
| 61 | 434 Ent Ramp (1768+25) | | | On-Ramp 434 Ent Ramp |
| 62 | 434 Ext Ramp (1787+50) | | | |
| 63 | West of EEWill (1815+15) | | | |
| 64 | East of EEWill (1841+25) | | | |

MODIFICATION OF THE WEB-BASED TRAFFIC PREDICTION SYSTEM

Some modifications were suggested by the UCF research team to ensure that all applications pertinent to travel time calculations on the web along the I-4 corridor are based on on- and off-ramps as origins and destinations, respectively. This ensures consistency with the short-term travel time prediction model, where all origins and

destinations were already mapped to on- and off-ramps in the previous section. The modifications were made to the real-time and historical travel time applications. Snapshots of the web site after accommodating the requested modifications are shown in this section.

Figure 13 shows the main page where point-to-point travel times were broken down by direction of travel under both real time and historical information. By clicking the link “Traveling Eastbound” or “Traveling Westbound” under real time information, the user will be directed to the pages shown in Figure 14 and Figure 15, respectively. In both figures, the user is expected to identify the on-ramp origin and off-ramp destination for his/her trip and the system will calculate the real time travel time according to the existing traffic conditions. Similarly, the user can retrieve travel time information from historical data by following the link to “Traveling Eastbound” or “Traveling Westbound” under historical information since 1993. In such case, the pages shown in Figure 16 and Figure 17 will be retrieved, allowing the user to specify the date and time of his/her trip, in addition to the origin and destination as previously outlined.

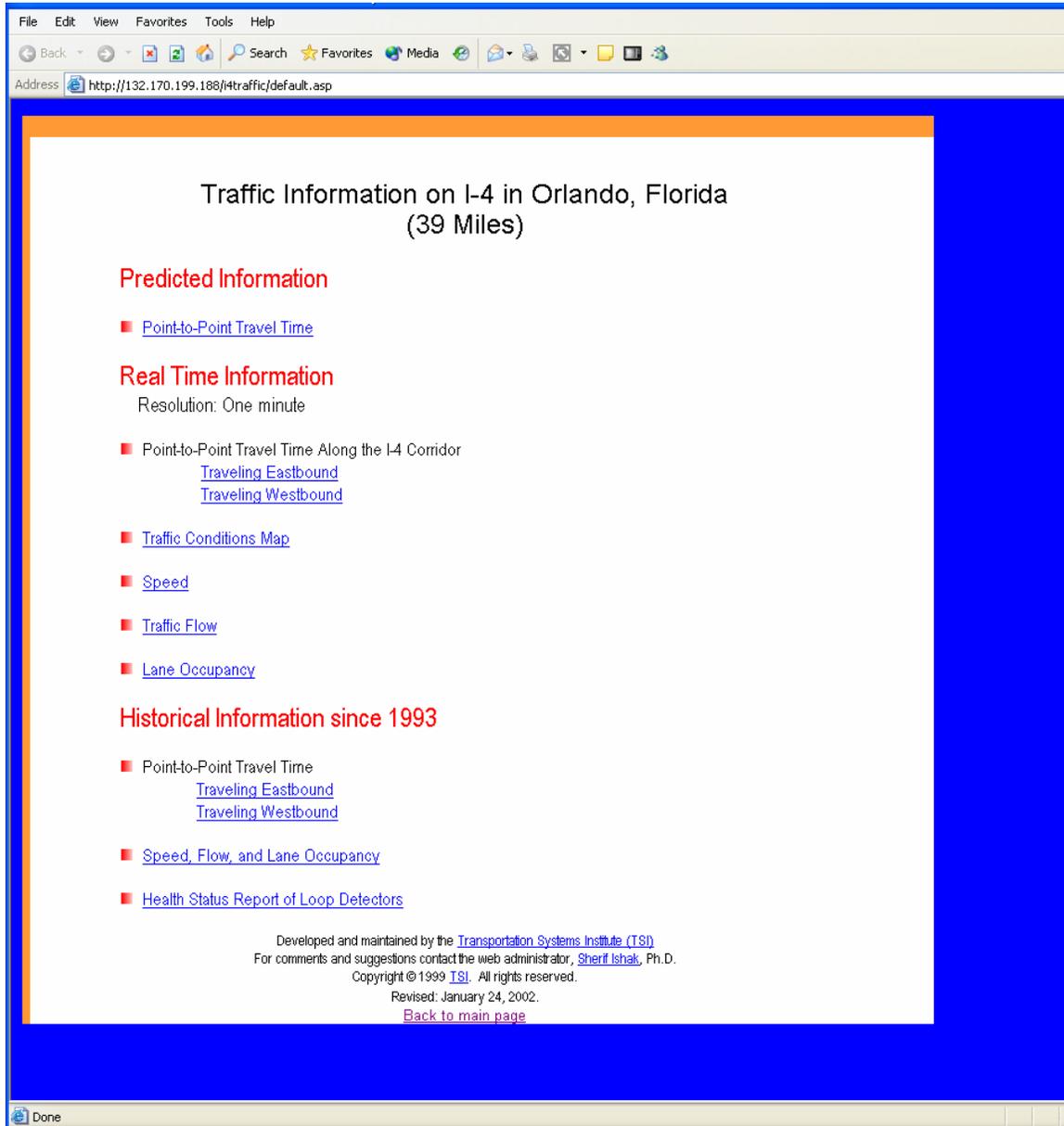


Figure 13: Snapshot of the I-4 Traffic Information Main Web Page

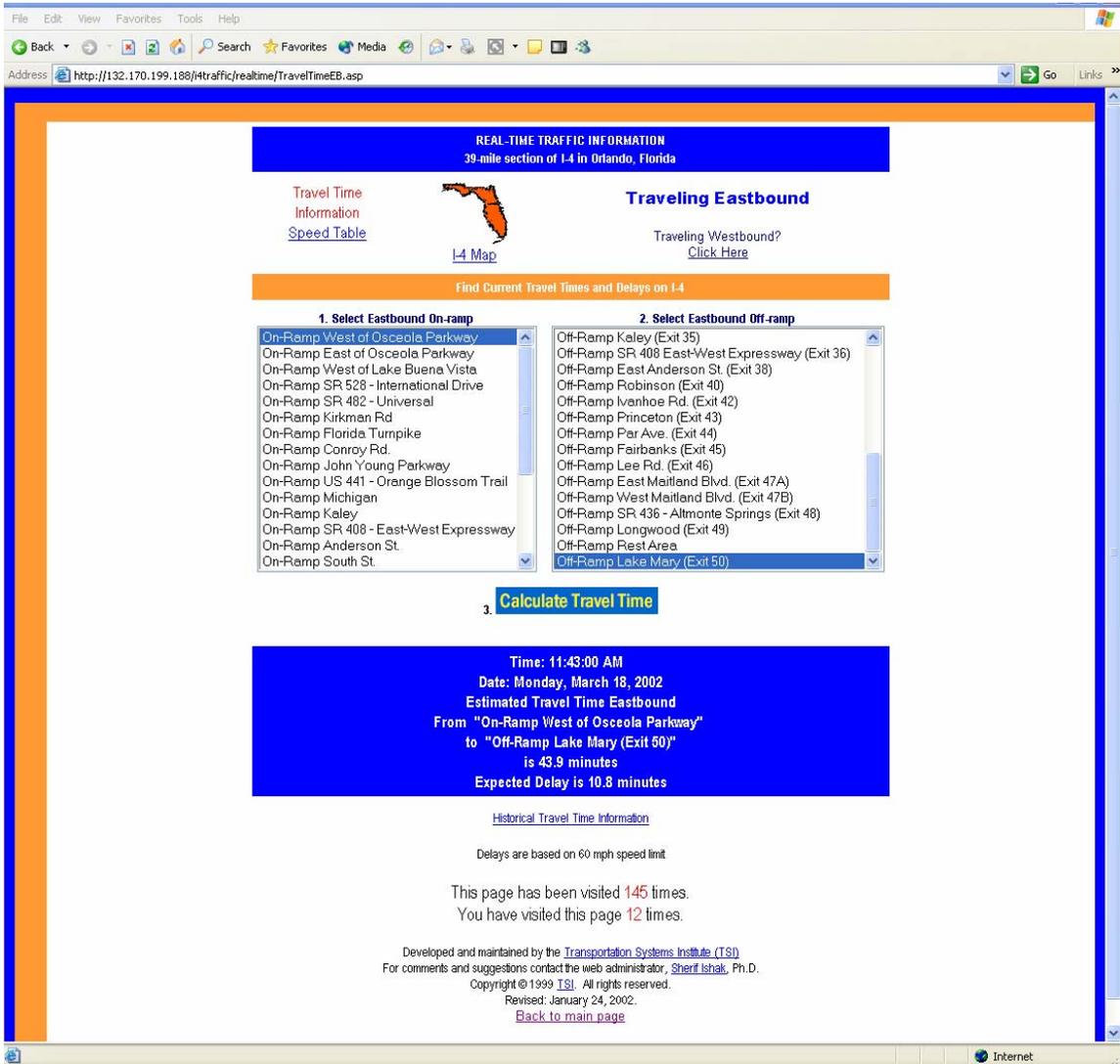


Figure 14: Snapshot of the Eastbound Real-Time Traffic Information Page

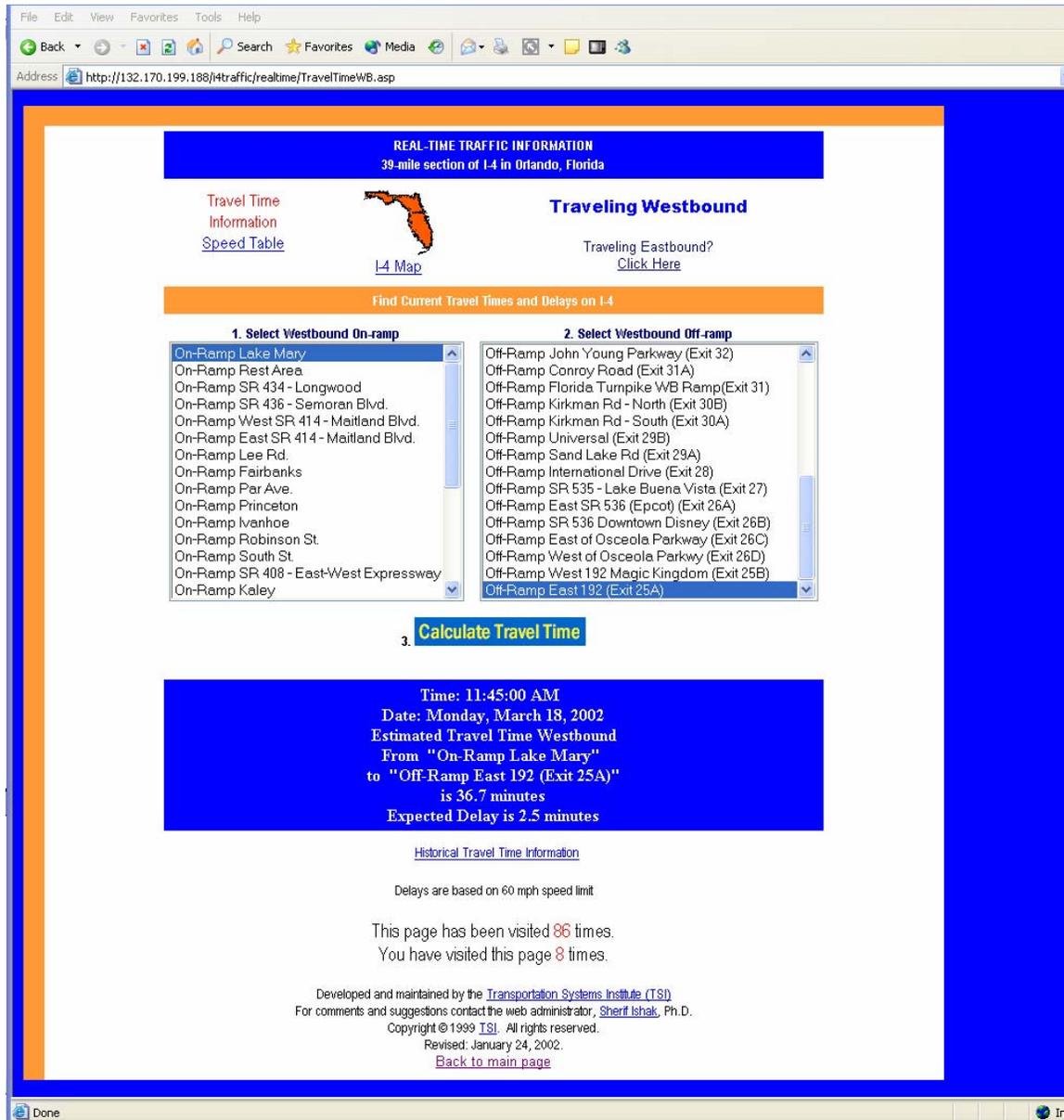


Figure 15: Snapshot of the Westbound Real-Time Traffic Information Page

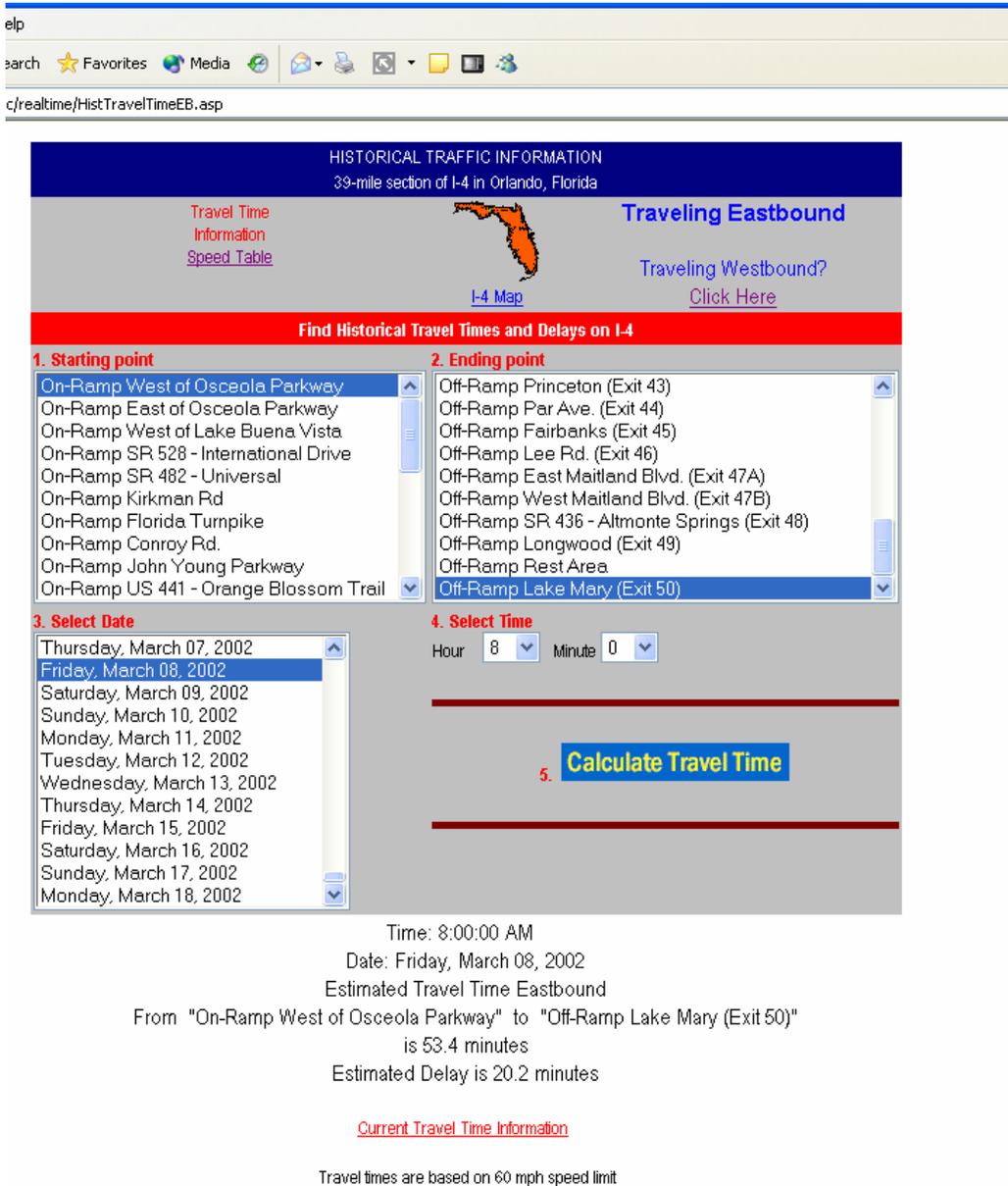


Figure 16: Historical Travel Time in the Eastbound Direction on Friday, March 8th, 2002
at 8:000 AM over the Entire 40-Mile Corridor

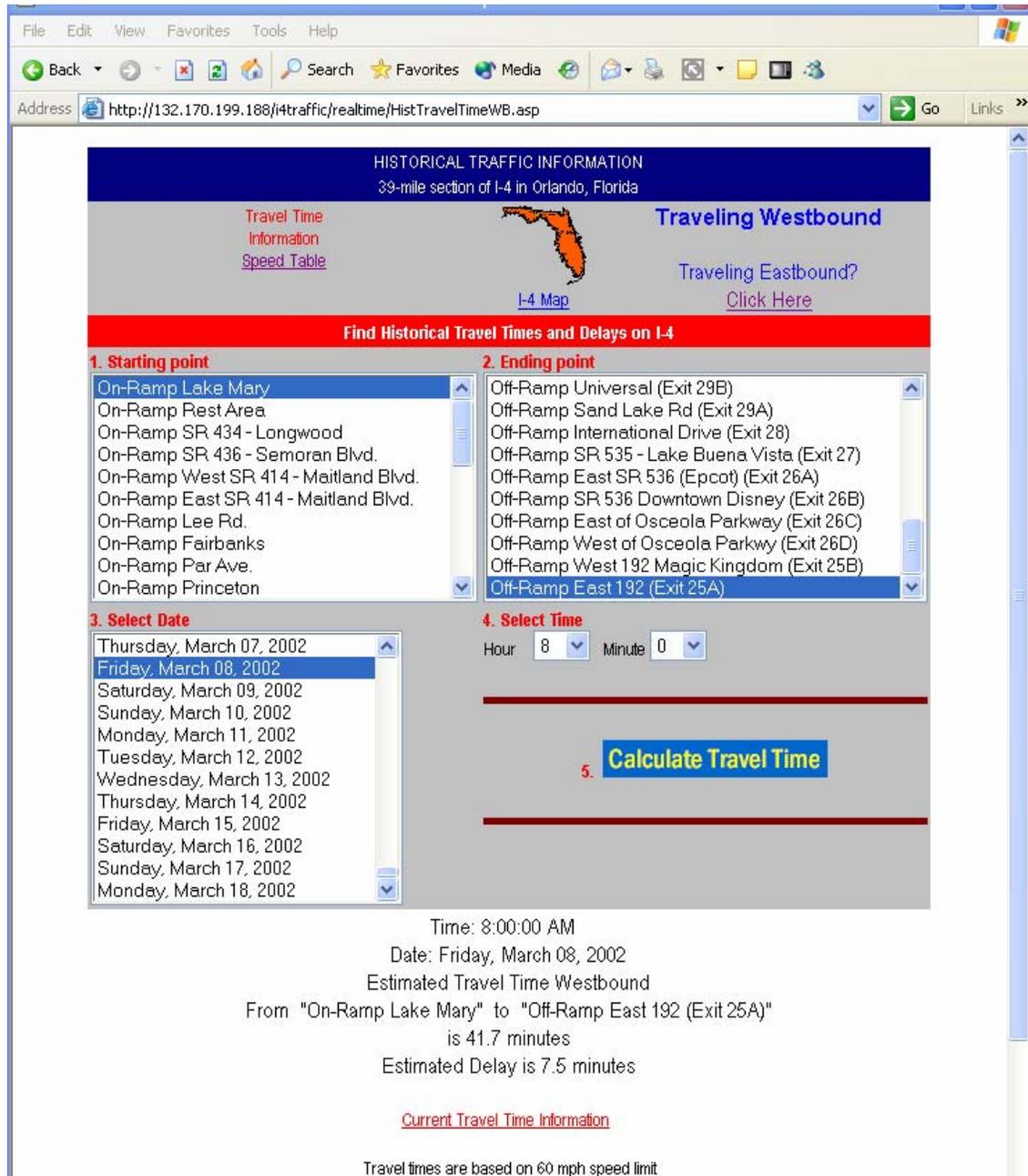


Figure 17: Historical Travel Time in the Westbound Direction on Friday, March 8th, 2002 at 8:00 AM over the Entire 40-Mile Corridor

LONG TERM TRAFFIC PREDICTION MODULE

In this project, the UCF research team has developed a long term traffic prediction approach to provide travelers with travel time information that is based on historical data. This approach was tested statistically and presented to the Louisiana State University (LSU) team to implement on the traffic information web site to supplement the short-term traffic prediction application currently running in real time. The LSU research team developed the application code and tested it thoroughly.

