National Evaluation of the SafeTrip-21 Initiative: California Connected Traveler Test Bed Final Evaluation Report: Networked Traveler – Transit / Smart Parking

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16. Abstract Through the U.S. Department of Transportation's (USDOT) SafeTrip-21 initiative, the USDOT is testing a variety of technologies in a number of locations in California as well as along the I-95 corridor on the east coast. This document presents the evaluation findings, resulting primarily from in-person interviews the Evaluation Team conducted with institutional partners.		
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ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
AVL	Automatic Vehicle Locator
CACT	California Connected Traveler
Caltrans	California Department of Transportation
DOT	Department of Transportation
DRI	Caltrans Division of Research and Innovation
GPS	Global Positioning System
HOV	High Occupancy Vehicle
I-95	Interstate 95
ITS	Intelligent Transportation Systems
MOEs	Measures of Effectiveness
MTC	Metropolitan Transportation Commission
NAHSC	National Automated Highway System Consortium
NT-T/SP	Networked Traveler-Transit/Smart Parking
PATH	Partners for Advanced Transit and Highways
SAFETRIP-21	Safe and Efficient Travel through Innovation and Partnerships in the 21^{st} century
SAIC	Science Applications International Corporation
UC	University of California
USDOT	U.S. Department of Transportation

EXECUTIVE SUMMARY

Under the guidance of the Volpe Center, the California Department of Transportation (Caltrans) was one of two organizations selected to conduct a test bed in support of the United States Department of Transportation's (USDOT) SafeTrip-21 Initiative. The Caltrans' test bed is located in the San Francisco Bay Area and is referred to as the California Connected Traveler (CACT) Test Bed. The second test bed is along the I-95 Corridor. Under the direction and funding of the RITA ITS Joint Program Office, SAIC was selected to conduct an independent national evaluation of the technologies being deployed as part of the two test beds. This document presents the findings of the national evaluation of one of the three applications that comprise CACT Test Bed, the Networked Traveler-Transit/Smart Parking (NT-T/SP) application.

PROJECT BACKGROUND

The NT-T/SP test was developed by the California Partners for Advanced Transit and Highways (PATH) and the University of California (UC) at Berkeley. PATH is administered by the UC Berkeley Institute of Transportation Studies, with a mission to develop solutions to the problems of California's surface transportation systems through cutting edge research.

EVALUATION APPROACH

The evaluation approach was driven by a series of objectives that align with the USDOT's goals for the SafeTrip-21 initiative. Each objective was supported by corresponding hypotheses and measures of effectiveness, which in turn were used to identify specific data sources for the key activities for the evaluation. These data sources provide a detailed bank of knowledge relevant to the application, and a comprehensive look at lessons learned and the success of the NT-T/SP test. To achieve the evaluation objectives, the evaluation team implemented the following key activities:

- Documented performance of the geo-fencing system by direct field observations – discussed in **Part II, Section 2**;
- Analyzed usage statistics using information provided by PATH – discussed in **Part II, Section 3**;
- Analyzed ratings of the attributes (timeliness, accuracy, usefulness, acceptance, etc.) using information provided by registered users – discussed in **Part II, Section 4**; and
- Conducted interviews with deployment and operational partners – discussed in **Part II, Section 5**.

SUMMARY OF FINDINGS

The NT-T/SP test involved the deployment of real-time transit information and trip planner applications that serve travelers along the US-101 corridor in San Francisco, California. With the support of several regional partners, PATH developed a set of web-based and smart phone-based applications branded as "PATH2Go" including the PATH2Go Trip Planner website, the PATH2Go Web Based Traveler Information website, and the PATH2Go Smart Phone Application. While the original scope of the test was to only provide parking and transit information for trips on the US-101 corridor, it was later expanded to provide real-time information to travelers across most transit agencies throughout the San Francisco Bay Area . This "one-stop shop" for traveler information was designed to help travelers make better pre-trip planning decisions in terms of mode selection and to serve as a tool for planning transit trips from any origin to any destination considering all transit options available. The applications also supported one another by allowing users to send personalized trip information from one of the website applications to the smart phone application so users could take the information with them.

The NT-T/SP test is unique in several ways. First, the test integrated a broad range of real-time multi-modal transportation information, including transit and parking information. While this is not unusual for traffic information, or for transit information provided by individual transit agencies, the NT-T/SP test integrated real time traffic, transit, and parking information across multiple agencies. Second, the test incorporated a technique referred to as “geo-fencing” to prevent the use of the smart phone application while driving. PATH developed a geo-fencing technique which attempted to determine which mode the traveler was using, in order to allow transit users to continue to receive updates while on the move but prevent drivers from using the information while driving.

The NT-T/SP test successfully provided real time transit information to internet and smart phone users for the duration of the evaluation, with close to no service disruption.

For smart phone users, the geo-fencing technique developed by PATH appears to have been effective in preventing use of the application while driving. The 5 mph threshold set by the PATH project team appeared to block the application for all smart phones when the GPS signal was available. However, if a smart phone is unable to obtain a GPS signal for significant portions of time, the application may be open for use. Although this was primarily due to limitations in the smart phone capabilities, this situation as well as others where satellite connections are limited does identify a disadvantage to designing geo-fencing functionality that relies heavily on smart phone GPS data to prevent distracted driving. On arterials and local roads where speeds are more variable due to greater occurrences of red lights at intersections, congestion, or stop and go traffic; the smart phone application is constantly being blocked and unblocked as driving speeds fluctuate above and below 5 mph. The ability to access the information on the application at low speeds or while stopped does present the opportunity for distraction to drivers regardless of whether or not users recognize the 5 mph design threshold.

The geo-fencing design can distinguish between users driving along a transit route versus users taking transit. While occasionally a user may be able to access the smart phone application while driving along a transit route, the time and distance constraints as well as the route matching and trip history requirements implemented into the geo-fencing design were mostly successful at preventing drivers from mimicking transit trips to gain access to the applications. In practice, the likelihood of users going to these lengths to gain access to the smart phone application is probably low. It is highly unlikely that a normal user would a) know enough about the server logic to know geo-fencing exceptions, b) go to such lengths to access the application while driving, or c) stumble across this scenario during normal travel behavior.

The evaluation team did observe several instances where the smart phone application was blocked while truly riding transit. Although unrelated to distracted driving, implementing a geo-fencing design into the smart phone application that primarily provides transit information may detract from the user experience of actual transit riders.

The PATH2Go applications experienced steady growth in registered users throughout the evaluation period while daily use of the PATH2Go Smart Phone Application and the PATH2Go website applications fluctuated throughout the evaluation period. The initial targeted marketing efforts of advertising the applications on the MTC 511 website, distributing a press release, and handing out flyers at transit stops/stations were effective in attracting registered users and increasing awareness of the website applications. The most significant increase in usage of the website applications came as the result of a Twitter post on a popular account followed by transit riders that use Caltrain. The website traffic generated by the Twitter post increased the total number of absolute unique visitors by 104 percent and the total number of visits by 66 percent in the span of five days.

Over the course of the evaluation period, which began with the launch on July 29, 2010 and ended November 15, 2010, the PATH2Go applications attracted over 900 registered users, 67 percent of which downloaded and used the smart phone application at least once and may have also used the website applications. 34 percent of the smart phone application users downloaded the app and only opened it once without returning; leaving 66 percent that used it more than once. According to a study produced by an iPhone application analytics firm called Pinch Media, it is actually common for smart phone applications to be abandoned after one use[1]. 33 percent of users registered on the project website, but only used the website applications. By the end of the evaluation period, the PATH2Go website applications attracted a total of 916 absolute unique visitors that accounted for 1,664 total visits to the website, and an average of 1.82 visits per user.

Usage analysis for each of the PATH2Go applications provided insight into the success of efforts put forth to market the application as well as insight into typical user behavior while accessing the applications. The usage analysis suggests that newer, more progressive forms of marketing like using social media websites such as Twitter can be significantly more effective in increasing awareness of real-time traveler information like the PATH2Go applications. Although still effective, more traditional forms of marketing like preparing a press release do not seem to generate the same level of exposure as quickly as a targeted social media effort without being covered by a major media source. Although the fluctuating website usage was greatly increased using Twitter, the impact was short-lived as usage quickly returned to its rolling pattern of approximately five to thirty website visits per day only a few days after the Caltrain tweet. While social media may have a greater ability than traditional marketing to attract a large number of visitors to a website quickly, the usefulness of or need for the information available on a website is generally what drives return visits.

With over 55 percent of users having only visited the website one time, regular or return users of the website were not as common. User frequency can often be an indicator of user acceptance and need for a website, but a number of factors may explain why less than half of website users returned for another visit. Possible explanations for this trend include:

- Length of Evaluation Period.
- User Travel Frequency using Transit.
- Usefulness of Real-time Information.
- Perceived Value of Website.
- Website Functionality.

[1] Gonsalves, Antone. "Apple App Store Downloads Often Abandoned." InformationWeek. InformationWeek Business Technology Network. 20 Feb. 2009. Web. 6 Dec 2010.

Link to article:
http://www.informationweek.com/news/personal_tech/iphone/showArticle.jhtml?articleID=214502225

With the exception of possible insight from the user survey, there is no definitive way to determine which of these explanations is responsible for the greater number of one-time users versus return users. Regardless, a low visit frequency may indicate low user acceptance or usefulness. Alternatively, it may simply be an indicator of how visitors use the information on the website relevant to the various possibilities listed above.

A web-based user survey was distributed to all registered users of the PATH2Go applications resulting in 121 survey responses. Respondents provided valuable insight into user perceptions and perceived benefits of the information provided by the applications. Most had heard about them from a web-based source (e.g., a web search, the MTC website, a link from another transportation site, or from an electronic message). A high proportion reported they heard it from a friend or colleague, which further indicates the importance of informing the public with “word of mouth” methods, especially as it comes from trusted sources.

Usage of the tools showed relatively low usage patterns, especially for the web-based applications. At least one-half of respondents reported never having used the Trip Planner or Traveler Information site and approximately one-fourth had not used either site in the week before completing the survey. Use of the Smart Phone application was slightly higher with only approximately one-half of respondents reporting they had never used it or had not used it in the past week. One-half of the respondents reported they use the applications to plan their transit trips and these are for regular trips (e.g., commuting to work or school).

While-half of the users reported having received the “Warning: Application Disabled While Driving” message, two-thirds of those who got the warning reported that it occurred relatively infrequently – less than 25 percent of the time. However, when it was received it was reported as annoying by 70 percent of users. This observation was borne out by respondent comments that focused on trying to use the application while riding on transit vehicles or as passengers in automobiles and “being blocked.”

When considering the attributes and value of all three PATH2Go applications, users were generally pleased with them though there were areas where the applications could be improved such as retrieving the information. For instance, approximately one-third reported that it was difficult to find what they were looking for and that the information was not well presented on the applications. However, at least 50 percent of respondents reported the applications provided them with the information they were looking for and stated that the information on the applications is valuable. Almost 40 percent reported the information is well organized.

There was also strong agreement that the ability to access multiple transit services and having reliable arrival and departure information was important. Finally, most respondents reported that having the transit information available to them made them more confident about using transit, though not as many respondents went as far to say that the application led them to choosing an alternative mode to their usual transportation method.

The PATH2Go tools will remains operational through 2011, with new Caltrans funding.

CONCLUSIONS

Overall, the NT-T/SP test was a success, as witnessed by the large number of registered users and website visits, and by the extent to which registered users provided positive feedback (including infrequent users and those who wished to provide constructive suggestions on how to enhance the initial, beta, system.)

The NT-T/SP test resulted in significant insight into the understanding of distributing real time transit information. The test demonstrated the ability to integrate transit, traffic, and parking information across multiple agencies in real time. The test highlighted the potential for distributing personalized information via the internet and smart phones, and to do so without causing driver distraction.

There were many technical challenges associated with the test, one example being the geo-fencing technique. While geo-fencing has existing for some time, the requirements for this test were different in that it had to prevent use of the smart phone application in one mode (cars) while allowing it in others (train and bus.) This was achieved by PATH, although arguably to the detriment of the overall user experience, essentially because users found it to be annoying and, at times, inappropriate.

With few exceptions, the geo-fencing technique developed by PATH was effective at blocking the use of the smart phone application in cars, and by extension was therefore able to minimize distracted driving. However, the technique was not foolproof, in part because it depends upon smart phones being able to access a GPS signal. Without this signal, the geo-fencing technique will be unable to calculate whether the user is moving faster than the 5 mph threshold. Users with a detailed knowledge of the design of the geo-fencing technique may be able to mimic a transit vehicle while travelling in a car, although this is considered a remote possibility. What is more likely is for a user to be blocked from using the smart phone application while riding transit, as the user may not have planned a trip in accordance with the requirements of the geo-fencing design. Under these circumstances the application will assume any such riders are actually in a car, and consequently block access to the application.

The NT-T/SP test adopted a design that implemented the geo-fencing technique that used a server-based method, rather than using a client-based approach on the smart phone devices. With any application design for smart phones, developers can decide whether to host the code and source information for certain application functionality on the server-side of the application or the client-side of the application. In other words, the decision-making can either take place on servers hosted by the developers or on the smart phone itself. The geo-fencing design was integrated into the PATH2Go Smart Phone Application using server-side logic, which allowed for a thin client-side design. Implementing a server side geo-fencing design prevented the design team from having to address differences in the operating systems of Windows Mobile, iPhone, and Android smart phones that could have an effect on geo-fencing performance. Client-based functionality would have required wrapping up all of the code and sources into the application download, which would have been demanding on the smart phone in terms of application size, processor speed, and battery life depending on complexity.

Overall, the PATH2Go tools experienced steady growth in the number of registered users – a possible indication of user acceptance. However it was clear that multiple approaches are necessary to raise awareness of the tools, rather than relying on a single approach. Equally, it was clear that repeated measures are necessary to retain momentum in growth. It is likely that each marketing technique affects each user in a different way; therefore, many different efforts are usually required to reach out to a wide variety of users.

Well over half of respondents “strongly agreed” or “agreed” that the information was valuable and this is contrasted with only 14 percent who “strongly disagreed” or “disagreed.” In fact, when using the applications, respondents felt that having information for multiple transit services was very useful. Almost two-thirds “strongly agreed” or “agreed” that supplying information for multiple services (e.g., Caltrain, BART, SF Muni) was very helpful. This was especially true for those trips that were non-routine and may have involved multiple services or services they normally did not use.

Additionally, there was relatively strong agreement from respondents that the real-time departure and arrival information supplied on the application was valid. While one-fourth reported they did not have enough experience to rate this, 40 percent reported they “strongly agreed’ or “agreed” that the schedule information was reliable. Only 12 percent “strongly disagreed” or “disagreed” that the information was reliable.

PART I: INTRODUCTION

In February of 2008, the Volpe Center established two test bed locations across the country to conduct a variety of field tests in support of the United States Department of Transportation's (USDOT) SafeTrip-21 Initiative. The overall goals of the initiative are to:

- Expand and accelerate the U.S. DOT's research in vehicle connectivity with the wireless communications environment.
- Build upon Intelligent Transportation Systems (ITS) research in advanced-technology applications.
- Explore and validate the benefits of deployment-ready applications that provide travelers, drivers, and transit and commercial motor vehicle operators with enhanced safety, real-time information, and navigation assistance.

The Volpe Center solicited proposals from potential partners with real-time ITS information, navigation, communication, and electronic payment systems currently installed (or with the potential to be installed) in an integrated operational setting. The Test Bed sites were to test and evaluate integrated, intermodal ITS applications, particularly those that do not entail extensive public sector infrastructure requirements but achieve immediate benefits and demonstrate the potential for sustainable ongoing deployment.

The Volpe Center made two awards, one being the California Connected Traveler (CACT) Test Bed, which involved an integrated Test Bed in the San Francisco Bay Area and two independent applications[2] that would be deployed in California. The other award was the I-95 Corridor Test Bed, which involved a Test Bed along the I-95 Corridor from North Carolina to New Jersey as well as an independent application[3].

The CACT Test Bed includes the following three field test applications:

- Mobile Millennium: This application is a real time traffic information system for highways and arterials in the San Francisco Bay Area. The major source of traffic information was participants' GPS-enabled smart phones, which were tracked as their owners drove around the Bay Area, essentially serving as a large scale deployment of vehicle probes. Traffic information, in the form of speed estimates displayed on a traffic map, was delivered to the participants' smart phones. Analysis of this application involved understanding consumer and stakeholder experience with the mobile application and assessing the highway and arterial models developed using smart phone data.
- Networked Traveler-Foresighted Driving: This application involves providing alerts of upcoming slow traffic to drivers of specially instrumented vehicles.
- Networked Traveler-Transit/Smart Parking: This application involves creating a multi-modal trip planning tool for travelers in the US-101 corridor in the Bay Area. The information is

[2] The independent applications were proposed by vendors. One was related to work zone safety and the other to intersection delay at traffic signals. There was an agreement between Volpe and Caltrans that independent applications could also be tested on the California Connected Traveler Test Bed.

[3] The independent application to be tested on the I-95 Test Bed was related to work zone safety.

available to all travelers through a website, and to registered users through a smart phone application.

Under the direction and funding of the RITA ITS Joint Program Office, SAIC was selected to conduct an independent national evaluation of the technologies being deployed as part of the two test beds, which are being managed by the Volpe Center. This document presents the findings of the national evaluation of Networked Traveler-Transit/Smart Parking test, one of the three applications that comprise the CACT Test Bed. The remainder of this document is organized as follows:

Part I: Introduction. The current section provides information on the CACT Field Operational test deployed under the SafeTrip-21 Initiative.

Part II: Findings.

- **Section 1 – Background.** Provides background information on the timeline for development of Networked Traveler-Transit/Smart Parking (NT-T/SP) test and describe the applications. This section also summarizes the evaluation approach, hypotheses, and measures of effectiveness developed previously and detailed in the Evaluation Plan.
- **Section 2 – Geo-fencing.** Provides a description of the geo-fencing design and implementation into the smart phone application. Presents the results of the geo-fencing evaluation test and lessons learned regarding the prevention of distracted driving.
- **Section 3 – Usage Statistics.** Details an analysis of usage of the NT-T/SP applications including detailed insight into the user base, the result of targeted marketing efforts and major usage events, and user characteristics.
- **Section 4 – User Perceptions.** Details the data collection plan and process. Summarizes the user perceptions and presents the results from the registered user survey.
- **Section 5 – Deployment Experience Assessment.** Details the design, deployment, and operational phases of the deployment by identifying successes, shortfalls, and significant lessons learned.

Part III: Summary and Conclusions. Summarizes the major findings of the evaluation and states the major conclusions drawn from the results.

Part IV: Appendices

PART II: FINDINGS

Part II of this evaluation report addresses the findings of the NT-T/SP test.

1. BACKGROUND

This section of Part II provides background on the project, describes the applications involved in the test, and gives background on the evaluation including information on the evaluation objectives, hypotheses, measures of effectiveness, and activities.

1.1 NETWORKED TRAVELER – TRANSIT/SMART PARKING TEST

The Networked Traveler – Transit / Smart Parking (NT-T/SP) test consists of real-time transit information and trip planner applications that serve travelers along the US-101 corridor in San Francisco, California. While the original scope of the test was to only provide parking and transit information for trips along the US-101 corridor, it was later expanded to include most transit agencies throughout the San Francisco Bay Area. The Bay Area is an ideal test bed for understanding what type of information is useful to travelers. It is an area of significant population density, traffic congestion, and alternate transportation options, especially along the US-101 corridor which provides access to San Francisco from other major metropolitan areas such as San Mateo, Palo Alto, and San Jose. The primary purpose of the test is to provide information to travelers in real-time across all transit agencies that serve the US-101 corridor. This "one-stop shop" for traveler information was designed to help travelers make better pre-trip planning decisions in terms of mode selection and to serve as a tool for planning transit trips from any origin to any destination considering all transit options available. The NT-T/SP test is unique in that it integrates a broad range of real-time multi-modal transportation information, including transit and parking information. In fact, the multi-modal trip planner website is the first to integrate real-time information for most transit agencies in the Bay Area.

The NT-T/SP test was developed by the California Partners for Advanced Transit and Highways (PATH)[4] and the University of California at Berkeley in partnership with the California Department of Transportation (Caltrans). PATH is administered by the UC Berkeley Institute of Transportation Studies, with a mission to develop solutions to the problems of California's surface transportation systems through cutting edge research.

It is important to note that this test was re-scoped towards the end of 2009 to address concerns on distracted driving. Previously, PATH had planned to integrate real time traffic, transit, and parking information to compare the fastest mode from the drivers' locations to their destinations during congested conditions. In situations where Caltrain, the commuter rail service in the US-101 corridor, was projected to be faster than driving, even after considering the time required to divert to a station and park, PATH planned to make mode shift alerts available to drivers through their dash-mounted smart phones. The mode shift alerts would have directed drivers to a specific train at a nearby railway station where real time parking status information indicated if parking spaces were available. Having switched to rail mode, the system would continue to provide real time transit status and connection information to drivers' destinations. After receiving an alert, drivers could send immediate feedback to PATH on the value of the alert by responding to simple questions on their smart phones.

[4] Link to the PATH's website: **http://www.path.berkeley.edu**

The re-scoping of the test resulted in a greater focus on pre-trip information for drivers and real time transit information via the smart phone application versus "en route" mode-shift alerts that could be a distraction to drivers. Alerts on transit status are provided by the smart phone application, but a technique referred to as "geo-fencing" was introduced to prevent the use of the smart phone application while driving. Traditional geo-fencing typically intends to provide alerts when individuals or assets deviate from a pre-defined route, zone, or time period while other smart phone applications attempt to prevent use of mobile phones while driving. Instead, PATH developed a geo-fencing technique which attempted to determine which mode the traveler was using, in order to allow transit users to continue to receive updates while on the move but prevent drivers from using the information while driving. In this way, the potential for distraction to the driver is substantially reduced, while service is maintained to transit riders.

With the support of several regional partners, PATH developed a set of web-based and smart phone-based applications branded as "PATH2Go." PATH made the applications available via its "Networked Traveler" project website[5] where users can access the multi-modal trip planner website, the transit smart phone application, and the transit and parking traveler information website. For the purposes of the evaluation and for overall clarity, the evaluation team is using the project team designated names for the two web-based applications and the smart phone application. These are the Trip Planner, the Web Based Traveler Information, and the Smart Phone Application, respectively, which together make up the suite of tools branded PATH2Go. The PATH2Go applications provide a variety of travel and transit information across most Bay Area transit agencies. The transit agencies available in all three of the PATH2Go applications are:

- Caltrain,
- SF Muni,
- VTA,
- BART, and
- SamTrans

The Networked Traveler website also provided detailed information about what each of the applications has to offer. Visitors to the project website had the option to register as a user by signing up and creating an account. Users were required to register in order to download the PATH2Go Smart Phone Application, but could use either of the web-based applications with or without registering. Users who created an account were asked to create a user name and password as well as fill out a short, optional survey with demographic, travel pattern, and marketing questions. The user registration survey is available in Appendix A.

1.1.1 PATH2Go Trip Planner

The PATH2Go Trip Planner website[6] provides multi-modal trip planning information for travel along the US-101 corridor in the San Francisco Bay Area. Users accessing the website can plan a trip by entering an origin and destination in the form of a physical address, landmark, transit

[5] Link to the Networked Traveler project website: **http://www.networkedtraveler.org/**

[6] Link to the PATH2Go Trip Planner website: **http://tlab.path.berkeley.edu/dpiVII/?p=true**

station/stop, or any other location recognizable by the system, which uses a combination of Google® Map API and its own transit database developed by PATH.

In return, the system provides detailed information about the different transportation options available for the trip, including transit only, driving to transit, driving only, and bicycling. Users can compare itineraries for several different transportation mode options with the ability to make a decision based on time, cost, and carbon emissions. For each trip option available, the system provides the total time required to complete the trip, the estimated total cost of the trip, and the expected carbon emissions or savings as the result of the trip; allowing travelers to make a decision based on which factor is most important to them for that trip. Figure 1-1 below is a screenshot of the output presented on the PATH2Go Trip Planner website after an example trip from Palo Alto, CA to San Francisco, CA has been planned. As shown below, the trip summary information allows users to consider the cost/benefit of choosing one option compared to another. For driving to transit trips, the system provides the estimated cost of fuel for the driving leg of the trip, the actual cost of parking when the user will transfer to transit, and the actual fare for the transit leg of the trip. Users can even enter their vehicle's fuel efficiency to update their itinerary with a more accurate estimate of fuel consumption. To help users consider the potential savings of considering alternate modes, the system displays a graphical representation of work/relax time versus driving time and driving emissions versus emissions saved by taking public transit for each trip option available.

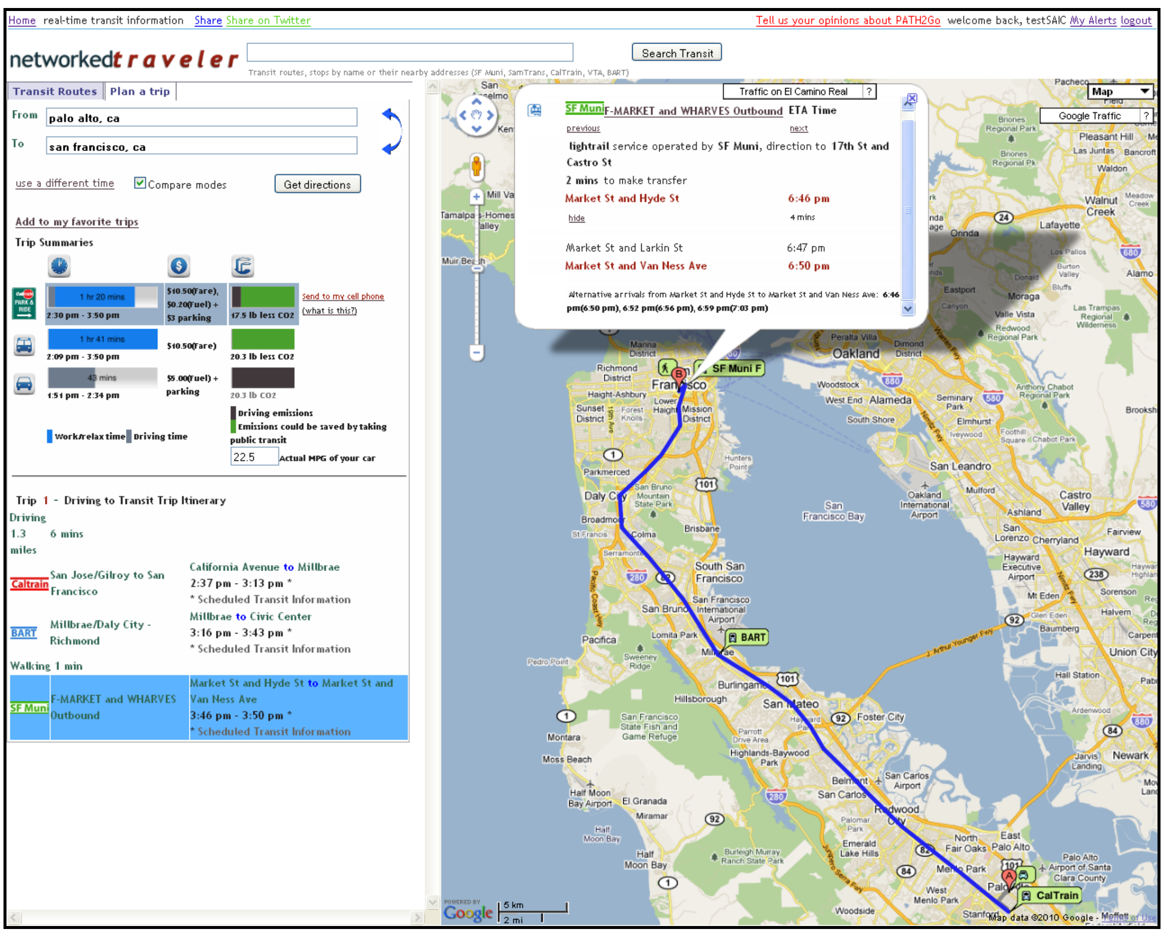

Figure 1-1. Screenshot of PATH2Go Trip Planner Website.

The system also allows users to view the detailed itinerary specific to each trip option by clicking on any of the trip options in the trip summary. For example, if a user clicks on a bicycling trip, the system will provide turn-by-turn directions for that trip. Alternately, clicking on the transit trip will provide users with detailed information about the start and end transit station/stop and any transfer points as well as real-time arrival and departure times for each leg of the trip. As shown in the figure above, a window with detailed travel times for the route selected as well as additional departure times from that location in case the user misses the first train/bus is displayed when a user selects a specific leg of any transit trip.

While the functionality presented above is accessible to non-registered users, there are added benefits to being a registered user when using the trip planner website in conjunction with the smart phone application. Registered users can plan a trip using the website and choose to send the itinerary for that trip to their smart phone in order to use the smart phone application functionality for the transit portion of the trip. With access to real-time arrival and departure times on-the-go using their smart phone, users can potentially reduce wait-time at a transit stop/station. Other additional functionality for all users of the trip planner website includes the ability to view color-coded traffic congestion information on roadways where its available using the Google Maps API or the same information on El Camino Real specifically using sensor data provided by Caltrans. The congestion information allows users to assess traffic conditions on the roadways used for the driving or bus segments of a planned trip.

The PATH2Go Trip Planner and PATH2Go Web Based Traveler Information applications access information from two different servers, but both are actually hosted on the same website. Although different URLs are available to navigate to each specifically, the applications are accessible from each other by selecting between the two tabs available, the “Plan a trip” tab and the “Transit Routes” tab, respectively. A trip planner server stores all of the information needed to plan a trip on the PATH2Go Trip Planner website and the PATH2Go Smart Phone Application. A traveler information server stores all of the real-time transit information accessed by all three of the applications.

1.1.2 PATH2Go Web Based Traveler Information

The PATH2Go Web Based Traveler Information website[7] provides real-time, detailed transit information for all Bay Area transit agencies that serve the US-101 corridor. The website provides a variety of transit information to travelers for train, commuter rail, light rail, BRT, and bus routes including real-time schedule information for most transit agencies in the Bay Area.

The primary purpose of the PATH2Go Web Based Traveler Information website is to provide real-time arrival and departure times for all transit routes where available as well as real-time parking availability information for several instrumented Caltrain lots along the US-101 corridor. This allows transit riders to browse transit options and plan trips across several providers versus going to each transit agency website individually. Users can view real-time information versus just schedule information, which could impact user perception of the convenience of riding transit.

In order to implement this type of information into one system, PATH had to work closely with the transit agencies involved to establish a constant stream of up-to-date schedule information, route information, and changes in service. While SF Muni and BART provide open source data to the general public, the other transit agencies involved either did not provide the data to the public or did not have it available. PATH put forth a considerable effort to coordinate retrieving this data or

[7] Link to the PATH2Go Web Based Traveler Information website: **http://tlab.path.berkeley.edu/dpiVII/?p=false**

gathering this data themselves. Some of their efforts included implementing GPS trackers on trains and buses where not available, building route shapes to identify bus routes and stations/stops, and creating algorithms to estimate real-time arrivals and departures based on real-time and historical data. Where real-time arrival and departure times were not available, automatic vehicle locator (AVL) data was not available, or GPS trackers could not be installed; the project team used normal schedule information to feed the traveler information server. Table 1-1 below presents the source for real-time tracking information collected by PATH for each of the transit agencies involved in the test.

Table 1-1. Data Source by Transit Agency.

Transit Agency	Data Source	Notes
Caltrain	GPS devices installed by PATH.	PATH installed GPS devices on the full fleet of Caltrain locomotives to allow for real-time tracking.
SF Muni	Open Source.	SF Muni provides open source data for real-time arrival and departures times across the whole system.
VTA	GPS devices installed by PATH or schedule information.	PATH installed GPS devices on the full fleet of 22 buses on the VTA 522 route in Palo Alto, which is a high use bus-rapid transit route. For all other VTA routes, PATH used static schedule information.
BART	Open Source.	BART provides open source data for real-time arrival and departures times across the whole system.
SamTrans	GPS devices installed by PATH and SamTrans AVL data or schedule information.	PATH installed GPS devices on 15 SamTrans buses. For all other SamTrans routes, PATH used AVL data or schedule information.

Unlike the trip planner website which seeks to connect users from origin to destination using transit or other modal options, the traveler information website allows users to do the trip planning themselves by searching or browsing all transit routes available from the transit agencies covered by the system. When accessing the website, users have the option to select a specific transit agency and route from drop-down menus, use the search bar to find a specific transit route, search for a transit route using a nearby address, or select from a list of recently viewed routes. All transit routes and stations/stops provided by each transit agency are available using the search bar or drop-down menus.

Additionally, the website offers parking lot capacity or real-time parking availability information for Caltrain Park-and-Ride lots to travelers who use Caltrain. As a test, four parking lots along the Caltrain route were instrumented with sensors to count the number of vehicles entering and exiting the lot in order to provide the available number of parking spots in real-time. Figure 1-2 below shows a 3G transmitter at a lot in Redwood City that sends information from the PATH-installed sensors to its server.

Figure 1-2. Caltrain Smart Parking 3G Transmitter in Redwood City, CA.

Photo Courtesy of PATH.

Many of the Caltrain parking lots along this busy commuter corridor are generally at or near capacity on any given day. To best serve commuters who may consider taking an alternative mode by parking their car and riding transit for the remainder of their trip, the PATH team did a survey of all Caltrain parking lots in September 2008. The study showed that about half of all Caltrain parking facilities operate at or near capacity during the middle of the day. However, the team identified ten lots that had excess parking available and decided to instrument four of these lots at Caltrain stations with hopes to advertise the excess parking to commuters who are willing to switch modes. Table 1-2 below was provided by PATH and presents the details of the instrumented lots.

Table 1-2. Details of Instrumented Caltrain Parking Lots.

Station	Lot	Technology	Instrumented By	Notes
Millbrae	Caltrain Lot	Sensys sensors	PATH	182 spots total
Redwood City	Surface Lot	Sensys sensors	PATH	157 spots total
	Underground Lot	Aldis Video Camera	ParkingCarma	515 spots total
Menlo Park	North Lot	Sensys sensors	PATH	
	South Lot	Sensys sensors	PATH	
Palo Alto	West Lot	Sensys sensors	PATH	

Once a user has identified a transit agency and a transit route, the website displays a full list of the stops along that route. Figure 1-3 below presents a screen shot of the PATH2Go Web Based Traveler Information website with Caltrain information including real-time arrivals and departures for the South San Francisco station as well as the list of all stations along the route with parking availability at each. A user can use the list of station/stop names or the map to select a specific stop and view all upcoming arrival and departures times for that stop in real-time. Because most transit trips have a direction associated with the route, users can also choose to reverse the route to view the schedule information in the opposite direction. Additionally, users can elect to view the real-time information or view the route schedule for the entire day by selecting the “Arrivals for now” or “Schedules for all day” buttons, respectively. As shown in the figure, the instrumented lots display the total number of parking spaces available at that location in real-time while other lots simply list total capacity. The times highlighted yellow in the South San Francisco station window represent “Baby Bullet” or express trains that only stop at specific stations to lower long-distance commute times.

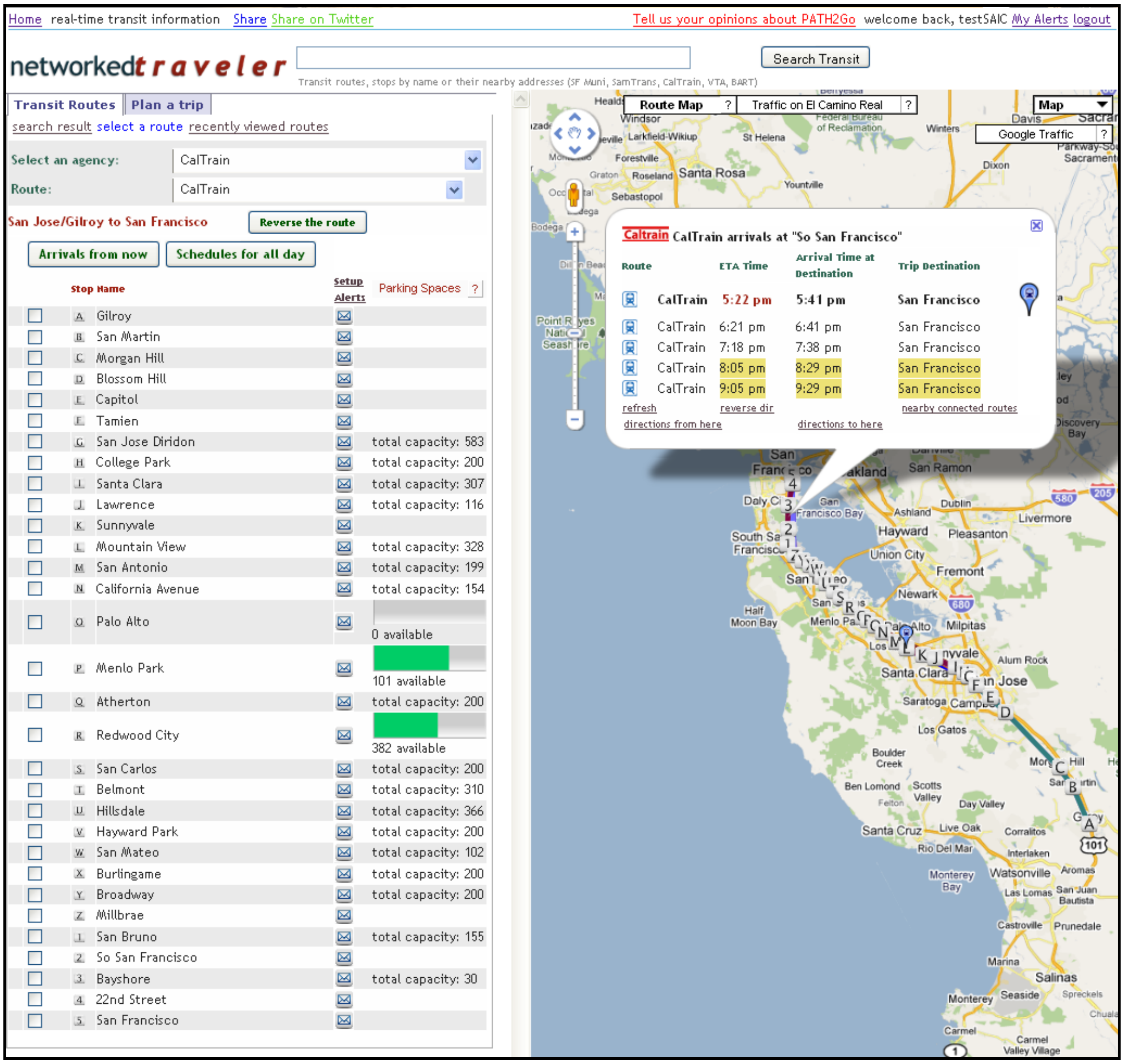

Figure 1-3. Screenshot of the PATH2Go Web Based Traveler Information Website.

As with the PATH2Go Trip Planner website, there are added benefits to being a registered user when using the traveler information website in conjunction with the smart phone application. Registered users can set-up alerts to be sent to their smart phone application on a regular basis. By identifying specific transit routes, users can view real-time schedule information for that transit trip on their smart phone for a specific time of day (i.e., a user’s morning or evening commute). With access to real-time arrival and departure times on-the-go, users can potentially reduce wait-time at a transit stop/station. Other functionality available to all users of the traveler information website includes the ability to view color-coded traffic congestion information on roadways where its available using the Google Maps API or the same information on El Camino Real specifically using sensor data provided by Caltrans. The congestion information allows users to assess traffic conditions on the roadways they use to travel to transit stops/stations. Users can also access a list of nearby connecting transit routes from the same or other transit agencies as well as directions to or from any transit stop/station using the trip planner website at the click of a button.

1.1.3 PATH2Go Smart Phone Application

The PATH2Go Smart Phone Application is a multi-agency transit trip planner that provides real-time arrival and departure information and user location-based trip details for transit available in the Bay Area along the US-101 corridor. The application uses the GPS functionality of smart phones to help users identify transit options and guide them step-by-step through a planned transit trip itinerary. The primary purpose of the application is to provide real-time transit information across multiple transit agencies on-the-go.

The application allows users to view real-time transit schedules, plan transit trips by selecting nearby stops (based on their current GPS location), or create itineraries by providing origin and destination transit stops or locations. Users can select their current location or enter an origin and destination in the form of a physical address, landmark, transit station/stop, or any other location recognizable by the system, which uses a combination of Google® Map API and its own transit database developed by PATH. As mentioned before, the smart phone application uses both the trip planner and traveler information servers developed by PATH to compile information and present it to the user.

The PATH2Go Smart Phone Application was available for download on smart phones with an iPhone, Android, or Windows Mobile software platform. iPhone and Android smart phone users can download the application named “PATH2Go” from the Apple iTunes App Store or Google Android Market, respectively. Windows Mobile users have to download the application from PATH’s Networked Traveler website after registering as a user. Although iPhone and Android users can technically download the application before registering, all smart phone application users have to register on the Networked Traveler website before they can log-in to the smart phone application (see Figure 1-4). Once registered, users can begin sending transit trips planned with the PATH2Go Trip Planner website or the PATH2Go Web Based Traveler Information website to the smart phone application. Smart phone users receive a notification within the application when it was time for the first leg of the planned trip to begin. Functionality between the website applications and the smart phone application gives users the benefit of working on a computer (i.e., bigger screen and faster internet speeds) while planning a trip or exploring transit options as well as the benefit of taking the detailed itinerary with them to reference throughout their transit trip via their smart phone.

Figure 1-4. PATH2Go Smart Phone Application Login Screen on Apple iPhone.

In addition to the compatibility between the websites and smart phone application, users can also use the smart phone application on its own to plan trips or view transit itineraries. Although the functionality and design of the smart phone application varies across the different software platforms, the basic information provided by the application is essentially the same for each.

Figure 1-5 below shows the PATH2Go Smart Phone Application on a Windows Mobile phone, Android phone, and iPhone (from left to right, respectively).

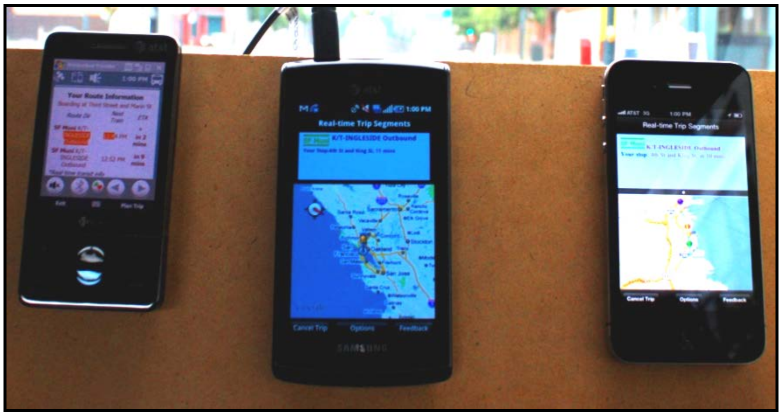

Figure 1-5. PATH2Go Smart Phone Application.

Using the Apple iPhone as an example, Figure 1-6 below shows screenshots of the PATH2Go Smart Phone Application user interface and the steps required to plan a transit trip on the application. The first screenshot on the left shows the default screen displayed after a user logs into the application. The application uses the smart phone's GPS capabilities to identify the user location when it is opened, which is represented by the green pin in the screenshot. Next, the user has three options for choosing a trip origin: select a nearby stop identified using the user location, choose from previous locations selected, or select an origin from the list of transit stops/stations by transit agency. The middle screenshot shows the interface for selecting a transit stop/station from the list. Users also have the option to search for a specific stop/station using the search bar. After a user has identified an origin for their transit trip, they can then choose a destination by using their trip history, by selecting from the list of transit stops/stations by transit agency, or by typing a physical address or landmark into an address bar. Once an origin and destination are established, the user can view the planned itinerary before finalizing the trip. The screenshot on the far right shows the resulting view after a trip has been planned and submitted. The application displays the first segment of the transit trip planned and provides real-time arrival and departure times. In addition to the schedule information, the map on the screen displays the current user location, the trip origin, the trip destination, and the current location of the bus/train using color-coded pins. The application automatically displays the first segment of the transit trip, but the user can scroll through any additional segments in the trip by swiping the top portion of the screen to the left. The three dots below the top portion of the screen indicate that there are three segments to the current planned trip. From this screen, a user can follow their trip progress throughout the entire trip as their current location pin updates automatically and moves along the route highlighted in green on the map. Once a trip is planned, the application begins providing alerts to the user when their train/bus is approaching their initial boarding stop and as the train/bus approaches their next stop and/or destination. Alerts are provided for each trip segment and schedule and location information is updated constantly throughout the planned trip.

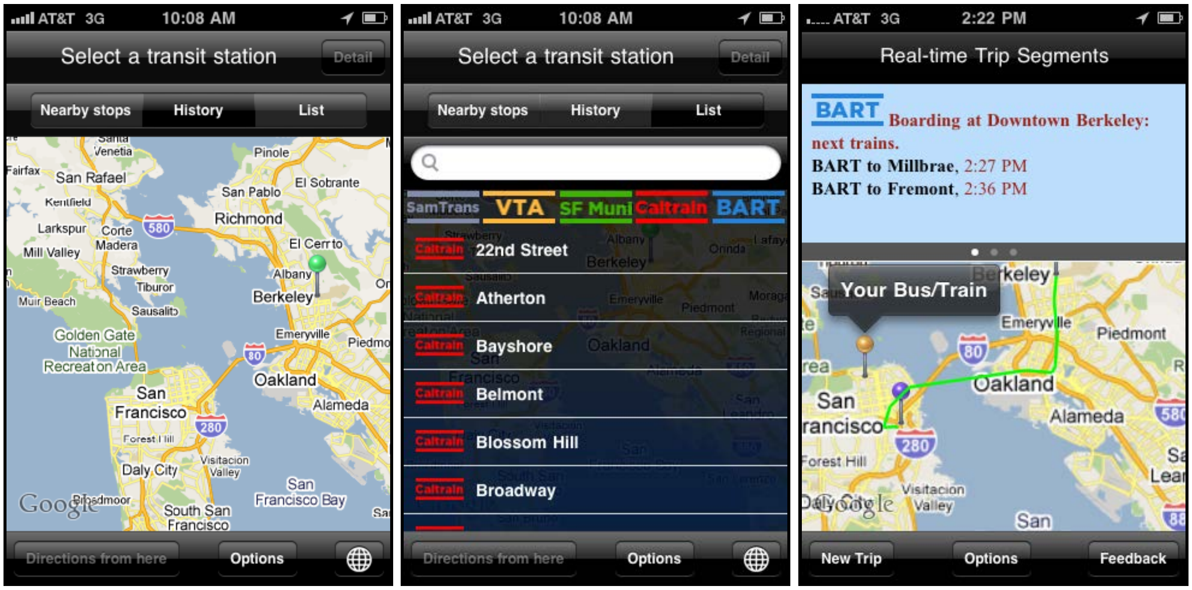

Figure 1-6. Apple iPhone User Interface for the PATH2Go Smart Phone Application.

Although the application is designed for use while traveling on transit, it is possible that many users access transit by driving and parking at or near a transit stop/station. As mentioned above, geo-fencing functionality was implemented into the PATH2Go Smart Phone Application design when the project was re-scoped to discourage use of the application while driving. The geo-fencing design compares transit route information stored on the traveler information server with speed and location data provided by the smart phone GPS to determine whether a user is traveling along a planned transit route or driving a vehicle. If the system determines that a user is driving, a warning message that reads "Warning! Application Disable While Driving" appears and blocks users from the information provided on the application (see Figure 1-7). To better understand the effectiveness of the geo-fencing functionality in preventing distracted driving, the evaluation team conducted a test of the geo-fencing design. The geo-fencing design and evaluation activities are presented in greater detail in the following section of the report.

Figure 1-7. PATH2Go Smart Phone Application – Distracted Driving Alert.

1.2 EVALUATION APPROACH

The evaluation approach was driven by a series of objectives that align with the USDOT's goals for the SafeTrip-21 initiative – see Table 1-3.

Table 1-3. Goals, Objectives, and Hypothesis Statements

SafeTrip-21 Goal	Evaluation Objectives	Hypothesis
Expand / accelerate research in vehicle connectivity with the wireless communications environment	Observe the consumer response to the NT-T/SP application	Use of smart phones for delivery of transit and mode shift information will be adopted, accepted, and will expand over time.
Build on ITS research	Understand the technical and institutional issues associated with distributing multi-modal information to smart phone users	Lessons learned through the development of the NT-T/SP application will build on current knowledge / understanding of the use of smart phones for providing in-vehicle mode shift alerts and en-route transit information.
	Test the ability of geo-fencing as a method to prevent distracted driving	Geo-fencing is an effective means to prevent the use of mobile devices while driving
	Understand the development process and institutional issues associated with implementing a server-based geo-fencing method versus a client-based method on mobile devices	A server-based geo-fencing method is efficient and effective, but has limitations in user capacity and only limits mobile device use at the application-level
Explore / validate benefits of real-time, smart phone mode shift alerts and transit information	Measure usage of the NT-T/SP application	Usage of the NT-T/SP application will be an indication of user acceptance. Usage will increase over time.
	Analyze the perceived accuracy and usefulness of mode shift alerts and en-route transit information	Mode shift alerts and en-route transit information will be perceived to be accurate and useful.

Each objective was supported by corresponding hypotheses and measures of effectiveness, which in turn were used to identify specific data sources for the key activities for the evaluation. These data sources provide a detailed bank of knowledge relevant to the application, and a comprehensive look at lessons learned and the success of NT-T/SP. To achieve the objectives above, the evaluation team implemented the following key activities:

- Documented performance of the geo-fencing capabilities of the PATH2GO Smart Phone Application by conducting test scenarios across all transit agencies with various smart phones – discussed in **Part II, Section 2**;
- Analyzed usage statistics using information provided by PATH – discussed in **Part II, Section 3**;
- Analyzed ratings of the attributes (timeliness, accuracy, usefulness, acceptance, etc.) using information provided by registered users – discussed in **Part II, Section 4**; and
- Conducted interviews with deployment and operational partners – discussed in **Part II, Section 5**.

2. PATH2GO SMART PHONE APPLICATION GEO-FENCING TEST

As described in the Background section of the report, the PATH2Go Smart Phone Application was outfitted with geo-fencing functionality as the result of a project re-scope to address distracted driving concerns. This section of the report begins with a discussion of the concept of geo-fencing as it relates to the NT-T/SP test, specifically the PATH2Go Smart Phone Application. Next, the geo-fencing design developed by the project team is described in detail. Last, this section of the report presents the evaluation findings of the geo-fencing test conducted by the evaluation team including lessons learned regarding the prevention of distracted driving.

2.1 GEO-FENCING 101

A geo-fence is a virtual perimeter or boundary line for a real-world geographic area. Typically, the act of geo-fencing generates a notification when a location-aware device enters or exits a geo-fenced area, or crosses a geo-fence. Under this definition, geo-fencing does not directly prevent the user of a location-aware device from crossing a geo-fence, or restrict the functioning of the device. Geo-fencing has been available for several years, although not necessarily in a mass market form, e.g. using an on-board GPS device in a truck to track high value freight and to detect the possibility of theft if the truck deviates from a predetermined corridor or route. Past uses of the term geo-fencing referred to tracking while new uses of the term seek to restrict functionality.

Various technologies have emerged more recently that are designed to address the issue of distracted driving, by preventing the use of cell phones while driving. Such technologies rely on the ability to detect the movement of the location-aware device at speeds faster than walking. PATH has prepared an inventory of these technologies, including an overview of each. These technologies are not geo-fencing products, as defined above, in that they do not require a virtual perimeter or boundary to be defined, and they do not generate notifications when such geo-fences are crossed. Instead, their intent is to restrict the normal functionality of a device under certain circumstances, e.g. texting, making calls, emailing while driving. As such, the user of the location-aware device will experience a temporary loss of service when traveling above walking speed.

As required by USDOT, PATH has implemented a technique (also referred to as geo-fencing) to minimize the possibility that a smart phone user can access the mobile application for the NT-T/SP test while driving. PATH's approach, as detailed more fully below, shares some functional similarity with geo-fencing and the distracted driving technologies described in the preceding paragraphs. It too relies on the ability to detect the movement of the location-aware device at speeds faster than walking. It also uses the ability to identify the device's proximity to transit routes and railroads. However PATH's technique uses a more sophisticated approach that attempts to identify the mode of travel involved. In doing so, the NT-T/SP mobile application can (with some exceptions) be accessed on a smart phone while traveling on buses and trains, but not in cars. It is noted that PATH's technique only applies to the NT-T/SP mobile application (PATH2Go Smart Phone Application). It does not otherwise restrict the normal functionality of a mobile device while driving.

The NT-T/SP test redefines the meaning of the term geo-fencing actually restricting use of the application based on user mode of transportation. However, for the purpose of consistent referencing, the term geo-fencing will be used when referring to PATH's method of preventing drivers from using the PATH2Go Smart Phone Application throughout this document.

2.2 GEO-FENCING DESIGN

In order to evaluate how the geo-fencing design functions within the PATH2Go Smart Phone Application, it is important to fully understand the server structure used to develop the NT-T/SP system. The following is a description of how the Smart Phone Application interacts with the NT-T/SP system and how the geo-fencing design functions within that system.

As mentioned above, the primary goal of implementing geo-fencing functionality is to detect driving and prevent use of the application by drivers. Therefore, the geo-fencing design was integrated into the PATH2Go Smart Phone Application, which provides real-time transit information to users on the move. With any application design for smart phones, developers can decide whether to host the code and source information for certain application functionality on the server-side of the application or the client-side of the application. In other words, the decision-making can either take place on servers hosted by the developers or on the smart phone itself.

- Client-based functionality requires wrapping up all of the code and sources into the application download, which can be demanding on the smart phone in terms of application size, processor speed, and battery life depending on complexity.
- With server-based functionality, all of these processes, or decisions, can take place on the system's server and then can be wirelessly communicated to the client, or smart phone application.

The geo-fencing design was integrated into the PATH2Go Smart Phone Application using server-side logic, which allowed for a thin client-side design. Implementing a server side geo-fencing design prevented the design team from having to address differences in the operating systems of Windows Mobile, iPhone, and Android smart phones that could have an effect on geo-fencing performance. Figure 2-1 below was developed by PATH to explain the basic design of geo-fencing into the system.

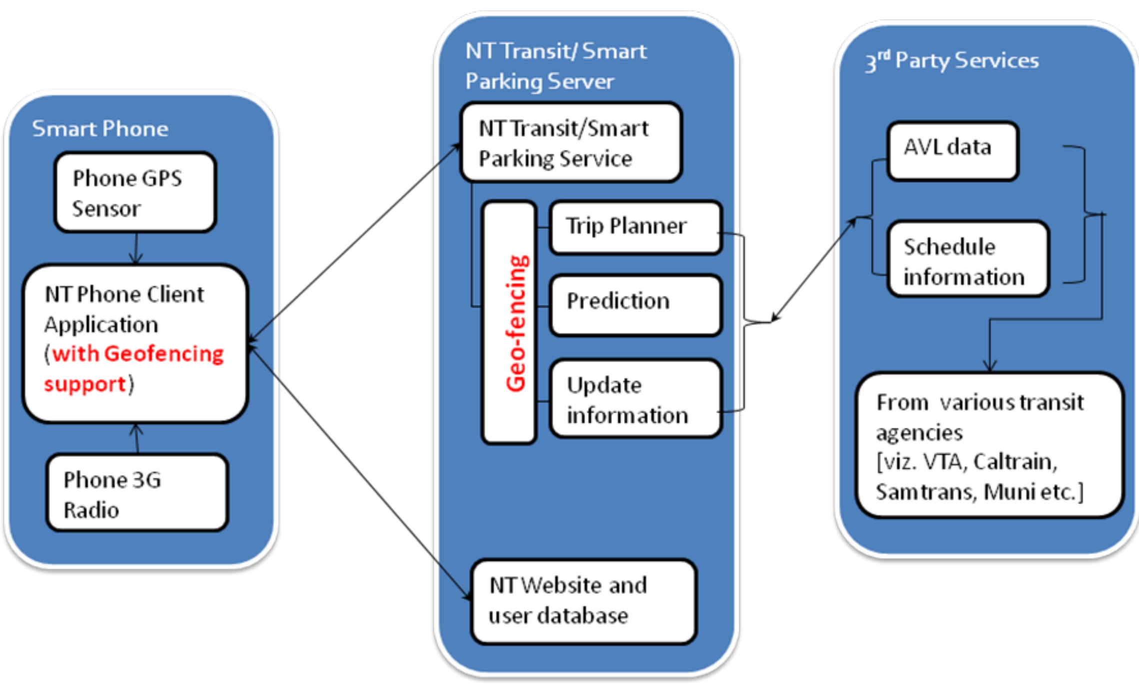

Figure 2-1. PATH2Go Smart Phone Application – Geo-fencing System Design.

Courtesy: PATH

If PATH had decided to design their geo-fencing functionality using a client-based design, the processes that take place on the NT-T/SP server and the communication with third party services as shown in figure above would all have to be carried out by the smart phone application, which could be quite burdensome on the phone's operating system as mentioned above.

As for the decision process for blocking users from the application, the geo-fencing design uses a combination of GPS data provided by the smart phone and trip information provided by the system server to determine whether or not a user is driving. As mentioned in the Background chapter, the PATH2Go Smart Phone Application displays a warning message to block users from accessing the information on the application when geo-fencing is engaged. The decision whether or not to block users from the application is initially dependent on these two primary factors: 1) the GPS location and speed of the smart phone, and 2) whether a trip has been planned by the user. From there, a number of other thresholds/constraints and decision processes are assessed to determine whether a user is riding transit or driving a vehicle. Figure 2-2 shows a simplified version of the decision process used to determine whether or not to display the distracted driving message.

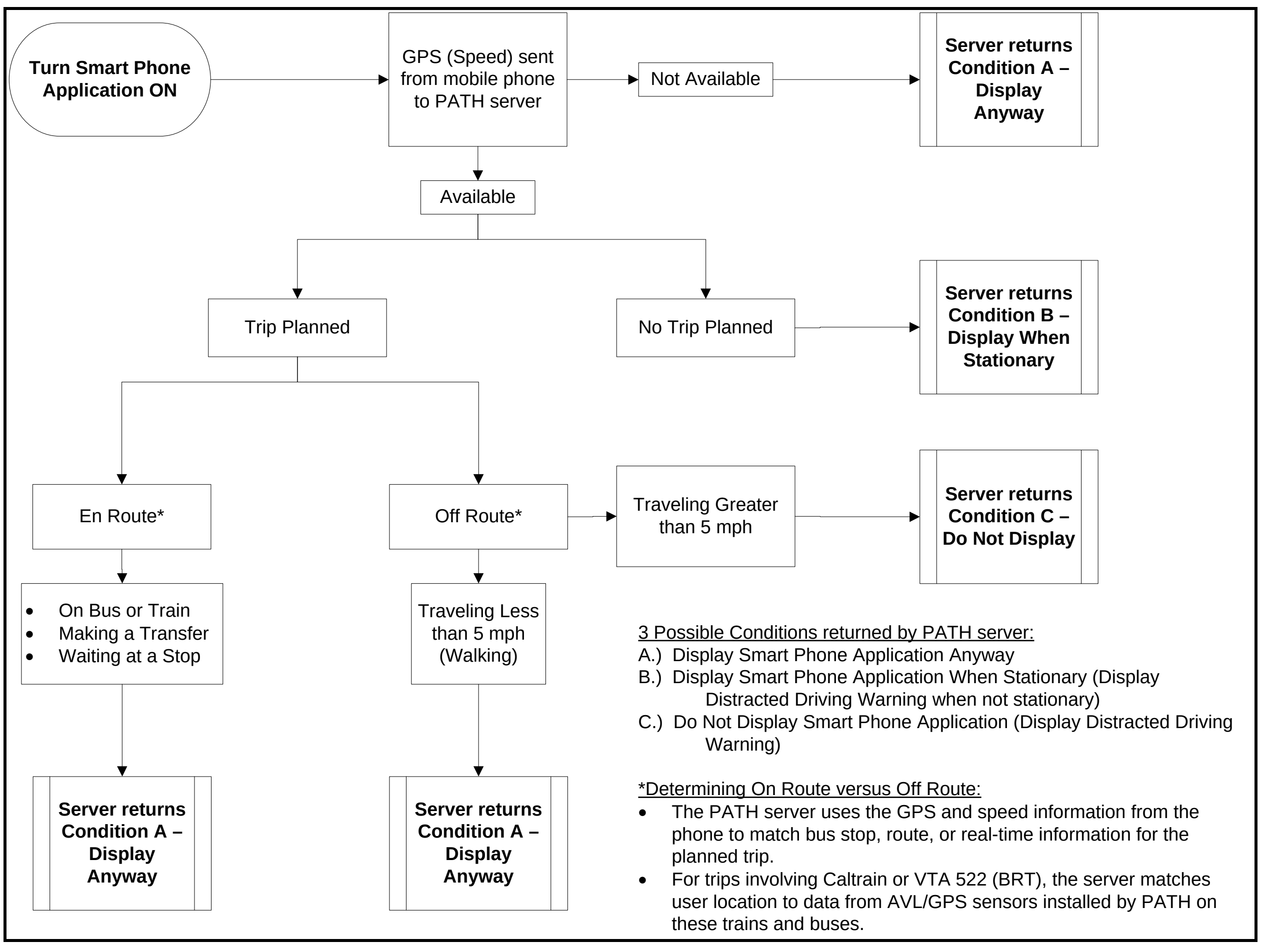

Figure 2-2. Geo-fencing Design Decision Process.

The geo-fencing design is driven by a set of thresholds and/or constraints at each step in the decision process presented in the figure above. The GPS speed and location serve as a primary source for threshold and constraint checks while the application is being used. When the application is open, the status of the geo-fencing is continuously checked and updated using the decision process above until certain conditions are met. The rate at which the geo-fencing status is updated is dependent on the smart phone model. The Android platform updates the geo-fencing status every thirty seconds while the iPhone and Windows Mobile platforms update every second and every five seconds, respectively.

The primary constraint controlling the geo-fencing status initially is the GPS location and speed of the smart phone. If the data is not available from the smart phone, the server assumes the user is out of satellite range and most likely not driving a vehicle realizing that there are exceptions (i.e., tunnels, satellites blocked by skyscrapers). In this situation, the user can access the application (Condition A). If the GPS location and speed are available, the server logic looks next at whether or not a trip has been planned. If a trip has not been planned, the geo-fencing status is dependent on the speed of the smart phone. If it is determined that a user is traveling 5 mph or greater, then the application is blocked. This speed constraint is considered in every remaining step of the decision process until specific conditions are met (Condition B).

If a trip has been planned, the server then goes into a more complicated decision process to determine whether or not a user is on a transit route. This process involves determining the user location and its relation to the route identified in the planned trip. First, the system uses the relevant station/stop location data for the planned trip to verify that a user has arrived at the start location of that trip. The user location must meet certain time and distance thresholds in relation to the beginning station/stop location in order to confirm that the user is actually beginning a transit trip. Distance thresholds are dependent on the transit station/stop, but can be as high as a 1,000 foot radius around the station/stop. The time threshold requires a user to be located at the beginning stop for at least 1 minute. If users do not meet these initial time and location constraints, they will be blocked from the application based on their speed (Condition A or Condition C).

While the geo-fencing status continues to be dependent on the speed of the user, the time and distance thresholds are continuously checked and updated along with the geo-fencing status. This allows the application to block users while they are driving off the transit route or driving to the transit stop/station (Condition C). However, once a user arrives at the transit stop/station and the beginning stop conditions are met, they can board the correct bus or train and will not be blocked from the application during their transit trip (Condition A). Although the application is not blocked after the initial conditions are met, the geo-fencing status is still continuously checked and updated to ensure the user is actually traveling on transit and did not just go to the beginning stop before driving again (Condition C). To confirm travel along the transit route, the user's GPS location is compared to the GPS/AVL data on the transit vehicle or the transit route shape data for the planned trip. At this point, the geo-fencing status is dependent on user GPS location in relation to route matching (i.e., GPS/AVL or route shape data) and the trip history collected since the beginning of the trip (i.e., server requests). If the server receives several consecutive confirmations that a user is traveling along the planned transit route, the geo-fencing status is set to leave the application open and is not checked again until the user arrives at a transfer stop or plans another trip.

2.3 GEO-FENCING TEST

This section of the report details the evaluation activities conducted by the evaluation team to test the capabilities of the geo-fencing design integrated into the PATH2Go Smart Phone Application.

The geo-fencing test conducted by the evaluation team was limited to assessing the geo-fencing functionality as it relates to preventing distracted driving.

2.3.1 Test Approach

Based on the server logic for the geo-fencing design identified in the previous section, the PATH project team developed a list of test scenarios that the smart phone application is capable of identifying when determining whether or not to block a user from the application. Presented in Table 2-1 below, the list of scenarios was tested by PATH using various transit trips covered by the PATH2Go Smart Phone Application along the US-101 corridor. The results of the test conducted by the project team are presented in the “Identifiable” column with corresponding notes for further clarification.

Table 2-1. Identifiable Scenarios Based on Geo-fencing Design Provided by PATH

Scenarios			Identifiable	Notes
No trip planned on Smart Phone Application (Pre-Trip)	1	Determine whether a user is 1) driving or 2) not driving.	✓	The system uses GPS data including location and speed to determine whether or not a user is driving.
	2	Determine whether a user 1) is near a bus/train stop when not driving or 2) is not near a bus/train stop when not driving.	✓	Using the smart phone GPS, the system takes user location relevant to bus/train stops into consideration when deciding whether or not to block application use.
	3	Distinguish between 1) a user who is riding a bus/train, and 2) one who is driving.	X	Because GPS traces are not available unless a trip is planned, the system cannot identify whether a user is on a transit route or driving.
Trip planned on Smart Phone Application (En-Route)	4	Distinguish between 1) a user who is walking to a bus/train station, and 2) one who is driving to a bus/train station.	✓	The system tracks speed and location history and uses a speed threshold of 5 mph to distinguish between driving (≥5mph) and walking (<5mph).
	5	Distinguish between 1) a user who is waiting at a bus/train stop, and 2) one who is passing a bus/train stop while driving.	✓	The system compares the location of the user to the bus/train routes in the planned trip using GPS traces to differentiate mode.
	6	Distinguish between 1) a user who is riding a bus/train, and 2) one who is driving along a bus/train route.	✓ (with constraints)	Because GPS traces are used to determine user mode, the system may allow users who closely follow the bus/train on a planned transit route via car to use the application.

Because the geo-fencing test was limited to testing geo-fencing functionality as it relates to preventing distracted driving, only scenarios 1 and 4 – 6 were tested. The test was focused on assessing the ability of users to access information on the application while traveling in a vehicle. While conducting this test, no member of the evaluation team attempted to use a mobile device while operating a vehicle. The scenarios below that involve driving were tested by the passenger who attempted to access the information available on the application with a smart phone while the vehicle was being driven by another member of the evaluation team.