The long term traffic prediction application provides travelers with travel time information that is based solely on historical information collected in the past along the Interstate-4 corridor. The application is intended to assist motorists with travel time estimates when prediction horizons exceed 30 minutes and thus the short-term traffic prediction model no longer applies. The long term travel time prediction is provided for each direction of I-4 separately, as shown in Figure 18. Travelers must select the day of week, month of year, and time of day (increments of 30-minute periods). Then, the origin and destination must be selected from the list of available on- and off-ramps in the direction of travel. Finally, the travel time can be estimated by clicking the “Compute EB (or WB) TT” button.

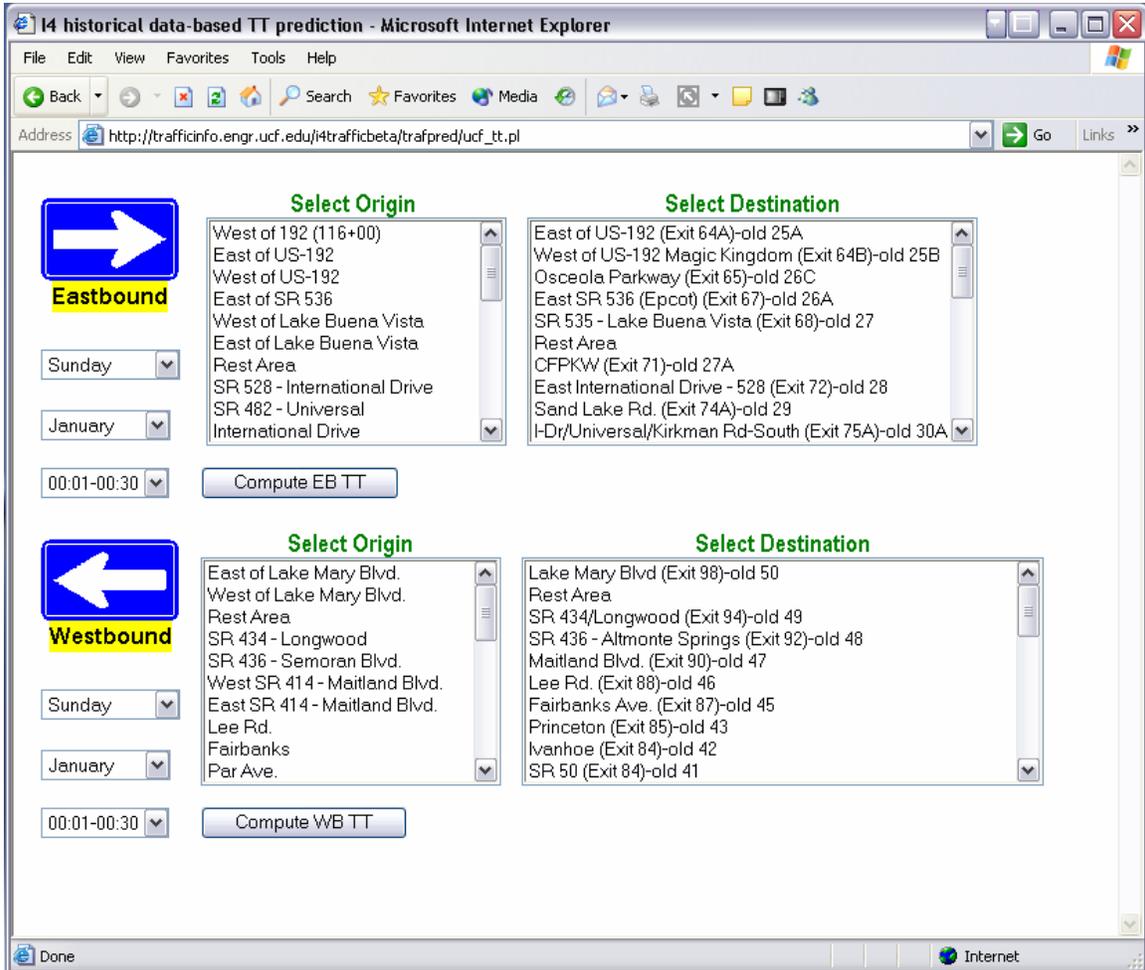


Figure 18: Snapshot of the long term traffic prediction application

Figure 19 shows an instance of estimating the travel time from West Lake Buena Vista on-ramp to the Fairbanks (Exit 87) off-ramp on Monday from 8 to 8:30 AM in the month of March. The travel time is provided between the origin and each subsequent off-ramp in the table shown in Figure 19. As shown in the figure, the total travel time in this time frame is estimated as 22 minutes and 35 seconds, based on typical traffic conditions often observed in the past.



Figure 19: Snapshot of the average and cumulative long term traffic prediction in the eastbound of I-4 from West of Lake Buena Vista to Fairbanks (Exit 87)

TRAVELER INFORMATION SURVEYS IN THE I-4 CORRIDOR

The UCF research team designed the pilot survey and tested it among themselves, then the same version of the survey was tested in a pilot study using both the telephone and the Internet. The telephone survey was random and respondents were working or living in the Central Florida area. This telephone survey was provided to a well-known survey and marketing research firm with the target of receiving 400 completed responses. The marketing research firm was compensated for their services. The Internet based pilot survey was designed in-house by the UCF Statistics department, however the same questions were used as in the telephone survey. The target population for the Internet survey was UCF students, faculty, and staff (over 43,000 people). Both surveys were completed and the results follow.

1) Telephone-Based Pilot Survey

A pilot CATI (Computer-Aided Telephone Interview) survey was conducted in the last week of October 2002 to measure the level of familiarity with I-4 web site and also the 511 telephone service. The research team at UCF designed the survey. Western Watts marketing research company was subcontracted to conduct the interview. The desired complete sample was 400. The screening questions were that the respondents have to be I-4 users and live and/or work in Central Florida. Random digit dialing was performed to obtain the desired sample.

Among the significant results was that about 25% of the sample use I-4 for commute, and about 20% use it for work related trips. The remaining percentage use I-4 for other trip purposes. About 28% of the sample use I-4 5 or more times per week. About 26% of the sample use I-4 both in the morning and afternoon peak periods, 14%

use it only in the morning peak, and 16% use it only in the afternoon peak. Surprisingly about 30% of the respondents use I-4 on weekends.

As for information, only 7 respondents indicated that they use the present web site, and also only 7 indicated that they use the 511 phone service. However 48 respondents (12% of the sample) indicated that they are familiar with the UCF web site. Also 120 respondents (30% of the sample) indicated that they are familiar with the 511 Phone traveler information service. In general, respondents indicated that the information they need the most is related to the locations of incidents and the expected delay. For detailed results of the survey, please refer to Appendix –A-.

2) Web-Based Pilot Survey

A web-based pilot survey was conducted in the last month of 2002 to measure the level of familiarity with I-4 web site and also the 511 telephone service. The research team at UCF designed and implemented the web-based survey with SAS/IntraNet software. Although the design sample size is 400, the web-based survey was so popular and it reached the sample size of 439 in the first few days of the survey period. Since the design of this web-based survey included automatic validating capability, the data quality for web-based survey is much higher than the traditional phone based survey system with relatively low cost. The screening questions were that the respondents have to be I-4 users and live and/or work in Central Florida.

Among the significant results was that about 35% of the sample use I-4 for commute, and about 12% use it for work related trips. The remaining percentage use I-4 for other trip purposes. About 33% of the sample use I-4 5 or more times per week.

About 29% of the sample use I-4 both in the morning and afternoon peak periods, 9% use it only in the morning peak, and 14.74% use it only in the afternoon peak. Surprisingly, about 29% of the respondents use I-4 on weekends and that is similar to the finding through regular phone based survey.

As for information, there are 34 respondents (9%) indicated that they use the web site that is much higher than 7 respondents found in phone survey. This is an indicator that web-based survey can reach web surfers much more effectively than regular residents. In general, the respondents indicated that the information they needed the most is related to the locations of incidents and the expected delay. For detailed results of the web-based survey, please refer to the Appendix B and for the design of the web-based survey, please refer to the Appendix C.

REFERENCES

- AL-DEEK, H., Ishak, S., and Wang, M. "A New Short-Term Traffic Prediction and Incident Detection System on I-4, Volume-I-," Final Research Report, Transportation Systems Institute (TSI), Department of Civil & Environmental Engineering, University of Central Florida, 153 pages, May 2001.
- AL-DEEK, H., Ishak, S., and Wang, M. "A New Short-Term Traffic Prediction and Incident Detection System on I-4, Volume-II-," Final Research Report, Transportation Systems Institute (TSI), Department of Civil & Environmental Engineering, University of Central Florida, 131 pages, May 2001.
- Kaysi, I., M. Ben-Akiva, and H. Koutsopoulos. An Integrated Approach to Vehicle Routing and Congestion Prediction for Real-Time Driver Guidance. Presented at 72nd Annual Meeting of Transportation Research Board, Washington, D.C., 1993.
- Ben-Akiva M., A. de Palma, and I. Kaysi. Dynamic Network Models and Driver Information Systems. In *Transportation Research A*, Vol. 25, No. 5, September 1991, pp. 251-266.
- Ben-Akiva, M., E. Kroes, J. de Ruiter, S. Smulders, J. Whittaker, and K. Lindveld. "Real-Time Prediction of Traffic Congestion." In *Vehicle navigation & information systems: conference record of papers*. Institute of Electrical and Electronics Engineers. New York, N.Y., 1992, pp. 557-562.
- Stamatiadis, C. and W. Taylor. Travel Time Predictions for Dynamic Route Guidance with a Recursive Adaptive Algorithm. Presented at 73rd Annual Meeting of Transportation Research Board, Washington, D.C., 1994.

- Ahmed, M., and A. Cook. Analysis of Freeway Traffic Time Series Data by Using Box-Jenkins Techniques. In *Transportation Research Record 722*, TRB, National Research Council, Washington, D.C., 1982, pp. 1-9.
- Gazis, D., and C. Knapp. On Line Estimation of Traffic Densities from Time Series of Traffic and Speed Data. In *Transportation Science*, Vol. 5, No. 3, March 1971, pp. 283-301.
- Kyte, M., J. Mark, and D. Frith. Using Multivariate Time Series Analysis to Model Freeway Traffic Flow. Presented at 68th Annual Meeting of Transportation Research Board, Washington, D.C., 1989.
- Lu Jian. Prediction of Traffic Flow by an Adaptive Prediction System. *Transportation Research Record 1287*, TRB, National Research Council, Washington, D.C., 1990, pp. 54-61.
- Nihan, N., and G. Davis. Application of Prediction-Error Minimization and Maximum Likelihood to Estimate Intersection O-D Matrices from Traffic Counts. In *Transportation Science*, Vol. 23, No. 2, 1989, pp. 77-90.
- Okutani, I. and Y. Stephanedes. Dynamic Prediction of Traffic Volume through Kalman Filtering Theory. In *Transportation Research B*, Vol. 18, No. 1, February 1984, pp. 1-11.
- Vojak, R., J.L. Vehel, and M. Danech-Pajouh. A First Step Towards Road Traffic Short-Term Prediction Using Multifractal Tools. *Proceedings of the DRIVE-II Workshop on Short Term Traffic Forecasting*, Delft, Netherlands: TNO Institute for Policy Studies, 1994, pp. 243-250.

- Lee, S. and D. Fambro. Application of the Subset ARIMA Model for Short-Term Freeway Traffic Volume Forecasting. In *Transportation Research Record 1678*, TRB, National Research Council, Washington, D.C., 1999, pp. 179-188.
- Jiang, Y. Dynamic Prediction of Traffic Flow and Congestion at Freeway Work Zones. Presented at 78th Annual Meeting of Transportation Research Board, Washington D.C., 1999.
- Iwasaki, M. and K. Shirao. A Short Term Prediction of Traffic Fluctuations Using Pseudo-Traffic Patterns. In *ITS world congress conference proceedings*, 1996.
- Chen, M. and S. Chien. Dynamic Freeway Travel Time Prediction Using Probe Vehicle Data: Link-based vs. Path-based. In *Transportation Research Board 80th Annual Meeting* (CD-ROM), Washington D.C., 2001.
- Kwon, J., B. Coifman, and P. Bickel. Day-to-Day Travel Time Trends and Travel Time Prediction from Loop Detector Data. Presented at 79th Annual Meeting of Transportation Research Board, Washington D.C., 2000.
- Park, D. and L. Rilett. Forecasting Multiple-Period Freeway Link Travel Times Using Modular Neural Networks. In *Transportation Research Record 1617*, TRB, National Research Council, Washington, D.C., 1998, pp. 163-170.
- Rilett, L., D. Park. Direct Forecasting of Freeway Corridor Travel Times Using Spectral Basis Neural Networks. In *Transportation Research Record 1752*, TRB, National Research Council, Washington, D.C., 2001, pp. 140-147.
- Park, D., L. Rilett, B. Gajewski, and C. Spiegelman. Optimal Aggregation Internal Size of Probe-based Travel Time Information for ATIS. Presented at 80th Annual Meeting of Transportation Research Board, Washington D.C., 2001.

Abdulhai, B., H. Porwal, and W. Recker. Short-Term Freeway Traffic Flow Prediction Using Genetically Optimized Time-Delay-Based Neural Networks. Presented at 78th Annual Meeting of Transportation Research Board, Washington D.C., 1999.

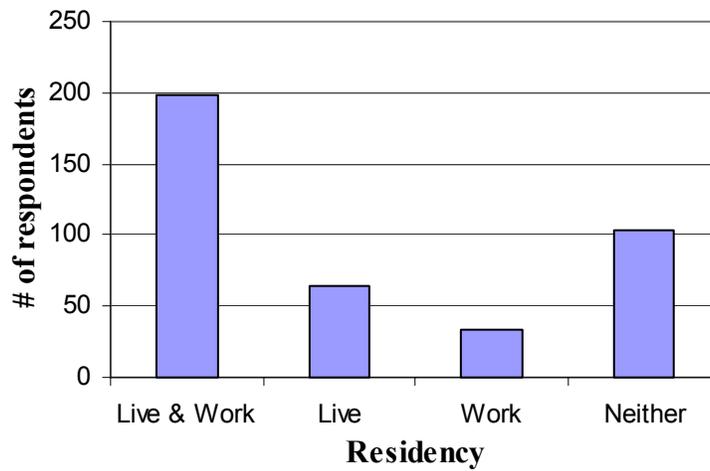
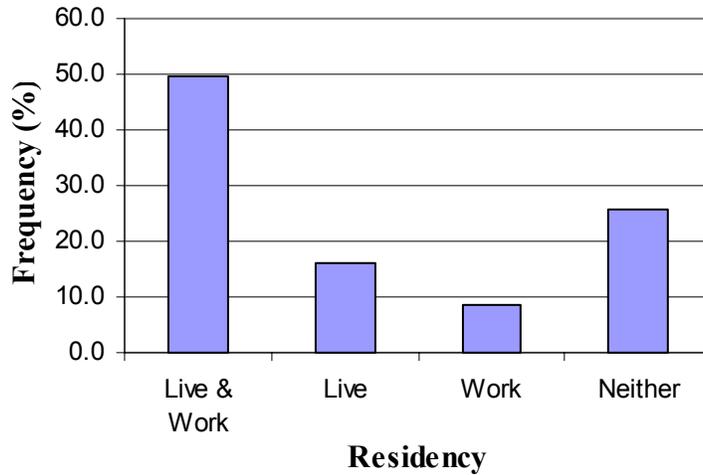
Tong, H. *Non Linear Time Series. A Dynamic Approach*. Oxford University Press, Inc., New York, 1993.

APPENDIX –A-
DETAILED RESULTS OF THE CATI (TELEPHONE-BASED) PILOT SURVEY

SURVEY RESULTS

1. Do you live or work in the Orlando Metropolitan area?

(1) both live and work (2) live (3) work (4) neither

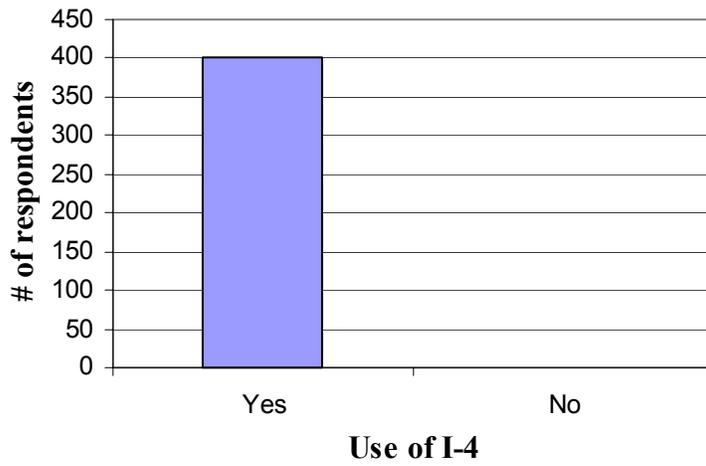
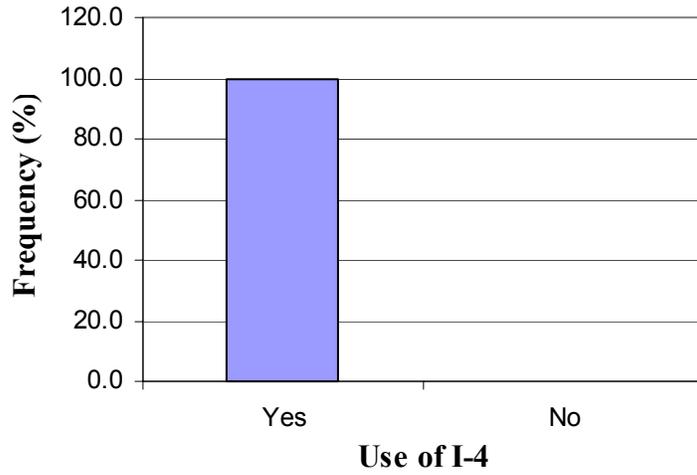