To assess the scenarios above, the evaluation team ran test trips by traveling (i.e., driving in a vehicle, walking, or riding transit) to specific transit routes or along specific transit routes while using the PATH2Go Smart Phone Application. The PATH2Go Smart Phone Application is available for download on Apple iPhones, Android phones, and Windows Mobile phones. All test trips were conducted using each type of phone. The test trips covered all transit agencies that have information available on the application including:

- Caltrain
- BART
- SF Muni
- SamTrans
- VTA

The test trips also covered all types of transit available from each transit agency (i.e., train, light rail, BRT, bus). Again, the focus of this test was to evaluate the ability of the geo-fencing design to prevent distracted driving. Therefore, the majority of the test trips involved driving to a transit route or along a transit route to assess whether or not the user was blocked from using the application while in a vehicle on a roadway. Each test trip presented in the itinerary is associated with a specific transit route. Table 2-2 below lists the transit routes identified for the test.

Table 2-2. Test Transit Routes

Transit Route	Transit Agency	Transit Type	Plan a Trip		Route
			From	To	
A	Caltrain	Train	SF 4th St & King	22nd St	San Francisco to San Jose/Gilroy
B	SF Muni	Light Rail	3rd St & Marin St	4th St & King St	K/T Ingleside Outbound
C	SF Muni	Bus	4th St & Townsend St	3rd St & Market St	30 – Stockton Outbound
D	VTA	BRT	Palo Alto Caltrain Station	El Camino & Showers	522 – Eastridge – Palo Alto
E	VTA	Bus	El Camino & Showers	El Camino & Hollenbeck	22 – Eastridge – Palo Alto/Menlo Park
F	VTA	Light Rail	Mountain View Station	Whisman Station	902 – Mountain View – Winchester
G	BART	Commuter Rail	Millbrae	San Bruno	Millbrae/Daly City – Richmond
H	SamTrans	Bus	Millbrae Transit Center	San Bruno BART	391 North

In order to test for and identify inconsistencies, the itinerary was designed to test scenarios 1 and 4 – 6 at least three times each within one run of the itinerary. Any test trips that showed anomalies in the geo-fencing design were run additional times. The three tables presented in Appendix B provide the three sets of the itinerary used for the geo-fencing test. Each step of the itinerary lists the scenarios tested with that step and the transit route and mode of transportation used to test the scenarios. The goal of the test was to push the geo-fencing design to its limits to understand exactly how it works and whether or not it is effective in preventing distracted driving. After several discussions with the PATH project team, the evaluation team gained a solid understanding of the geo-fencing design, its capabilities, and its limitations and how those related to the test scenarios. Ultimately, the evaluation team set out to assess how the system could be "tricked" into not blocking the information available on the application while driving and whether or not those scenarios are likely to be repeated by actual users. Essentially, the thresholds and constraints related to test scenarios 1 and 4 – 6 are what determine whether or not a user is blocked from the application.

As discussed in section 2.2 above (Geo-fencing Design), these constraints and thresholds include:

- Geo-fencing as the result of GPS speed (Test Scenarios 1 and 4).
    - Threshold – users traveling 5 mph or greater are considered to be driving.
- Geo-fencing as the result of GPS location and speed in relation to route planned (Test Scenarios 5 and 6).
    - Threshold/Constraints – the geo-fencing status is dependent on user GPS location and speed in relation to route matching (i.e., GPS/AVL or route shape data) and the trip history collected since the beginning of the trip (i.e., server requests). Users confirmed to be on a transit trip can access the application; otherwise, the application is blocked.

The itinerary developed primarily involves running trips to test whether or not users can gain access to the application by imitating transit trips while driving a car, which tests scenario 6. The geo-fencing test was conducted over two consecutive days beginning on November 6, 2010.

2.3.2 Findings

Table 2-3 presents the data and observations collected during the geo-fencing test by each step of the itinerary. For each step of the itinerary, the evaluation team recorded general observations of scenarios where the application was blocked and scenarios where the user was able to access the information available on the application, designated as the application being "open". The evaluation team also kept track of differences in smart phone functionality as it relates to the geo-fencing design. For the driving steps in the itinerary, the evaluation team recorded the primary roadway type traveled for that step to best understand under which driving conditions the geo-fencing functionality was most effective. During steps where the evaluation team attempted to gain access to the application while driving by mimicking a transit rider planning a transit trip and following the transit route closely by car, detailed observations were collected to better understand what aspects of the server logic produced those results (highlighted red in the table below).

Table 2-3. Observations Collected During Geo-Fencing Test, November 6, 2010 – November 7, 2010.

Step	Individual	Scenario Tested	Mode of Transportation	Transit Route	Trip Instructions for Application	Observations
1	Driver & Passenger	4	Driving	A	Plan trip A prior to departing start address.	Interstate/Highway Trip. Berkeley to San Francisco. No GPS signal for WM for 16 minutes of 40 minute trip. Application blocked while traveling on highway and GPS signal available. Application open when stopped at traffic signals.
	Passenger	4	Walking	A	Upon arrival at end address, exit car and walk to transit station.	Application open.
2	Passenger	6	Riding transit	A	Board Caltrain – San Francisco to San Jose/Gilroy and ride one stop to 22nd Street.	Application open.
	Driver	-	Driving	-	Depart Caltrain station and drive to 22nd St & Penn Ave. Pick up passenger.	-
3	Driver & Passenger	4	Driving	B	Plan trip B prior to departing start address.	Urban Arterial Trip More difficulties with WM GPS signal while traveling to station. Application open when stopped at traffic signals.
	Passenger	4	Walking	B	Upon arrival at end address, exit car and walk to transit stop. Return to car without boarding.	Application open.
4	Driver & Passenger	5, 6	Driving	B	After identifying SF Muni light rail, attempt to follow the route of the train/bus.	Following light rail on 4 lane urban arterial. Allowed complete access to application while driving throughout the entirety of following the train. However, following light rail required non-typical driving behavior (i.e., slowing, stopping, etc.). Even after leaving the route, application still allowed access and seemed to still be linked to light rail. Was phone GPS disabled and system relying on light rail GPS?
5	Driver & Passenger	1	Driving	C	Do not plan a trip before departing start address. Take 4th St away from the water to Townsend St. Upon arriving, plan trip C.	Urban City Streets Trip Application blocked except when driving slowly or stopped at traffic signals.
	Passenger	4, 5	Walking	C	Upon arrival at end address, exit car and walk to transit stop. Return to car without boarding.	Application open.

Step	Individual	Scenario Tested	Mode of Transportation	Transit Route	Trip Instructions for Application	Observations
6	Driver & Passenger	5, 6	Driving	C	After identifying SF Muni bus, attempt to follow the route of the train/bus.	Following bus on urban city streets. The application/system seemed to think that we were on the bus, but we were still receiving the geo-fencing message when we reached greater speeds despite following the bus very closely. The traffic was stop and go in many cases, so it was difficult to see if we were just seeing short instances of the geo-fencing message or if the application was being blocked because we weren't actually on the bus.
7	Driver & Passenger	1	Driving	D	Do not plan a trip before departing start address. From US-101 S, take exit 404B to Willow Rd. Turn left onto Middlefield Rd. Turn right at University Ave. Turn right toward Mitchell Ln. Take second left onto Mitchell Ln.	Interstate/Highway Trip ending with local streets. Berkeley to Palo Alto. Application blocked except when driving slowly or stopped at traffic signals.
	Passenger	4, 5	Walking	D	Upon arrival at end address, exit car, plan trip D, and walk to VTA 522 BRT stop.	-
8	Driver & Passenger	5, 6	Driving	D	After identifying VTA 522 BRT, attempt to follow the route of the bus.	-
9	Passenger	4, 5	Walking	E	Exit car upon arrival at El Camino & Showers stop. Plan trip E and identify VTA 22 bus stop. Return to car.	-
10	Driver & Passenger	5, 6	Driving	E	After identifying a VTA 22 bus, attempt to follow the route of the bus. Drive east on El Camino Real towards Hollenbeck Ave.	Following bus on arterials and urban city streets. The application/system seemed to think that we were on the bus, but we were still receiving the geo-fencing message when we reached greater speeds despite following the bus very closely. The traffic was more free flow in this case, so we were thinking the system realized we were not on the bus. At one of the stops, we exited the car and boarded the bus to see if we still received the geo-fencing message. Despite being on the bus, we still received the geo-fencing message at speeds above 5 mph.
11	Driver & Passenger	4	Driving	F	Plan trip F prior to departing start address.	Highway and Urban Arterial Trip. Application blocked except when driving slowly or stopped at traffic signals.
	Passenger	4, 5	Walking	F	Upon arrival at Mountain View VTA Station, exit car and walk to station.	Application open.

Step	Individual	Scenario Tested	Mode of Transportation	Transit Route	Trip Instructions for Application	Observations
12	Driver & Passenger	4	Driving	G	Plan trip G prior to departing start address. Take US-101	Interstate/Highway and Urban Arterial Trip. Application blocked except when driving slowly or stopped at traffic signals.
	Passenger	4, 5	Walking	G	Upon arrival at Milbrae Transit Center, exit car and walk to BART station.	Application open.
13	Passenger	4, 5	Walking	H	Before departing Milbrae Transit Center. Plan trip H and identify SamTrans 391 bus stop. Return to car.	Application open.
14	Driver & Passenger	5, 6	Driving	H	After identifying a SamTrans 391 North bus, attempt to follow the route of the bus.	Following bus on arterials and urban local streets. The application/system seemed to think that we were on the bus, but we were still receiving the geo-fencing message when we reached greater speeds despite following the bus very closely.
15	Driver & Passenger	1	Driving	-	Return back to the hotel after final trip without trip planned.	Interstate/Highway and Urban Arterial Trip. Application blocked except when driving slowly or stopped at traffic signals.

After completing the geo-fencing test, the evaluation team interviewed the project team to better understand the situations observed during testing, especially those highlighted red in Table 2-3. Table 2-4 below presents the findings by test scenario based on the discussions with the project team and the results of the test.

Table 2-4. Geo-fencing Test Results by Test Scenario.

Scenarios			Tested by Itinerary Step	Result	Notes
No trip planned on Smart Phone Application (Pre-Trip)	1	Determine whether a user is 1) driving or 2) not driving.	5,7, 15	✓ (with constraints)	App not blocked when driving slowly or stopped.
	2	Determine whether a user 1) is near a bus/train stop when not driving or 2) is not near a bus/train stop when not driving.	-	-	Not Tested
	3	Distinguish between 1) a user who is riding a bus/train, and 2) one who is driving.	-	-	Not Tested
Trip planned on Smart Phone Application (En-Route)	4	Distinguish between 1) a user who is walking to a bus/train station, and 2) one who is driving to a bus/train station.	1, 3, 5, 7, 9, 11, 12, 13	✓	Confirmed. Based on GPS signal.
	5	Distinguish between 1) a user who is waiting at a bus/train stop, and 2) one who is passing a bus/train stop while driving.	4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	✓ (with constraints)	Confirmed with constraints
	6	Distinguish between 1) a user who is riding a bus/train, and 2) one who is driving along a bus/train route.	2, 4, 6, 8, 10, 14	✓ (with constraints)	Confirmed with constraints

2.3.2.1 Results of Test Scenario 1

For test scenario 1, the evaluation team used itinerary steps 5, 7, and 15 to confirm that using GPS data on the smart phone to control geo-fencing status is a sufficient way to prevent users from accessing the smart phone application while driving. The 5 mph threshold set by the PATH project team appeared to block the application for all smart phones when the GPS signal was available. However, the evaluation team observed several instances where the Windows Mobile phone was not able to obtain a GPS signal for significant portions of time. During this time, the application was open for use. Although this was primarily due to limitations in the smart phone capabilities, this situation as well as others where satellite connections are limited does identify a disadvantage to designing geo-fencing functionality that relies heavily on smart phone GPS data to prevent distracted driving.

Additionally, the evaluation team observed that the geo-fencing design with a 5 mph threshold is more effective at preventing distracted driving on certain types of roadways versus others. As mentioned in the Geo-fencing Design section, the geo-fencing status is constantly being checked and updated within the smart phone application by the system server. On roadways where there is mostly uninterrupted, free-flow traffic like interstates and major highways, the geo-fencing design is very effective at preventing users from accessing information on the application because driving speeds tend to not vary as much and rarely drop to less than 5 mph, which would open the application for use. However, on arterials and local roads where speeds are more variable due to greater occurrences of red lights at intersections, congestion, or stop and go traffic; the smart phone application is constantly being blocked and unblocked as driving speeds fluctuate above and below 5 mph. Although driver distraction may be less dangerous at lower speeds or when a vehicle is stopped, an unblocked smart phone application is another temptation among many that could attract driver attention to somewhere other than the roadway. While it was known that the geo-fencing design would not be able to block the smart phone application at speeds less than 5 mph, it is still important to note that the ability to access information on the application while operating a vehicle at any speed is distracting. Moreover, it is possible that users could begin to recognize the opportunity to access the application at speeds less than 5 mph or when stopped, which could cause an even greater level of distraction if users adjust driving behavior to gain access to the application. While this specific scenario is likely far-fetched, the above observations suggest that completely eliminating distraction due to a smart phone application likely requires completely eliminating driver access to that application.

2.3.2.2 Results of Test Scenario 4

For test scenario 4, the evaluation team used itinerary steps 1, 3, 5, 7, 9, 11, 12, and 13 to confirm that the geo-fencing design can indeed distinguish between users driving to a transit station and users walking to a transit station. The geo-fencing design's ability to identify this scenario relies on GPS speed data from the user smart phone. When the user was traveling at or above 5 mph while en route to a transit stop/station, the application was blocked. Alternately, when the user was walking to a transit stop/station, the application was not blocked. However, the same concerns about distracted driving in regard to the limitations of the geo-fencing design in terms of the 5 mph threshold discussed in test scenario 1 apply to test scenario 4 as well.

2.3.2.3 Results of Test Scenario 5

Scenario 5 was tested using itinerary steps 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 14. As described previously, the geo-fencing design uses a time and a distance constraint to determine whether or not a user is waiting at a transit station/stop. The evaluation team observed 10 instances where the geo-fencing design successfully distinguished between users waiting at a station/stop versus users driving past a station/stop and one instance where it did not. Seven of the test itinerary steps assessed the geo-fencing design's ability to recognize that a user was waiting at a transit station/stop while four steps tested whether or not a user could gain access to the application by driving near the beginning stop of a planned trip. All seven of the waiting steps and three of the driving steps confirmed the test scenario while the driving trip test in step 4 resulted in access to the smart phone application.

Purposely, the testers waited in the car near the beginning stop of a planned trip on light rail and followed the train just as it was boarding and departing the stop. The location of the smart phone being tested must have successfully met the time and distance constraints required for that transit station/stop. The testers in the car drove alongside the train, which was using a median right-of-way, closely for several blocks and were allowed complete access to the application. This means the smart phone test in the car must have also consistently met the route matching and trip history requirements of the transit trip planned, which resulted in the geo-fencing status being set to allow application access and not check status again. Even after the testers left the train route, the smart phone application on each phone continued providing updates to the transit trip. Although the testers were successful in gaining access to the smart phone application while driving by mimicking a light rail transit trip, it is highly unlikely that a normal user would a) know enough about the server logic to know geo-fencing exceptions, b) go to such lengths to access the application while driving, or c) stumble across this scenario during normal travel behavior. For those reasons, the one exception to test scenario 5 is not concerning in terms of distracted driving.

It is important to note that the other three driving trip tests successfully blocked the smart phone application despite the best efforts of the testers to follow the bus closely and mimic the transit trip while driving. It appears that the varying distance constraints for the different beginning transit stations/stops was the primary factor in confirming or denying test scenario 5. The bigger the distance constraint, the easier it was for the testers to meet the initial distance and time criteria for mimicking a transit trip while driving.

2.3.2.4 Results of Test Scenario 6

For test scenario 6, the evaluation team used itinerary steps 2, 4, 6, 8, 10, and 14 to confirm that the geo-fencing design can indeed distinguish between users driving along a transit route versus users taking transit. In the first itinerary step, the testers took a transit trip on Caltrain and confirmed that geo-fencing design could successfully allow actual transit riders to access the application while taking transit. The remaining itinerary steps resulted in the same observations discussed in test scenario 5 above. These were trips where testers attempted to mimic a transit trip by waiting near a transit station/stop and then following a bus/train along the transit route while driving in a car. As discussed, the evaluation team observed one scenario where the user was allowed access to the smart phone application while driving along a transit route. Generally, the time and distance constraints as well as the route matching and trip history requirements implemented into the geo-fencing design successfully prevent drivers from mimicking transit trips to gain access to the applications. Again, the likelihood of users going to these lengths to gain access to the smart phone application is probably low. It does not seem likely that distracted driving would occur as the result of test scenario 6.

In several other transit trips not listed in the test itinerary, the evaluation team did observe several instances where the smart phone application was blocked while truly riding transit. Although unrelated to distracted driving, implementing a geo-fencing design into the smart phone application that primarily provides transit information may detract from the user experience of actual transit riders.

3. USAGE STATISTICS

To better understand how the PATH2Go applications were used, the evaluation team planned to collect usage data for each of the applications and worked closely with the project team to determine the best method for tracking usage. Because of the complicated server structure that provides information to all three applications, collecting usage statistics for each of the applications individually proved difficult. Additionally, separating usage data for registered users versus anonymous users was also a challenge.

Despite the difficulties, the project team was able to establish tracking logs for each of the servers that provide information to the PATH2Go applications. The logs developed by PATH were useful for tracking the number of registered users as well as identifying the general usage the applications. In addition to the tracking logs, the project team also used a web analytics tool called Google Analytics™ to track usage of the PATH2Go Trip Planner and PATH2go Web Based Traveler Information applications specifically. As mentioned in the Background section, the two applications are hosted on the same website and are accessible from each other despite providing different information. Therefore, the data collected by Google Analytics provides usage information for all visits to either website application by both registered users and anonymous users together.

Although the PATH2Go applications were officially launched on July 29, 2010, not all usage information was available immediately. The number of registered users and number of anonymous user sessions for the PATH2Go applications were tracked from the beginning, but additional server logs and Google Analytics tracking were not implemented until mid-August 2010. The server logs developed by PATH were primarily used to identify the total number of registered users and to assess the general usage of the PATH2Go Smart Phone Application.

The Google Analytics data provided the opportunity to analyze more detailed usage information for the two website applications and was collected from mid-August to mid-November 2010, when the evaluation period came to an end. Google Analytics provides data on the frequency of visits, looking at whether users were returning or new to the website, and looking at where the majority of web traffic was originating. This information supplements the other evaluation activities in determining how frequently the website applications are used and by what audiences. Some of the specific measures available in the website analytics tracker include:

- Visitor frequency.
- Visitor type (i.e., new vs. returning).
- Visitor location.
- Visitor trending (e.g., page views, time on site, total visits).
- Visitor loyalty (e.g., recency, length of visit, loyalty).

All of these measures are available by day or over any specified time period, allowing for an in-depth analysis of website usage. With the wide variety of metrics available on Google Analytics™, the evaluation team was able to perform specific analyses that are important to evaluating usage of a website.

In the sections below, the evaluation team presents a high-level analysis of usage statistics for the PATH2Go Smart Phone Applications using the server logs provided by PATH and a more detailed analysis of the usage statistics for the PATH2Go Trip Planner and PATH2Go Web Based Traveler Information website applications together using data collected with Google Analytics. Both sets of analyses allowed the evaluation team to identify the user base, observe how usage was affected by targeted marketing efforts, and capture user characteristics for the all of the PATH2Go applications.

3.1 APPLICATIONS LAUNCH

As mentioned in the Background chapter, the PATH2Go applications were officially launched on July 29, 2010 on MTC's 511 website[8]. The 511 website is a very popular and well-known source for detailed travel and transportation information in the San Francisco Bay Area. Over a million users visit the website each day. The applications were advertised on the homepage of the website with an advertisement link (identified with the red arrow in Figure 3-1 below) for four to five weeks through August and into September 2010. In addition to the advertisement on Announcements section of the homepage, the application was also temporarily available on the Traffic page of the website and permanently added to the list of third party applications featured on the Mobile & Apps page. The link provided on the 511 website led users to the Networked Traveler project website which provided background information on each application.

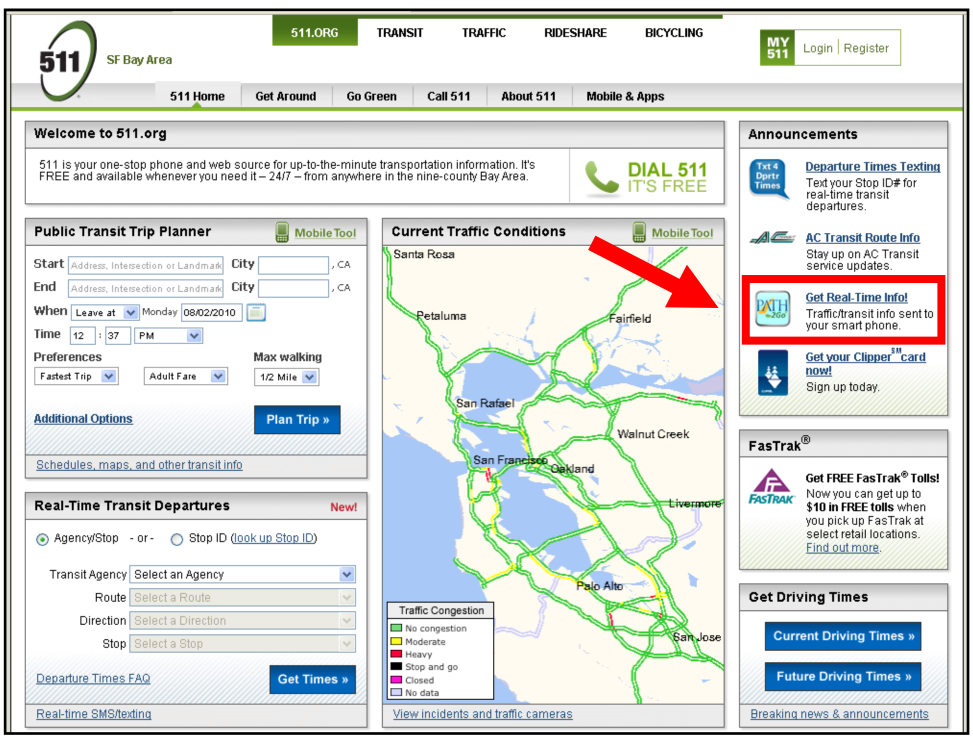

Figure 3-1. PATH2Go applications Launch on MTC 511 Website, July 29, 2010.

Although the MTC advertisement served as the primary launch for all three PATH2Go applications, the PATH2Go Smart Phone Application was also launched into the respective app markets for the iPhone and Android versions of the application separately. Titled *PATH2Go*, the

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[8] Link to the MTC 511 website: http://www.511.org/

iPhone app was released into the Apple iTunes App Store just prior to the primary launch on July 20, 2010. The Networked Traveler project website was available at the time in preparation for the MTC launch, so iPhone owners could technically download the iPhone app and register as users before the test's official launch. Also titled *PATH2Go*, the Android app was released into Google's Android Marketplace around September 6, 2010. The Windows Mobile version of the application was only available for download from the Networked Traveler project website, so it was launched with the MTC advertisement. Users could choose between having a link to the application download sent to their smart phone via text message or they could navigate to the Networked Traveler project website via their smart phone web browser to click on a link and download the application.

Although efforts to increase awareness of the PATH2Go applications were on-going, the evaluation team began collecting usage statistics as soon as they became available. It is important to note that the evaluation period is defined as July 29, 2010 through November 15, 2010, or from when the applications were officially launched until the evaluation ended.

3.2 USER BASE

Knowing the total number of users who have accessed the PATH2Go applications is an important factor in evaluation. This information helped determine the expected sample size for user survey activities, and has helped provide insight into the level of exposure that the PATH2Go applications received. The first metric considered was the total number of registered users. As mentioned before, the server logs developed by PATH helped tracked the total number of registered users throughout the evaluation period. Figure 3-2 below shows the growth in registered users throughout the evaluation period, which includes users from all three applications. Again, users who wanted to use the PATH2Go Smart Phone Application were required to register while users accessing the PATH2Go Trip Planner and PATH2Go Web Based Traveler Information website could do so anonymously or logged in as a registered user. Therefore, the number of registered users in the figure below contains all smart phone application users, but may also include users who registered but only used the website applications and does not show users who used either website application but did not register. As of November 15, 2010, there were a total of 905 registered users for the PATH2Go applications.

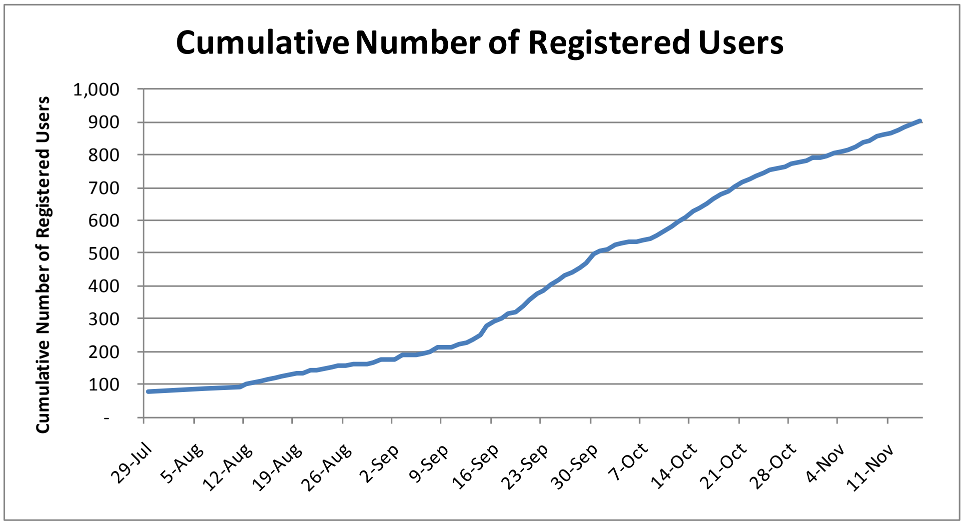


Figure 3-2. Cumulative Number of Registered Users, July 29, 2010 – November 15, 2010.

3.2.1 PATH2Go Smart Phone Application

Next, the evaluation team was able to use the tracking logs provided by PATH to determine how many of the total registered users had downloaded and opened the PATH2Go Smart Phone Application at least once. Using tracking code that recorded requests sent from the smart phone to the server each time a user started the smart phone application, the evaluation team determined that 602 of the 905 registered users, or 67 percent, had downloaded and opened the smart phone application at least once. Figure 3-3 below presents the total number of users that opened the PATH2Go Smart Phone Application each day. Please note that this tracking information was only available from August 23, 2010 – November 2, 2010, which is a subset of the evaluation period. Therefore, any calculations made for the PATH2Go Smart Phone Application usage using these tracking logs are conservative.

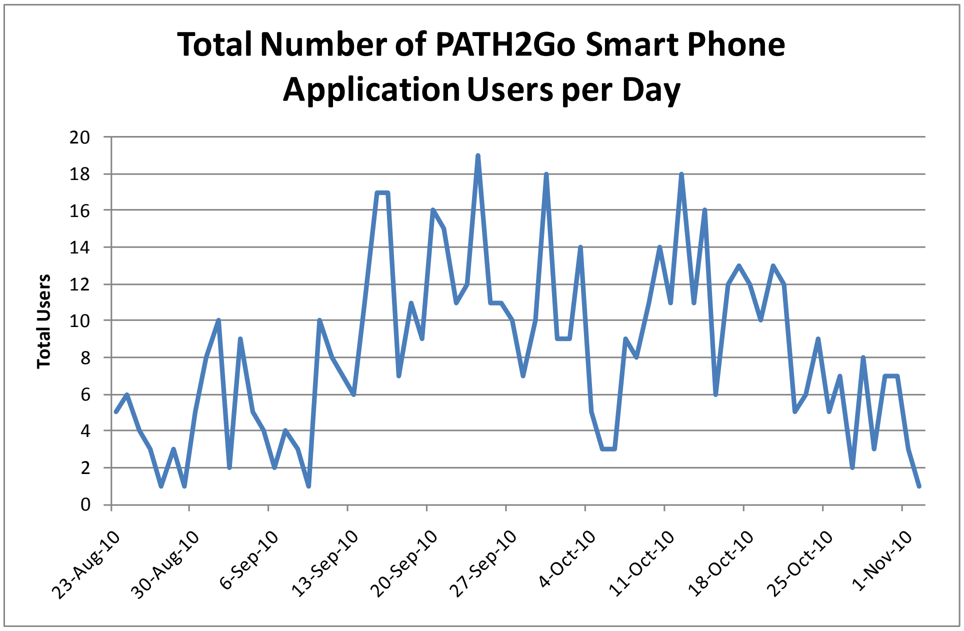


Figure 3-3. Total Number of PATH2Go Smart Phone Application Users per Day, August 23, 2010 – November 2, 2010.

Further calculations were made to better understand how often users were opening the smart phone application. The average total number of times a user opened the application on their smart phone was 6.16 times. Interestingly, 202 of the 602 smart phone applications users, or 34 percent, only opened the application one time. However, according to research presented in a February 2009 *InformationWeek* article on Apple App Store downloads[9], this trend can be expected for smart phone application downloads.

According to the research conducted by an iPhone application analytics firm called Pinch Media, "most people stop using iPhone applications downloaded from Apple's App Store after the first day." After monitoring more than 300 million downloads, the firm found that only 20 percent of users downloading free apps and 30 percent of users downloading paid apps were using the applications the next day. With 66 percent of users returning for more than one use, the PATH2Go Smart Phone Application seems to have successfully captured user attention. In fact, when one-time users are excluded, the average total number of times a user opened the smart phone application rises to 8.76 times.

It is important to note that the accuracy of the methodology used to determine the number of one-time smart phone application users is dependent on the type of smart phone. The numbers presented above are conservative and represent the highest number of one-time users possible based on the server logs. Some smart phones including the iPhone 4 and certain Android models have functionality that keeps applications running in the background when a user navigates to another app versus exiting the application completely. For this reason, it is possible that some of the 202 users who were recorded as one-time users could have used the

[9] Gonsalves, Antone. "Apple App Store Downloads Often Abandoned." InformationWeek. InformationWeek Business Technology Network. 20 Feb. 2009. Web. 6 Dec 2010.

Link to article:
http://www.informationweek.com/news/personal_tech/iphone/showArticle.jhtml?articleID=214502225

application several times during a single session where as other smart phone models would have opened and closed the app several times showing multiple sessions.

3.2.2 PATH2Go Website Applications

By taking the difference in total registered users and those who downloaded the smart phone application and opened it at least once, the evaluation team observed that 303 of the registered users, or 33 percent, only used one or both of the PATH2Go website applications. While the number of registered users using the website applications only is now known, it is possible that all or some of the users who downloaded the smart phone application could have also used the website applications logged in as a registered user or anonymously. Therefore, Google Analytics was used to gain further insight into usage of the website applications by registered users and anonymous users together. Again, it is important to note that the PATH2Go Trip Planner and PATH2Go Web Based Traveler Information are hosted on the same website. Google Analytics cannot distinguish between the use of each application, so the analysis includes usage of both applications together.

There are two metrics available in Google Analytics™ which are important to distinguish between when analyzing website usage: *visits* and *visitors*. The number of visits is an indication of the general usage of a website, as in how many times the content is viewed in total, where as the number of visitors is an indication of how many individuals are using the website. A single visitor could account for multiple visits after using the website more than once. Figure 3-4 shows the website usage by total number of visits per week from the website's launch through the end of the evaluation period in November 2010.

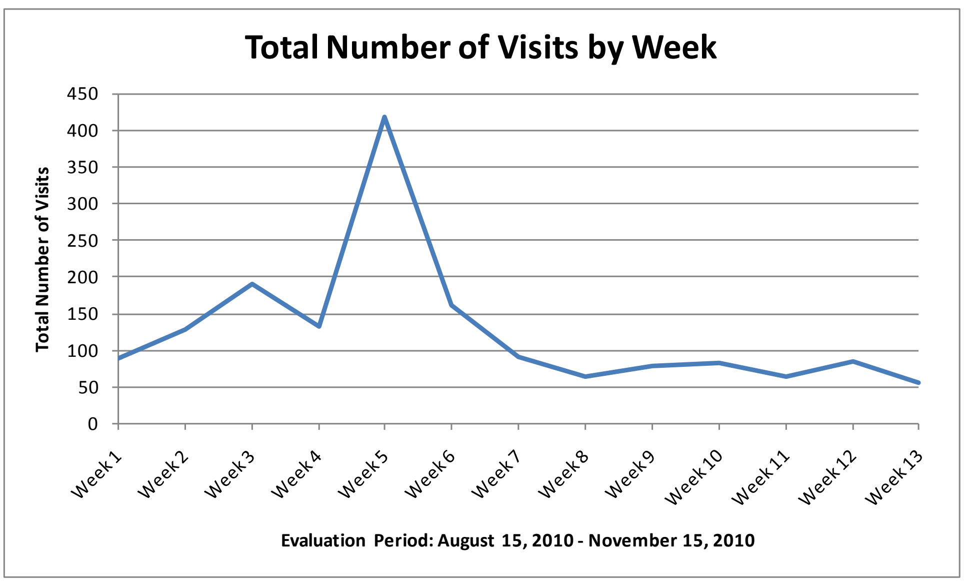


Figure 3-4. Total Number of Website Visits by Week, August 15, 2010 – November 15, 2010.

It is important to realize that a large number of visits does not necessarily translate to a large number of visitors and vice versa. The number of visits is an indicator of how much the website is being used, while the number of visitors is an indicator of how many people are using the website. The relationship between visits and visitors can provide insight into how frequently visitors are using the website, which will be addressed specifically in the discussion of website user characteristics later in this chapter. The total number of individuals who have visited the website one or more times, or visitors, is the metric used to determine the website user base. Google Analytics™ determines the user base by measuring *absolute unique visitors.* This metric uses first party cookies stored on a user's computer to determine if he/she has visited the website previously within a specified time period. It is important to consider the possibility of error in this metric as web browsers generally allow users to delete or disable cookies if they would like (i.e., if a user deletes his/her cookies before returning to the website again, he/she will be marked as an absolute unique visitor on his/her next visit). However, as long as users have not deleted their cookies at any point over the time span of using the website, they will be recognized as a returning visitor for up to 2 years and only counted once as an *absolute unique visitor* over the website life cycle.

Figure 3-5 shows how the website user base has grown over time from when the PATH2Go Applications were first launched at the end of July 2010 through the end of the evaluation period in November 2010. Apparent in both Figure 3-4 above and Figure 3-5 below, the number of users visiting the website experienced a significant increase in early September. Possible explanations for the sharp increase in visits and visitors will be addressed in the next section of this chapter.

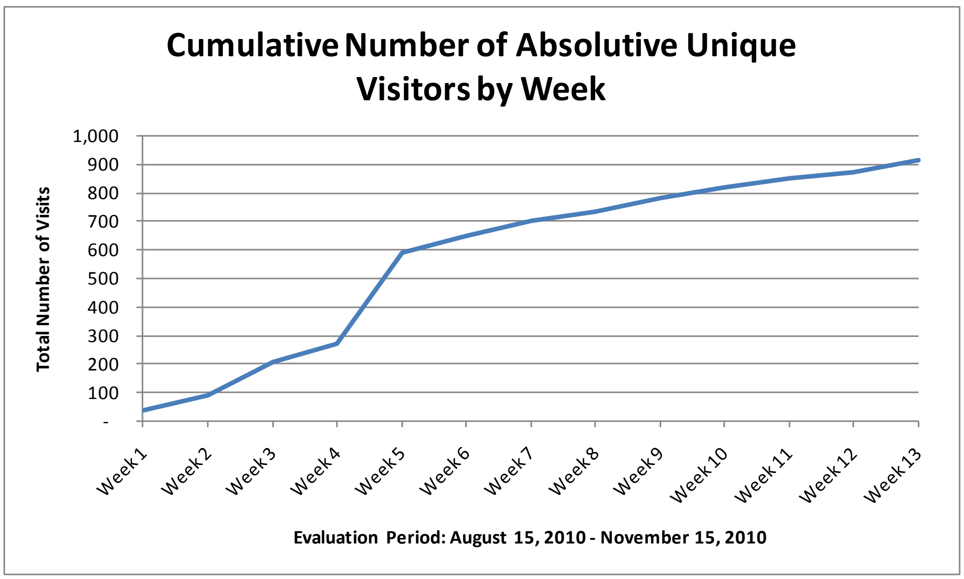


Figure 3-5. Cumulative Number of Absolute Unique Visitors by Week, August 2010 – November 15, 2010.

As of November 15, 2010, a total of 916 absolute unique visitors made up the PATH2Go website applications user base, accounting for 1,664 total visits to the website, and an average of 1.82 visits per user.

3.3 TARGETED MARKETING EFFORTS

A discussion of the PATH2Go applications user base and how it has grown over time transitions well into the topic of how website usage was affected by targeted marketing efforts put forth by the project team. Exploring what events may have caused the various spikes in usage of the PATH2Go applications provides additional insight into the user experience. It also addresses the public need for and use of the applications aside from what can be learned from survey activities. In addition to analyzing usage statistics, the evaluation team actively monitored outreach efforts put forth by the project team and any corresponding media coverage or website posts where the PATH2Go applications were mentioned or advertised. By looking at the response to marketing efforts put forth by the PATH team, lessons learned can be compiled about what efforts are most effective in “spreading the word” about real-time traveler information tools like the PATH2Go applications.

3.3.1 Impact of Direct Marketing on Usage

The project team took several strides to market the PATH2Go applications to Bay Area travelers, beginning with its launch on the MTC 511 website on July 29, 2010. Additionally, there were three other major marketing efforts coordinated by the project team. First, PATH worked with the communications staff at the UC Berkeley Institute of Transportation Studies (ITS) to prepare and distribute a press release explaining the research that produced the PATH2Go applications. The press release was distributed on August 31, 2010 and immediately received the attention of several local and regional media outlets over the following days. Although there were over 900 hits on the press release website and several questions from major media outlets, local Berkeley news outlets including the student-run newspaper and UC Berkeley news center and several transit/transportation websites and blogs were the primary sources of coverage resulting from the press release.

The usage data collected for the PATH2Go website applications using Google Analytics was the best source for insight into the impact of the press release and corresponding media coverage. Figure 3-6 below shows website usage in number of visits by day. There is a clear increase in visits to the website applications beginning on the day the press release was distributed. The full press release is available in Appendix C. In addition to collecting usage statistics, the evaluation team also recorded a detailed list of the specific media coverage and internet sources that referenced or mentioned the PATH2Go applications. This list is provided in Appendix D.

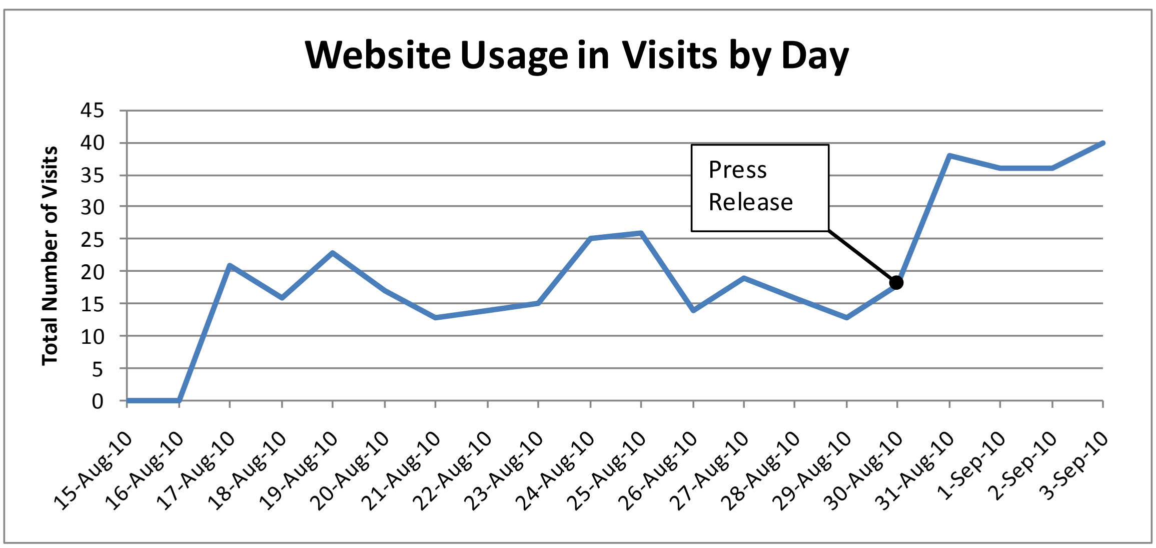


Figure 3-6. Website Usage in Visits by Day, August 15, 2010 – September 3, 2010.

From the beginning of September through early October 2010, the PATH team added another targeted marketing effort by distributing flyers two or more times per week at various transit stations covered by the PATH2Go applications. With the permission of several transit agencies, PATH staff stood on transit platforms and at bus stops handing out flyers to increase awareness of the applications from the beginning of September 2010 through early October 2010. The flyer developed by PATH is available in Appendix E.

Because it provided background information for each three PATH2Go applications, the press release and flyer developed by PATH as well as the MTC launch all advertised a link to the Networked Traveler project website[10] as shown in the Appendices. The Google Analytics data presented above was for the website applications only. The evaluation team also had access to usage data using Google Analytics for the Networked Traveler project website. Because that was the link advertised in these three major marketing efforts, the usage data for the project website provides additional insight into the impact of the press release on awareness of the PATH2Go applications. Figure 3-7 below presents the website usage in number of visits by day for the Networked Traveler project website throughout the entire evaluation period. The figure shows an even more drastic increase in website usage on the project website compared to the actual website hosting the PATH2Go website applications. In fact, the number of visits to the project website almost reached 100 in the days following the press release while usage of the website applications did not exceed 40 visits. This indicates that a number of website visitors responding to the media coverage viewed the project background information, but did not continue on to try or use the website applications. This is a possible indicator of usefulness. The other various bumps and spikes in visits to the project website through early October can likely be attributed to PATH's efforts in distributing flyers at transit stations to market the applications. However, without the actual dates that flyers were distributed, this cannot be stated with any certainty.

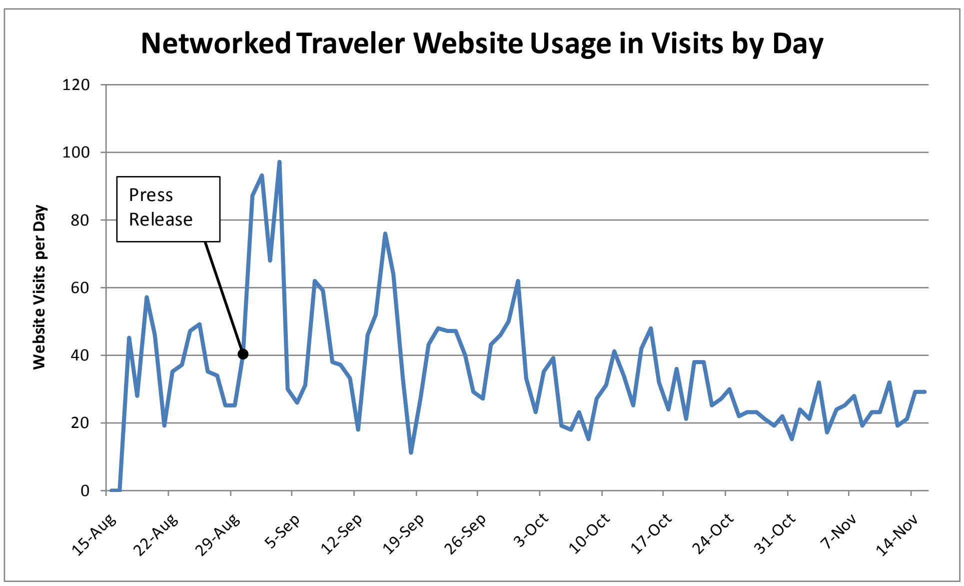


Figure 3-7. Networked Traveler Project Website – Usage in Visits by Day, August 15, 2010 – September 3, 2010.

PATH coordinated one last targeted marketing effort using the social media website, Twitter™. The project team posted a "tweet" to the "followers" of *caltrain* Twitter account, which allows Caltrain riders that use Twitter to post and/or receive delay information or service updates as

[10] Link advertised for the Networked Traveler project website: **www.networkedtraveler.org**

they are happening through the account[11], which enjoys the attention of over 5,000 followers. On September 15, 2010, the project team posted a link directing users to the specific Caltrain real-time schedule and parking information available on the PATH2Go Web Based Traveler Information website. Figure 3-8 below shows the tweet posted by PATH on the *caltrain* Twitter page as well as a few examples of normal tweets posted on the account.

Figure 3-8. Twitter Post on *caltrain* Twitter page.

The usage data collected using Google Analytics was able to capture the impact of this effort. Figure 3-9 below shows the staggering increase in website usage resulting from the Twitter post. In fact, website usage prior to the tweet and through the remainder of the evaluation period after the tweet pales in comparison to the number of website visits on the days immediately following the *caltrain* tweet. The website traffic generated by the Twitter post increased the total number of absolute unique visitors by 104 percent and the total number of visits by 66 percent in the span of five days.

The figure below also shows website usage for the entire evaluation period. Figure 3-9 actually presents the same information as Figure 3-4 in the User Base section above. However, the figure below uses a different collection period interval (by day instead of by week) and clearly paints a different picture. The increased definition in the graph clearly shows how the targeted marketing efforts, which can occur on a single day or over successive days, significantly affected website usage. From the perspective of the entire evaluation period, usage increased initially but fluctuated after the targeted marketing efforts of preparing a press release and distributing flyers at transit stations. While this increased the size of the user base, usage of the PATH2Go website applications experienced a staggering increase after social media was used as a marketing tool.

[11] Link to the *caltrain* Twitter page, which includes instructions on how to post a "tweet": **http://twitter.com/#!/caltrain**

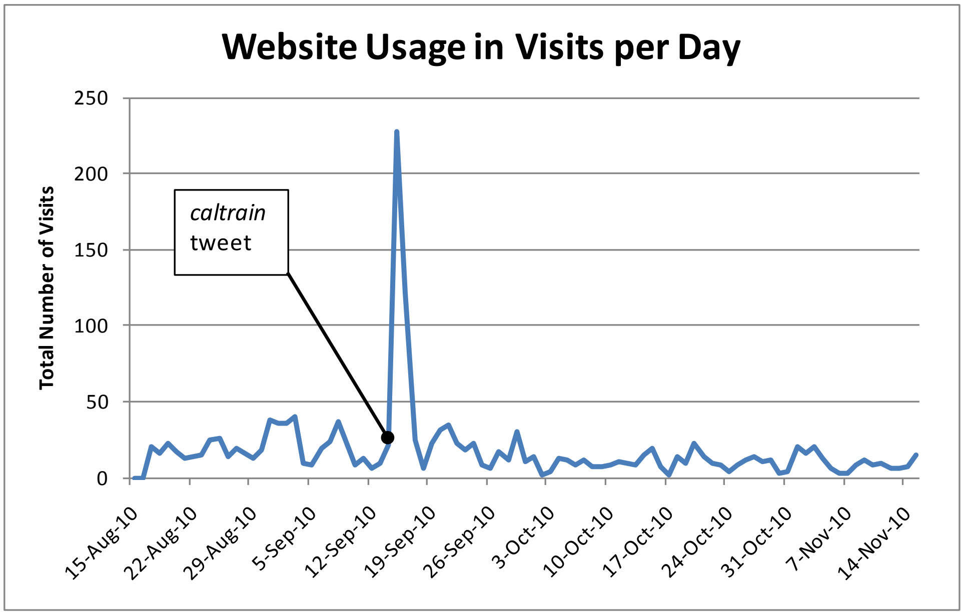


Figure 3-9. Website Usage in Visits by Day, August 15, 2010 – November 15, 2010.

These observations suggest that newer, more progressive forms of marketing like using social media websites such as Twitter can be significantly more effective in increasing awareness of real-time traveler information like the PATH2Go applications. However, it is important to point out that using social media without a focus may not be as effective. The significant increase in website usage is likely the result of targeting a specific group on Twitter with a vested interest in the type of information provided by the PATH2Go applications.

Although still effective, it seems that more traditional forms of marketing like preparing a press release cannot generate the same level of exposure as quickly as a targeted social media effort without being covered by a major media source.

Overall, usage seemed to settle into somewhat of steady up and down pattern after the initial marketing efforts put forth by the project team. Then, the response to a tweet on the *caltrain* Twitter account clearly had a major impact on usage. However, the impact was short-lived as usage quickly returned to its rolling pattern of approximately five to thirty website visits per day. While social media may have a greater ability than traditional marketing to attract a large number of visitors to a website quickly, the usefulness of or need for the information available on a website is generally what drives return visits.

3.4 USER CHARACTERISTICS

In addition to determining the user base and exploring what establishes and drives usage, it is equally important to observe the general characteristics and actions of users in regard to the use of the PATH2Go applications. While some of this analysis was presented in the user base section above for the PATH2Go Smart Phone Application, Google Analytics provides detailed usage statistics that offer insight into user behavior when accessing a website. This analysis provides insight into the visitors' use of the website such as frequency by which they visit, the means by which they access the website, and the general geographic location of website users. Although this section will focus primarily on user characteristics related to the PATH2Go website applications, it will also provide insight into how users became aware of the PATH2Go applications as a whole. User characteristics for the PATH2Go website applications were available for August 15, 2010 through November 15, 2010 using Google Analytics.

3.4.1 Trends in User Frequency

Determining how frequent visitors use the website is as important to the evaluation as knowing the size of the user base. The following metrics show what percentage of users only visit the website one time versus those who return for additional visits. These measures can serve as key indicators in understanding how useful the website appears to be or how often the users have a need for this type of information. Google Analytics breaks down visitor frequency into two different metrics: "loyalty" and "recency."

Visitor loyalty provides a useful assessment of how often users are returning to the website relative to the evaluation period. Figure 3-10 shows that approximately 45 percent of website users returned to the website for additional visits following their first visit.

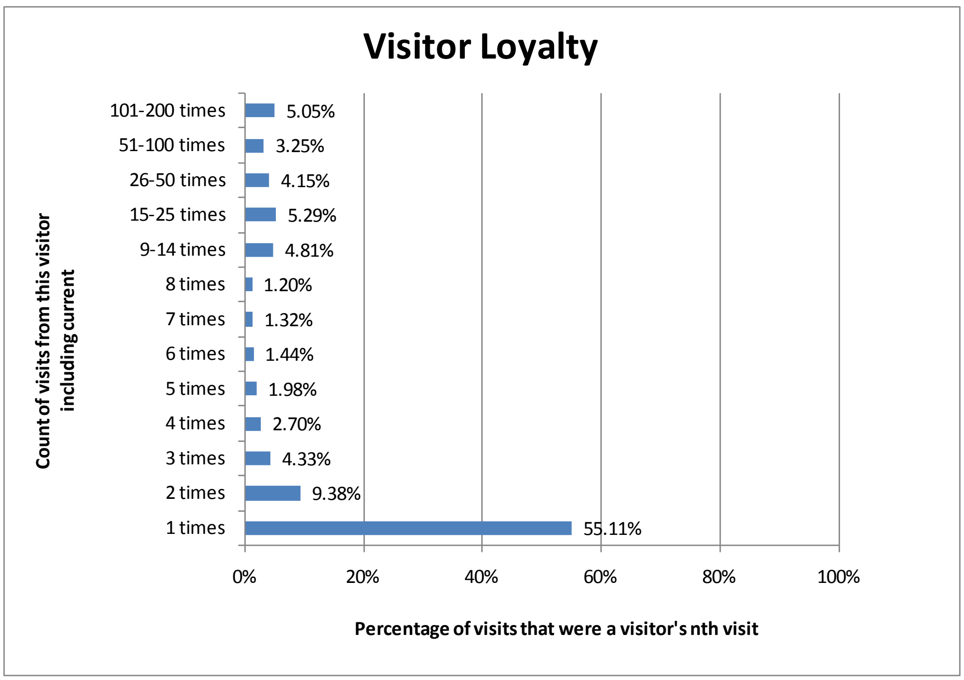


Figure 3-10. Visitor Loyalty, August 15, 2010 – November 15, 2010.

Visitor loyalty can be an indicator of user acceptance and need for a website, but it is difficult to infer why more than half of first-time website users did not return for another visit. Figure 3-10 also confirms what Figure 3-9 above shows. The large number of visits generated by the *caltrain* tweet was short lived and did not result in a consistent level of usage from that point forward. A wide variety of factors could contribute to this trend. Possible reasons include:

- **Length of Evaluation Period and Frequency of Travel on Transit.** It is also possible that a large number of website users travel on transit only a handful of times per year and only access the website when needed. Many users may not have had a need for repeat use of the website within the evaluation period of three months.

- **Usefulness of Real-time Information.** Some users may solely use the website to identify their transit options. Despite the fact that the website provides real-time schedule and trip planning information, users may not find a need to return to the website after identifying the best mode and route for their trip. It seems intuitive that frequent transit riders or commuters would be more interested in the real-time information but may have less of a need for trip planning capabilities while infrequent transit riders may have equal or less interest in the real-time information but more interest in the trip planning capabilities. Real-time information may not be as important to transit riders who are not waiting at transit stops/stations or affected by transit delays as often. Another possibility is that users were looking for information about a specific transit route or parking lot that was not covered by the website and did not return because that information was not available.

- **Perceived Value of Website.** It is possible a large number of initial visitors could have accessed the website quickly in response to any of the targeted marketing efforts for a preview of what information was available on the website, but did not initially find it to be useful enough to warrant a return visit. It is important to note that these one-time visitors are still considered to be part of the website user base.

- **Website Functionality**. First-time visitors may have had problems with website functionality or difficulty using the website and elected not to return for an additional visit.

Figure 3-11 provides additional insight into visitor frequency by showing visitor recency, or how many days typically go by before visitors return for subsequent visits. It is important to note that only the most recent user behavior is recorded in the visitor recency metric. These measurements are all correlated to when the user last visited the website. For example, a user who visited the website for the first time on Day 1, but then did not return to the website until Day 7, would be included in the "6 days ago" category for visitor recency measured on Day 7. However, if this same user returned on Day 8 and visitor recency was recorded on Day 9, the user would then be included in the "1 days ago" category. Therefore, the measure of recency is always relative to when recency is recorded, which is November 15, 2010 for the figure below.

As Figure 3-10 indicated and Figure 3-11 confirms, over 55 percent of users have only visited the website one time. However, Figure 3-12 below only includes the *previous visits tracked* for return visits to the website (i.e., the *first visit* category was removed and percentages were calculated based on the remaining categories). Relative to November 15, 2010, Figure 3-12 shows that over 70 percent of visits by return visitors to the website were made within the same day as their last visit. Although no conclusions can be drawn about what percentage of website users are represented in this figure because of the significant difference between *visits* and *visitors*, it does show that often times return users visit the website more than once a day. This trend suggests that users who have used the website more than once prefer to view the information presented on the website several times in one day in order to make the best use of it, which seems intuitive to real-time information.

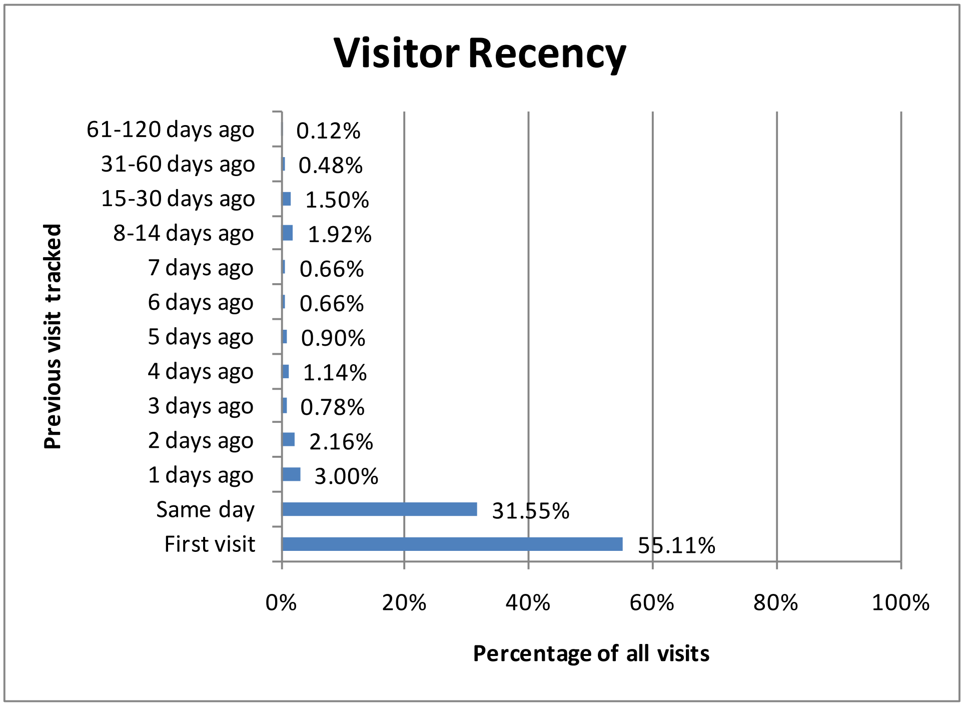


Figure 3-11. Visitor Recency, August 15, 2010 – November 15, 2010.

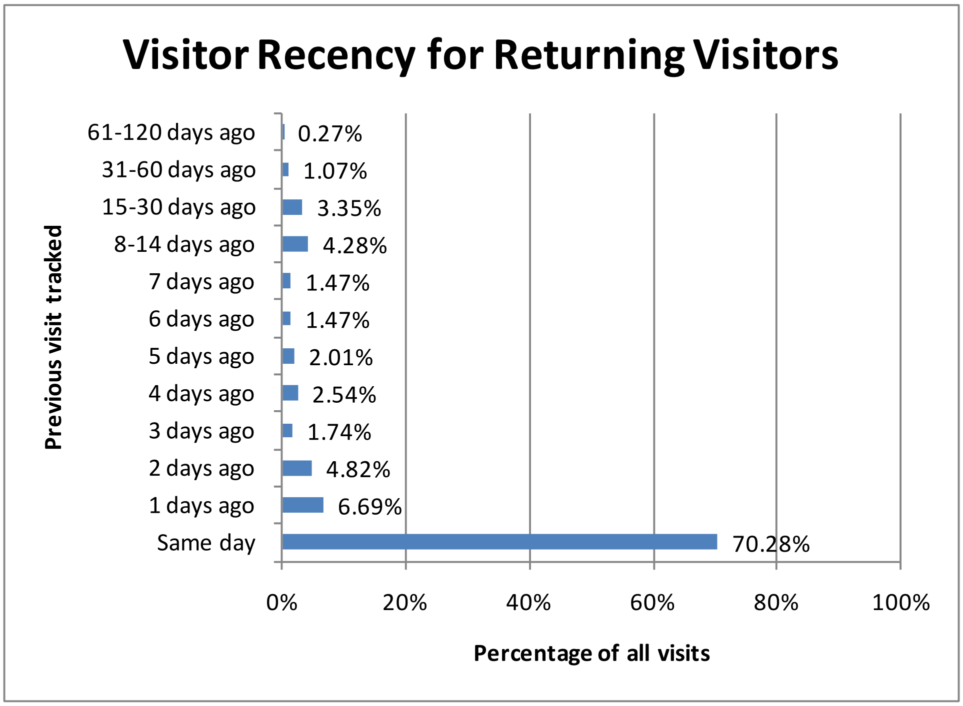


Figure 3-12. Visitor Recency for Returning Visitors Only, August 15, 2010 – November 15, 2010.

3.4.2 Trends in Website Visits

There are several Google Analytics metrics that provide a snapshot of the typical user visit to the website. The analyses below give insight into typical user behavior as well as how website visitors generally use the information it provides. Figure 3-13 displays the total number of visits to the website by time of day. Overall, the highest usage is seen at 3:00pm and 6:00pm with a significant peak occurring at 4:00pm. Although steady usage occurs throughout the morning and into the early afternoon hours, website usage doubles at the 4 o'clock hour. This trend suggests that on the whole users find the information available on the website most valuable during the early afternoon rush hour, 3:00pm – 5:00pm.

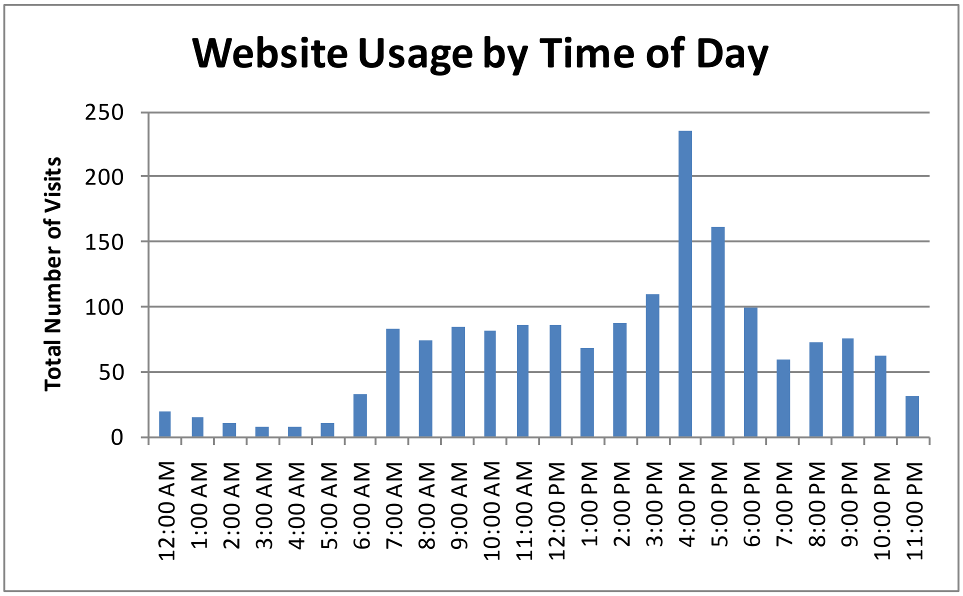


Figure 3-13. Website Usage in Visits by Time of Day, August 15, 2010 – November 15, 2010.

Figure 3-14 displays the total number of visits to the website by day of the week. Wednesday and Thursday account for the greatest number of visits to the website, which suggests traveler information is most useful in the mid to late work week.

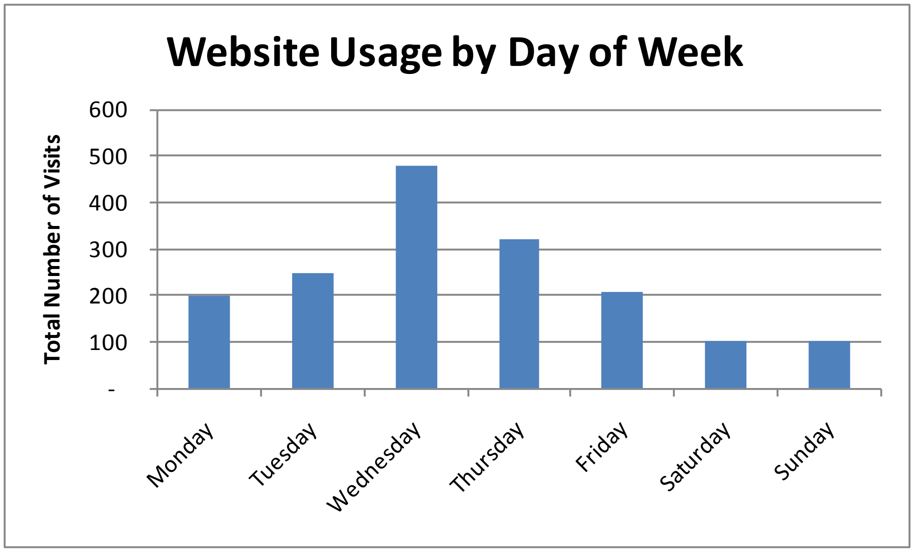


Figure 3-14. Website Usage in Visits by Day of Week, August 15, 2010 – November 15, 2010.

Another important metric to consider when analyzing website user characteristics is the amount of time users spend on the website. Figure 3-15 shows user length of visit, or how long users generally stay on the website when they visit. This figure suggests that users are spending very little time on the website when they are visiting, but it is important to understand how Google Analytics calculates this information before drawing this conclusion. This metric is actually recorded relative to the number of pages a user views while visiting the website. The program records the time when a user first arrives on the webpage and can only determine the length of visit when the user actually visits another page on the website or exits the webpage. It calculates the length of visit by finding the difference between the timestamp on the new page visited and the initial timestamp recorded on the original page visited. Because of this, a user must visit more than one page in order for a true length of visit to be recorded. Another indicator of how long visitors spend on the website is the average time on site calculated throughout the evaluation period, which was 2 minute and 12 seconds.

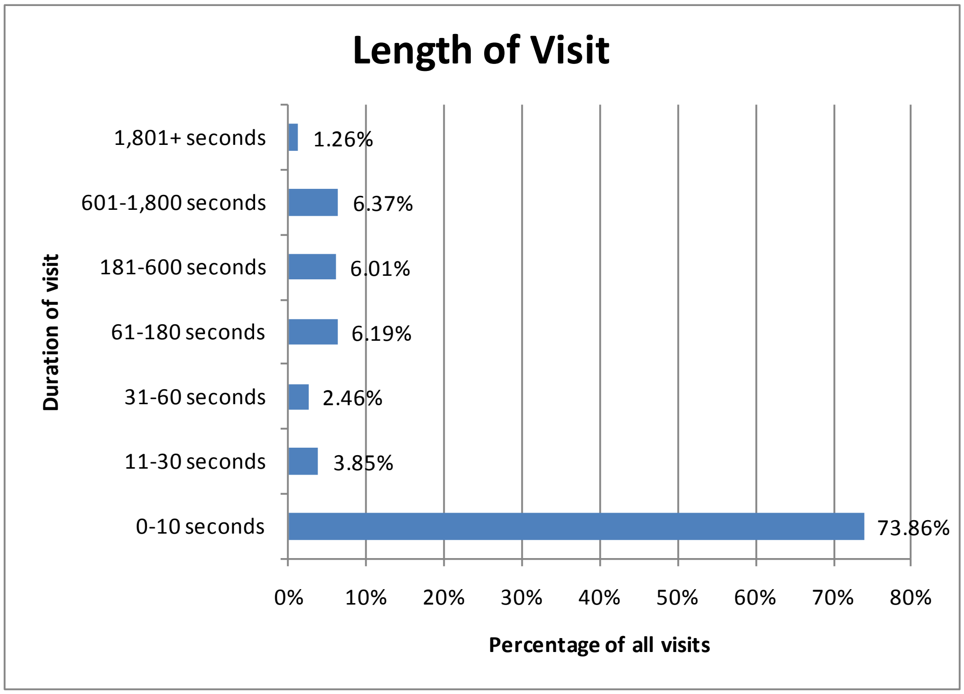


Figure 3-15. Length of Visit, August 15, 2010 – November 15, 2010.