2. Did you use I-4 last month?

(1) yes

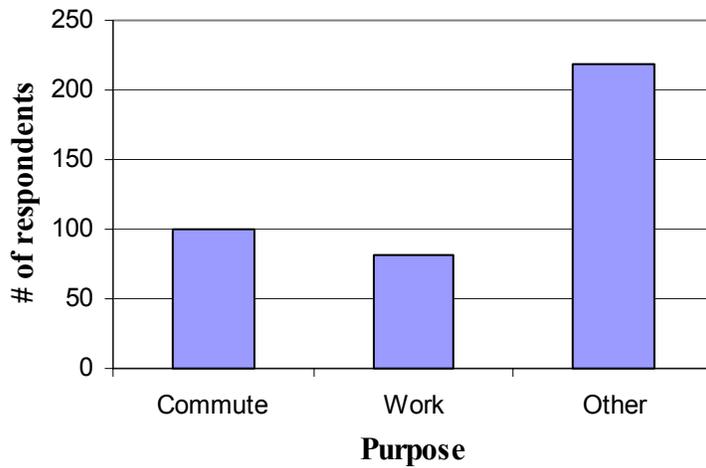
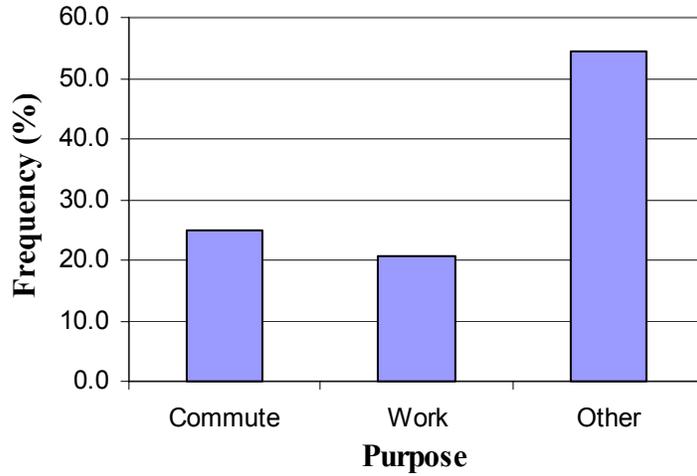
(2) no

(3) don't know/refused—DO NOT READ

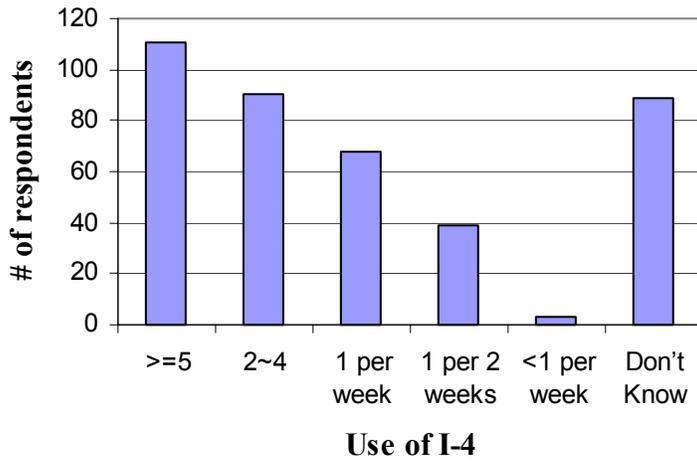
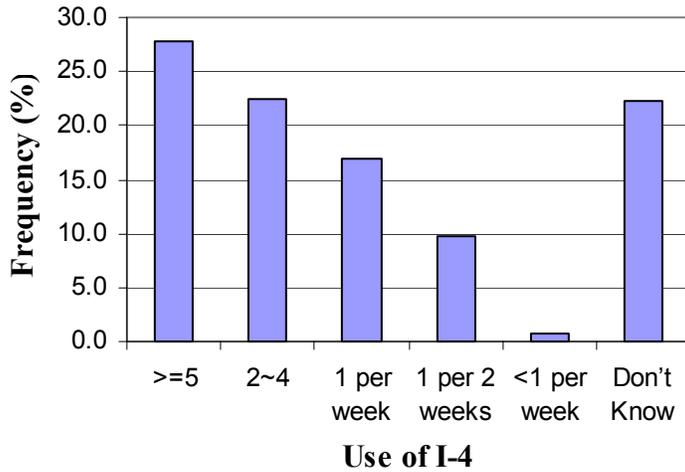


If answer of Q2 is 1 continue, else terminate

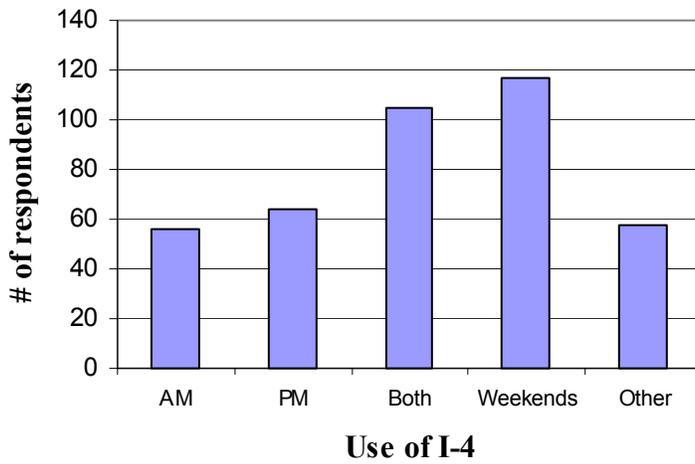
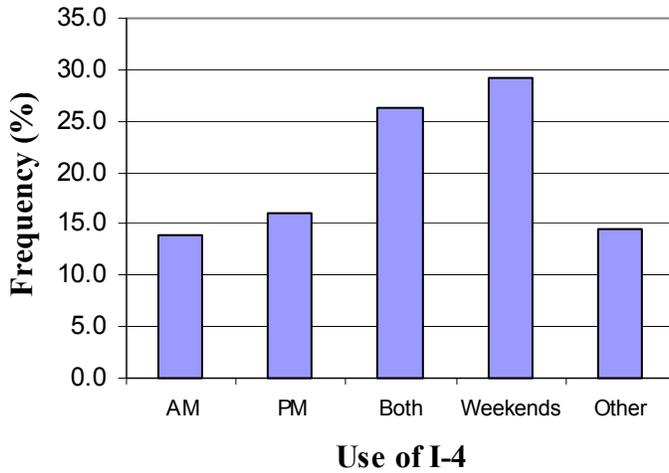
3. What is usually the purpose of using I-4?
(1) commute to/from work (2) work related/commercial (3) other (specify)



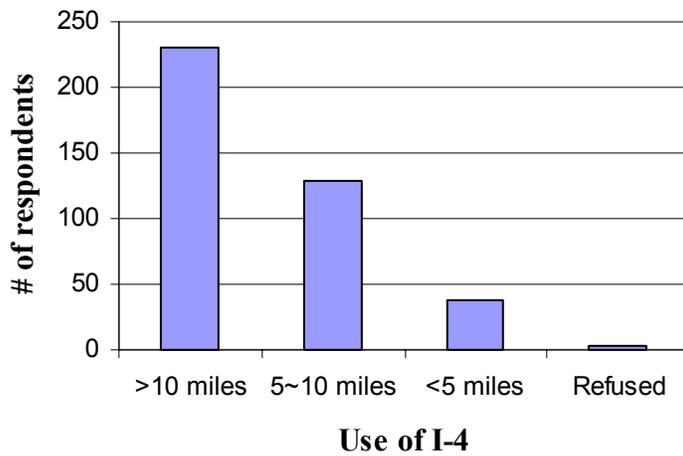
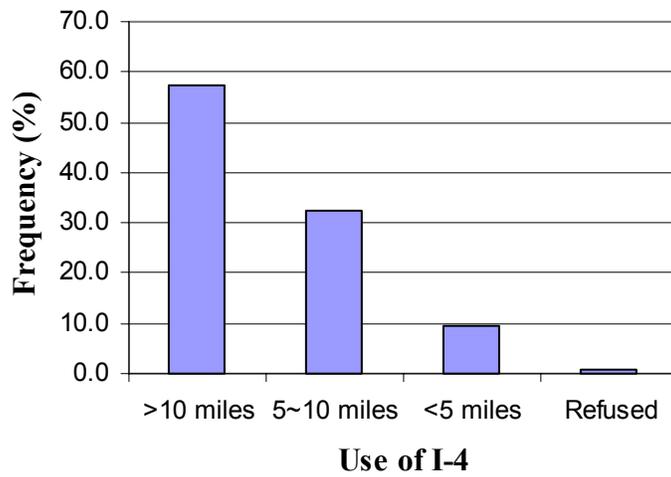
4. How frequently do you use I-4?
 (1) 5 or more times per week
 (2) 2-4 times per week
 (3) once per week
 (4) once every two weeks
 (5) (6) less than once in two weeks
 (6) (7) Don't Know/Refused—DO NOT READ



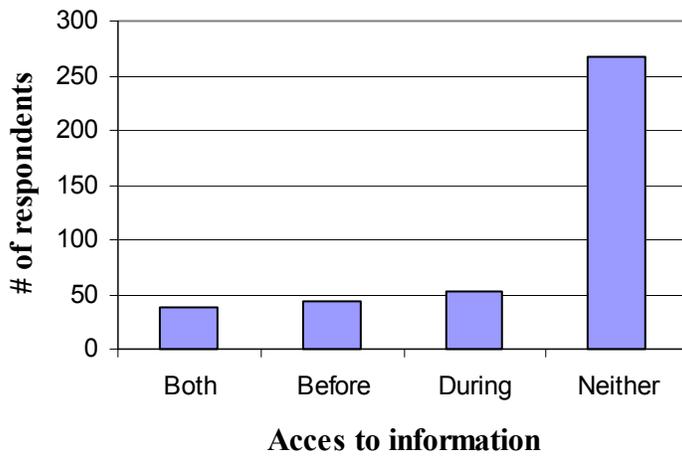
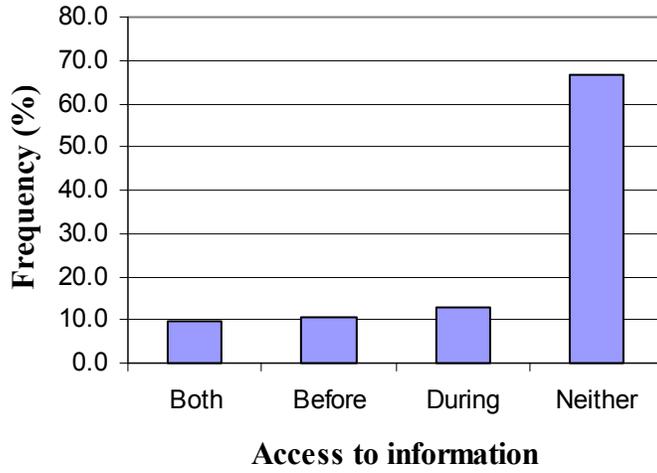
5. When do you most usually use I-4?
- (1) (1) Weekdays morning peak – 6-10 AM
 - (2) (2) Weekdays evening peak – 3-7 PM
 - (3) both Weekdays morning and evening peaks
 - (4) Weekends
 - (5) Other (specify)



6. On average how long is your trip on I-4?
(1) more than 10 miles
(2) (2) 5-10 miles
(3) less than 5 miles
(4) Don't know/refused—DO NOT READ

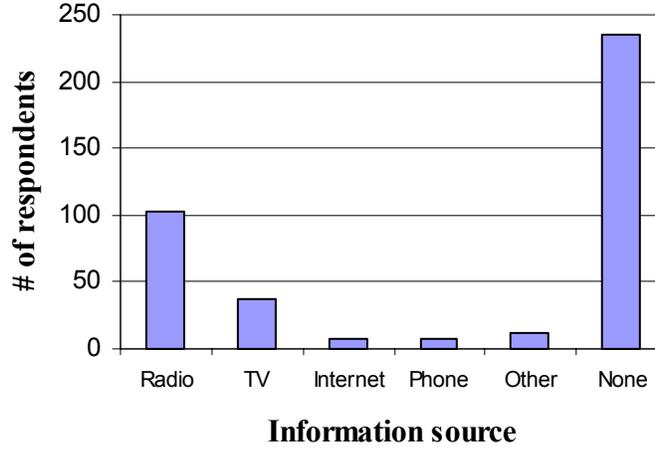
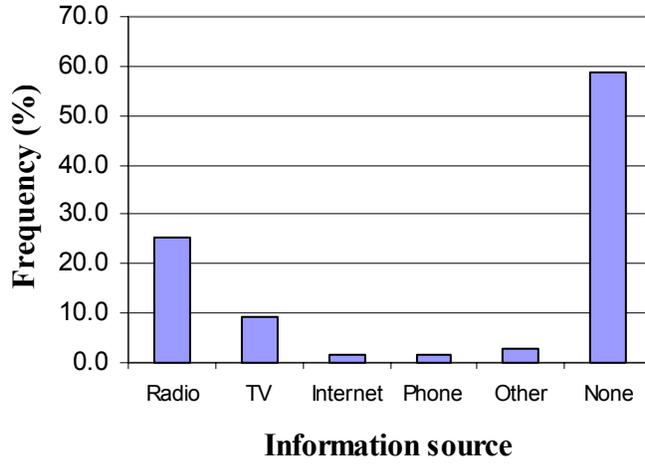


7. Do you usually obtain traffic information before or during your trip on I-4?
(1) before and during (2) before only (3) during only (4) neither



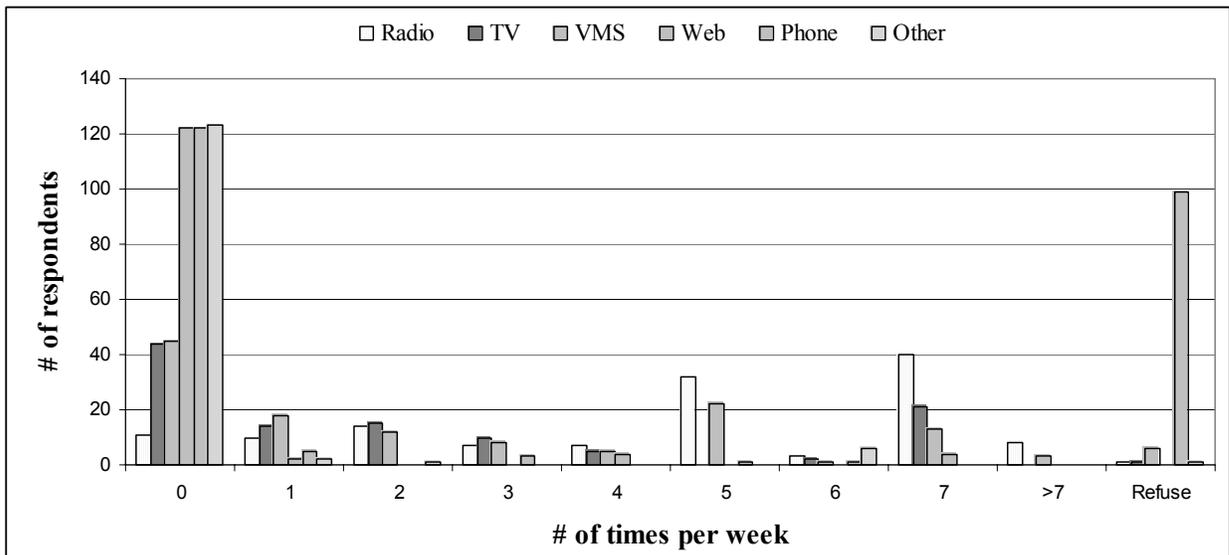
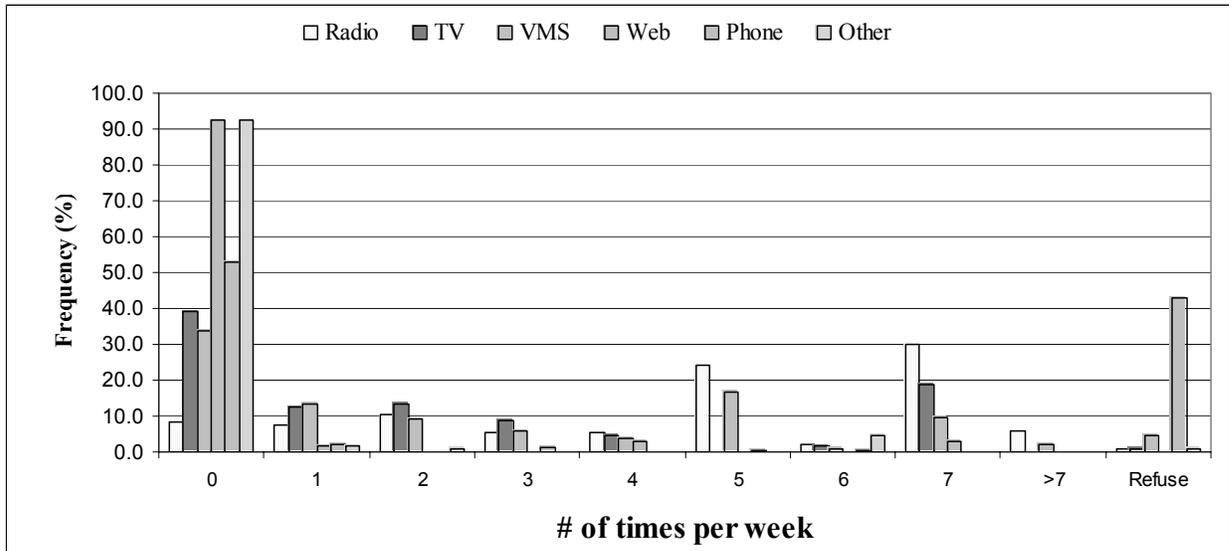
If answer of Q7 is 1, 2 or 3 goto Q8, else goto Q10

8. How do you usually receive traffic information? (mark all that applies)
 (1) Radio (2) TV (3) Internet (4) Phone (511) (5) other
 (specify)



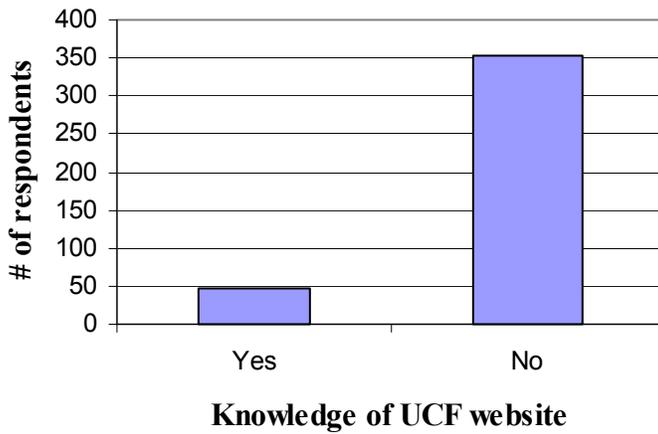
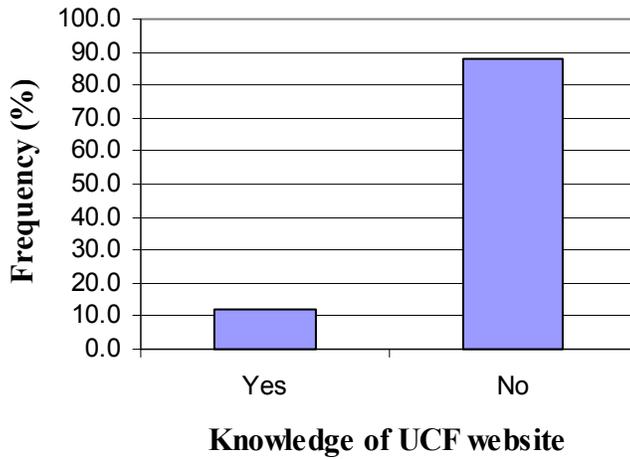
If answer to Q8 is 1, 2 or 5 goto 9 then 10
 If answer to Q8 is 4 goto 9 then 10
 If answer to Q8 is 3 goto 10, then 11

9. How many times per week do you usually receive/listen to traffic information from each of the following sources: (Allow 1-50, Refused = 99)
- (1) Radio
 - (2) TV
 - (3) Variable message signs
 - (4) Traffic web site
 - (5) Phone 511
 - (6) Other



10. Do you know that there is a UCF web site that provides information about the traffic conditions on I-4 at www.catss.ucf.edu?

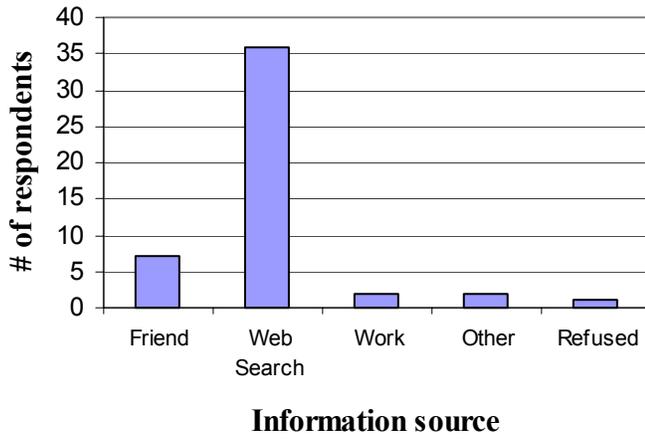
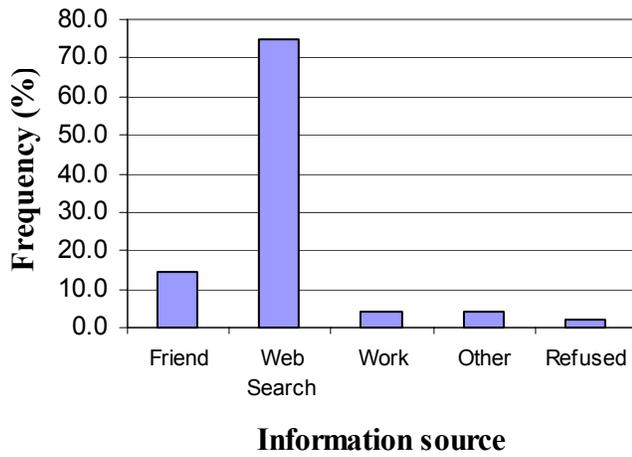
(1) yes (2) no



If answer to Q 10 is 1 goto 11, else goto 20

11. How did you hear about this web site?

- (1) friend
- (2) web search
- (3) work
- (4) other (specify)
- (5) don't know/refused



12. From which zipcode do you most frequently access this site? (don't know/refused =99999)

Not enough data points to generate meaningful statistics: 6 responses

| |
|-------|
| 32765 |
| 32771 |
| 32811 |
| 32812 |
| 32825 |
| 32828 |
| 99999 |

13. How long have you been accessing this web site to get traffic information?

- (1) 2 years
- (2) Less than two years but greater than one year
- (3) Less than one year but greater than one month
- (4) Less than a month
- (5) Don't Know/Refused—DO NOT READ

Not enough data points to generate meaningful statistics: 7 responses
Note) Error: there should be 48 responses.

| | |
|-------------------------------------------|---|
| 2 years | 1 |
| Less than 2 years but greater than 1 year | 0 |
| Less than 1 year but greater than 1 month | 2 |
| Less than a month | 1 |
| Don't Know | 3 |

14. How many times during the last week did you access this web site? (Allow 1-50, 99 = Don't Know/Refused)

Not enough data points to generate meaningful statistics: 7 responses
Note) Out of 48 people who know the web site, only 7 people have actually accessed it.

| |
|---|
| 0 |
| 0 |
| 0 |
| 0 |
| 1 |
| 2 |
| 4 |

15. On a scale of 1 to 5 with 1 being not at all useful, and 5 very useful, please rate the usefulness of the web site?
- (1) not at all useful
 - (2) not useful
 - (3) somewhat useful
 - (4) useful
 - (5) very useful
 - (6) Don't Know/Refused—DO NOT READ

Not enough data points to generate meaningful statistics: 7 responses

| |
|---|
| 3 |
| 3 |
| 4 |
| 4 |
| 5 |
| 5 |
| 6 |

16. Did you change your travel decisions based on information you received from the web site last month? (multiple answers permitted)
- (1) Changed departure time, *if yes ask:* how many times last month
 - (2) Changed route, *if yes ask:* how many times
 - (3) Changed both *departure time and route*, *if yes ask:* how many times
 - (4) Changed destination, *if yes ask:* how many times
 - (5) Changed mode, *if yes ask:* how many times

Not enough data points to generate meaningful statistics: 7 responses

| Departure Time | # | Route | # | Both | # | Destination | # | Mode | # |
|----------------|---|-------|---|------|---|-------------|---|------|---|
| 2 | | 2 | | 2 | | 2 | | 2 | |
| 1 | 1 | 1 | 1 | 2 | | 1 | 1 | 2 | |
| 1 | 1 | 1 | 1 | 1 | 1 | 2 | | 2 | |
| 2 | | 2 | | 2 | | 2 | | 2 | |
| 2 | | 1 | 2 | 2 | | 2 | | 2 | |
| 2 | | 2 | | 2 | | 2 | | 2 | |
| 1 | 3 | 1 | 4 | 2 | | 2 | | 2 | |

Yes= 1, no= 2

17. How often, if at all, was the information from the web site beneficial to you by providing advanced warning of traffic congestion?

- (1) Daily
- (2) Several times per week
- (3) Once per week
- (4) Once every two weeks
- (5) Once per month
- (6) Less than once per month
- (7) Has not saved me any time

Not enough data points to generate meaningful statistics: 7 responses

| |
|---|
| 1 |
| 2 |
| 3 |
| 3 |
| 5 |
| 7 |
| 7 |

18. What section of the web site do you view the most?

- (1) Traffic conditions map
- (2) Real-time point-to-point travel time
- (3) Forecasted point-to-point travel times
- (4) Historical point-to-point travel times
- (5) Other
- (6) Don't Know—DO NOT READ

Not enough data points to generate meaningful statistics: 7 responses

| |
|---|
| 1 |
| 1 |
| 1 |
| 2 |
| 2 |
| 6 |
| 6 |

19. On a scale of 1 to 5, with 1 being not at all important and 5 being very important, please rate the importance of some of the features that you might like to see on the web site? (Don't Know/Refused =9)

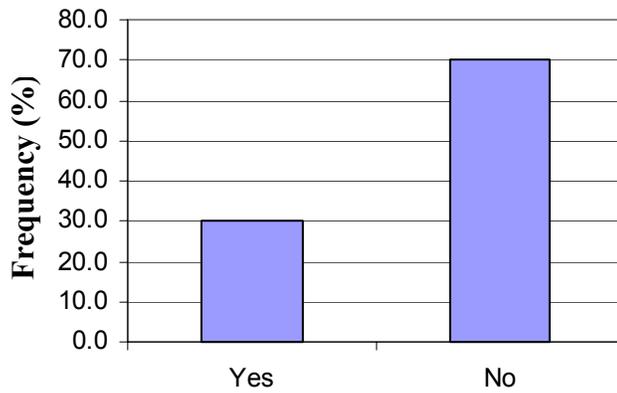
- (1) Map work zones and Incident locations/status
- (2) Text work zones and Incident locations/status
- (3) Text messages from variable message signs
- (4) Traffic video showing current situation on I-4
- (5) Traffic conditions on toll roads
- (6) Traffic conditions on other streets
- (7) Inclement weather/flooding conditions on streets

Not enough data points to generate meaningful statistics: 7 responses

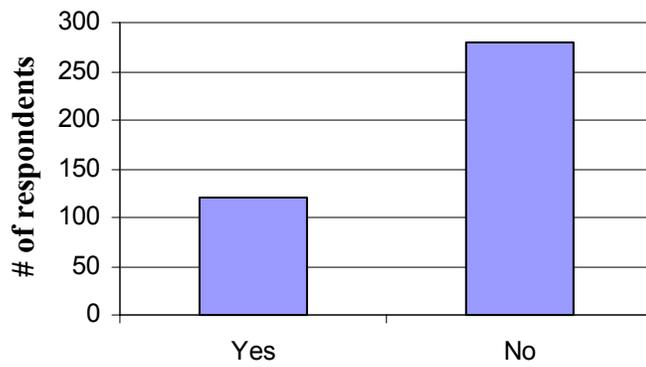
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|-----|-----|-----|-----|-----|-----|-----|
| 3 | 3 | 4 | 1 | 3 | 4 | 3 |
| 5 | 5 | 3 | 5 | 2 | 5 | 4 |
| 3 | 3 | 3 | 4 | 5 | 3 | 3 |
| 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| 3 | 2 | 4 | 2 | 2 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 2 |

20. Are you familiar with the 511 Phone traveler information service?

(1) yes (2) no



Familiarity with 511 phone service



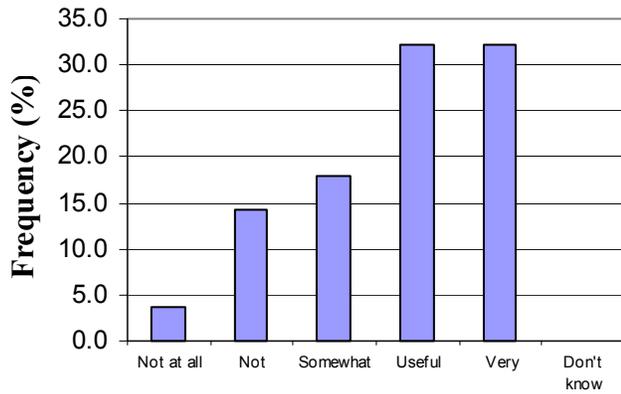
Familiarity with 511 phone service

If answer to Q20 is 1 continue, else goto Q24

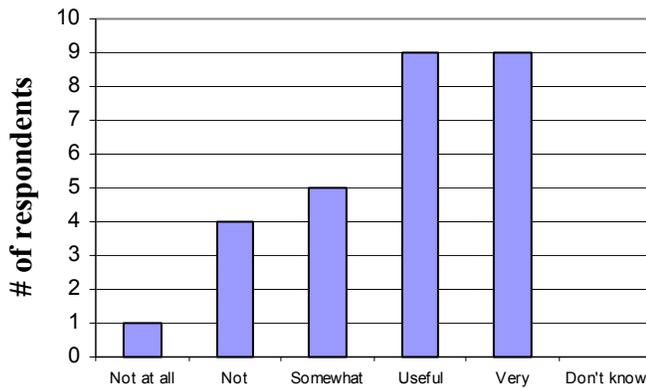
21. On a scale of 1 to 5 with 1 being not at all useful, and 5 very useful, please rate the usefulness of the 511 service?

- (1) not at all useful
- (2) not useful
- (3) somewhat useful
- (4) useful
- (5) very useful
- (6) don't know/refused

Note) Out of 120 people who are familiar with the 511 phone service, only 28 people actually responded.



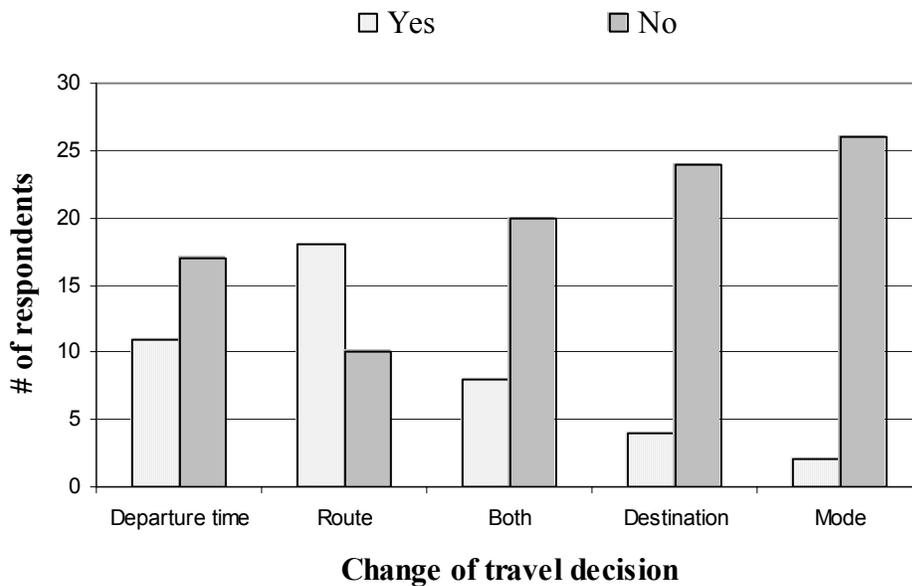
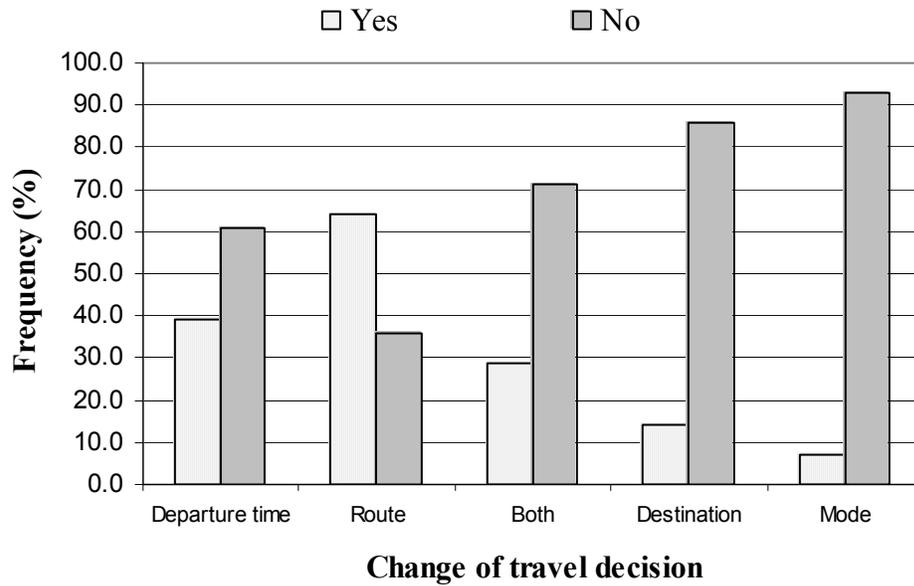
Usefulness of 511 phone service



Usefulness of 511 phone service

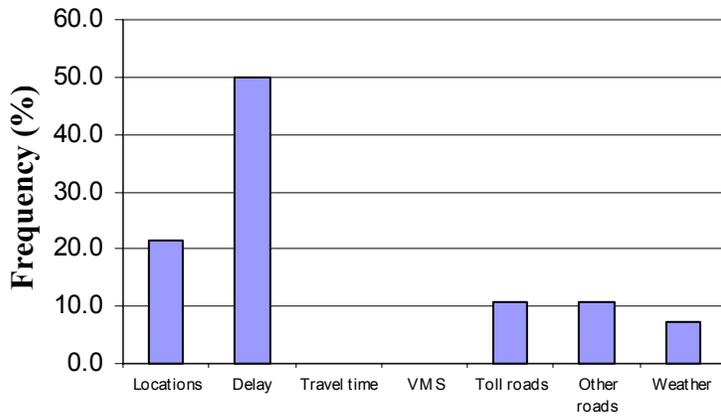
22. Did you change your travel decisions based on information you received from 511 last month? (multiple answers permitted)

- (1) Changed departure time, *if yes ask:* how many times last month
- (2) Changed route, *if yes ask:* how many times
- (3) Changed both *departure time and route*, *if yes ask:* how many times
- (4) Changed destination, *if yes ask:* how many times
- (5) Changed mode, *if yes ask:* how many times

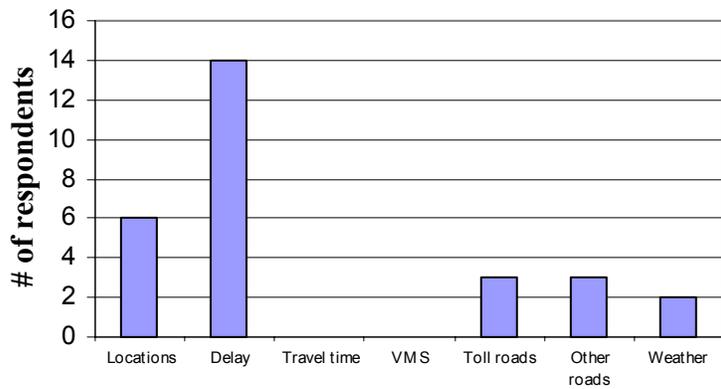


Not enough data points to generate meaningful statistics on the number of times to change the travel decisions

23. What kind of information do you need the most?
- (1) Locations of work zones and incidents
 - (2) Expected delay
 - (3) Expected travel time
 - (4) Text messages from variable message signs
 - (5) Traffic conditions on toll roads
 - (6) Traffic conditions on other streets
 - (7) Inclement weather/flooding conditions on streets



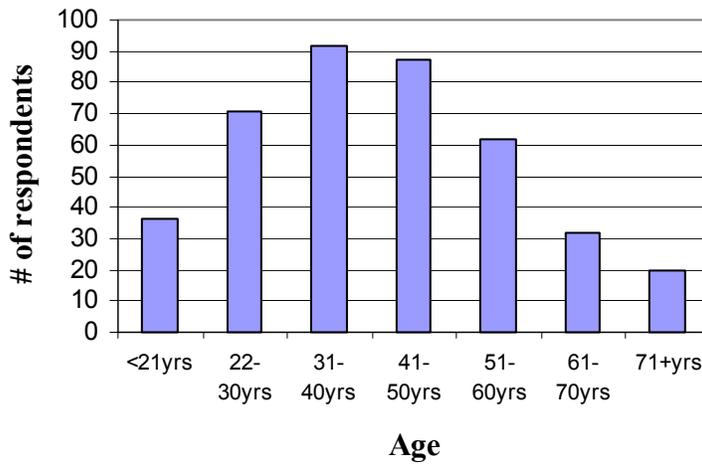
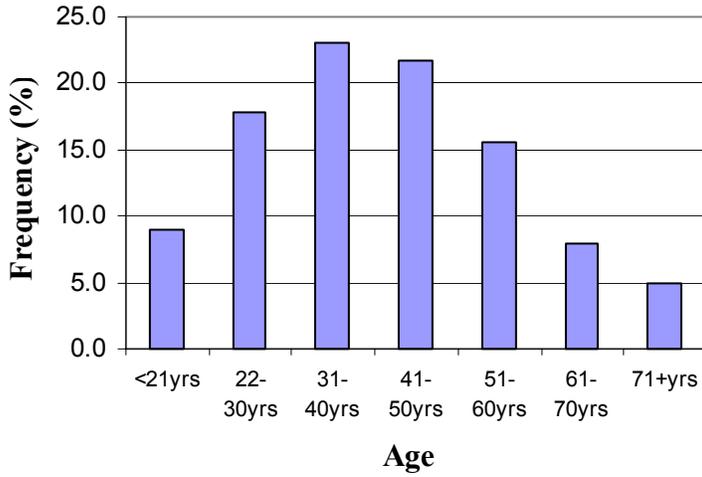
Needs of information



Needs of information

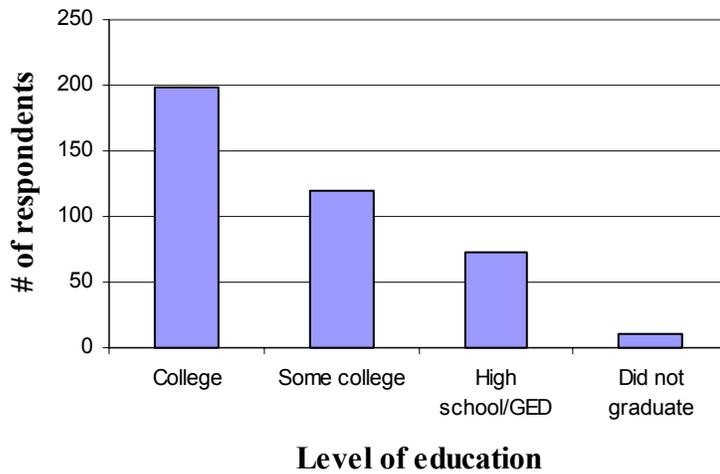
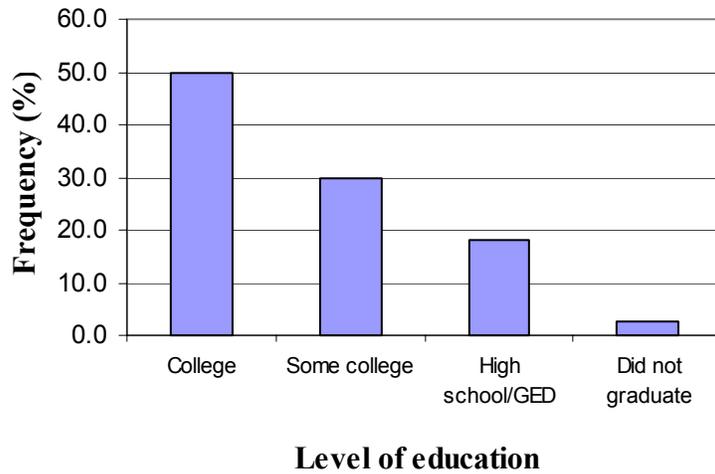
24. Which of the following groups includes your age?