3.4.3 Trends in Accessing the Website

Another important factor to analyze when considering the functionality of a website is how users arrive to the website in the first place. Source websites can be identified by looking at the breakdown in number of visits by traffic source, or essentially what outlet visitors are using to arrive at the website. Figure 3-16 below shows the percentage of visits associated with each type of traffic source. Trends in the way users access the website provide insight into how most users are finding the website in the first place. With 73 percent of users traveling to the website from a referring site, the remainder of the user traffic arrives by typing in the exact URL or using a bookmark in their browser (27 percent) or by typing keywords into a search engine (0.06 percent).

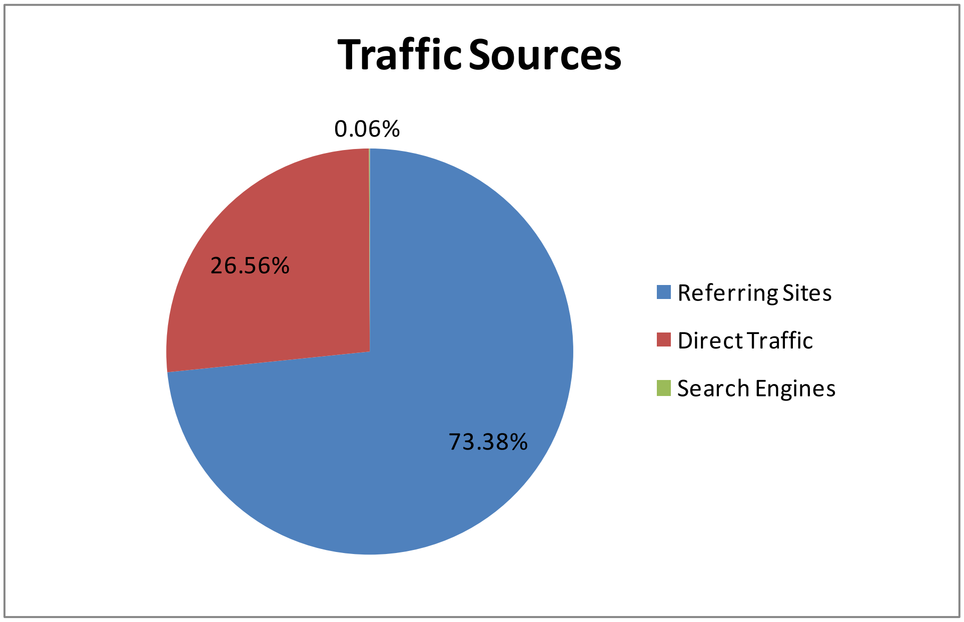


Figure 3-16. Types of Traffic Sources by Number of Visits, August 15, 2010 – November 15, 2010.

Table 3-1 below provides insight into which sources visitors are using to arrive to the PATH2Go website applications. As expected, the majority of visitors find their way to the website applications from the Networked Traveler project website. As mentioned above, the 27 percent of traffic that linked directly to the website can likely be attributed to visitors who have bookmarked the exact website URL. Social media, primarily Twitter, was the source of the remaining visits at slightly less than 15 percent.

Table 3-1. Traffic Sources by Number of Visits, August 15, 2010 – November 15, 2010.

Sources	Number of Visits	Percent
Referring site - networkedtraveler.org	962	57.81%
Direct Traffic	442	26.56%
Referring site - twitter.com	175	10.52%
Referring site - mobile.twitter.com	68	4.09%
Referring site - facebook.com	4	0.24%

Because the Networked Traveler project website was the primary traffic source for the PATH2Go website applications and was the website advertised for the MTC launch, press release, and flyer distribution, the Google Analytics traffic source data for the project website can provide additional insight into how users heard about the PATH2Go applications as a whole. Figure 3-17 below shows the percentage of visits associated with each type of traffic source for the project website. With almost 55 percent of users traveling to the website directly, the remainder of the user traffic arrived from a site with a link to the project website (36 percent) or by typing keywords into a search engine (9.36 percent).

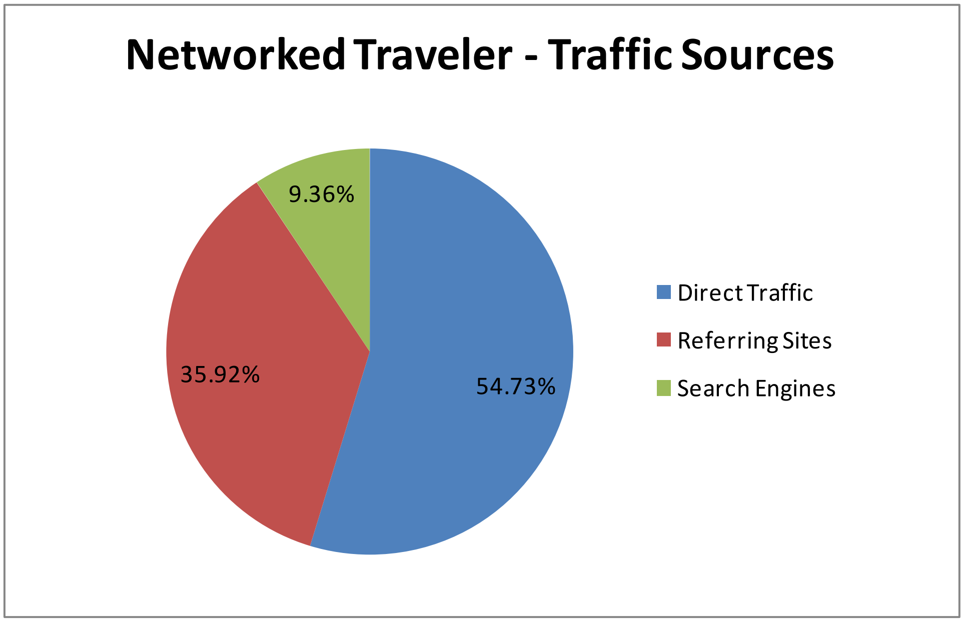


Figure 3-17. Networked Traveler Project Website – Types of Traffic Sources by Number of Visits, August 15, 2010 – November 15, 2010.

Table 3-2 below provides insight into which sources visitors led users to the project website. While the majority of visits come from users typing in the URL directly or having it bookmarked, the remaining lists shows a number of sources that can be directly attributed to the targeted marketing efforts. All of the 511.org sources are likely the result of the test launch on the MTC 511 website. Nearly all of the media outlets that covered the press release and are listed in Appendix D are accounted for in the table below. It is also possible that some of the direct traffic can be attributed to the flyers handed out by PATH staff.

Table 3-2. Networked Traveler Project Website – Traffic Sources by Number of Visits, August 15, 2010 – November 15, 2010.

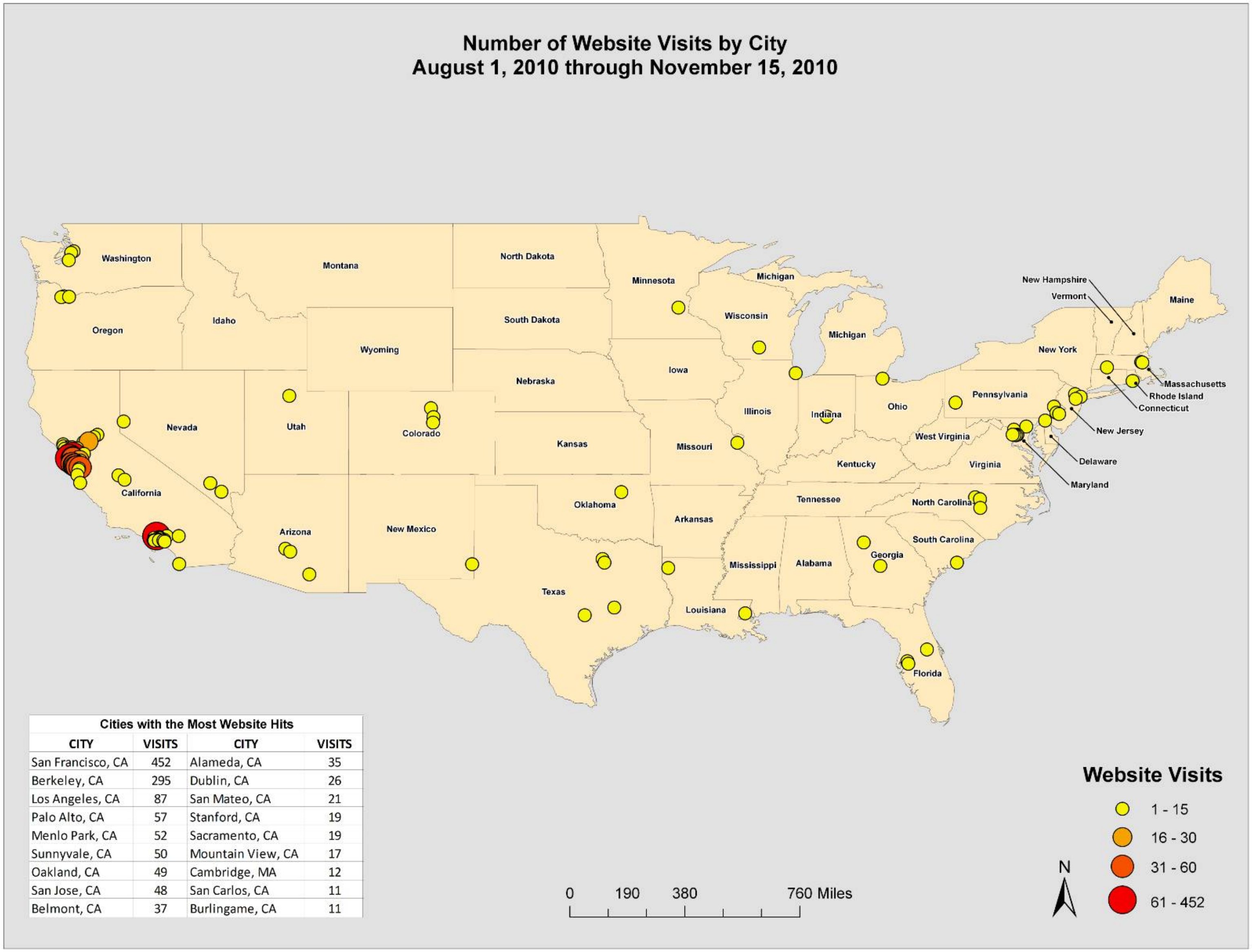
Sources	Number of Visits	Percent
Direct Traffic	1,766	54.73%
Referring Site - 511.org	482	14.94%
Search Engine - google.com	283	8.77%
Referring Site - tlab.path.berkeley.edu	122	3.78%
Referring Site - its.berkeley.edu	115	3.56%
Referring Site - traffic.511.org	110	3.41%
Referring Site - path.berkeley.edu	98	3.04%
Referring Site - my511.org	44	1.36%
Referring Site - tlab.path.berkeley.edu:8080	34	1.05%
Referring Site - americancity.org	21	0.65%
Search Engine - yahoo.com	16	0.50%
Referring Site - thetransitwire.com	14	0.43%
Referring Site - facebook.com	13	0.40%
Referring Site - aashtojournal.org	12	0.37%

Sources	Number of Visits	Percent
Referring Site - losangelestransportation.blogspot.com	12	0.37%
Referring Site - dot.ca.gov	11	0.34%
Referring Site - itunes.apple.com	11	0.34%
Referring Site - traffictechnologytoday.com	10	0.31%
Referring Site - masstransitmag.com	7	0.22%

3.4.4 Trends in Geographic Location of Users

Figure 3-18 and Figure 3-19 display the geographic location of website visitors based on their locations recorded in Google Analytics^{TM}, which are determined using visitor IP addresses. In regard to user privacy, it is important to note that the tool does not provide a list of IP addresses; it simply provides a city name and a State name for each visit to the website. The maps below represent density relative to website visits, which again is different from visitors. It is important to note that the densest areas on the map represent where the most use occurs, not necessarily where the most website visitors live.

After retrieving the list of cities from Google Analytics^{TM}, the evaluation team used the number of visits per city to create density maps, which group all cities into their corresponding areas. Figure 3-18 displays the website traffic across the entire country using a scale of circle size as an indicator of density. As shown in the figure, the website received national exposure with website users from all over the United States. While the PATH2Go applications provides information that is primarily for travelers in the San Francisco Bay Area, the additional usage from areas around the countries can likely be attributed to either out-of-town travelers that find the information useful or researchers or practitioners interested in learning more about the PATH2Go applications. Figure 3-19 provides show website usage in the Bay Area. As expected, the most usage occurred in the areas along and surrounding US-101 corridor. Of the website visits in the Bay Area, San Francisco, Redwood City, Berkeley, San Jose, and Oakland accounted for the most website visits.



Cities with the Most Website Hits

CITY	VISITS	CITY	VISITS
San Francisco, CA	452	Alameda, CA	35
Berkeley, CA	295	Dublin, CA	26
Los Angeles, CA	87	San Mateo, CA	21
Palo Alto, CA	57	Stanford, CA	19
Menlo Park, CA	52	Sacramento, CA	19
Sunnyvale, CA	50	Mountain View, CA	17
Oakland, CA	49	Cambridge, MA	12
San Jose, CA	48	San Carlos, CA	11
Belmont, CA	37	Burlingame, CA	11

Figure 3-18. National Website Usage by City Density, August 15, 2010 – November 15, 2010.

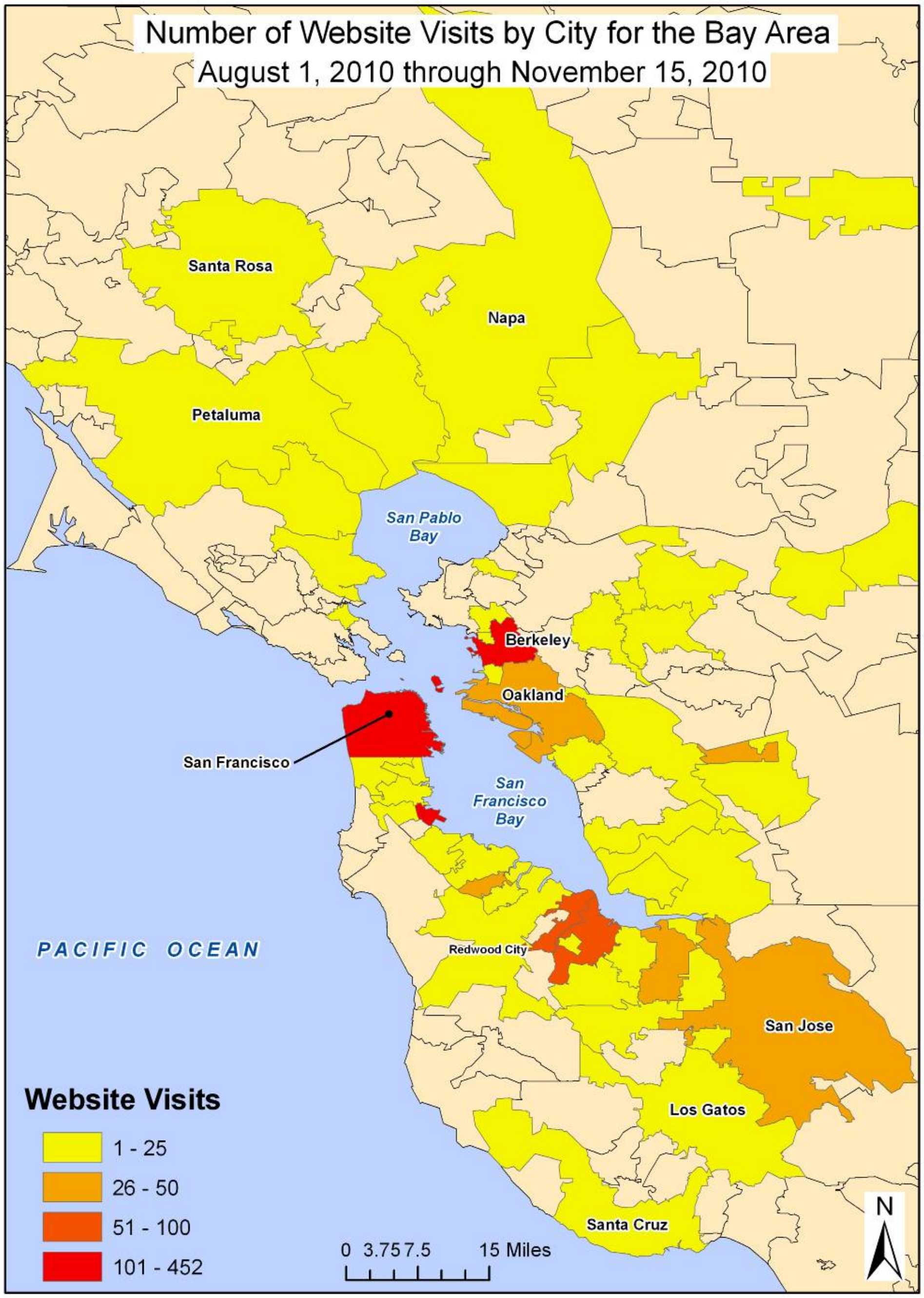


Figure 3-19. Bay Area Website Traffic by City Density, August 15, 2010 – November 15, 2010.

3.5 SUMMARY

In summary, the PATH2Go applications experienced steady growth in registered users throughout the evaluation period while daily use of the PATH2Go Smart Phone Application and the PATH2Go website applications fluctuated throughout the evaluation period. The initial targeted marketing efforts of advertising the applications on the MTC 511 website, distributing a press release, and handing out flyers at transit stops/stations were effective in attracting registered users and increasing awareness of the website applications. The most significant increase in usage of the website applications came as the result of a Twitter post on a popular account followed by transit riders that use Caltrain. The website traffic generated by the Twitter post increased the total number of absolute unique visitors by 104 percent and the total number of visits by 66 percent in the span of five days.

Over the course of the evaluation period, which began with the launch on July 29, 2010 and ended November 15, 2010, the PATH2Go applications attracted over 900 registered users, 67 percent of which downloaded and used the smart phone application at least once and may have also used the website applications. 34 percent of the smart phone application users downloaded the app and only opened it once without returning; leaving 66 percent that used it more than once. 33 percent of users registered on the project website, but only used the website applications. By the end of the evaluation period, the PATH2Go website applications attracted a total of 916 absolute unique visitors that accounted for 1,664 total visits to the website, and an average of 1.82 visits per user.

The usage analysis suggests that newer, more progressive forms of marketing like using social media websites such as Twitter can be significantly more effective in increasing awareness of real-time traveler information like the PATH2Go applications. Although still effective, more traditional forms of marketing like preparing a press release do not seem to generate the same level of exposure as quickly as a targeted social media effort without being covered by a major media source. Although the fluctuating website usage was greatly increased using Twitter, the impact was short-lived as usage quickly returned to its rolling pattern of approximately five to thirty website visits per day only a few days after the *caltrain* tweet. While social media may have a greater ability than traditional marketing to attract a large number of visitors to a website quickly, the usefulness of or need for the information available on a website is generally what drives return visits.

Website user characteristics provided insight into typical user behavior when accessing the PATH2Go applications. Trends in user frequency, trends in website visits, trends in accessing the website, and finally trends in the geographic location of users all provided valuable insight into the specific characteristics of the user base for the PATH2Go website applications. With over 55 percent of users having only visited the website one time, regular or return users of the website were not as common. User frequency can often be an indicator of user acceptance and need for a website, but a number of factors may explain why less than half of website users returned for another visit. Possible explanations for this trend include:

- Length of Evaluation Period.
- User Travel Frequency using Transit.
- Usefulness of Real-time Information.
- Perceived Value of Website.
- Website Functionality.

There is no definitive way to determine which of these explanations is responsible for the greater number of one-time users versus return users. Regardless, a low visit frequency does not necessarily indicate low user acceptance or usefulness, but may more so be an indicator of how visitors use the information on the website.

Trends in the time of day and day of the week that users access the website suggest that the information is most useful during the early afternoon rush hour, 3:00pm – 5:00pm, and the latter half of the work week, on Wednesdays and Thursday.

Trends in the way that users accessed the website provide insight into how it is that users came across the website in the first place. The usage analysis shows that the Networked Traveler project website, direct traffic to the site, and Twitter were the top traffic sources for the website applications. Because the Networked Traveler project website was the primary source for the PATH2Go website applications and was the website advertised for the MTC launch, press release, and flyer distribution, trends in the way users accessed the project website provided additional insight. While the majority of visits to the project website came directly, the results of the targeted marketing efforts were apparent in the list of traffic sources responsible for the most visits. The MTC 511 website as well as several of the media outlets that covered the press release were traffic sources for users visiting the Networked Traveler project website.

Lastly, trends in geographic location of users were assessed using density maps showing website visits in cities across the country. A view of the map from a national perspective showed that usage expanded to several different parts of the United States. The national exposure suggests that out-of-town travelers used the information or researchers and practitioners from around the country were interested in the PATH2Go applications. A second maps view provides a greater level of detail for the cities in the San Francisco Bay Area. As expected, the majority of website visits originated along or around the US-101 Corridor. San Francisco, Redwood City, and Berkeley accounted for the most website visits.

4. USER PERCEPTIONS

The evaluation team developed and conducted a web-based user survey to collect feedback from actual users of the PATH2Go applications. It is important to note that users were required to register in order to download the Smart Phone Application, but could use either of the web-based tools anonymously or as registered users. The evaluation team elected to only survey registered users in order to comply with the UC Berkeley CHPS guidelines established to protect users' privacy. The PATH team managed all registered users' personal information collected during the registration survey (including e-mail address), so that the evaluation team did not have to access or request any user contact information.

4.1 PURPOSE

The specific evaluation objective addressed by the web-based user survey was to analyze users' perceived accuracy and usefulness of the suite of PATH2Go applications. Specifically, the survey was designed to:

- Identify usage characteristics (e.g., applications used, frequency of use, etc.).
- Identify perceived usefulness and accuracy of PATH2Go applications.
- Determine users' opinions regarding the functionality and usability of the PATH2Go applications.
- Identify respondent travel behavior (e.g., primary mode of transportation, personal vehicle access, trip purpose, transit use, etc.)
- Identify respondent demographics (e.g., gender, age)

The purpose of the survey was to gather overall impressions that registered users had of the Path2Go applications, their impression of its overall utility for transit trip planning, and to gather specific information about the applications' features on a number of dimensions. While use of the Trip Planner website, Traveler Information website, and Smart Phone Application were recorded individually, the majority of survey items explored user perceptions of all three PATH2Go applications as a set, so the results represent, for the most part, global perceptions of the applications, not reactions to each individual tool. The survey included additional questions aimed at collecting user perceptions specific to the Smart Phone Application, its use, and the geo-fencing functionality implemented to prevent distracted driving.

4.2 SURVEY APPROACH

The evaluation team worked closely with PATH project team regarding possible options for surveying registered users. Initially, the teams decided on e-mailing all registered users to request their participation in the survey. The evaluation team developed an initial e-mail and a set of reminder e-mails, which PATH sent to registered users on its behalf. PATH also generously offered to extend the 100 dollar monthly drawing incentive offered on their own user survey to registered users who participated in the evaluation team survey. The survey was launched on October 11, 2010 when the first e-mail was sent to registered users (see Figure 4-1 below).

Good Morning,

Thank you for registering for the **Networked Traveler project**. We are contacting you with a unique opportunity to provide more detailed feedback about your experience with the PATH2Go applications and to get your thoughts regarding transit information provided by the smart phone and website applications.

Your anonymous responses will be part of a National Report on traveler information technology like the PATH2Go applications. Your responses could help shape whether or not this information is provided elsewhere throughout the country.

If you would like to participate in this unique opportunity, please click on the link below and answer our short survey about your experience with the PATH2Go applications:

Please click here to take the survey.

The survey should not take more than 5 minutes of your time. As a thank you for your time, you will have the opportunity to enter a drawing for one of three $100 gift cards upon completing the survey.

Your responses are very important to us, and we look forward to hearing from you.

Figure 4-1. Initial E-mail to Registered Users Requesting Survey Participation, October 11, 2010

The evaluation team closely monitored the response rate following the initial e-mail and follow-up e-mails were sent when the number of survey responses declined. A total of four reminder e-mails were sent to only registered users who had not responded to the survey. As the survey response rate declined from the initial spike of the survey launch, the evaluation team and project team began discussing additional ways to attract registered users to the survey. On November 1, the PATH project team added a link to the survey on both the Trip Planner website and the Traveler Information website that was only available when registered users were logged into the website. Additionally, they also implemented a pop-up box on both websites that appeared when registered users navigated to the site. Figure 4-2 below is screen shot of the Traveler Information website that provides a visual of both the text link and pop-up link to the user survey (see red boxes).

The survey was closed on November 15, 2010.

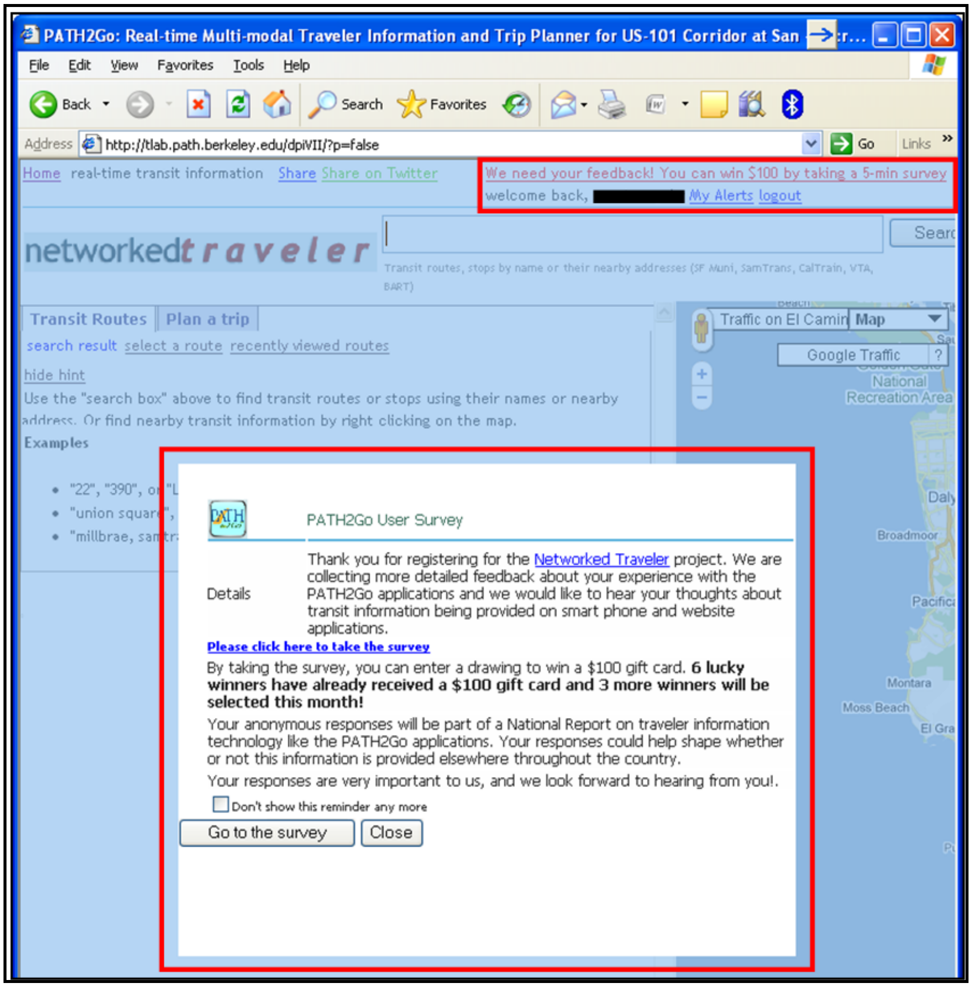


Figure 4-2. Pop-up and Text Links to User Survey on PATH2Go Traveler Information website

The survey was designed to be completed quickly, so that it was straightforward and low burden. It was comprised primarily of multiple choice/check boxes with a few opportunities for free response. While users were taking the survey, there was a progress bar along the top of the page showing the percent complete to give respondents feedback on where they are in the survey and to encourage them to continue through to the end. For both recruitment methods, only registered users were exposed to the user survey.

The evaluation team collected 108 completed surveys and 13 partial surveys for a total of 121 user surveys. Figure 4-3 below presents the survey sample size and the results of the survey recruitment efforts. As shown below, the recruitment efforts clearly had an impact on the response rate. The most surveys were collected on days where an e-mail was sent to registered users requesting their participation in the survey. The numbered stars in Figure 4-3 are placed on the dates when an e-mail was sent while the blank star marks the date that the pop-up and text link were designed into the website tools. It appears that the e-mails to registered users were the most effective recruitment method although the pop-up and text link did seem to engage a few additional respondents.

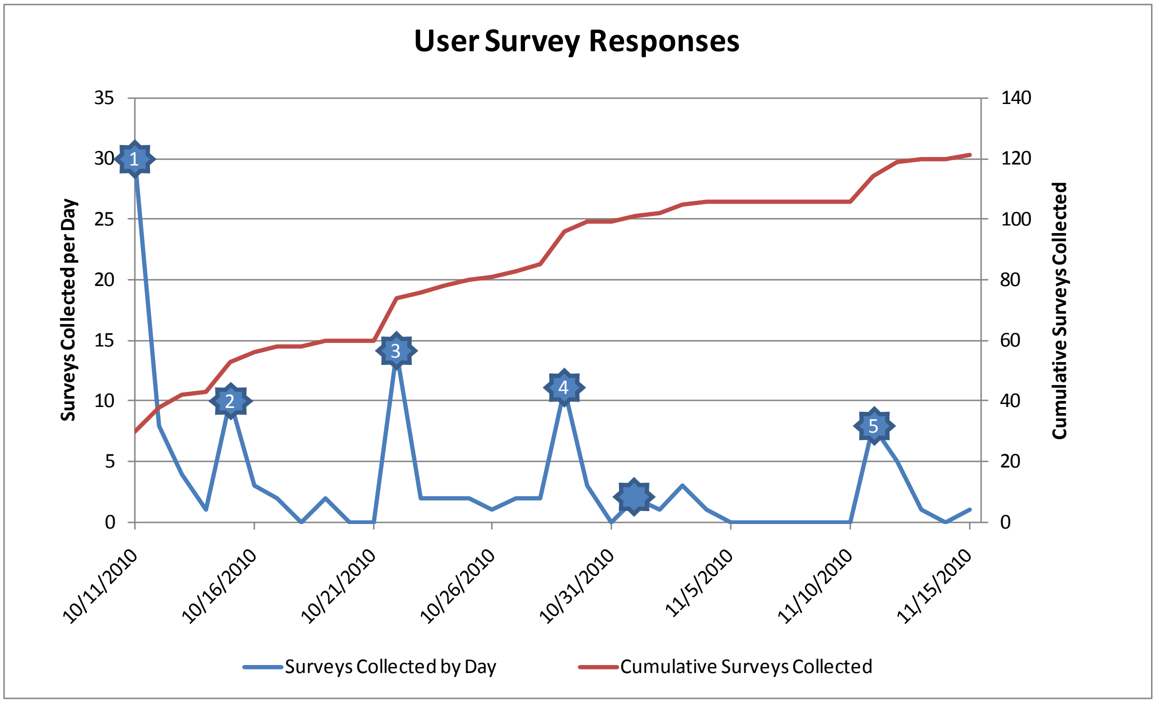


Figure 4-3. PATH2Go Web-Based User Survey Responses

The total number of registered users increased during the survey period from 571 when the survey was launched on October 11 to 905 when the survey was closed on November 15, 2010. It is important to note that the 5 times PATH sent an e-mail to registered users, up to 200 messages were returned due to invalid e-mail addresses. Although the user base (population) ranged from 571 – 905 throughout the survey period, a number of registered users were not exposed to the user survey since not all received the e-mail. For this reason, it is difficult to calculate the actual survey response rate (i.e., the user population increased during the data collection period which would provide a response rate range of 19 percent to 12 percent. Finally, the survey sample is considered self-selected because registered users could opt whether or not to participate in the survey. Users had the option to ignore the pop-up text on the website and could choose to disregard the text link or the survey link provided in the e-mail messages. Therefore, the results of the survey should be viewed as descriptive analysis of their perceptions, not as a statistically valid sample, though their perceptions do offer valuable insights into the design and performance of the applications.

4.3 SUMMARY OF RESPONDENT CHARACTERISTICS

Survey respondents were asked to supply general information regarding their typical commuting behaviors, age, and gender. Figures 4-4 and 4-5 show the age groups and gender of the respondents. As shown, the majority of the group was male and approximately one-third were in the 18-30 and 31-40 year old age groups. One-fourth was in the 41-50 year old group and about 10% were over 50 years old. The proportions of males and females in each age group were roughly similar.

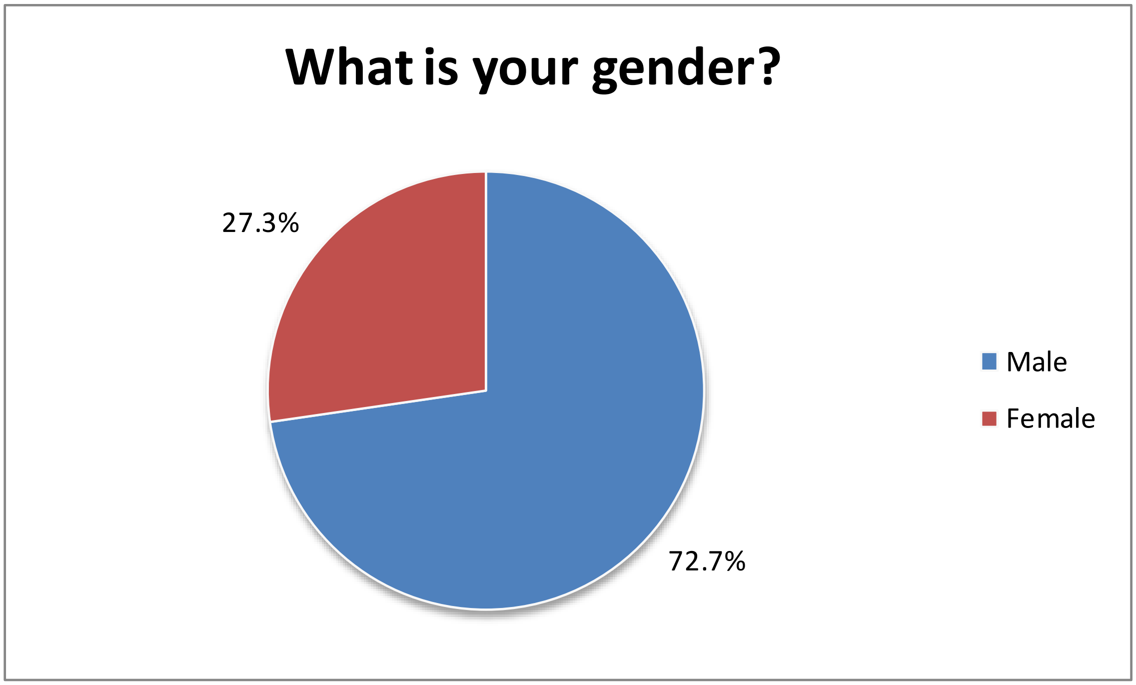


Figure 4-4. Respondent Gender

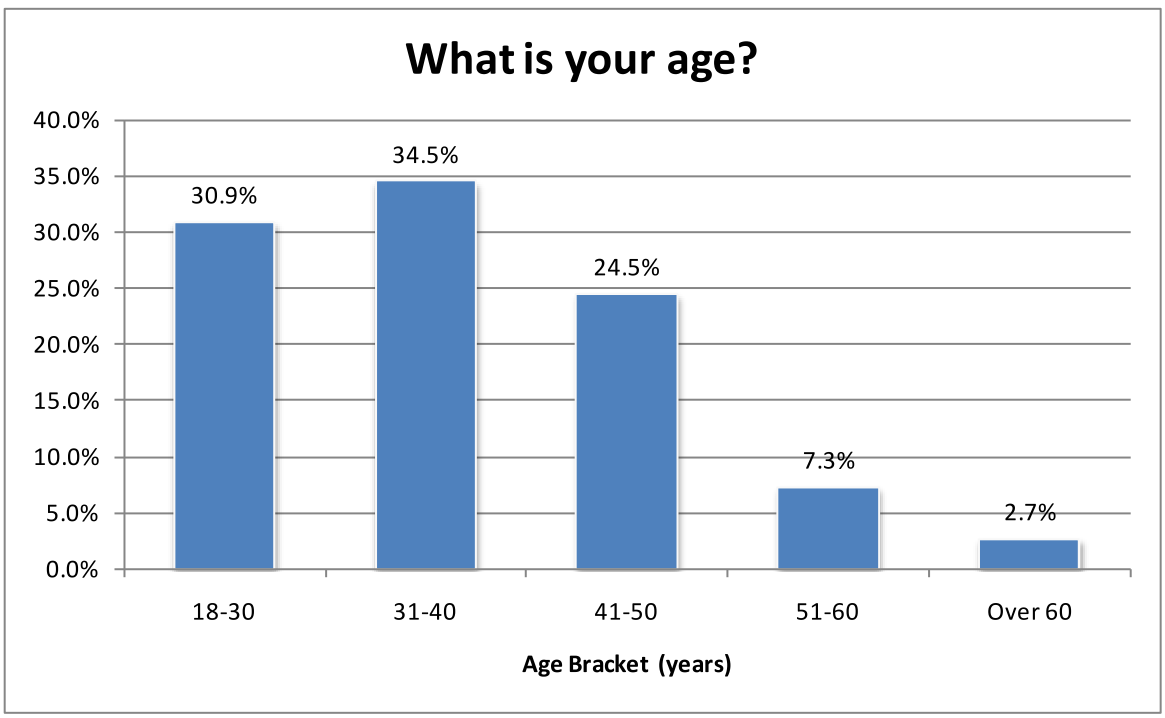


Figure 4-5. Respondent Age Group

Respondents also indicated whether or not they had regular access to a personal automobile, which could, ostensibly be used for their daily commutes. As shown in Figure 4-6, more than three-fourths of the respondents did have access.

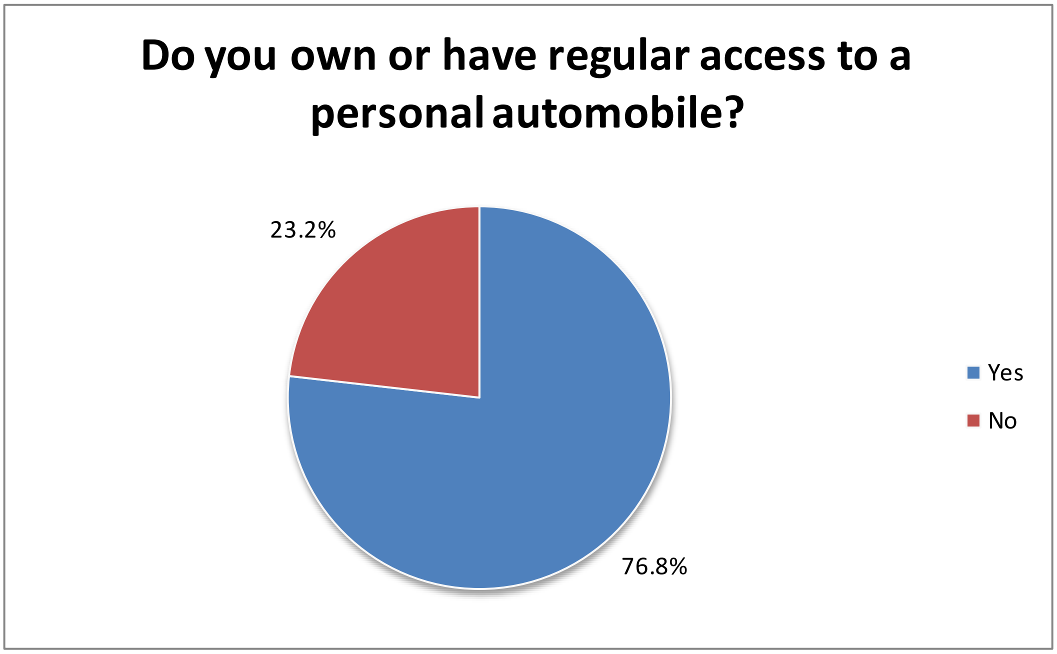


Figure 4-6. Respondents' Access to a Personal Automobile

However, while a high proportion did, almost half of respondents reported they used transit as their primary mode for commuting (Figure 4-7). Only slightly more than one-third reported they relied on their personal vehicles for their commutes and approximately one in ten either walk, cycle, or use carpools or vanpools.

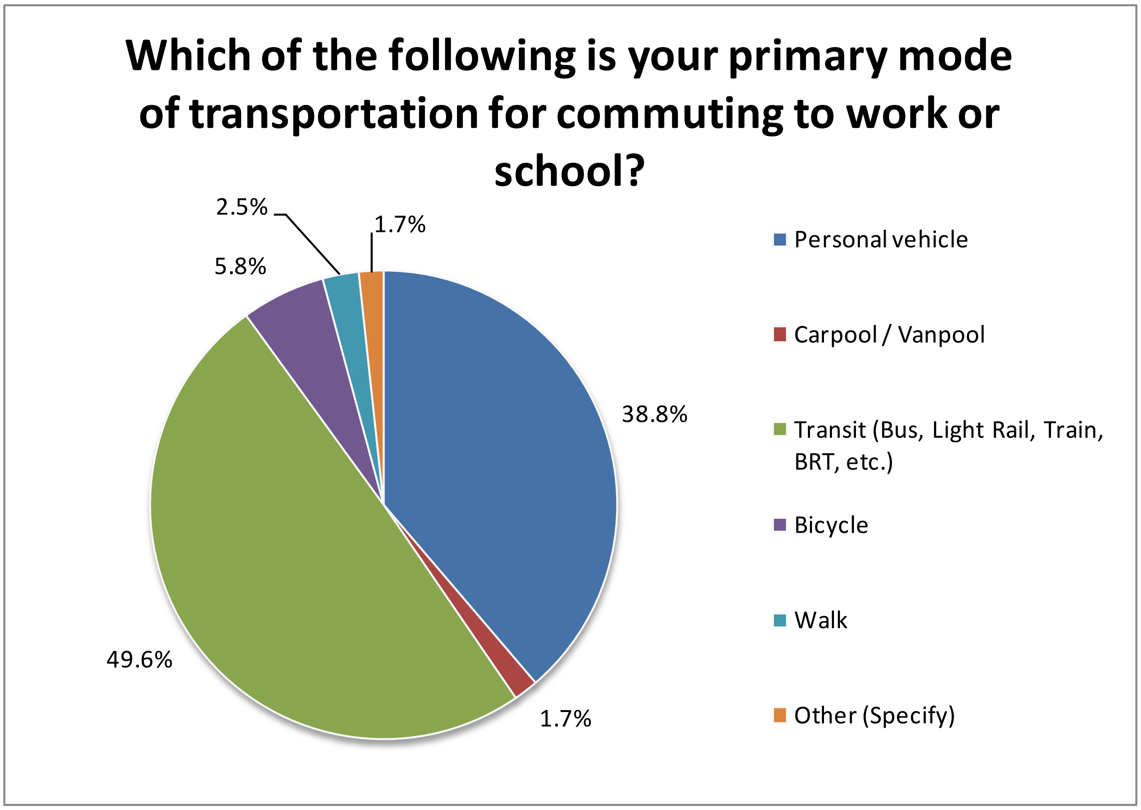


Figure 4-7. Respondents' Primary Mode for Commuting

When queried about other modes of transportation they might use for commuting (where respondents could choose more than one option), approximately one-half reported either using a personal vehicle or using transit. It would appear alternative transportation modes for commuters show similar proportions using a personal vehicle or transit (Figure 4-8). A high proportion of respondents also indicated using bicycles, carpools/van pools, or walking as alternatives.

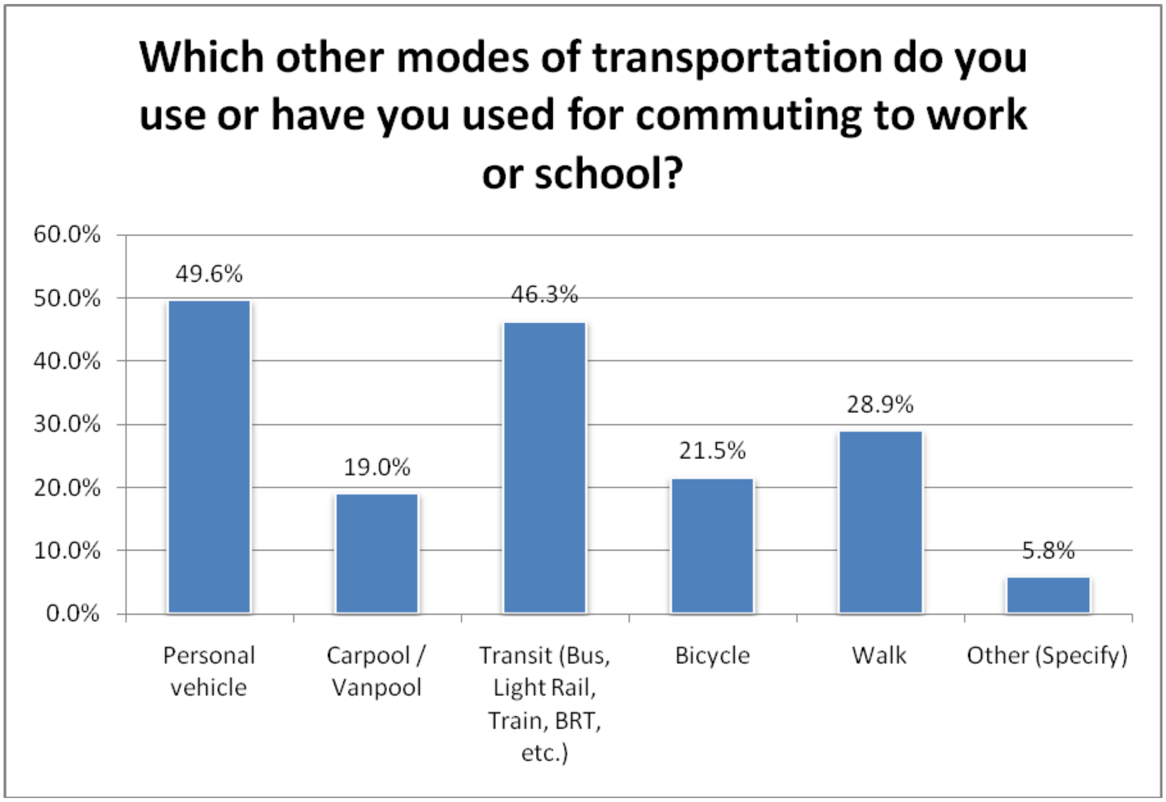


Figure 4-8. Respondents' Other Transportation Modes for Their Commute

For those who do use transit, the primary services they use is represented in Figure 4-9. Again, they could choose multiple transit services and their choices reflect both where they live and where they work, as discussed earlier, primarily along Route 101. A high proportion of respondents have identified BART, CalTrain, SFMuni, and VTA as the most used transit systems (as would be expected based on daily commute origins and destinations).

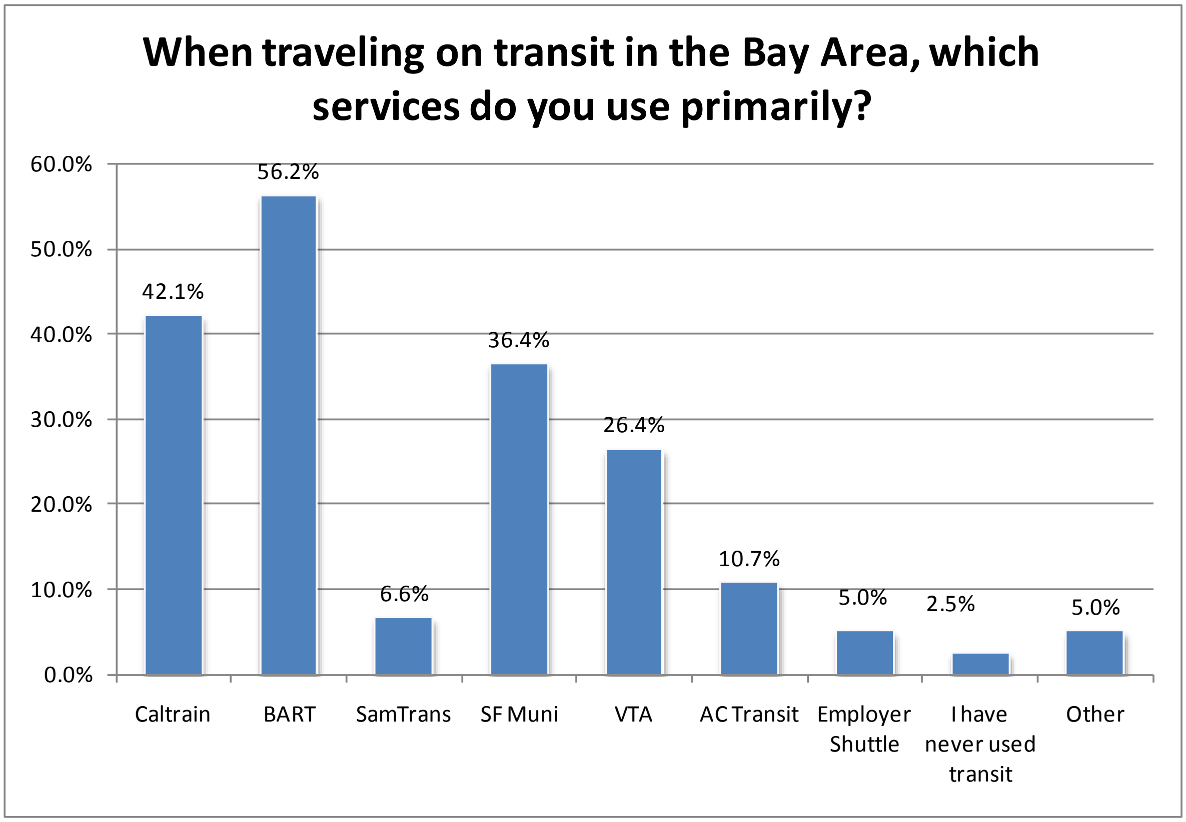


Figure 4-9. Primary Transit Services Used in the Bay Area

4.4 USE OF THE APPLICATIONS/WEBSITE

This section focuses on the respondents' usage patterns for the applications that were available to users, including the Path2Go Trip Planner website, the Path2Go Travel Information website, and the Smart Phone application.

As shown in Figure 4-10, most (46 percent) heard about the applications from web-based sources; either from a web search, the MTC website, a link from a transportation or traffic website, or a message received via email or listserv. The single most cited source was a friend or colleague (31%). And, about one-fourth reported "other"; these included such sources as Craigslist, but also included "having heard about the application from the ITunes store" and almost one-half who chose "other" reported they heard about it from the "Android Market."

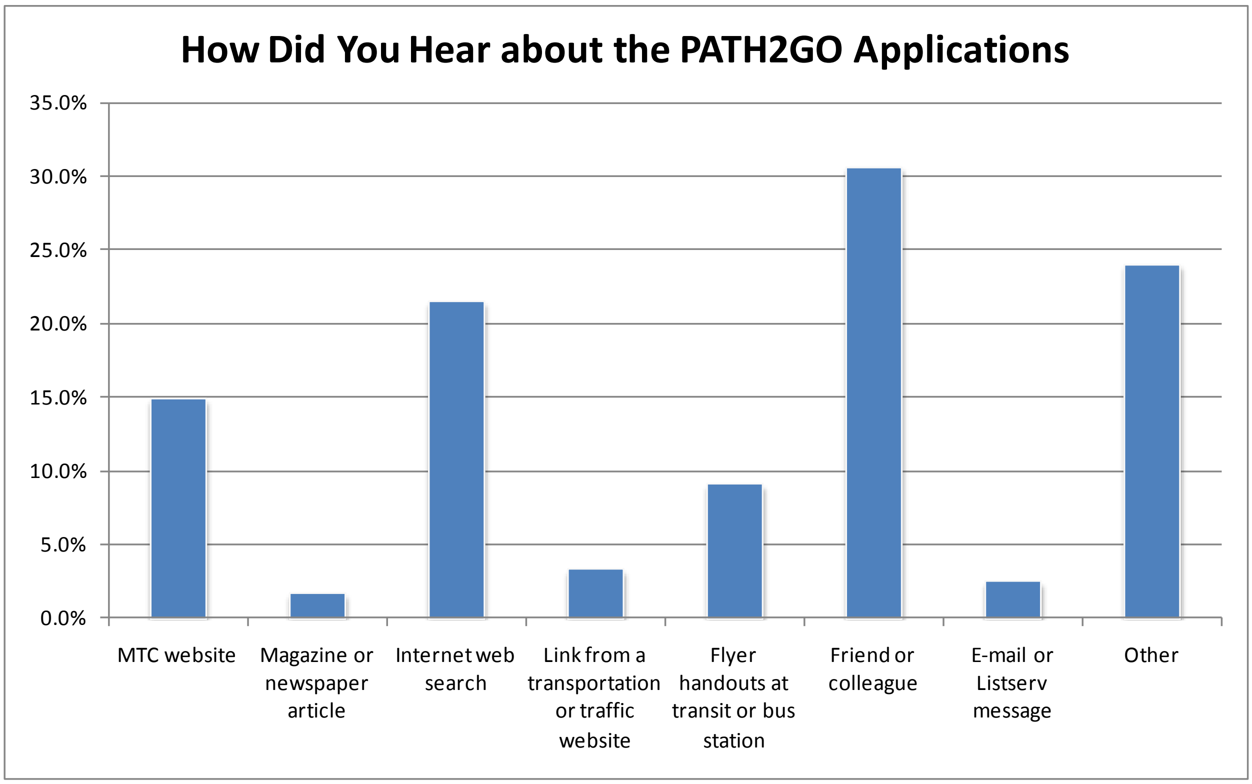


Figure 4-10. Sources Where Respondents Heard About the Path2Go Applications

As discussed earlier, there was some concern about asking for respondents' usage patterns, especially since those who used the iPhone applications would have had a longer usage period when compared to the Android-based application, due to its relatively late "roll out." Therefore, to attempt to equalize the usage, users were asked how often they had used the applications in the "past week."

As shown in Figure 4-11, approximately half of the users said they had never used the PATH2GO trip planner and another fourth had used it, but not in the past week.

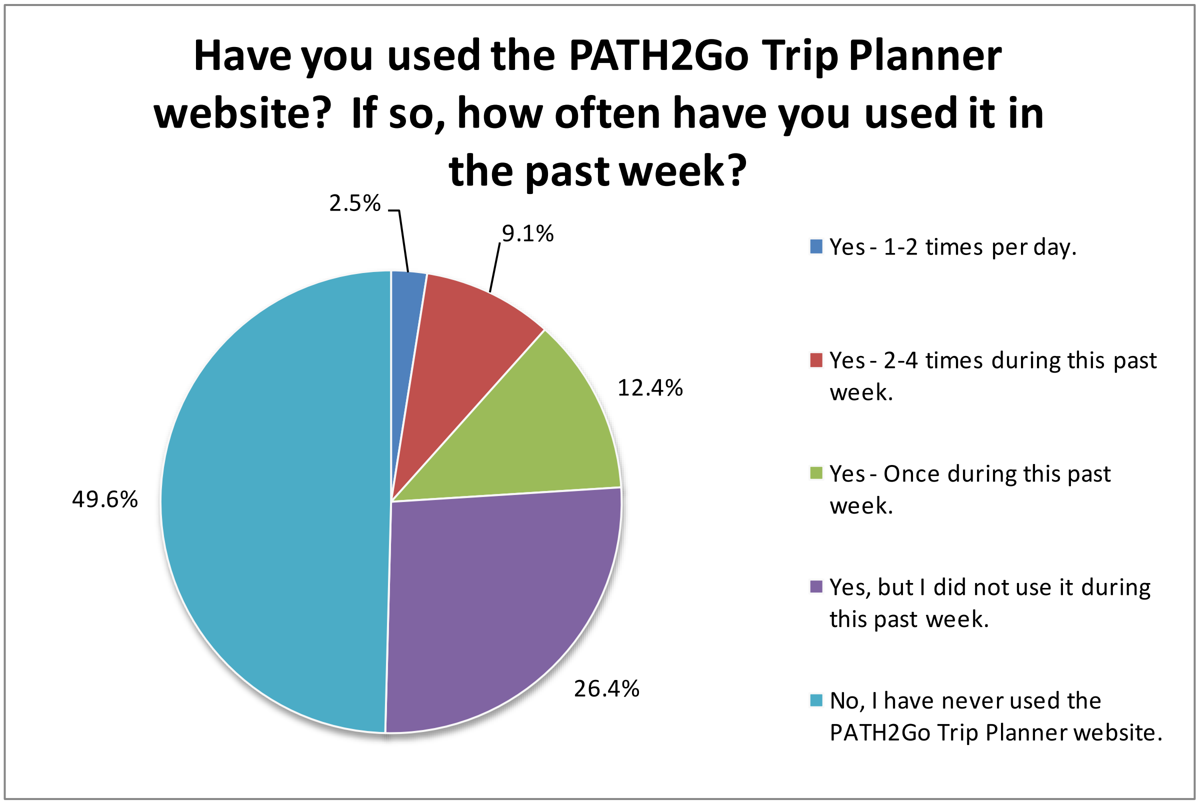


Figure 4-11. Use of the Path2Go Trip Planner Website

When considering use of the PATH2GO Traveler Information site (Figure 4-12), a similar pattern was also evident, though a higher proportion of all users reported they had never used the site (58.7 percent) or had not used it in the past week (22.3 percent).

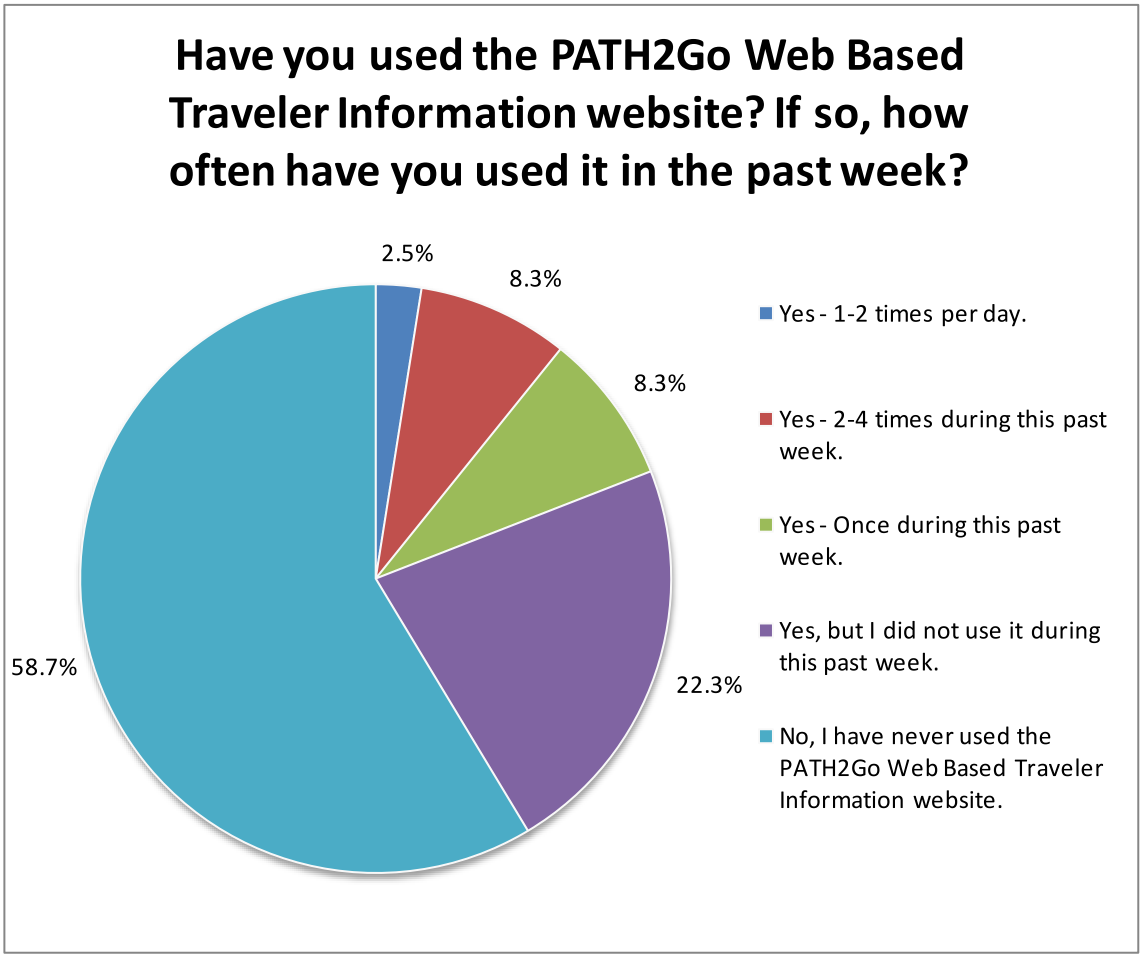


Figure 4-12. Use of the Path2Go Traveler Information Website

For those respondents who downloaded the Smart Phone application (Figure 4-13), usage frequency is different to that for the website, though the sample size of users represented is somewhat less (n=86). Just over one-fourth reported they had never used it, even after the application was downloaded; almost three-fourths of the respondents had used it, and over one-third had used it multiple times in the past week.

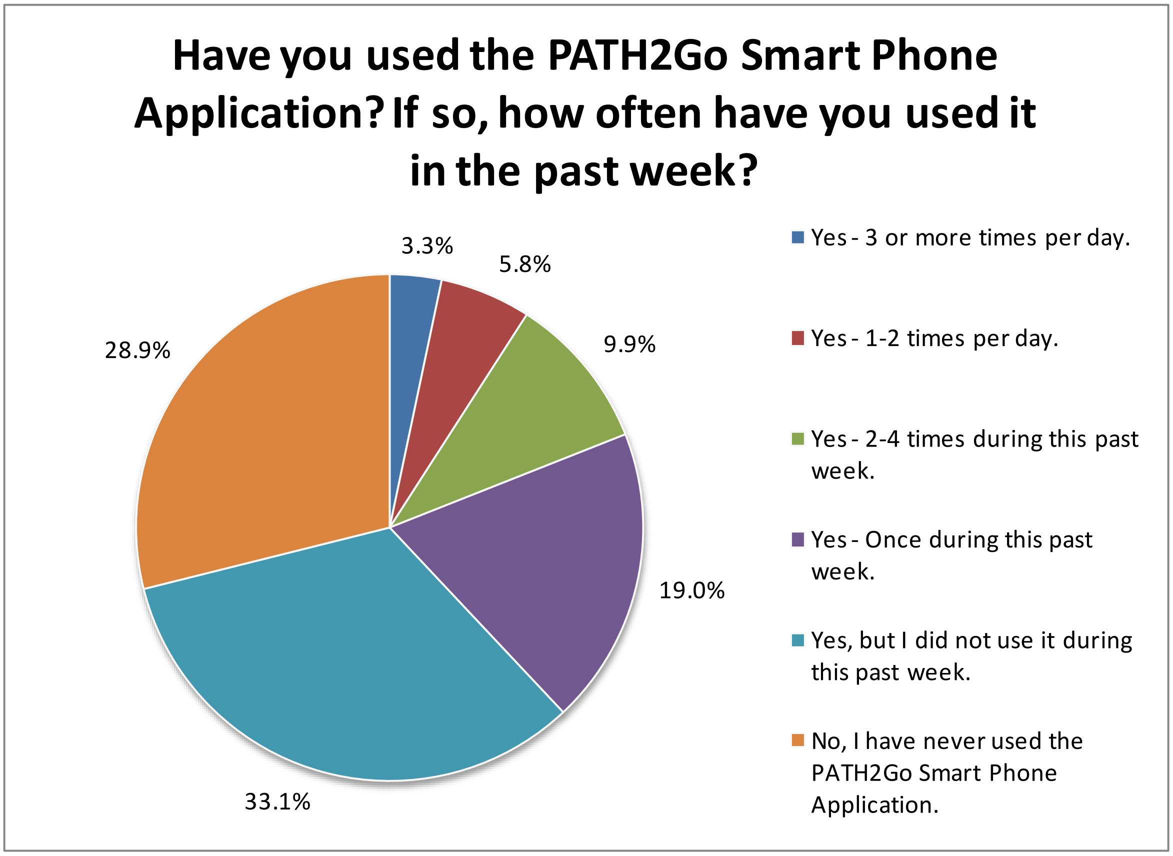


Figure 4-13. Use of the Path2Go Smart Phone Application

As shown on Figure 4-14, users identified only the Apple iPhone and the Android Phone as the mobile devices users reported for the application. More of the users reported having the Android phone (58%) than the Apple iPhone.

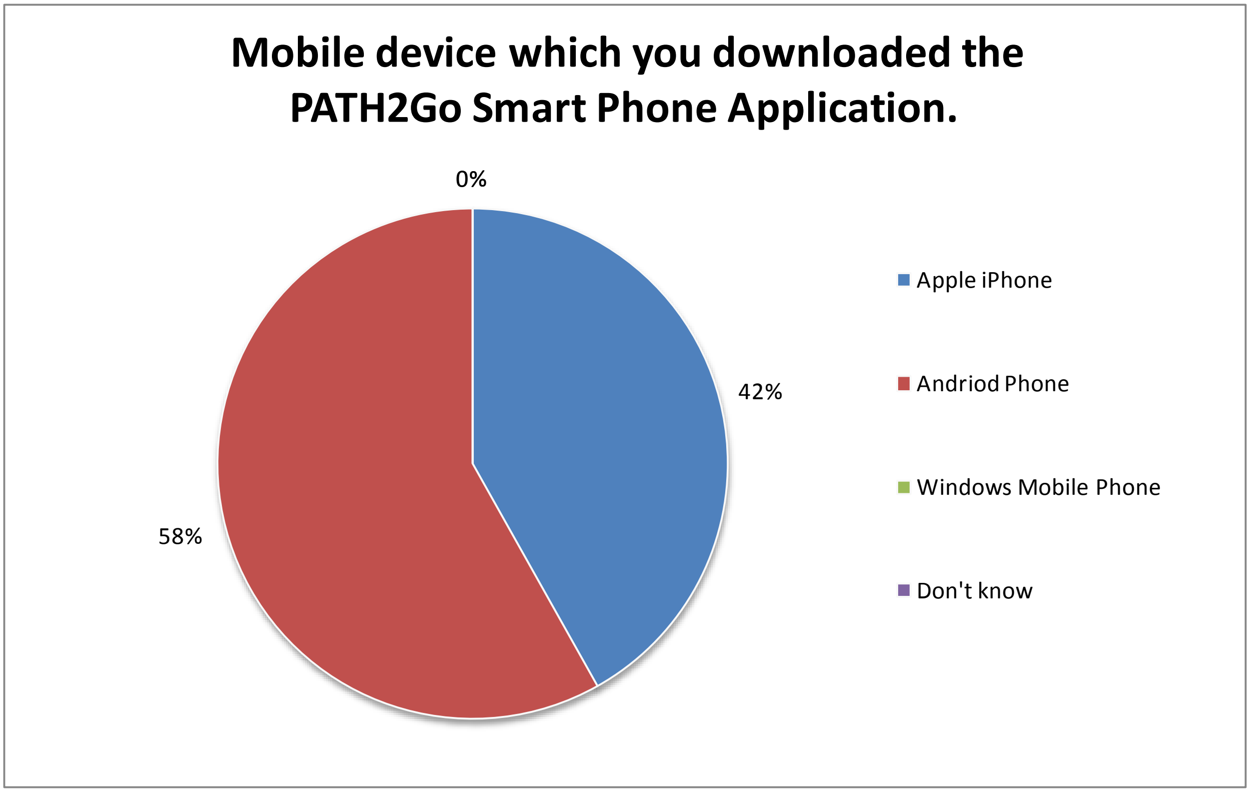


Figure 4-14. Mobile Device Used for the Smart Phone Application

When queried about whether the application protects their personal information (e.g., their location), the majority of users (59%) reported they "neither agreed nor disagreed" with the statement (Figure 4-15). Interestingly, approximately one-third either "agreed" or "strongly agreed" with this statement while only 10 percent "disagreed" or "strongly disagreed." Responses by device type were very similar across all response categories, indicating that regardless of the device used, respondents did not feel that the application compromised their personal information.