- (1) 21 or Younger
- (2) 22-30
- (3) 31-40
- (4) 41-50
- (5) 51-60
- (6) 61-70
- (7) 71+



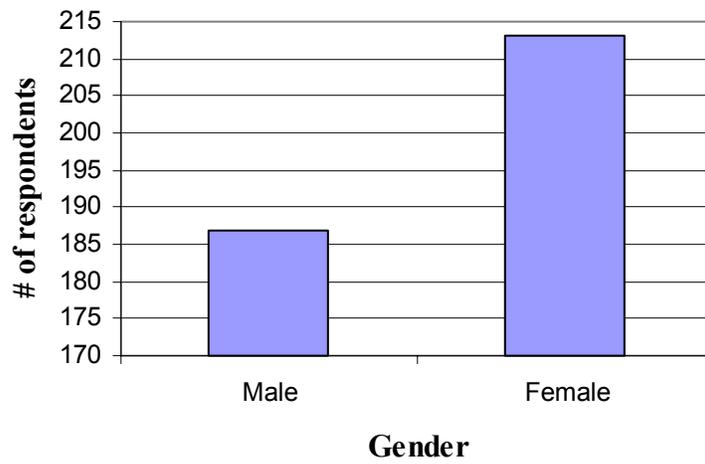
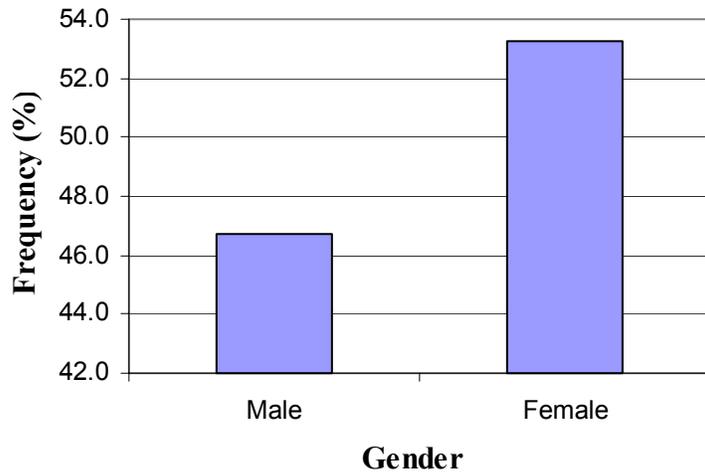
25. What level of education have you completed?

- (1) College
- (2) Some college
- (3) High School/GED
- (4) Did not graduate from high school



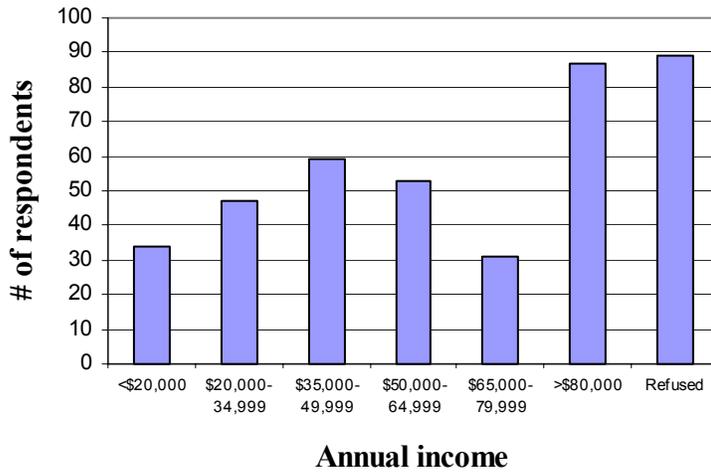
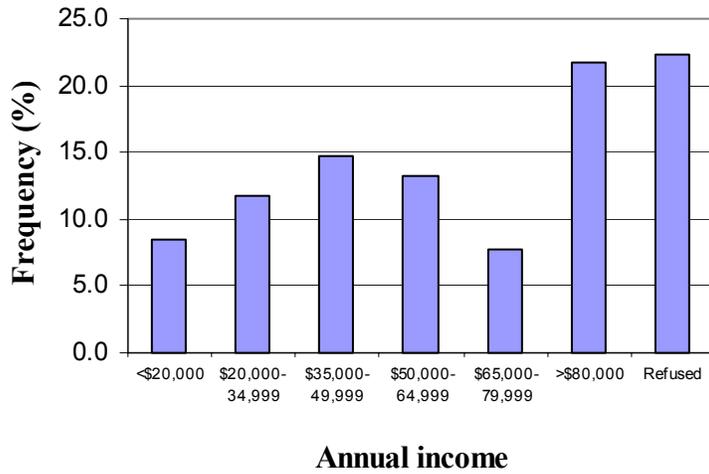
26. Are you (OBSERVE)

- (1) Male
- (2) Female



27. What is your total annual household income?

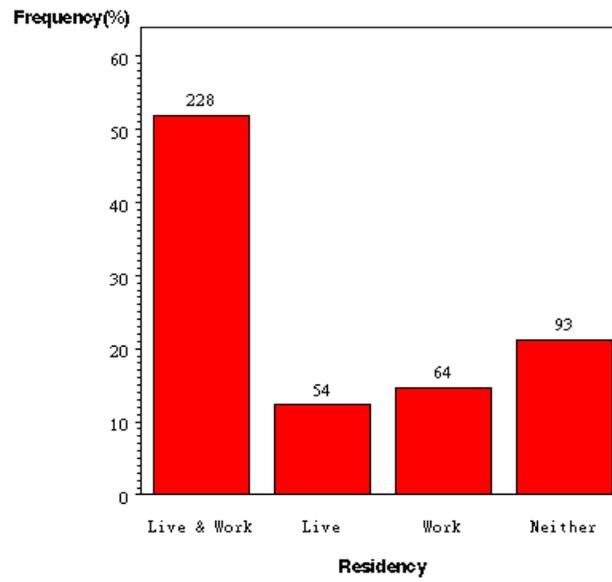
- (1) less than \$20,000
- (2) \$20,000 - 34,999
- (3) 35,000 – 49,999
- (4) 50,000 – 64,999
- (5) 65,000 – 79,999
- (6) 80,000 or more
- (7) don't know/refused



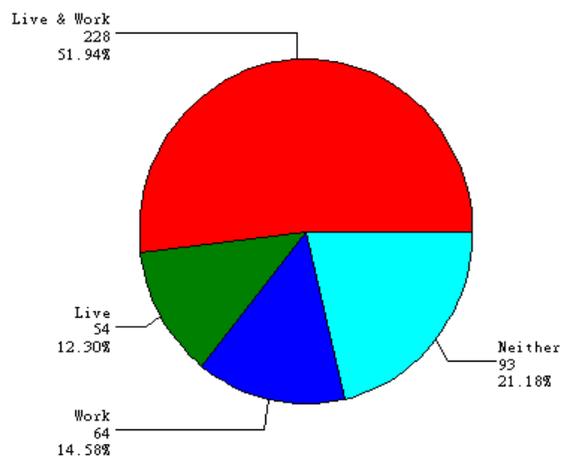
APPENDIX –B–
DETAILED RESULTS OF THE WEB-BASED PILOT SURVEY

SURVEY RESULTS

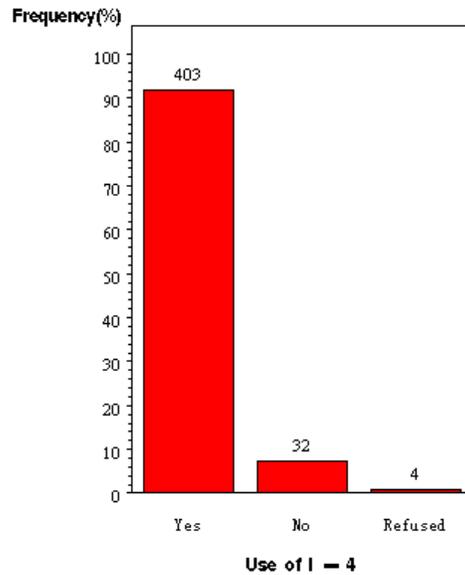
1. Do you live or work in the Orlando Metropolitan area?
(1) both live and work (2) live (3) work (4) neither



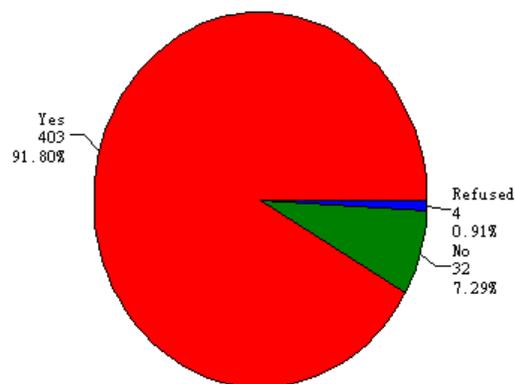
FREQUENCY of Q1



2. Did you use I-4 last month?
(1) yes (2) no (3) don't know/refused

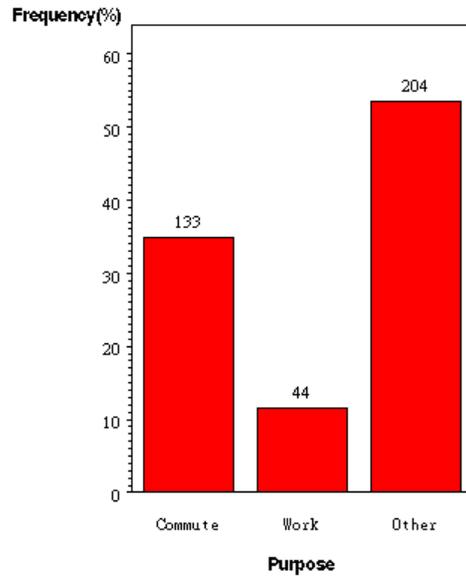


FREQUENCY of Q2

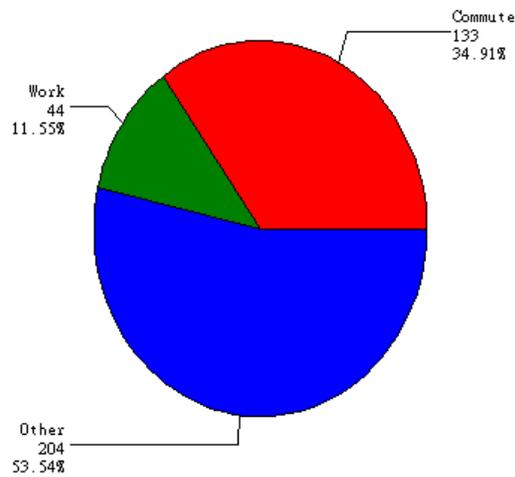


If answer of Q2 is 1 continue, else terminate

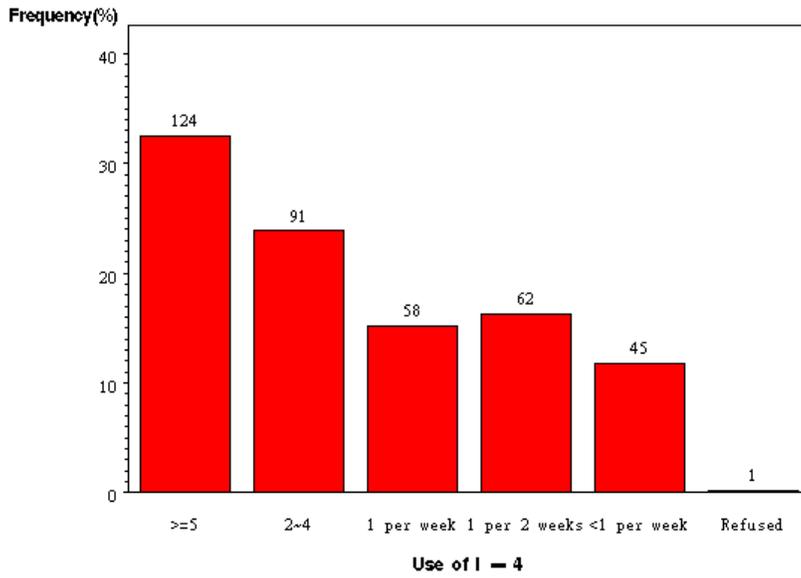
3. What is usually the purpose of using I-4?
(1) commute to/from work (2) work related/commercial (3) other (specify)



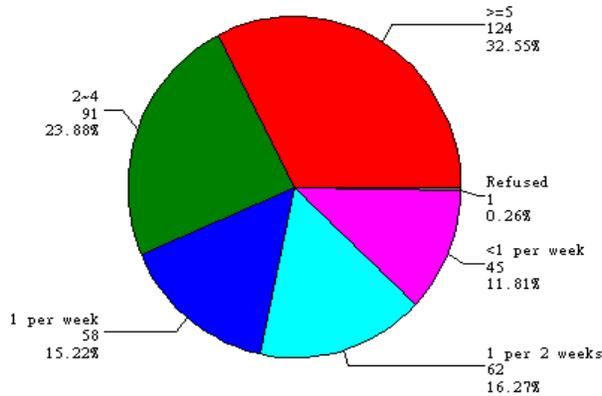
FREQUENCY of Q3



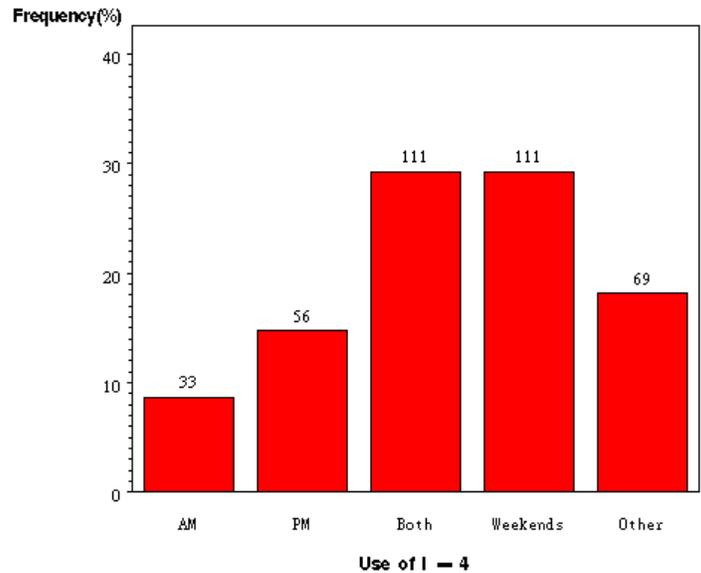
4. How frequently do you use I-4?
- (1) 5 or more times per week
 - (2) 2-4 times per week
 - (3) once per week
 - (4) once every two weeks
 - (6) less than once in two weeks
 - (7) Don't Know/Refused



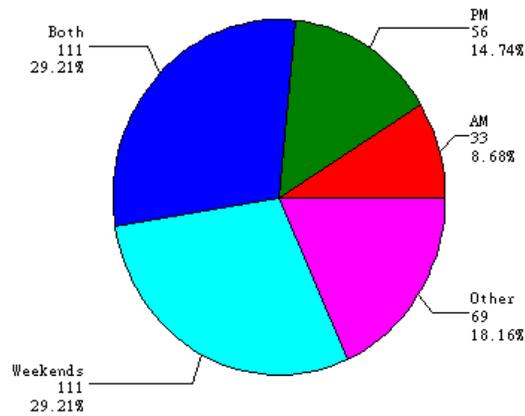
FREQUENCY of Q4



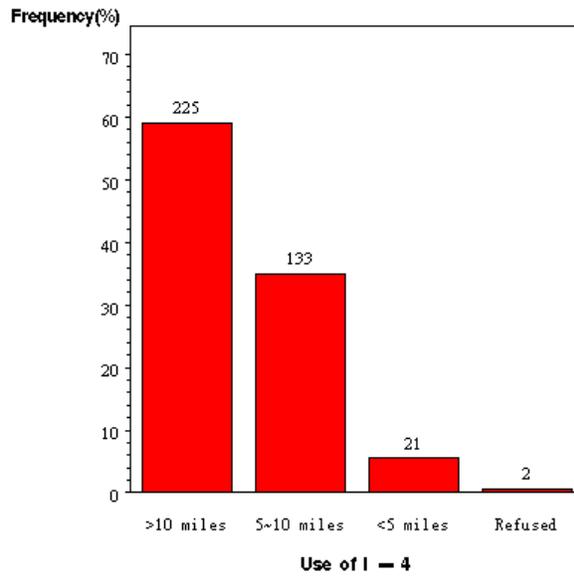
5. When do you most usually use I-4?
 - (1) Weekdays morning peak – 6-10 AM
 - (2) Weekdays evening peak – 3-7 PM
 - (3) both Weekdays morning and evening peaks
 - (4) Weekends
 - (5) Other (specify)



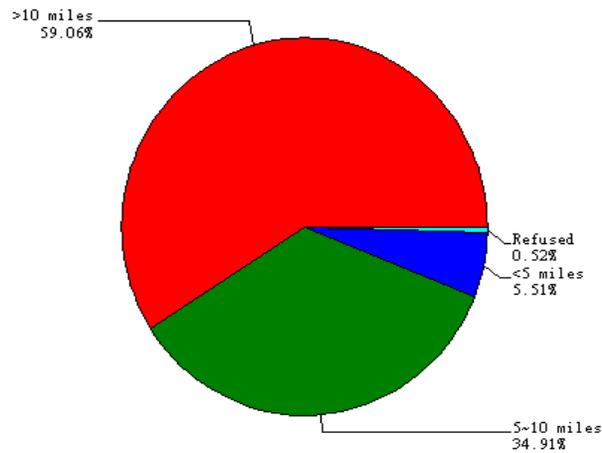
FREQUENCY of Q5



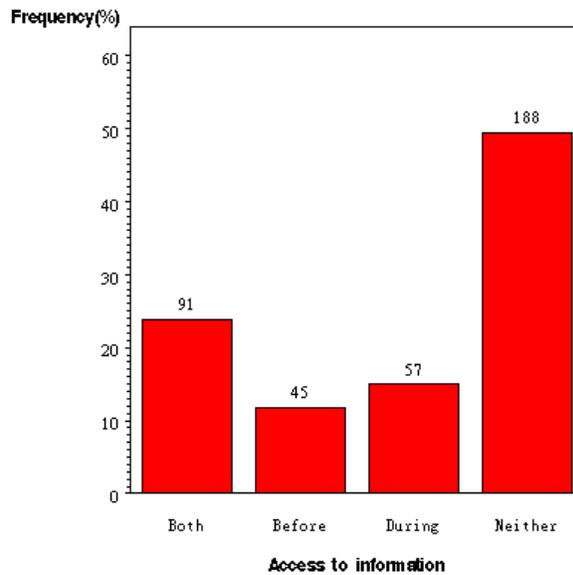
6. On average how long is your trip on I-4?
 (1) more than 10 miles
 (2) 5-10 miles
 (3) less than 5 miles
 (4) Don't know/refused—DO NOT READ



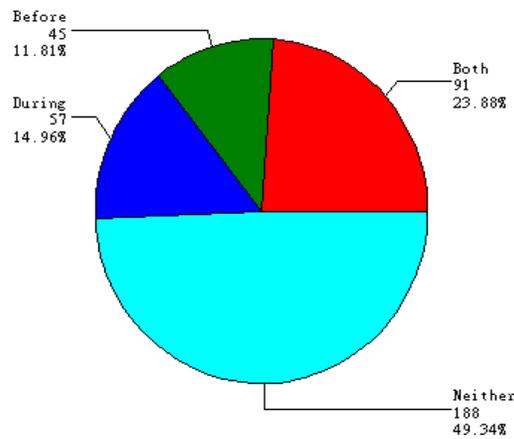
FREQUENCY of Q6



7. Do you usually obtain traffic information before or during your trip on I-4?
(1) before and during
(2) before only
(3) during only
(4) neither

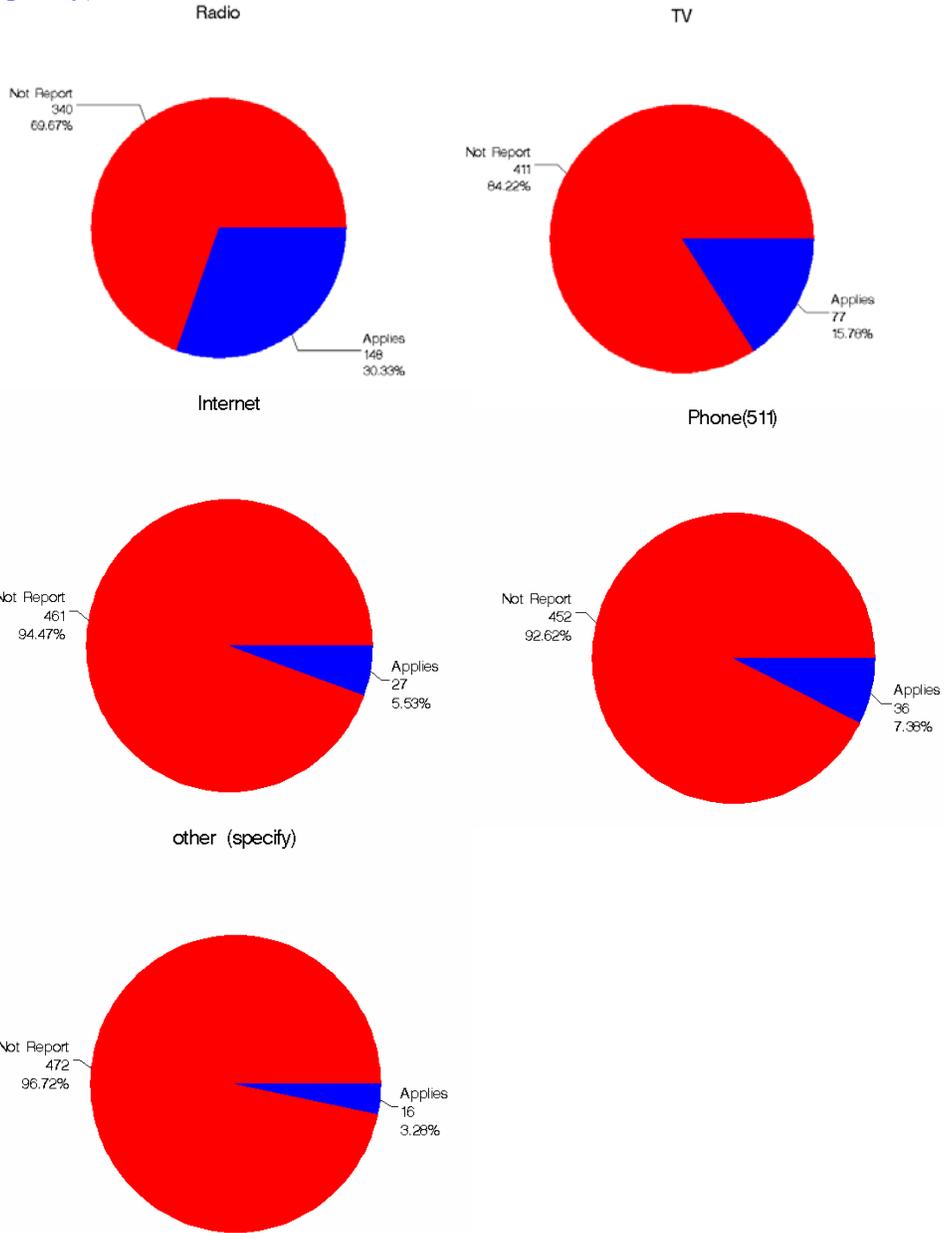


FREQUENCY of Q7



If answer of Q7 is 1, 2 or 3 goto Q8, else goto Q10

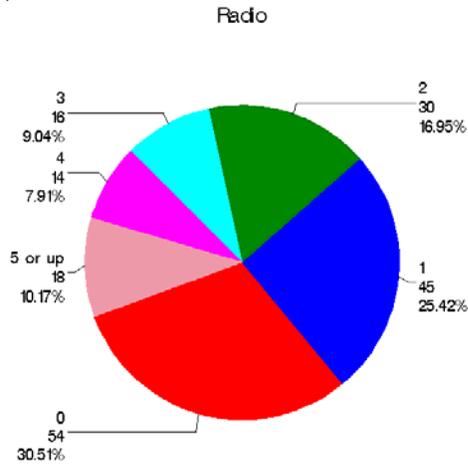
8. How do you usually receive traffic information? (mark all that applies)
 (1) Radio (2) TV (3) Internet (4) Phone (511) (5) other
 (specify)



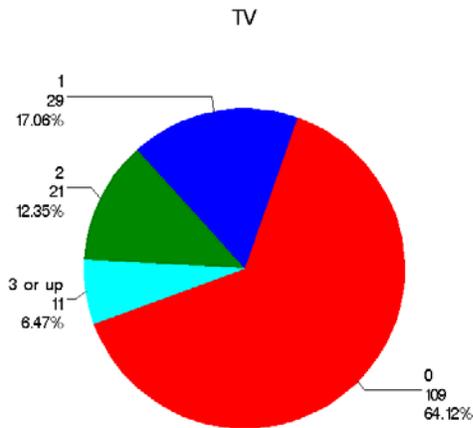
If answer to Q8 is 1, 2 or 5 goto 9 then 10
 If answer to Q8 is 4 goto 9 then 10
 If answer to Q8 is 3 goto 10, then 11

9. How many times per week do you usually receive/listen to traffic information from each of the following sources: (Allow 1-50, Refused = 99)

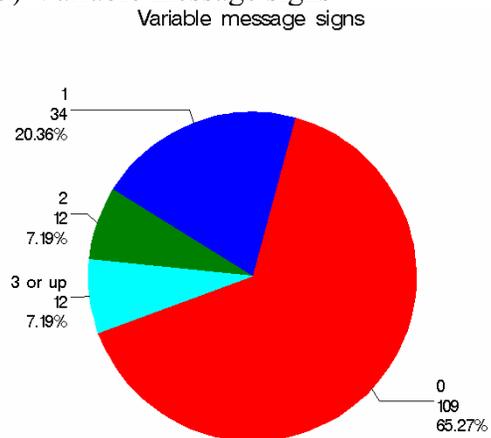
(1) Radio



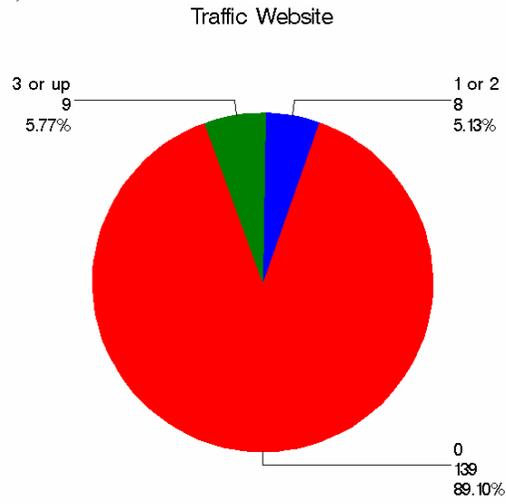
(2) TV



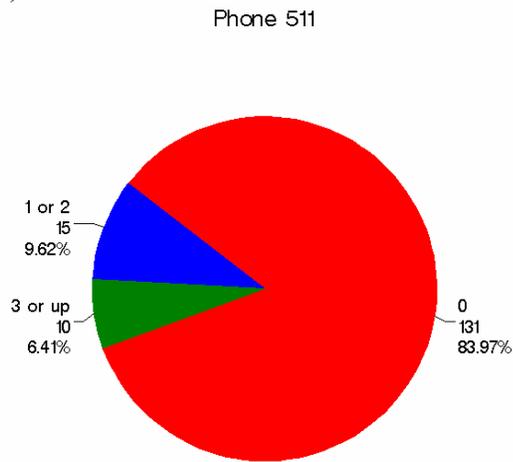
(3) Variable message signs



(4) Traffic Website



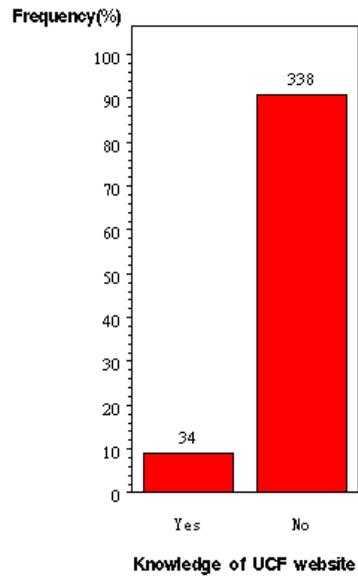
(5) Phone 511



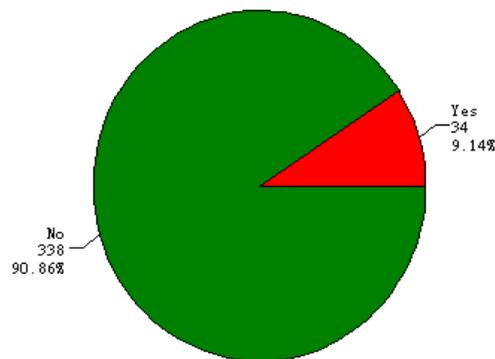
10. Do you know that there is a UCF web site that provides information about the traffic conditions on I-4 at www.catss.ucf.edu?

(1) yes

(2) no



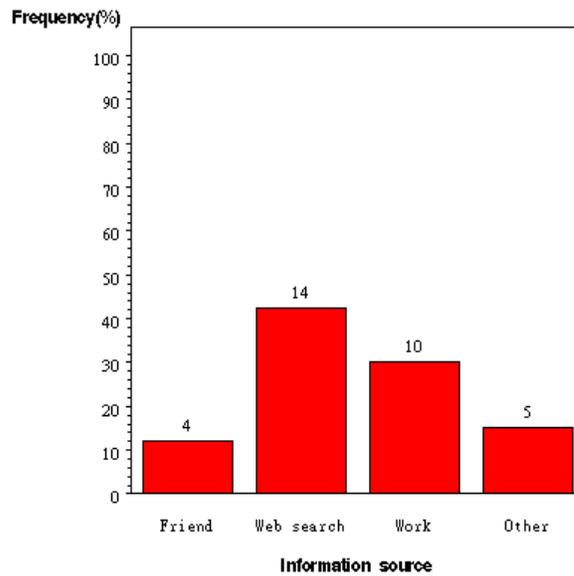
FREQUENCY of Q10



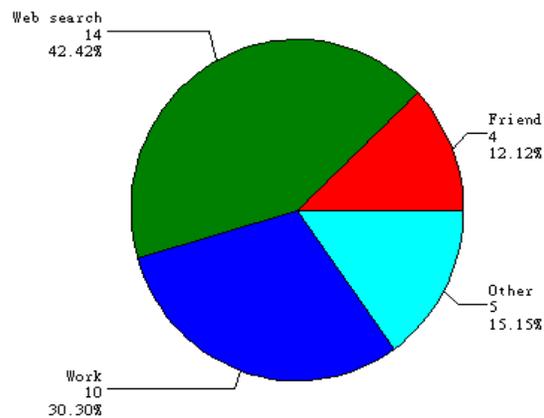
If answer to Q 10 is 1 goto 11, else goto 20

11. How did you hear about this web site?

- (1) friend
- (2) web search
- (3) work
- (4) other (specify)
- (5) don't know/refused



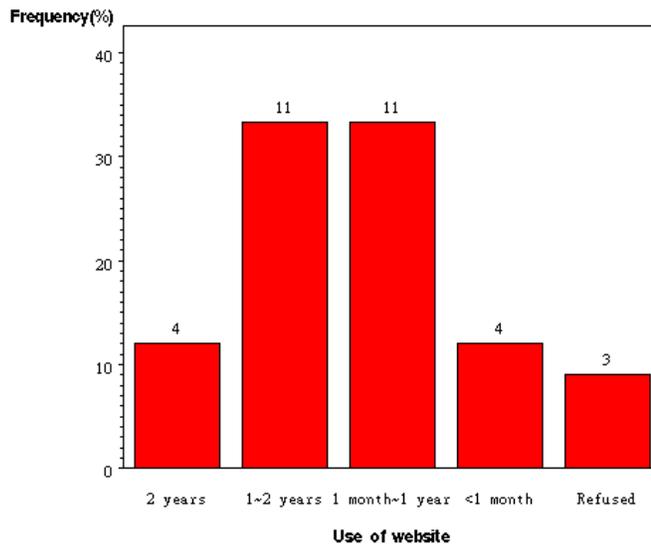
FREQUENCY of Q11



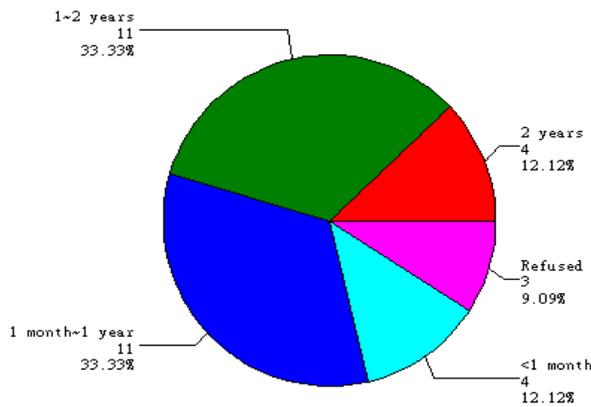
12. From which zipcode do you most frequently access this site?

13. How long have you been accessing this web site to get traffic information?

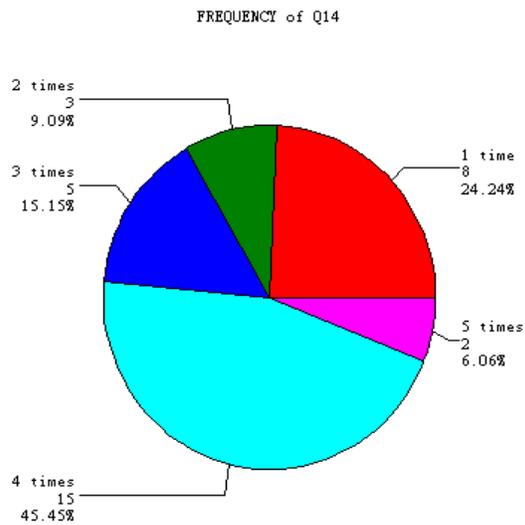
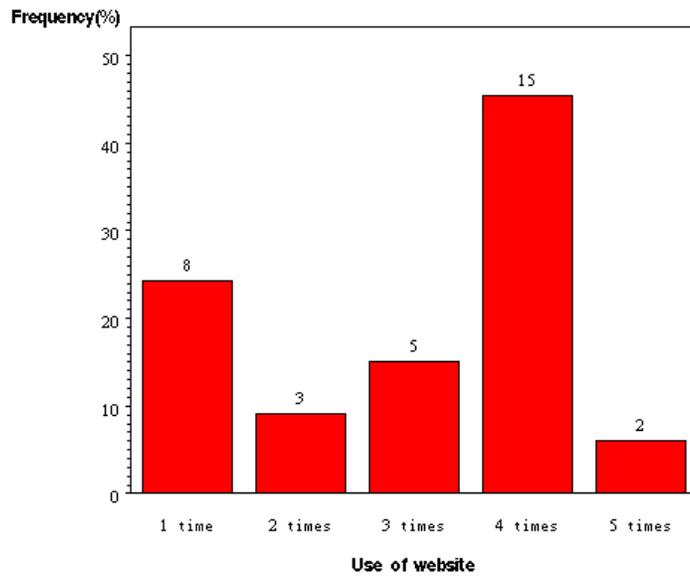
- (1) 2 years
- (2) Less than two years but greater than one year
- (3) Less than one year but greater than one month
- (4) Less than a month
- (5) Don't Know/Refused



FREQUENCY of Q13

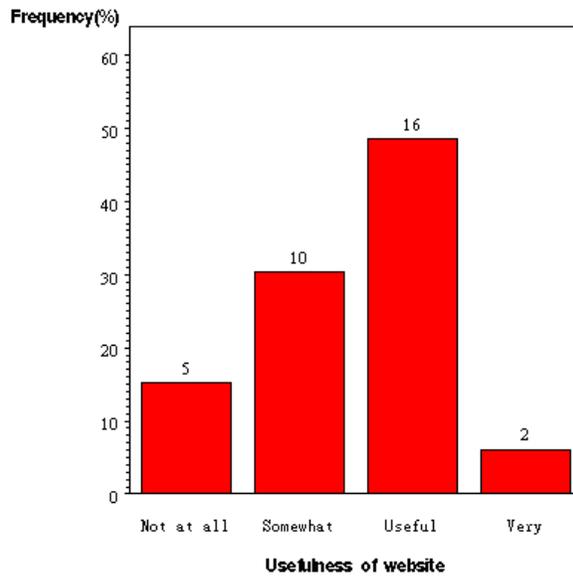


14. How many times during the last week did you access this web site? (Allow 1-50)

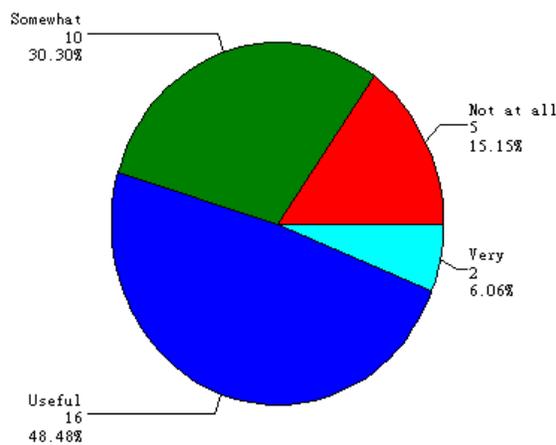


15. On a scale of 1 to 5 with 1 being not at all useful, and 5 very useful, please rate the usefulness of the web site?

- (1) not at all useful
- (2) not useful
- (3) somewhat useful
- (4) useful
- (5) very useful
- (6) Don't Know/Refused

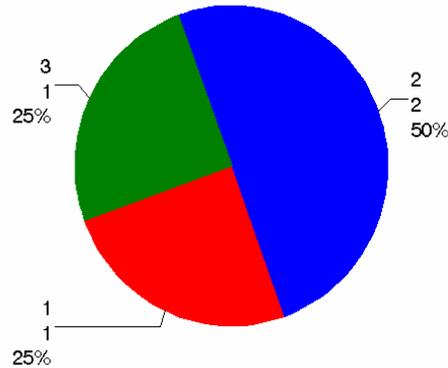


FREQUENCY of Q15

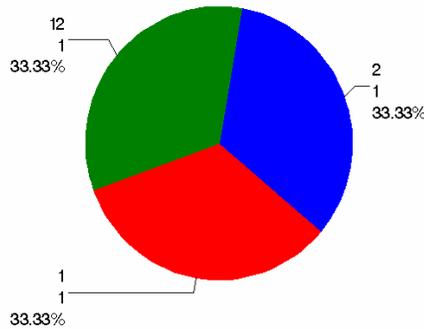


16. Did you change your travel decisions based on information you received from the web site last month? (multiple answers permitted)

- (1) Changed departure time, *if yes*, how many times last month
- (2) Changed route, *if yes*, how many times
Changed route, how many times(*if yes*)