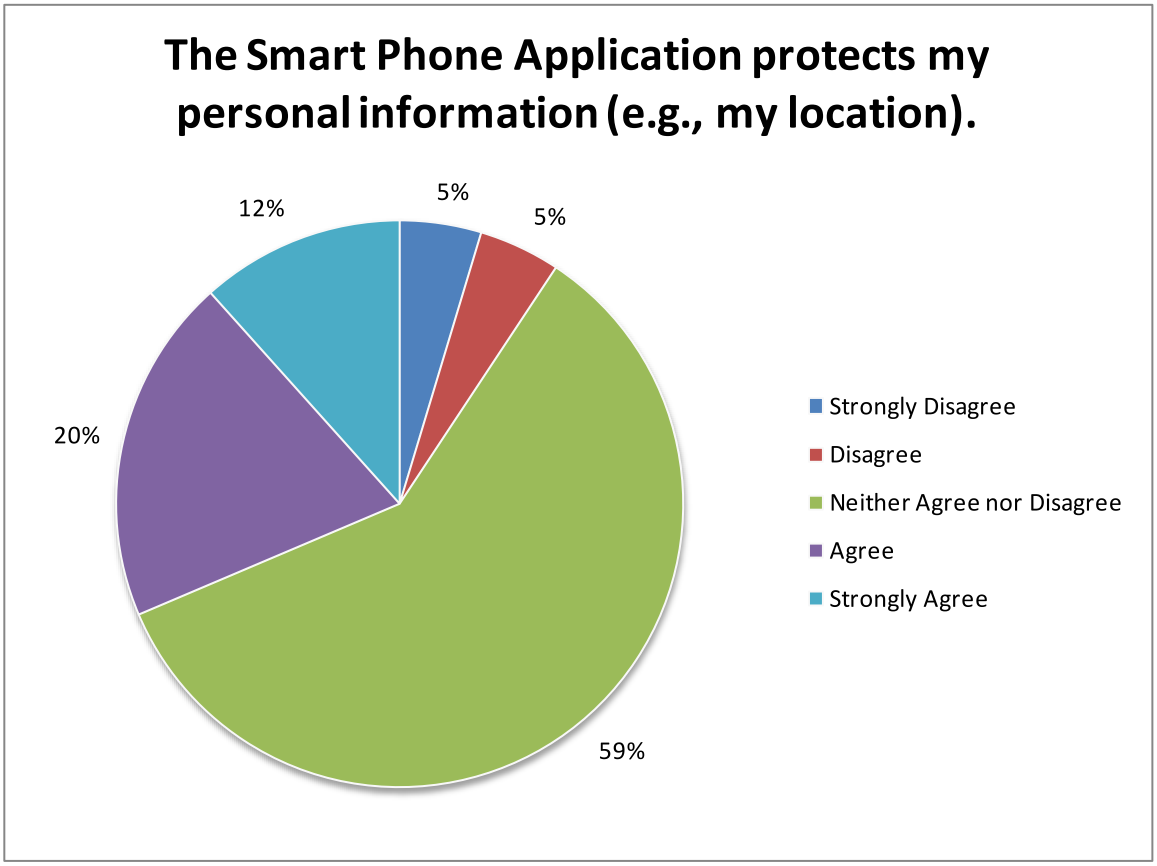


Figure 4-15. Respondents' Perceptions of the Smart Phone Application's Protection of Personal Information

Respondents were also queried regarding whether or not they received the warning message informing them that the device was disabled while they were driving. As shown in Figure 4-16, exactly half of the respondents reported receiving the message and one-half did not.

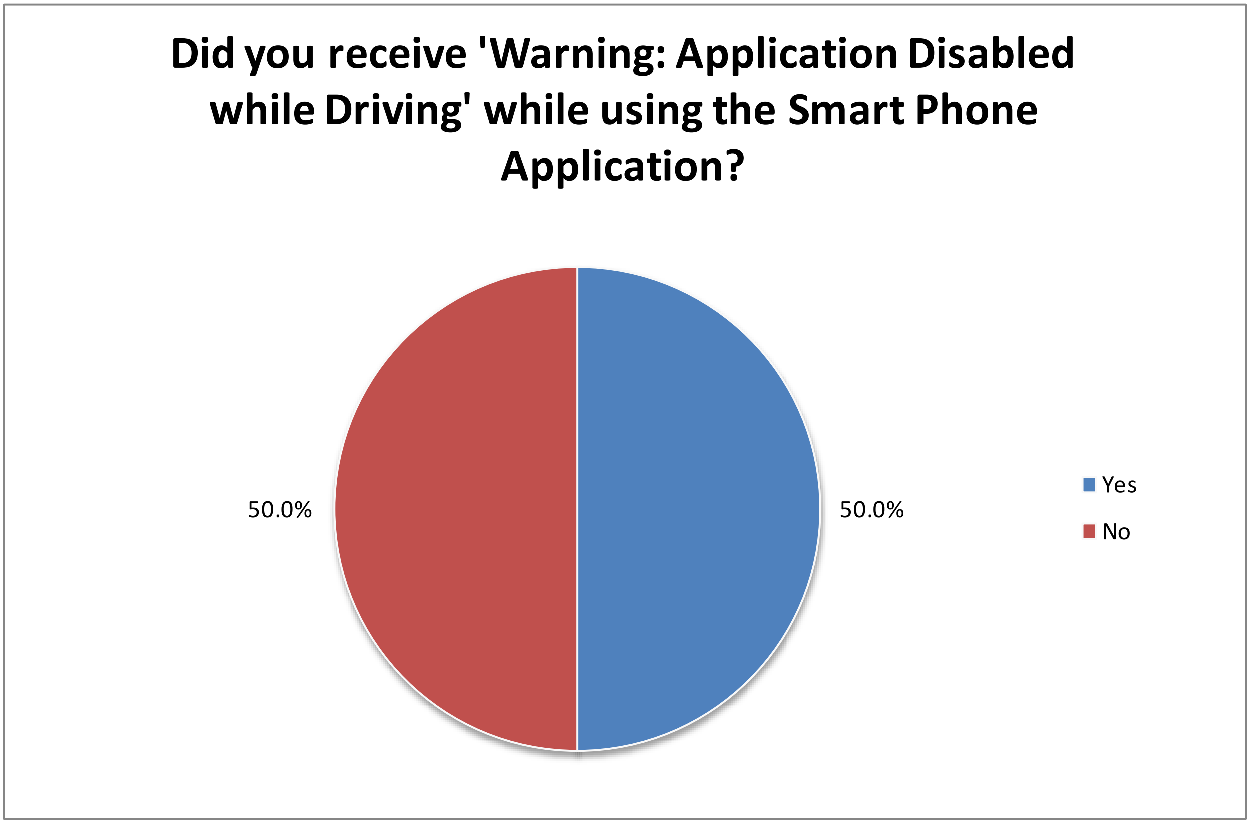


Figure 4-16. Respondents' Perceptions of Having Received the Disabled Warning While Using the Smart Phone Application

As shown in Table 4-1, the proportion of iPhone and Android users showed slightly different experiences with receiving the message; 56 percent of iPhone users reported they received the message compared to 46 percent of the Android users.

Table 4-1. Receipt of Disable Message (by Device)

Received Message?	Device Type	
	iPhone	Android
Yes	56 %	45%
No	44%	54%

As shown in Figure 4-17, almost two-thirds of the respondents felt that they received inappropriate warnings very infrequently, i.e., less than 25 percent of the time. Of note is that slightly over 16 percent perceived the warnings were inappropriate more than 75 percent of the time. In addition, the proportion of those who responded in this manner was consistent across both mobile devices. To help explain these findings, a number of similar comments were offered by the respondents. Many felt that they had received the warning while traveling on the different transit vehicles or as passengers in a car, while planning their trips.

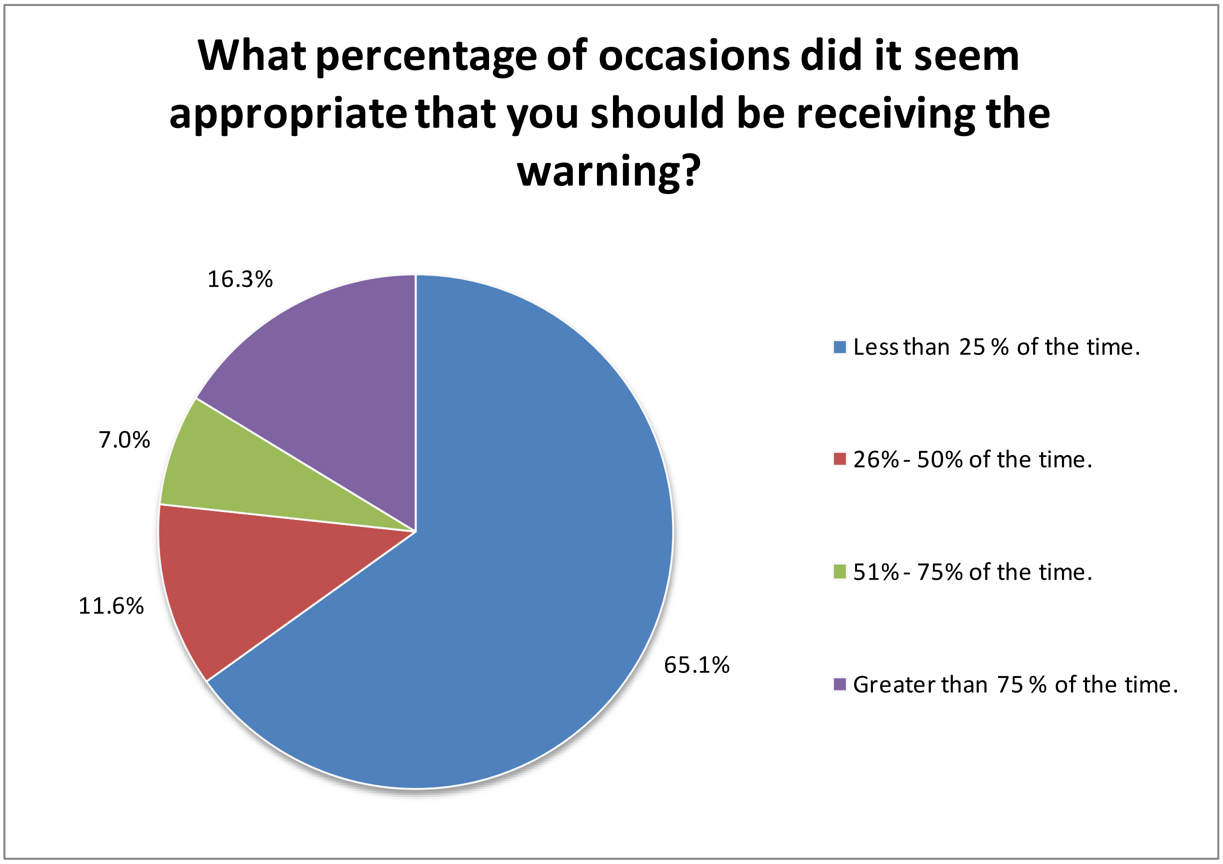


Figure 4-17. Respondents' Perceptions on the Appropriateness of the Warning Message Received

However, while most did not perceive the proportion of time being blocked very highly, when asked about the degree of annoyance they experienced (Figure 4-18), 70 percent of respondents reported they “strongly agreed” or “agreed” that being blocked was annoying. Again, this level of annoyance may have been due to a combination of the users’ understanding of how (and when) the application would be operable as well as to the effectiveness of the geo-fencing process.

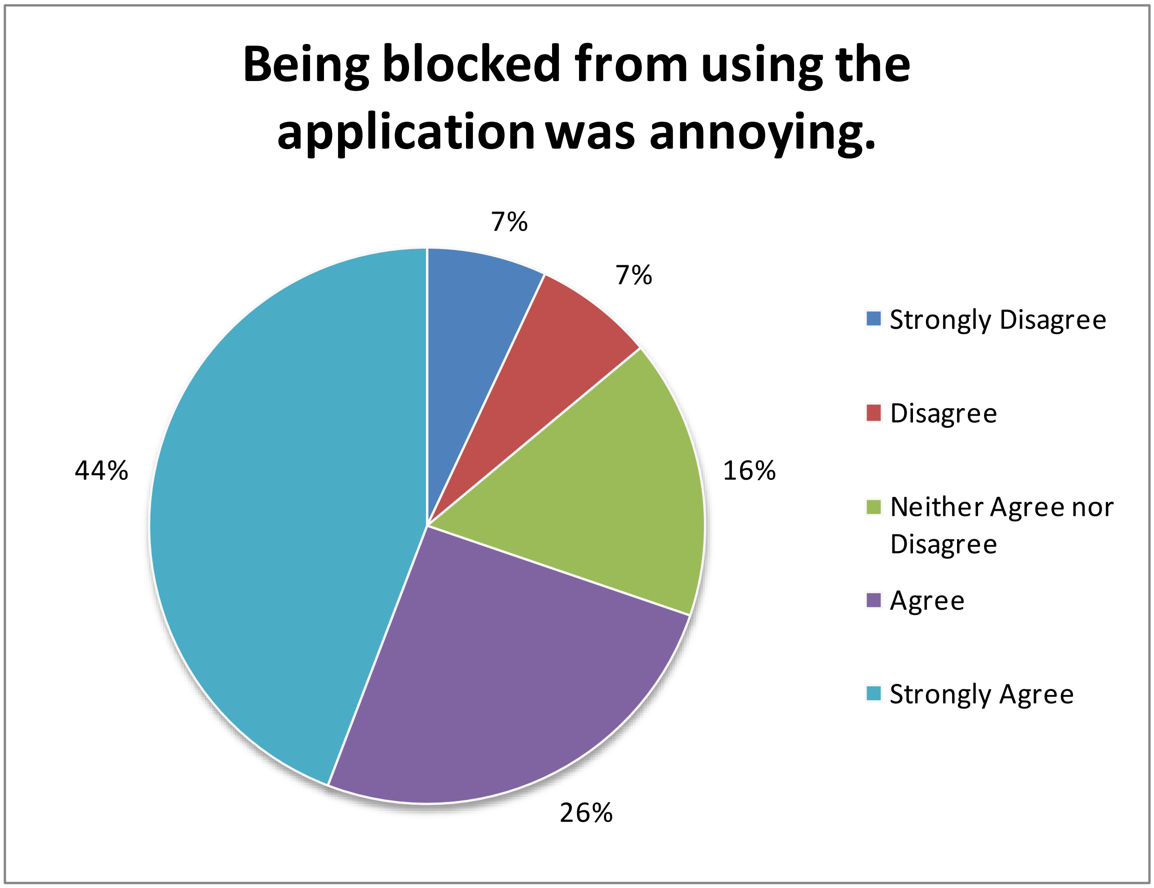


Figure 4-18. Respondents’ Perceptions on the Level of Annoyance of the Application Being Blocked

In fact, when looking at responses by device used, it appeared that iPhone users were more annoyed than the Android users (Table 4-2).

Table 4-2 Level of Annoyance when Device was Blocked (by Device)

"Being blocked was annoying"	iPhone	Android
Strongly Disagree / Disagree	15%	13%
Neither Agree nor Disagree	5%	26%
Strongly Agree / Agree	80%	61%

4.5 TRIP PLANNING USING THE PATH2GO APPLICATIONS

This section summarizes respondents' experiences and use of the PATH2Go applications (including both the websites as well as the downloadable Smart Phone application). It includes a discussion of the reasons for the use as well as users' perceptions of various aspects of the applications.

As shown in Figure 4-19, while respondents had reported using the applications, approximately one-half reported they "never" or "rarely" used the applications to plan their transit trips. An almost equal proportion reported they used the applications "sometimes" or "most of the time."

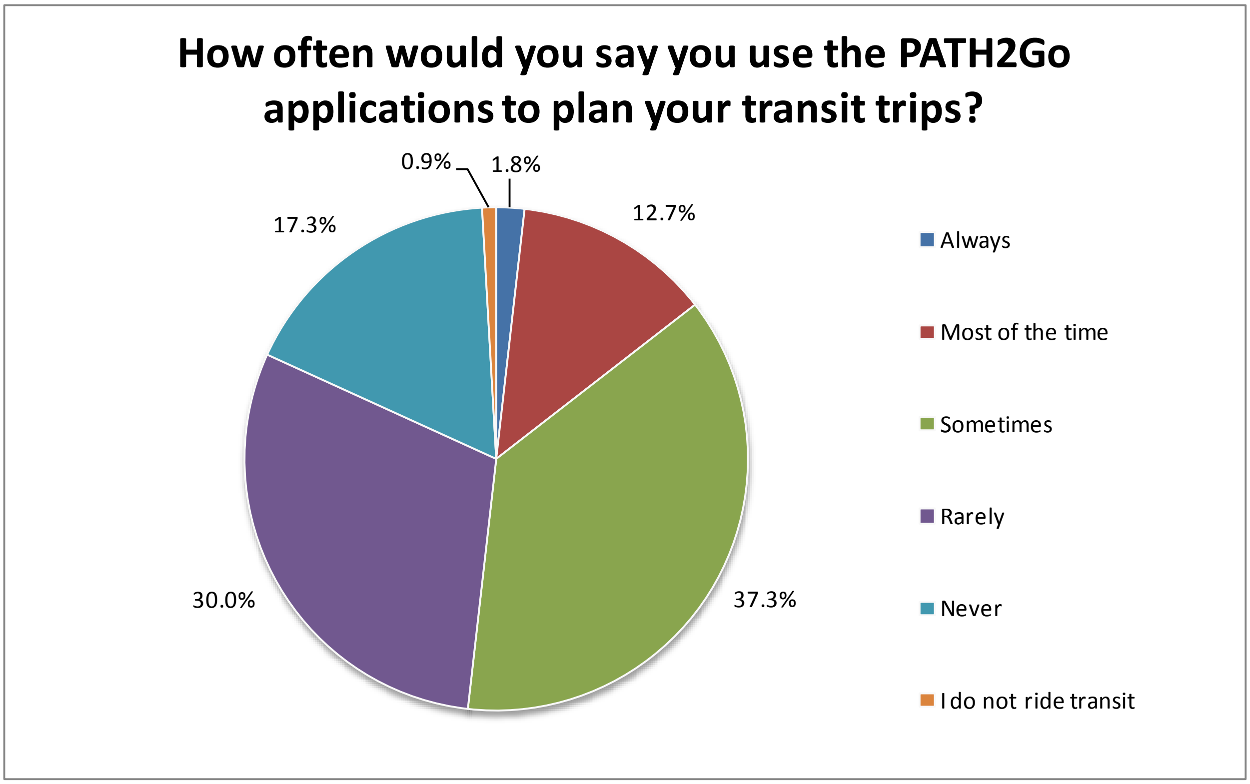


Figure 4-19. Frequency of Using PATH2Go Applications for Planning Transit Trips

When considering the types of trips that the applications were used for, as shown in Figure 4-20, it would appear that just over one-half of the trips were for regular commutes – either to one's work or job or to school. Since these are typically regular trips where respondents may travel the same routes at the same times, it may help explain the relatively low usage patterns of the applications. If the respondents are regular commuters, they may know their routes and, if using transit, may be very familiar with the road conditions and/or transit schedules. However, approximately one-half of the trip purposes may be considered non-routine – such as going shopping, running errands, or visiting family or friends. In these cases, respondents may need to search out the relevant information from the applications to help them plan the trips.

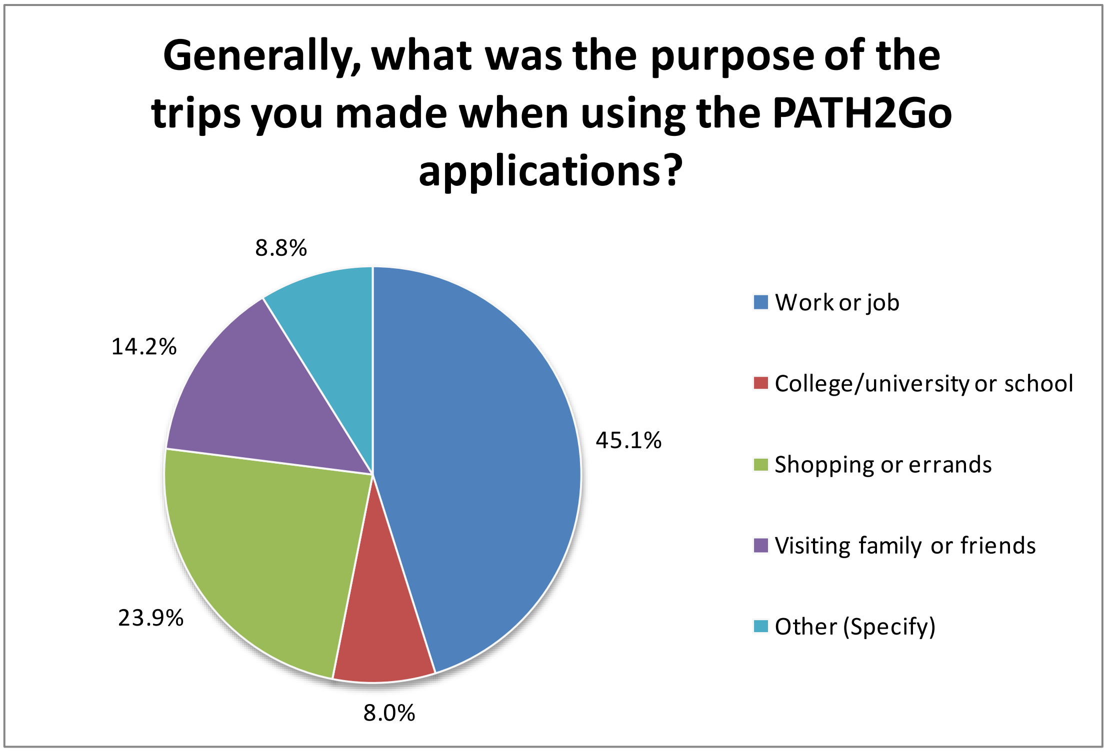


Figure 4-20. Purpose of Trips When Using the PATH2Go Applications

Figure 4-21 summarizes respondents' views on how well the applications provided them with the information they needed to plan their trips. As shown, almost one-half "strongly agreed" or "agreed" that the applications did provide them with the information they were looking for. Conversely, only 20 percent "strongly disagreed" or "disagreed" that the information was available. Finally, 18 percent reported they were neutral on this attribute. It would appear, therefore, that most users felt the applications did have the information they needed or wanted.

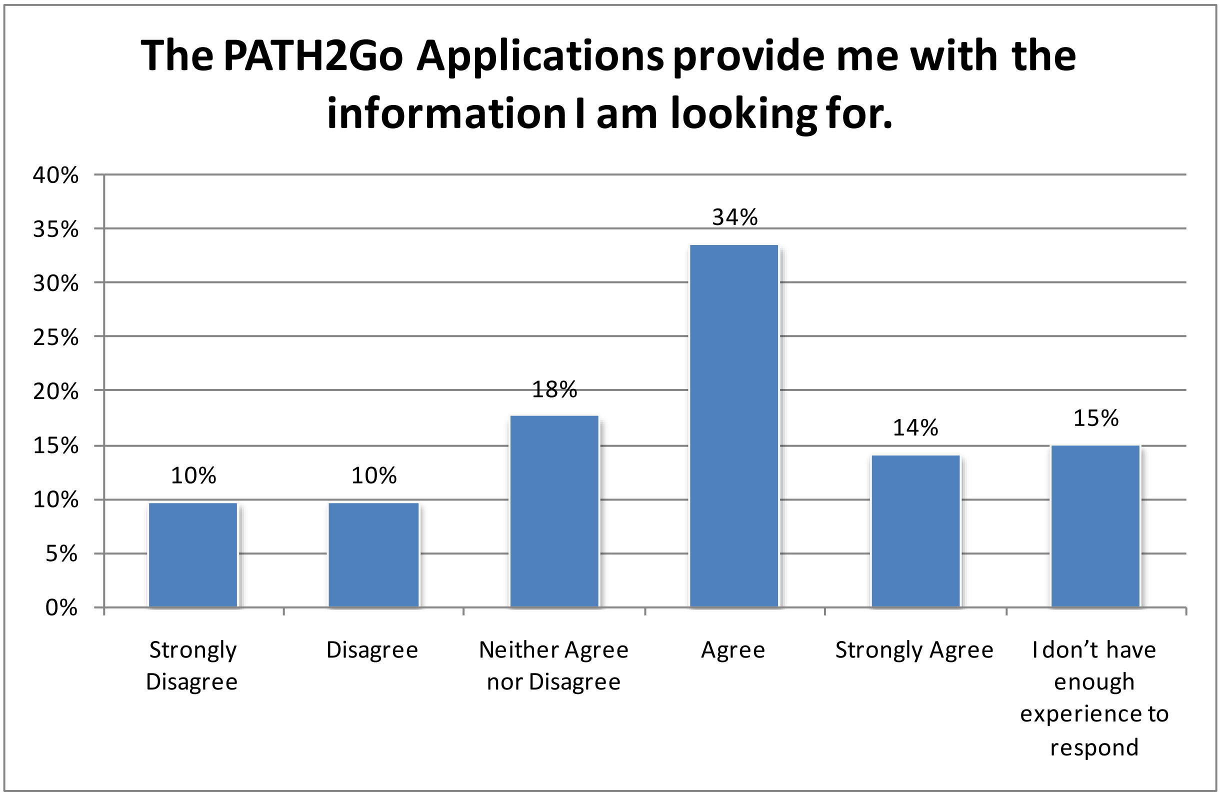


Figure 4-21. Respondents' Perceptions – Applications Provided them with Information They Were Seeking

However, as shown in Figures 4-22 and 4-23, while respondents said the applications had the information, they did not feel that the information was well presented or organized. An almost equal proportion of respondents "strongly agreed" or "agreed" that the information was well presented (35 percent) or was well organized (38 percent). Similar proportions "strongly disagreed" or "disagreed" that the information was well presented (31 percent) and well organized (24 percent). These findings are represented in comments received where respondents reported either they found the information they were looking for "but it took a long time – especially when I was first using the application" or "I gave up trying to find the schedules because I got lost in the site."

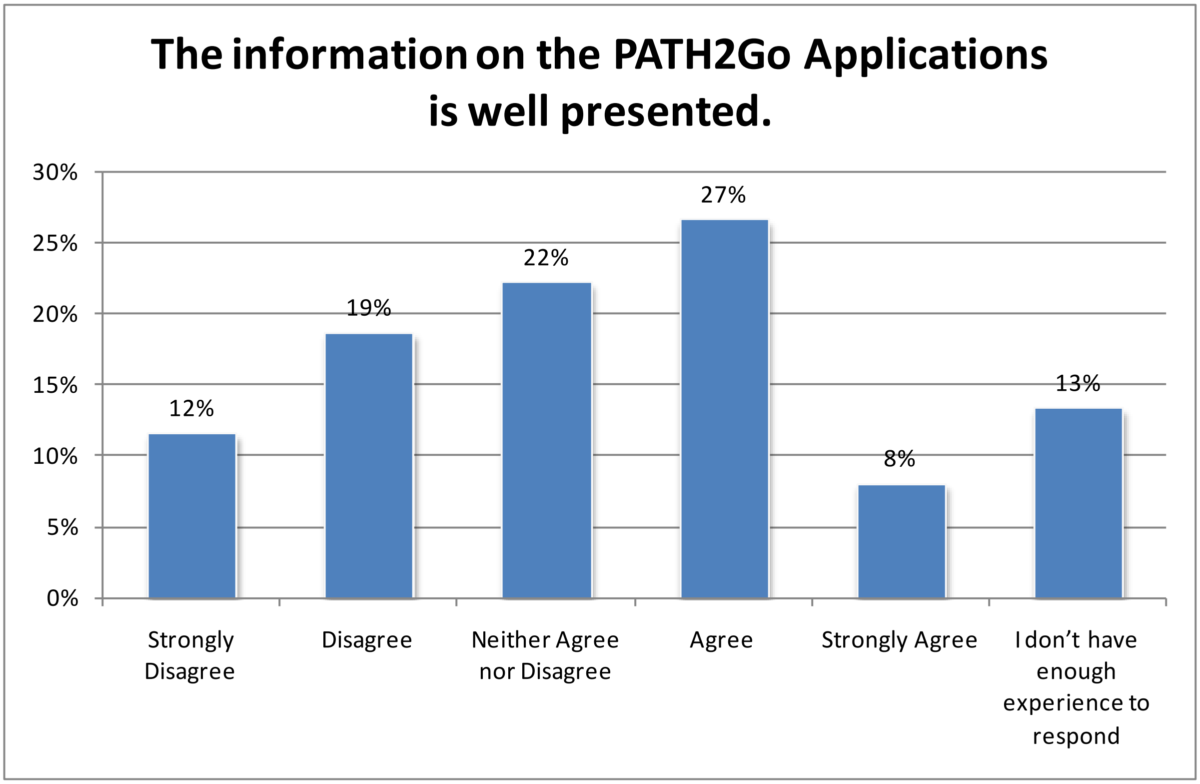


Figure 4-22. Respondents' Perceptions - Applications' Presentation

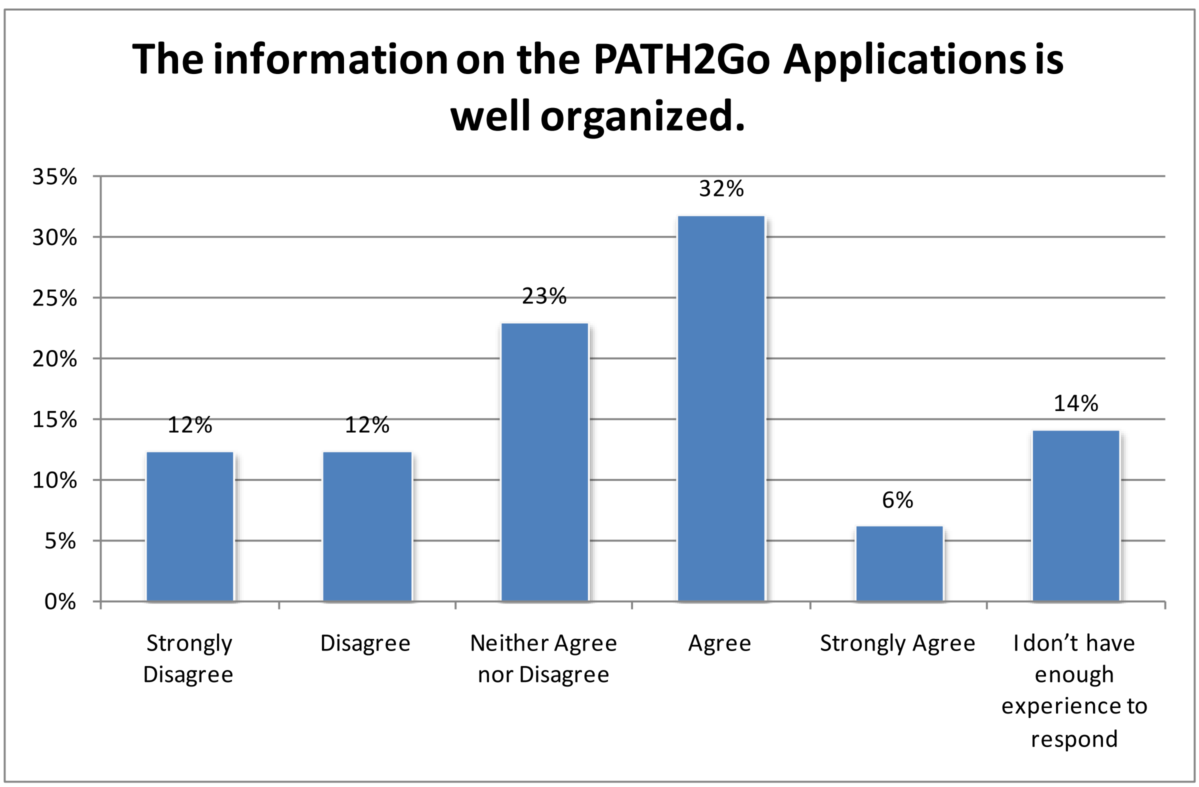


Figure 4-23. Respondents' Perceptions - Applications' Organization

These comments were also reflected in their perceptions of the ease at which the respondents could find the information they were seeking (Figure 4-24). Similar proportions were obtained from respondents; approximately one-third “strongly agreed” or “agreed” that it was easy for them to find the information and an almost equal proportion “strongly disagreed” or “disagreed.”