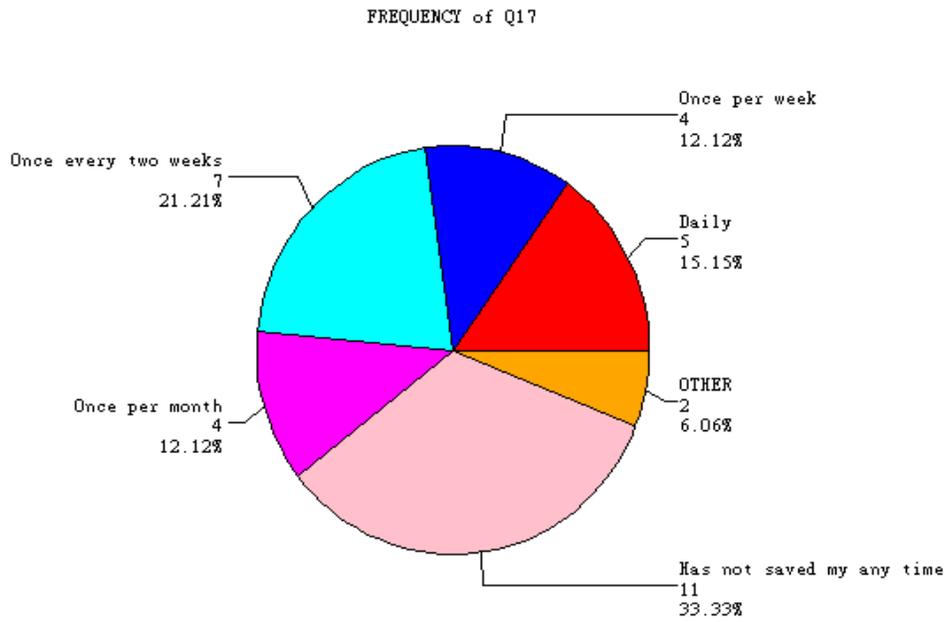
- (3) Changed both *departure time and route*, *if yes*, how many times
Changed both departure time and route, how many times(*if yes*)



- (4) Changed destination, *if yes*, how many times
- (5) Changed mode, *if yes*, how many times

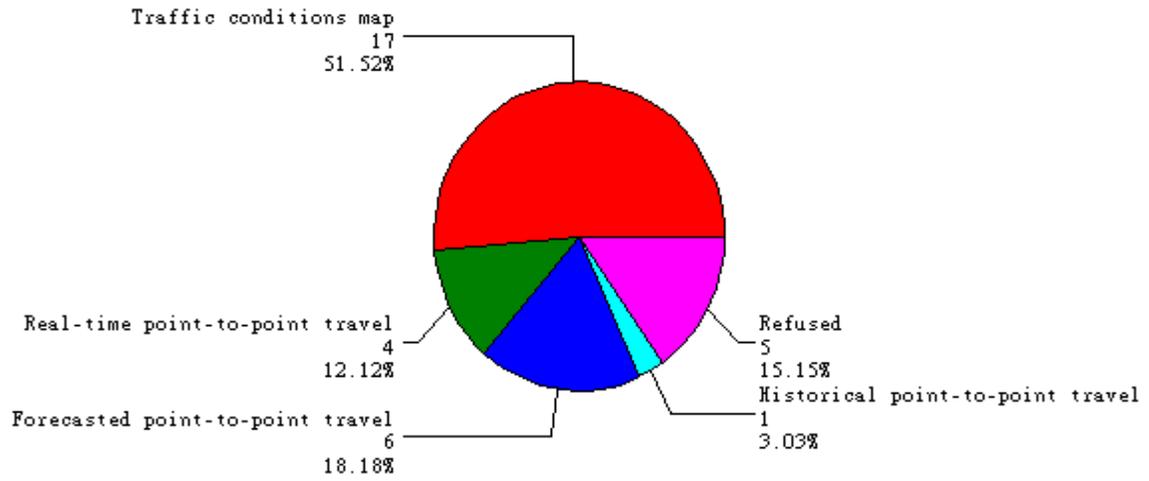
17. How often, if at all, was the information from the web site beneficial to you by providing advanced warning of traffic congestion?

- (1) Daily
- (2) Several times per week
- (3) Once per week
- (4) Once every two weeks
- (5) Once per month
- (6) Less than once per month
- (7) Has not saved me any time



18. What section of the web site do you view the most?
- (1) Traffic conditions map
 - (2) Real-time point-to-point travel time
 - (3) Forecasted point-to-point travel times
 - (4) Historical point-to-point travel times
 - (5) Other
 - (6) Don't Know

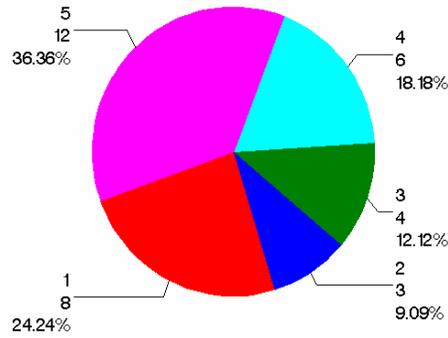
FREQUENCY of Q18



19. On a scale of 1 to 5, with 1 being not at all important and 5 being very important, please rate the importance of some of the features that you might like to see on the web site? (Don't Know/Refused =9)

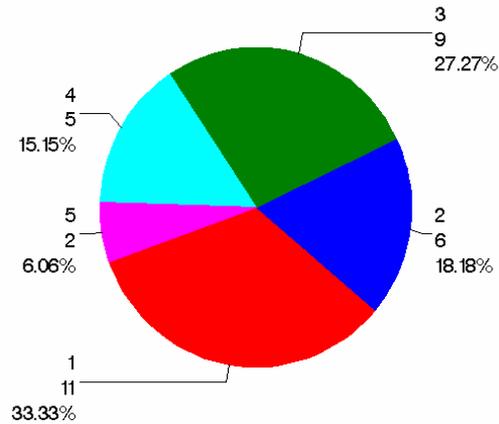
(1) Map work zones and Incident locations/status

Map work zones and Incident locations/status

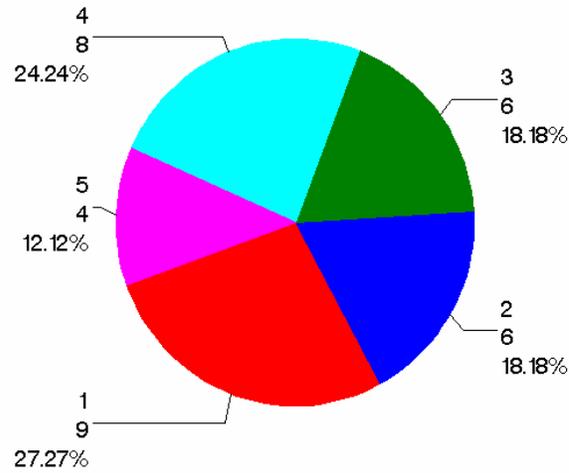


(2) Text work zones and Incident locations/status

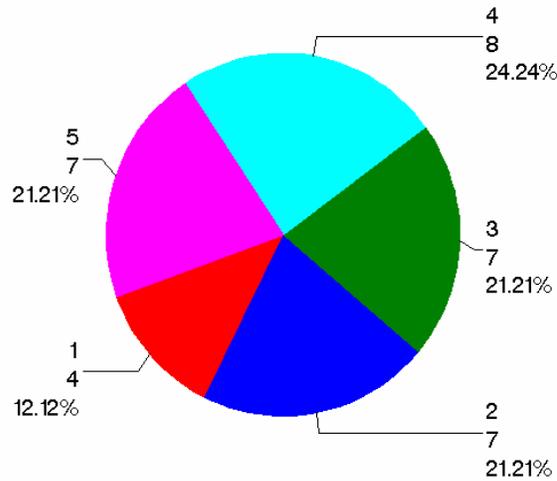
Text work zones and Incident locations/status



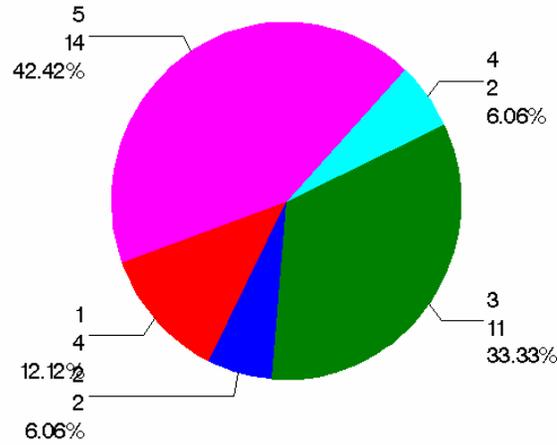
(3) Text messages from variable message signs
Text messages from variable message signs



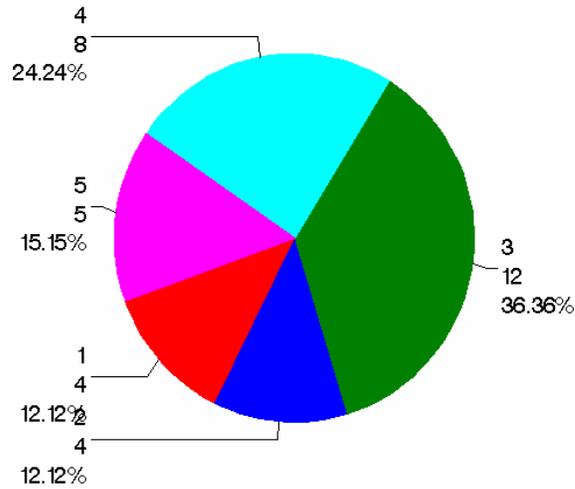
(4) Traffic video showing current situation on I-4
Traffic video showing current situation on I-4



(5) Traffic conditions on toll roads
Traffic conditions on toll roads

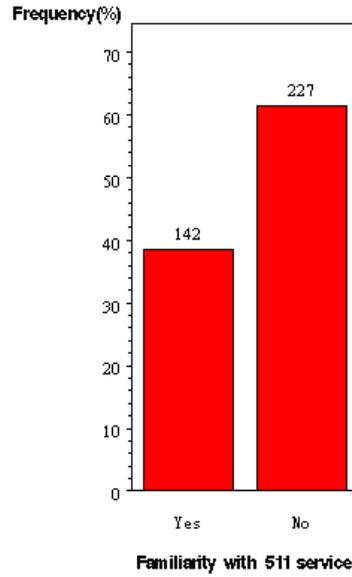


(6) Traffic conditions on other streets
Traffic conditions on other streets

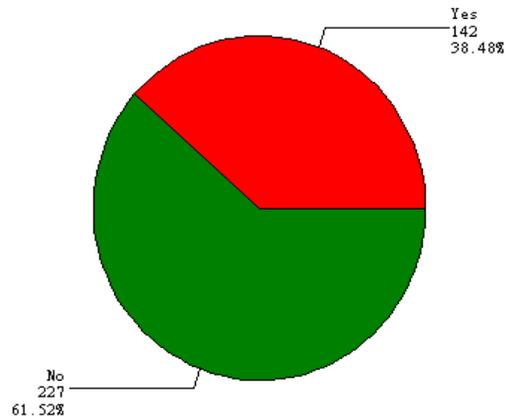


(7) Inclement weather/flooding conditions on streets

20. Are you familiar with the 511 Phone traveler information service?
(1) yes (2) no



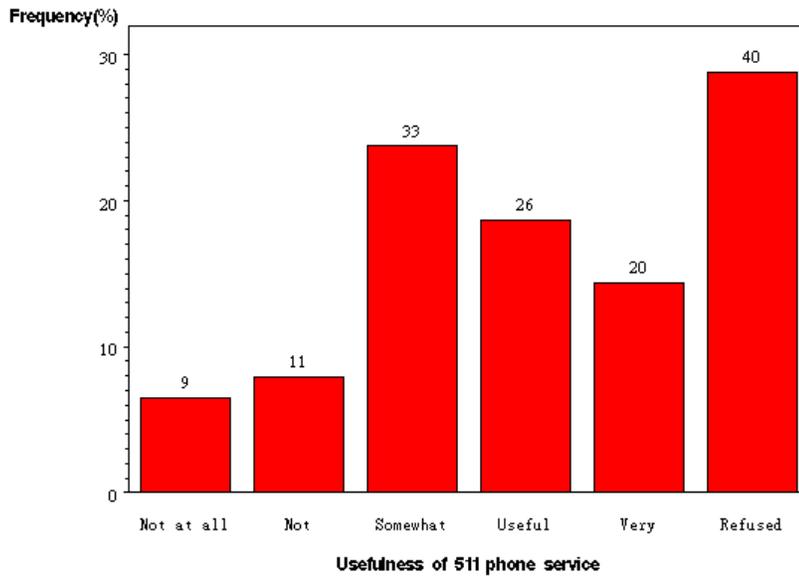
FREQUENCY of Q20



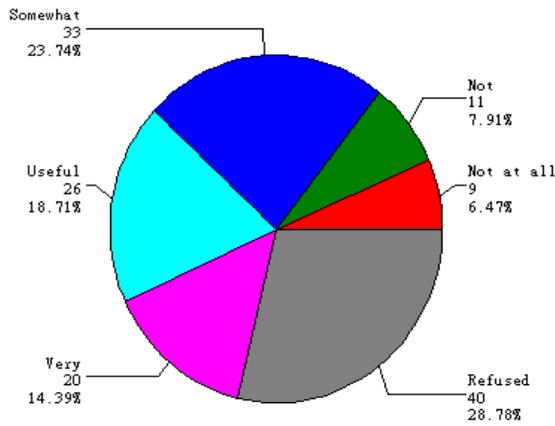
If answer to Q20 is 1 continue, else goto Q24

21. On a scale of 1 to 5 with 1 being not at all useful, and 5 very useful, please rate the usefulness of the 511 service?

- (1) not at all useful
- (2) not useful
- (3) somewhat useful
- (4) useful
- (5) very useful
- (6) don't know/refused

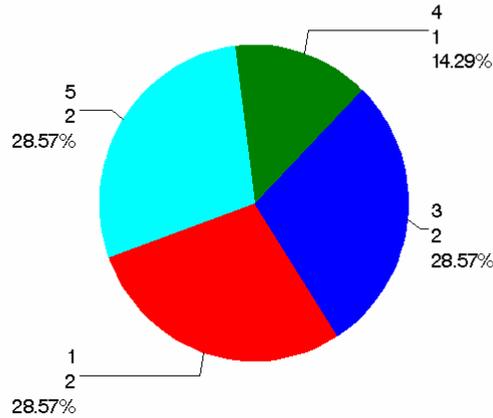


FREQUENCY of Q21

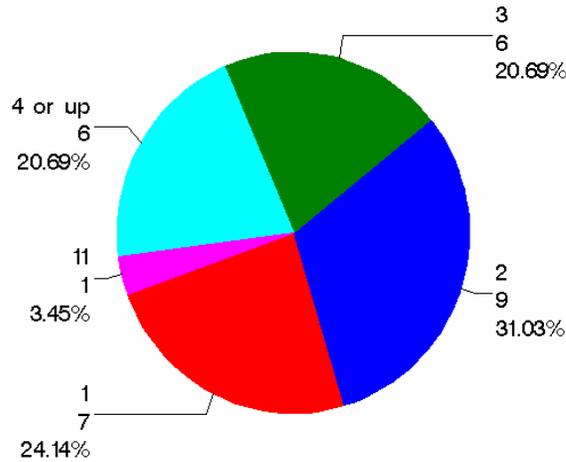


22. Did you change your travel decisions based on information you received from 511 last month? (multiple answers permitted)

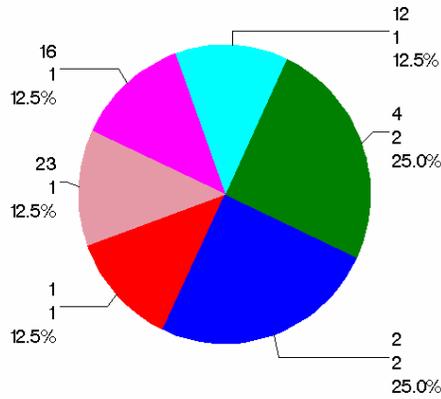
(1) Changed departure time, if yes, how many times last month
Changed departure time, how many times last month(if yes)



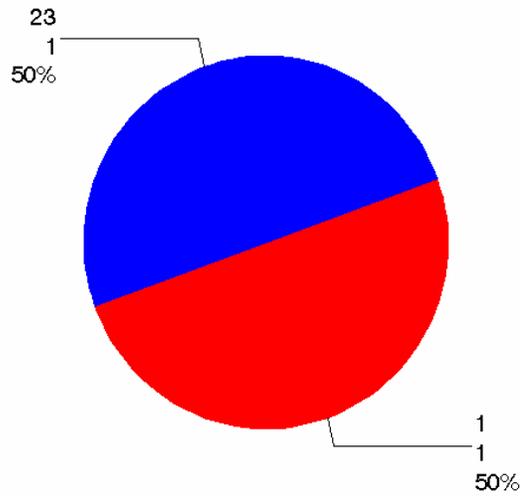
(2) Changed route, if yes, how many times last month
Changed route, how many times last month(if yes)



(3) Changed both departure time and route, **if yes**, how many times
 Changed both departure time and route,how many times(if yes)

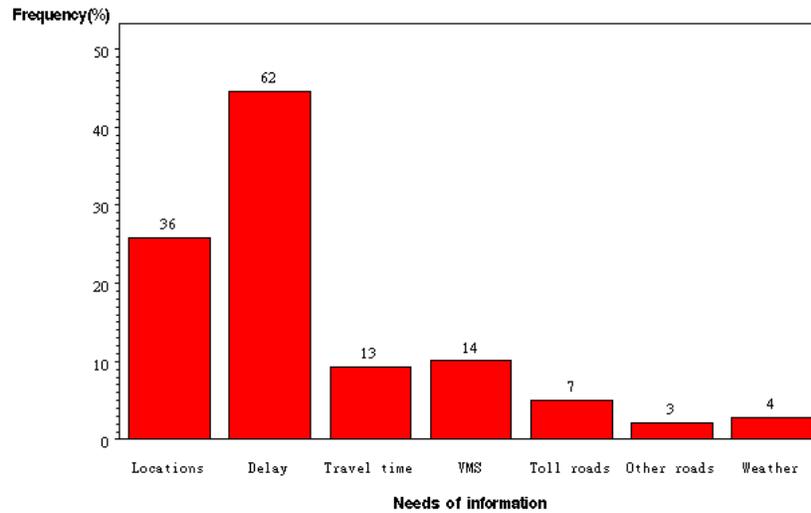


(4) Changed destination, **if yes**, how many times
 Changed destination, how many times(if yes)

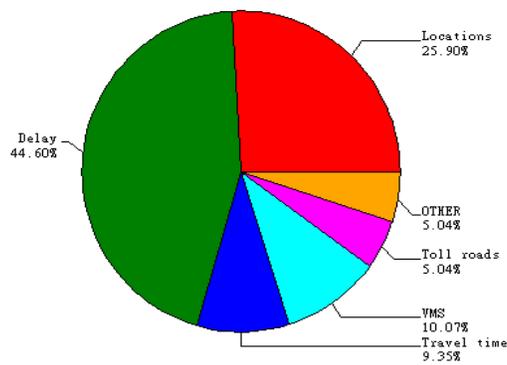


(5) Changed mode, **if yes**, how many times

23. What kind of information do you need the most?
- (1) Locations of work zones and incidents
 - (2) Expected delay
 - (3) Expected travel time
 - (4) Text messages from variable message signs
 - (5) Traffic conditions on toll roads
 - (6) Traffic conditions on other streets
 - (7) Inclement weather/flooding conditions on streets

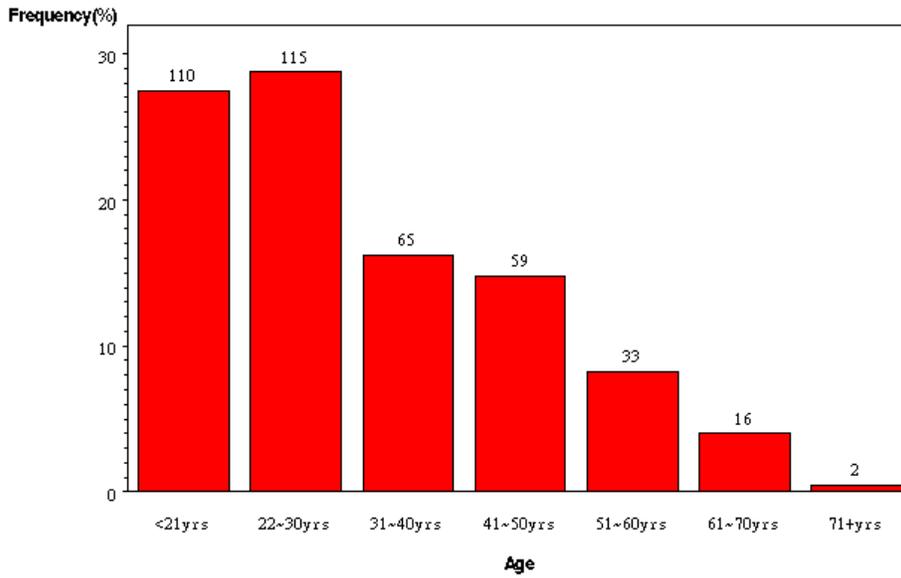


FREQUENCY of Q23

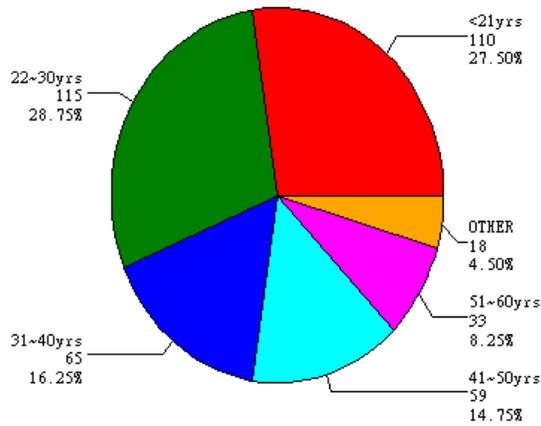


24. Which of the following groups includes your age?

- (1) 21 or Younger
- (2) 22-30
- (3) 31-40
- (4) 41-50
- (5) 51-60
- (6) 61-70
- (7) 71+

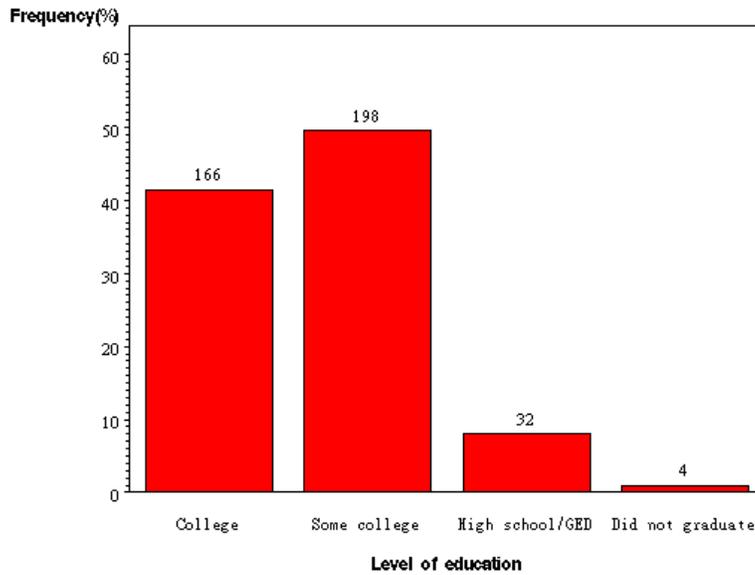


FREQUENCY of Q24

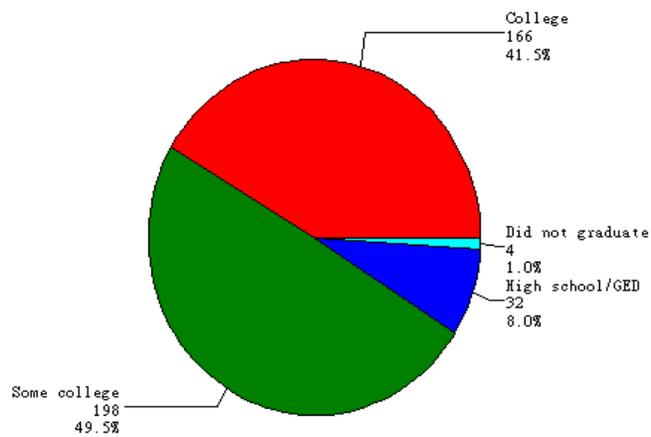


25. What level of education have you completed?

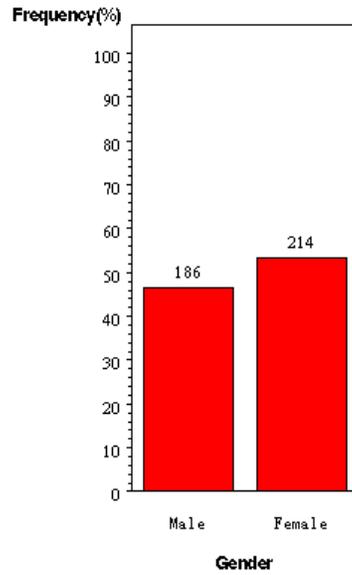
- (1) College
- (2) Some college
- (3) High School/GED
- (4) Did not graduate from high school



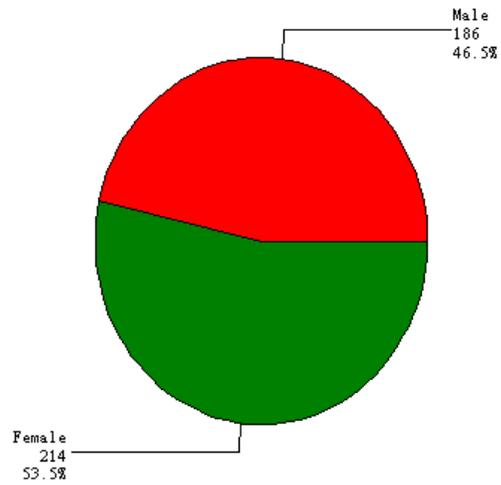
FREQUENCY of Q25



26. Are you
(1) Male
(2) Female

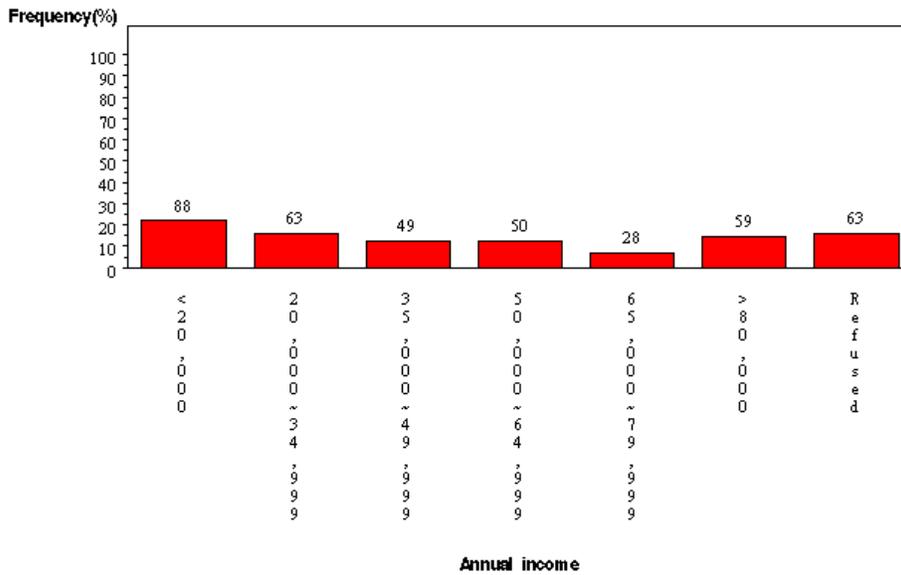


FREQUENCY of Q26

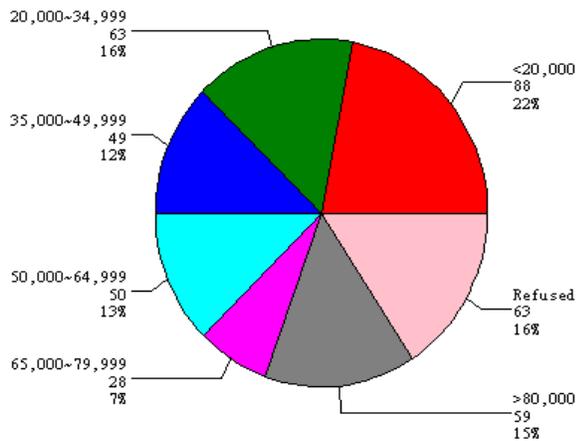


27. What is your total annual household income?

- (1) less than \$20,000
- (2) \$20,000 - 34,999
- (3) 35,000 – 49,999
- (4) 50,000 – 64,999
- (5) 65,000 – 79,999
- (6) 80,000 or more
- (7) don't know/refused

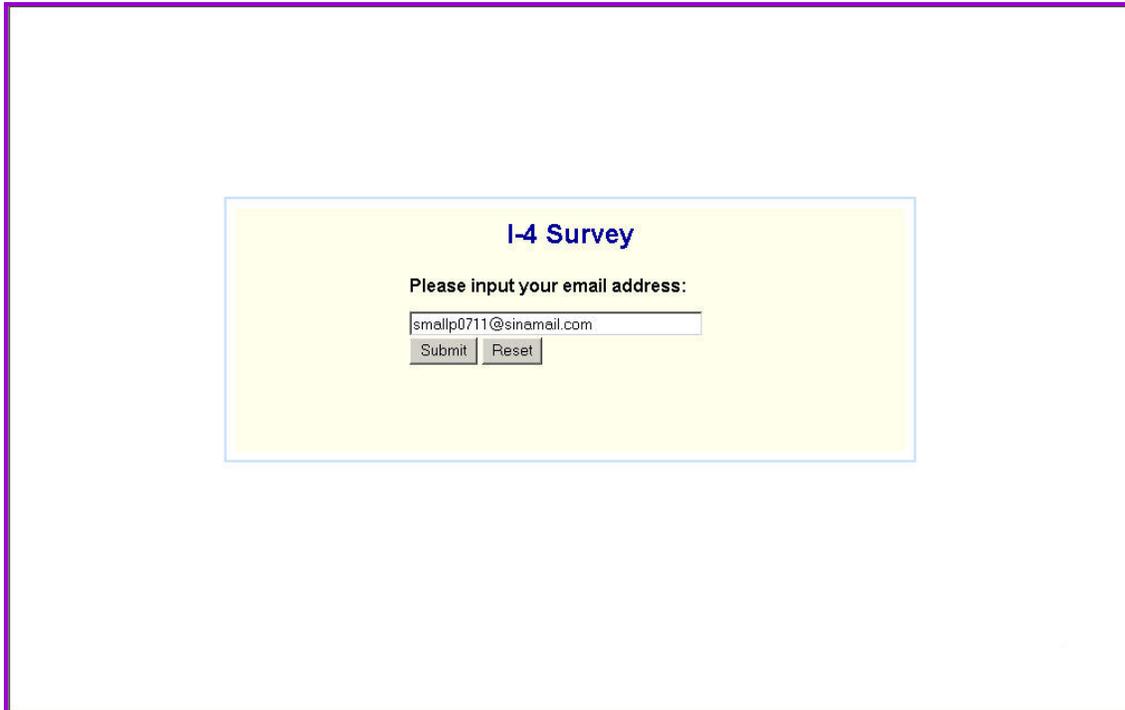


FREQUENCY of Q27



APPENDIX –C-
Design of the web-base survey

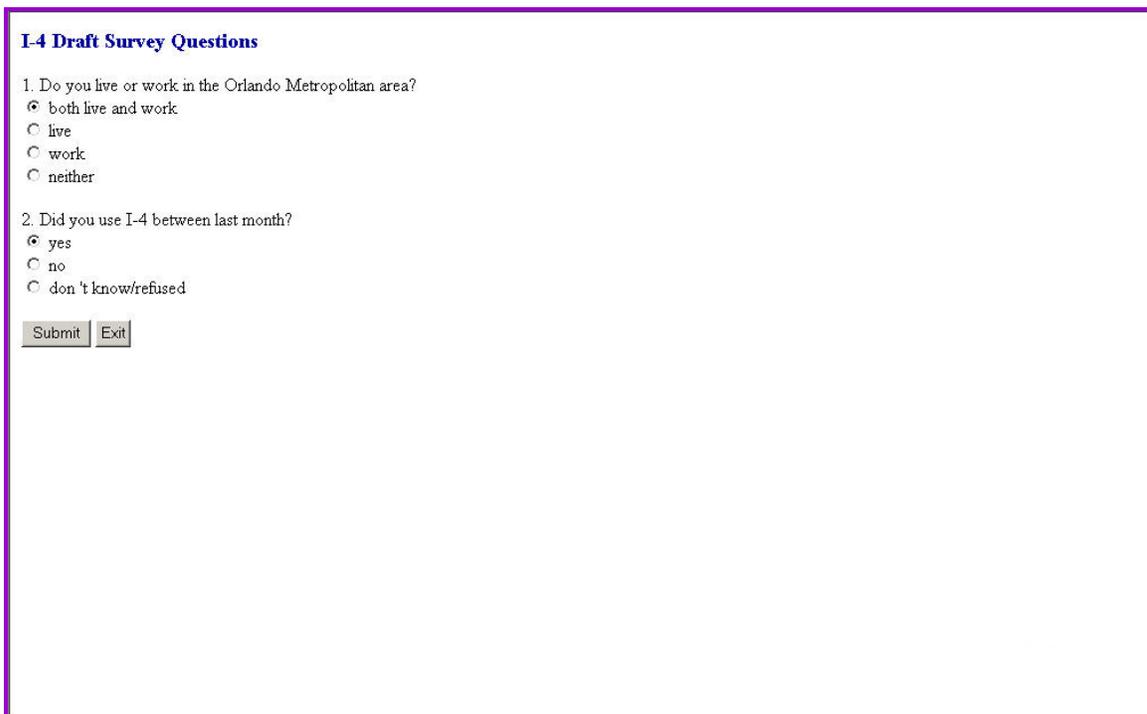
This I4 survey contains 27 questions. You may need to answer some or all of them depend on your answer. The following picture is the login page.



I-4 Survey

Please input your email address:

After you type your email and type the button of submit, you will enter to the 1st page of survey like the following picture. It contains questions 1-2.



I-4 Draft Survey Questions

1. Do you live or work in the Orlando Metropolitan area?

both live and work

live

work

neither

2. Did you use I-4 between last month?

yes

no

don't know/refused

The following picture is the 2nd page of the survey. It contains question 3-7.

3. What is usually the purpose of using I-4?

- commute to/from work
- work related/commercial
- other(Please specify):

4. How frequently do you use I-4?

- 5 or more times per week
- 2-4 times per week
- once per week
- once every two weeks
- less than once in two weeks
- Don't Know/Refused

5. When do you most usually use I-4?

- Weekdays morning peak (6-10 AM)
- Weekdays evening peak (3-7 PM)
- both Weekdays morning and evening peaks
- Weekend (3-7 PM)
- Other(Please specify):

6. On average how long is your trip on I-4?

- more than 10 miles
- 5-10 miles
- less than 5 miles
- Don't know/refused

7. Do you usually obtain traffic information before or during your trip on I-4?

- before and during
- before only
- during only
- neither

The following picture is the 3rd page of the survey. It contains question 8.

8. How do you usually receive traffic information? (mark all that applies)

Radio
 TV
 Internet
 Phone (511)
 other(Please specify):

The following picture is the 4th page of the survey. It contains question 9.

9. How many times per week do you usually receive/listen to traffic information from each of the following sources:

| | 1-5 | 6-10 | 11-15 | 16-20 | 21-25 | 26-30 | 31-35 | 36-40 | 41-45 | 46-50 |
|----------------------------|----------------------------------|----------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| (a) Radio | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| (b) TV | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| (c) Variable message signs | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| (d) Traffic Website | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> |
| (e) Phone 511 | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> |
| (f) other | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

The following picture is the 5th page of the survey. It contains question 10.

10. Do you know that there is a UCF website that provides information about the traffic conditions on I-4 at www.catss.ucf.edu??

yes
 no

The following picture is the 6th page of the survey. It contains question 11-19.

11. How did you hear about this web site?
 friend
 web search
 work
 Other (Please specify):
 don't know/refused

12. From which zipcode do you most frequently access this site?

13. How long have you been accessing this website to post traffic information?
 Greater than 2 years
 Less than two years but greater than one year
 Less than a year but greater than one month
 Less than a month
 Don't Know/Refused

14. How many times during the last week did you access this website?
 Daily
 3-5 times a week
 1-2 times a week
 none
 Don't Know/Refused

15. On a scale of 1 to 5 with 1 being not at all useful, and 5 very useful, please rate the usefulness of the website??
 Not at all useful
 Not useful
 somewhat useful
 Useful
 Very useful
 Don't Know/Refused

16. Did you change your travel decisions based on information you received from the website last month?(multiple answers permitted)
 Changed departure time, how many times last month
 Changed route, how many times
 Changed both, how many times
 Changed destination, how many times
 Changed mode, how many times
 Did not change

17. How often, if at all, was the information from the website was beneficial to you by providing advanced warning of traffic congestion?
 Daily
 Several times per week
 Once per week
 Once every two weeks
 Once per month
 Less than once per month
 Has not saved me any time

18. What section of the website do you view the most?
 Traffic conditions map
 Real-time point-to-point travel time
 Forecasted point-to-point travel times
 Historical point-to-point travel times
 Other
 Don't Know/refused

19. On a scale of 1 to 5, with 1 being not at all important and 5 being very important, please rate the importance of some of the features that you might like to see on the website?

| | 1 | 2 | 3 | 4 | 5 |
|------------------------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------------------------|
| (a) Map work zones and Incident locations/status | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
| (b) Text work zones and Incident locations/status | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
| (c) Text messages from variable message signs | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
| (d) Traffic video showing current situation on I-4 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
| (e) Traffic conditions on toll roads | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
| (f) Traffic conditions on other streets | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
| (g) Inclement weather/flooding conditions on streets | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |

The following picture is the 7th page of the survey. It contains question 20.

20. Are you familiar with the 511 Phone traveler information service?

yes
 no

Submit Exit

The following picture is the 8th page of the survey. It contains question 21-23.

21. On a scale of 1 to 5 with 1 being not at all useful, and 5 very useful, please rate the usefulness of the 511 service?

Not at all useful
 Not useful
 Somewhat useful
 Useful
 Very useful
 don't know/refused

22. Did you change your travel decisions based on information you received from 511 last month? (multiple answers permitted)

Changed departure time, how many times last month

Changed route, how many times

Changed both, how many times

Changed destination, how many times

Changed mode, how many times

Did not change

23. What kind of information do you need the most?

Locations of work zones and incidents
 Expected delay
 Expected travel time
 Text messages from variable message signs
 Traffic conditions on toll roads
 Traffic conditions on other streets
 Inclement weather/flooding conditions on streets

Submit Exit

The following picture is the 9th page of the survey. It contains question 24-27.

24. Which of the following groups includes your age?

- 21 or Younger
- 22-30
- 31-40
- 41-50
- 51-60
- 61-70
- 71+

25. What level of education have you completed?

- College
- Some college
- High School/GED
- Did not graduate from high school

26. Are you

- male
- Female

27. What is your total annual household income?

- less than \$20,000
- \$20,000 - 34,999
- 35,000 - 49,999
- 50,000 - 64,999
- 65,000 - 79,999
- more than or equal 80,000
- don't know/refused

After you finish this survey, you will see the following page.