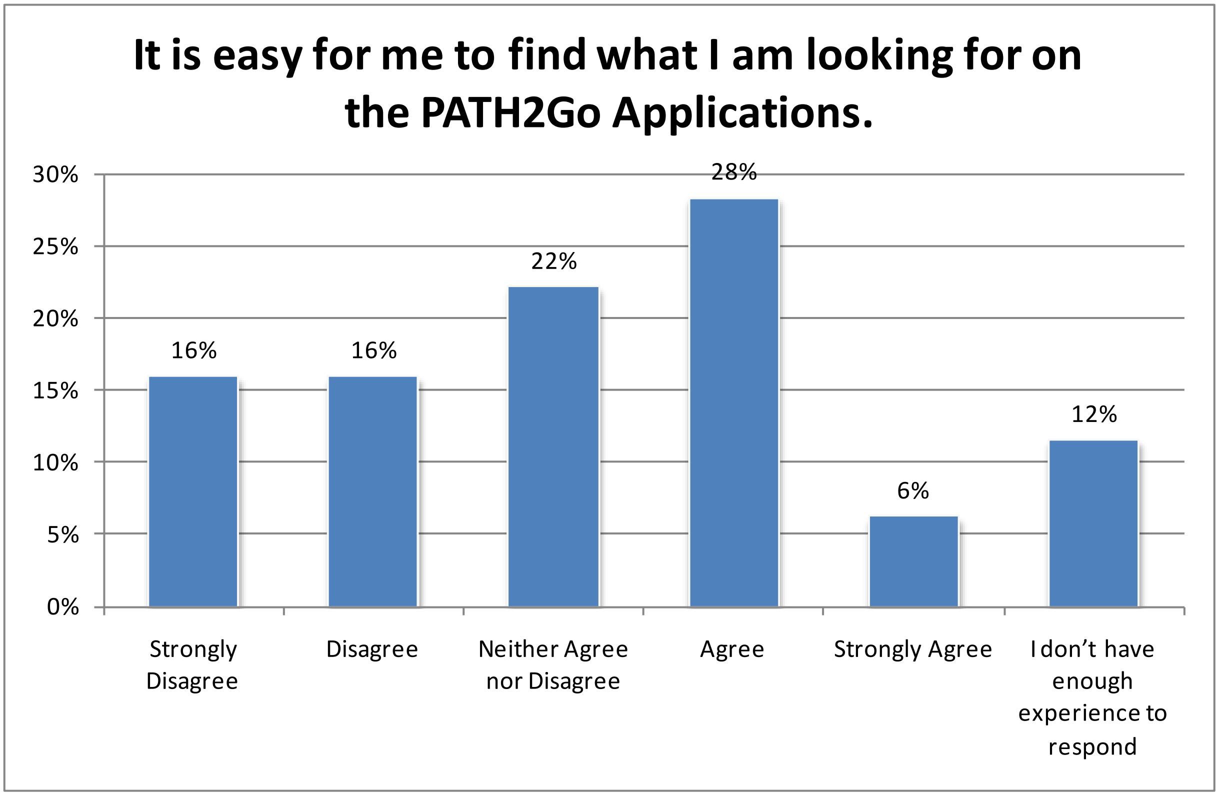


Figure 4-24. Respondents’ Perceptions – How Easy to Find Information on Applications

Perhaps respondents' perceptions of the use of the application are best summarized in Figure 4-25. As shown, less than one-third "strongly agreed" or "agreed" that the applications were trouble free. Very few, in fact, strongly agreed that the applications were trouble free. Over one-third "strongly disagreed" or "disagreed" they were trouble free; in fact one in six strongly disagreed – indicating, perhaps that some of the users were disappointed in how the applications functioned.

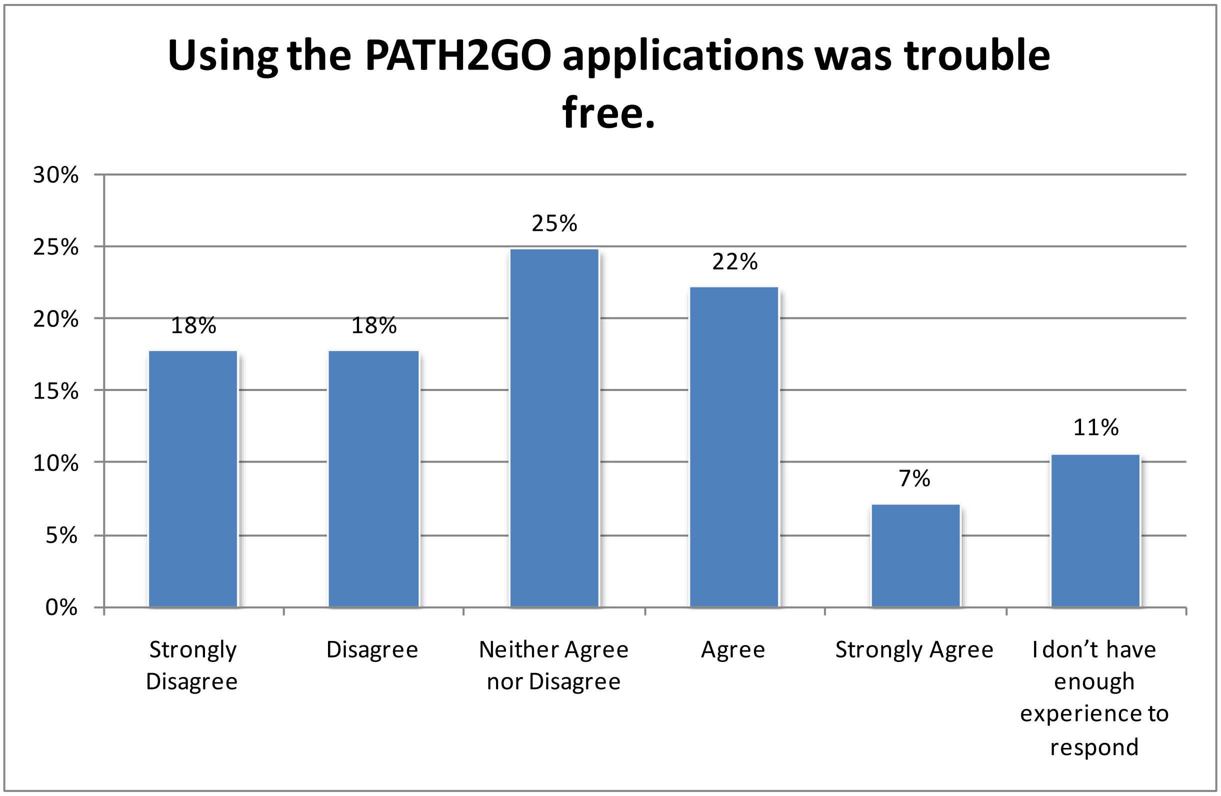


Figure 4-25. Respondents' Perceptions – Application was Trouble Free

However, while the users may have not perceived the applications as providing well presented, organized, or trouble free information, as shown in Figure 4-26, they did perceive the information as valuable. Well over half of respondents “strongly agreed” or “agreed” that the information was valuable and this is contrasted with only 14 percent who “strongly disagreed” or “disagreed.” Therefore, while searching for the information on the applications may have been somewhat frustrating, respondents did see the value in having the information.

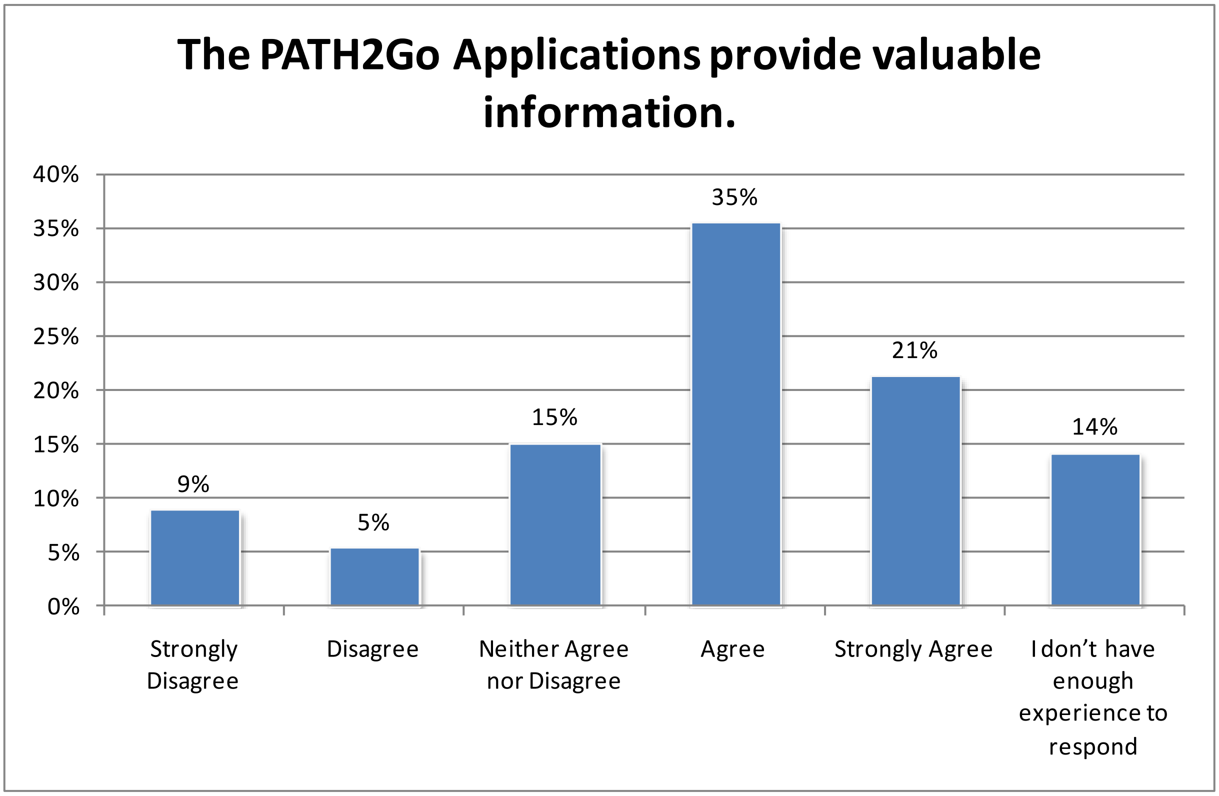


Figure 4-26. Respondent Perceptions – Applications Provide Valuable Information

In fact, when using the applications, respondents felt that having information for multiple transit services was very useful (Figure 4-27). Almost two-thirds “strongly agreed” or “agreed” that supplying information for multiple services (e.g., Caltrain, BART, SF Muni) was very helpful. This was especially true for those trips that were non-routine and may have involved multiple services or services they normally did not use.

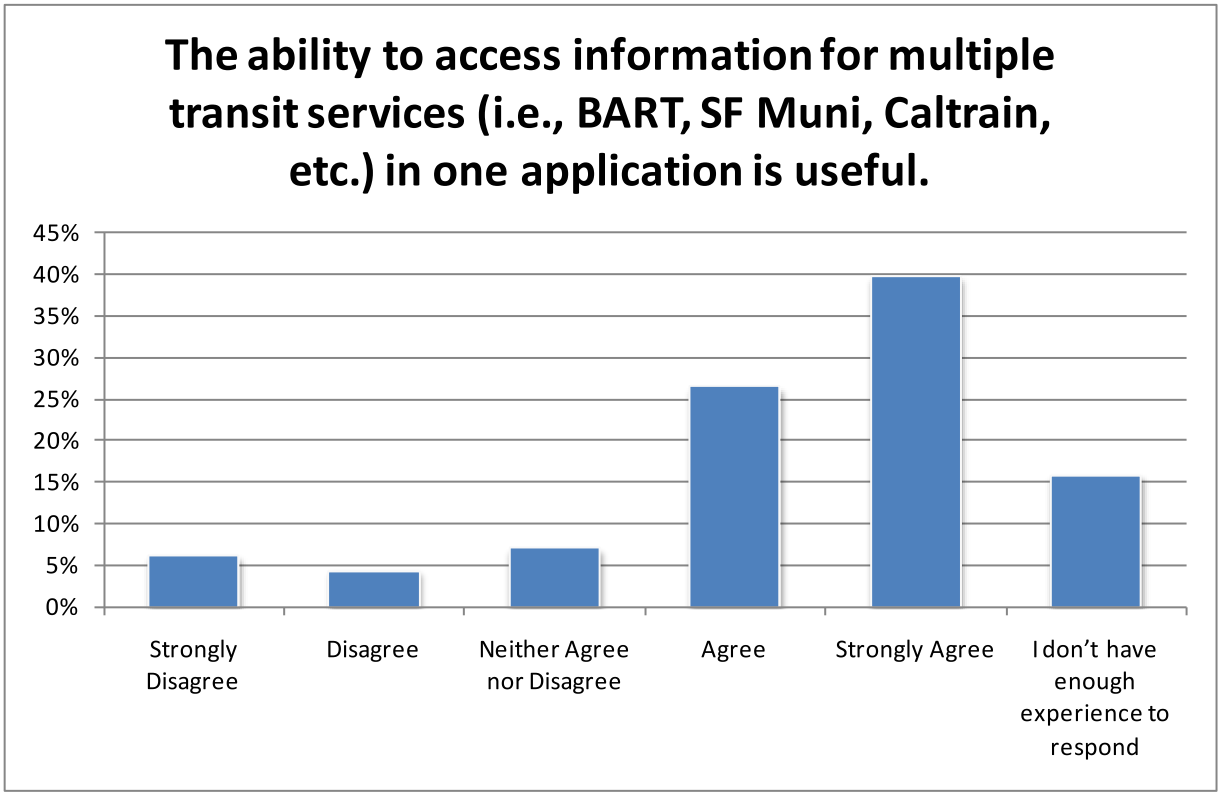


Figure 4-27. Respondents’ Perceptions – Application Information for Multiple Transit Services

Additionally, there was relatively strong agreement from respondents that the real-time departure and arrival information supplied on the application was valid (Figure 4-28). While one-fourth reported they did not have enough experience to rate this, 40 percent reported they “strongly agreed’ or “agreed” that the schedule information was reliable. Only 12 percent “strongly disagreed” or “disagreed” that the information was reliable.

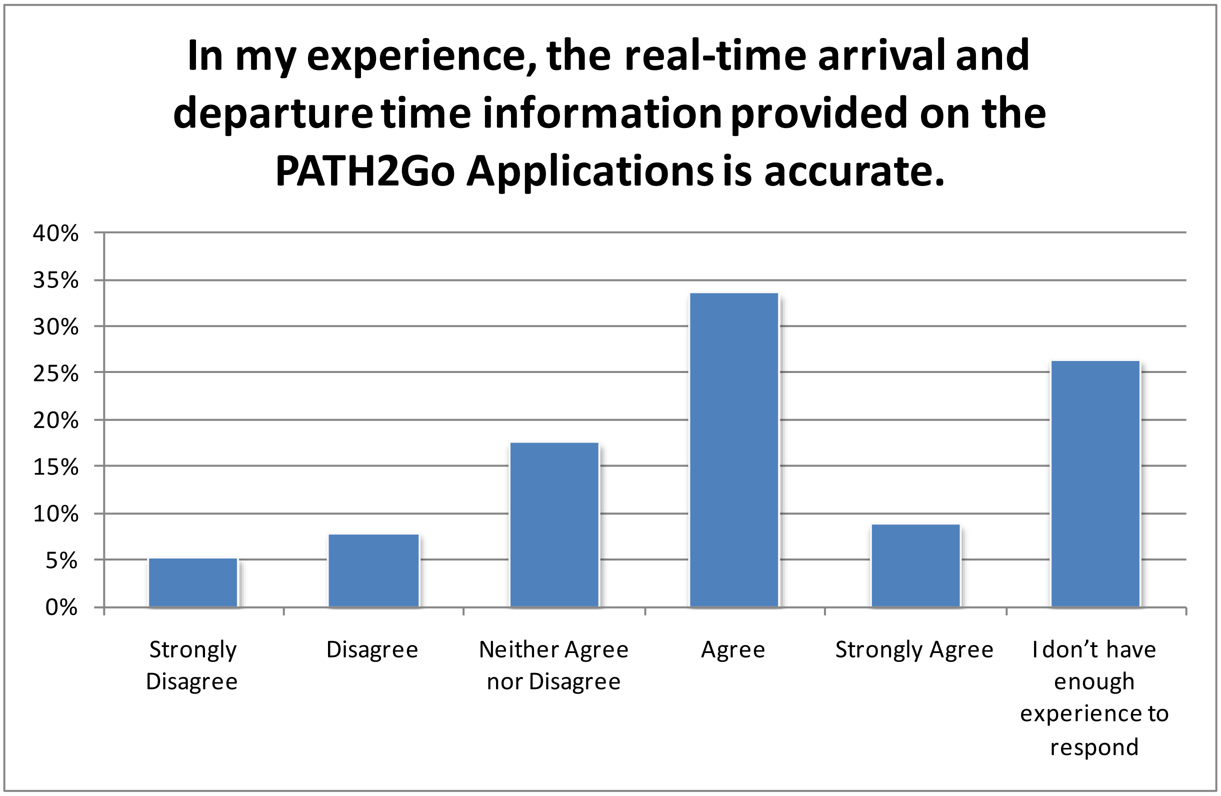


Figure 4-28. Respondents’ Perceptions – Reliability of Real-time Arrival and Departure Information

These previous perceptions are reflected in the respondents' feelings of confidence about using transit (Figure 4-29). As shown in this figure, slightly over 40 percent reported they "strongly agreed" or "agreed" that the information on the applications would make them feel more confident about using transit. Conversely, less than 20 percent had opposite perceptions.

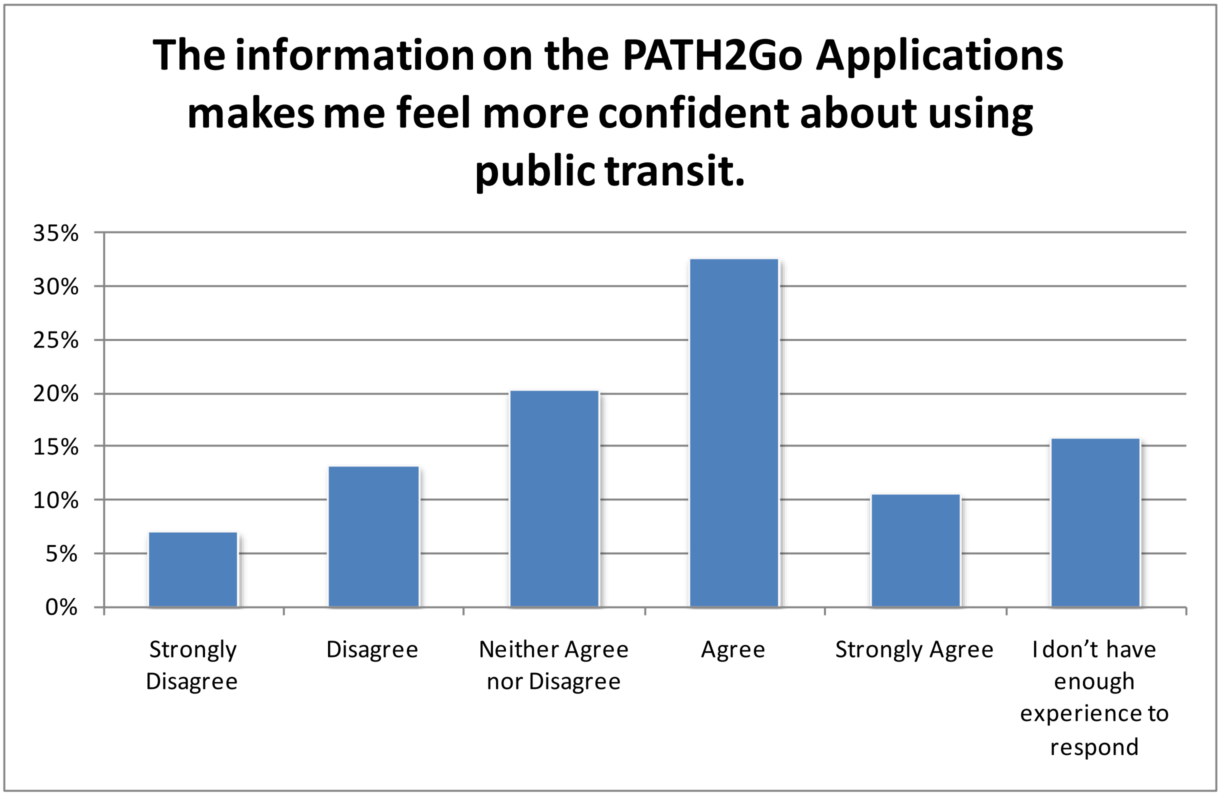


Figure 4-29. Respondents' Perceptions – Applications Make Them More Confident About Using Transit

While, however, they may feel more confident, as shown in Figure 4-30, using the applications would only influence about one-third to choose an alternate transportation mode. A slightly lower proportion reported they would not choose another mode while 38 percent were unsure. Since approximately half report they currently use transit and a similar proportion report using a private automobile, it cannot be said for certain if drivers would consider using transit, based on these results, though one may surmise that there is a higher probability of drivers shifting to transit than transit riders shifting to driving their vehicles.

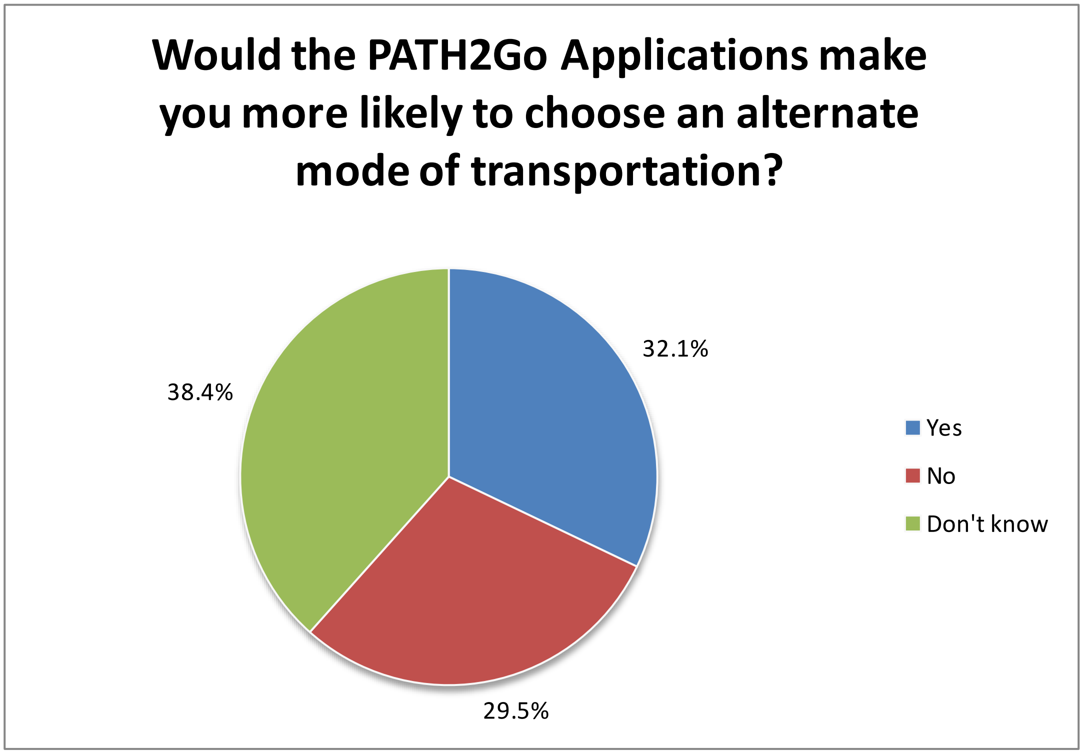


Figure 4-30. Respondents' Perceptions – Would Applications Influence Transportation Mode

As shown in Figure 4-31, respondents overwhelmingly reported they would not change their intended routes based on the information available on the applications. It would appear, perhaps, that the information provided by the applications (Trip Planning, Traveler Information, and SmartPhone application) would not satisfy users' needs for considering different routes.

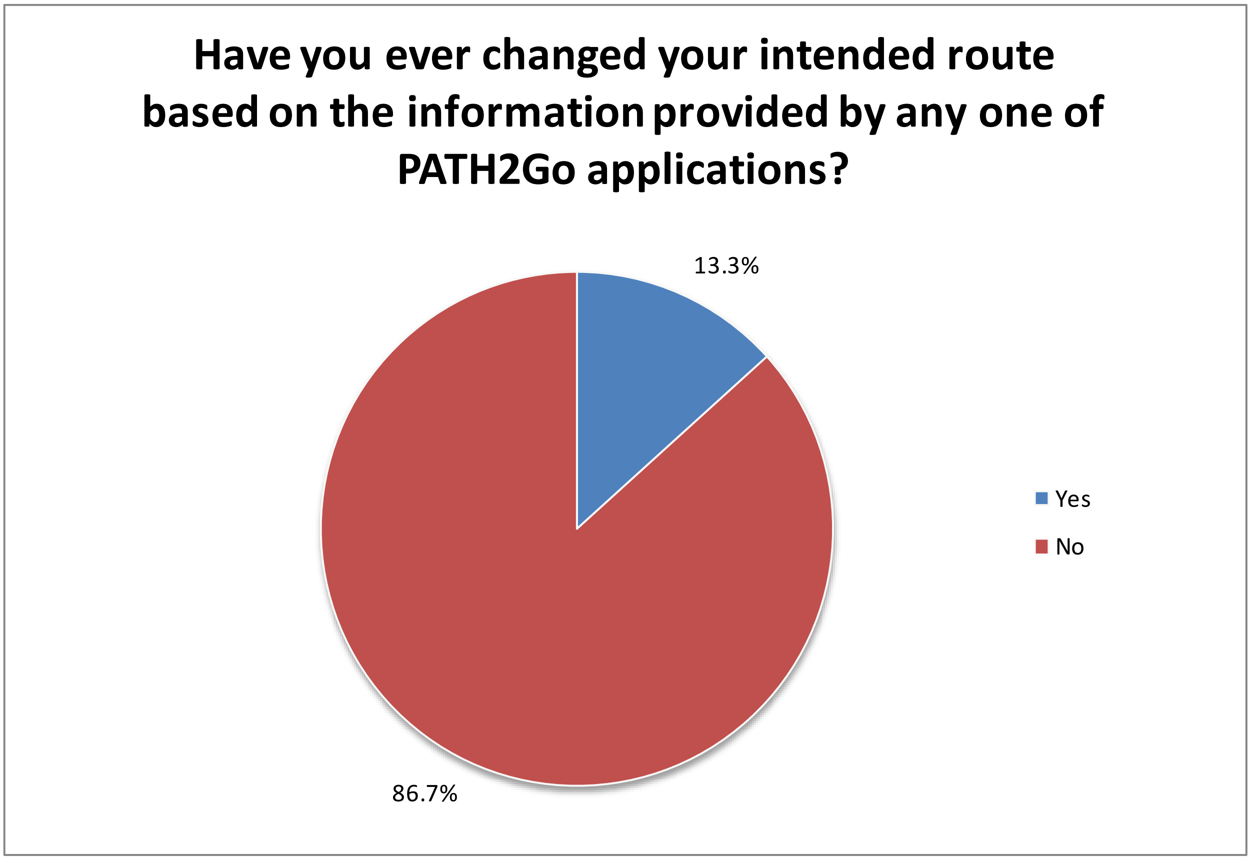


Figure 4-31. Respondents' Perceptions – Application Influence on Intended Route

4.6 SUGGESTIONS FOR MAKING THE APPLICATION BETTER

Respondents were asked to suggest how to make the applications better. Slightly less than one-half supplied comments, which could be grouped into two general categories – performance and design.

In terms of design, representative comments seemed to focus on the ability to get to the needed information efficiently, especially for routine (daily commute) information. Representative comments included:

- "The iPhone app layout is also quite confusing... Logging in every time I use this app is annoying."
- "Put color coded agencies on the TOP of the first screen, don't make use click to get there. Include ALL transit agencies covered by 511… "

- "It is way too hard to use and very confusing [about] what's going on. I should be able to save common trips."

In addition to the design issues, many also mentioned the applications' performance, focusing primarily on the mobile devices, and specifically on the geo-fencing function. Representative comments included:

- "The web application is a little bit slow to be useful"
- "I installed the [Smart Phone] application and tried to use it once or twice but found it a bit slow and clunky."
- "The 'Application Disabled while Driving' [message] is a problem when I'm using transit (either a bus or train) and either want to track the trip I'm currently on or want to plan a trip after the one I'm on."
- "The app assumed I was driving and prevented me from using it for periods. I was on the train, not driving! Bad assumption."
- "Today I tried to use the app while on the VTA tram to see the schedule since I was running late; it told me not to use it while I was driving and denied me access!"

While many of the users are aware of the applications' limitations, they also indicated that they understand the applications are relatively new and appreciate their utility, as reflected in these comments:

- "While I don't have a phone that supports the app and commute mostly by bicycle, I do encourage you to go on – this is a very important initiative."
- "Wasn't able to enter a destination address to get directions… very confusing. But liked having easy and quick access to the schedules."
- "I've only had a limited opportunity to evaluate it, but it looks promising."

4.7 SUMMARY

Registered users were asked to provide feedback on the applications beginning in October 11, 2010 through November 15, 2010. A total of 121 surveys were received from registered users. This sample is considered a convenience sample and is not considered to be reprentativ of all users, therefore, the analyses conducted and presented here is a descriptive summary of the responses received. Based on the information gathered, the respondents were predominantly male and most were in the 18 to 40 year old age group. Approximately one-half reported their primary mode of transportation was transit and 40 percent reported they used a personal automobile or carpool/van pool. When asked how they heard about the applications, most reported a web-based source (e.g., a web search, the MTC website, a link from another transportation site, or from an electronic message). A high proportion, 30 percent, reported they heard it from a friend or colleague, which further indicates the importance of informing the public with "word of mouth" methods, especially as it comes from trusted sources.

Recent usage of the applications (within one week of completing the survey) showed relatively low usage patterns, especially for the web-based applications. At least one-half of respondents reported never having used the Trip Planner or Traveler Information site and approximately one-fourth had not used either site in the week before completing the survey. Use of the Smart Phone application was slightly higher with only approximately one-half of respondents reporting they had never used it or had not used it in the past week. One-half of the respondents reported they use the applications to plan their transit trips and these are for regular trips (e.g., commuting to work or school).

For those who had used the Smart Phone application, 58 percent had downloaded it to an Android device and 42 percent to an iPhone. One-half of the users reported having received the "Warning: Application Disabled While Driving" message, though two-thirds of those who got the warning reported that it occurred relatively infrequently – less than 25 percent of the time. However, when it was received it was reported as annoying by 70 percent of users. This observation was borne out by respondent comments that focused on trying to use the application while riding on transit vehicles or as passengers in automobiles and "being blocked." Annoyance levels were slightly higher for those with iPhones when compared to Android users.

When considering the attributes and value of all three applications, users were generally pleased with them though, there were areas where the applications could be improved such as retrieving the information. For instance, approximately one-third reported the applications were not trouble free; it was not easy to find the information they were looking for; and the information was not well presented. However, one-half of respondents reported the applications provided them with the information they were looking for and slightly more than half reported that the information on the applications is valuable. Almost 40 percent also reported the information is well organized.

There was also strong agreement that the ability to access multiple transit services and having reliable arrival and departure information was important. Finally, most respondents reported that having the transit information available to them made them more confident about using transit, though there was not overwhelming evidence that having this information would lead to them choosing an alternative mode to their usual transportation method.

5. DEPLOYMENT EXPERIENCE ASSESSMENT

This section focuses on the deployment experience of the NT-T/SP test, including operational experiences and lessons learned during development and deployment. The information in this section is mostly based on interviews conducted with representatives of PATH. The purpose of the interviews was to identify obstacles and difficulties that the project partners encountered as well as best practices and successes while implementing this application.

5.1 FINDINGS

The NT-T/SP test was somewhat unusual in that it effectively provided a consumer service, rather than a management or operations tool. While the PATH2Go tools comprised a 'beta' system, i.e. a pre-mass market application, with free participation for registered users, they nonetheless had to be managed in a rapidly changing product environment that demands high standards for customer service. It is not unreasonable to assume, therefore, that users would have their own expectations for mobile services and electronic consumer products based on similar commercially available products and services.

5.1.1 Background

Since its inception in 1986, PATH has been a leader in ITS research. Its research activities are focused on three program areas – Transportation Safety, Traffic Operations, and Modal Applications. PATH's Modal Applications Program conducts research on new concepts, methods, and technologies for innovating, enhancing and improving transit solutions. Related research areas include modal integration of transportation systems, bus rapid transit technologies, and innovative transit operations. PATH has also been active in research and demonstrations of smart parking initiatives that provide real time information to drivers regarding location and availability of transit parking.

For the SafeTrip-21 initiative, PATH leveraged its research capabilities and resources with its longstanding working relationships with transit agencies in the Bay Area. This was a key to developing the PATH2Go tools in such a way that they provided comprehensive, integrated, and real time transit travel information through the US-101 corridor.

5.1.2 PATH goals

PATH had two original goals for the Transit component of the test, namely to determine whether the PATH2Go tools could provide valuable information to transit riders, and to determine whether buses could serve as useful traffic data probes. For the Smart Parking component of the test, a specific goal was to determine whether real-time information related to auto and transit service within the test bed commuting corridor could induce a modal shift to transit, and provide congestion relief to the highway (US 101).

After the test was re-scoped towards the end of 2009 (due to distracted driving concerns related to use of smart phones while driving) expectations of any measurable modal shift occurring as a result of the test were minimal. In effect, the test became more focused on transit riders rather than auto drivers. Also, the goal of using buses as traffic probes was de-emphasized, in part because of the high level of effort required to develop the PATH2Go tools, especially the geo-fenced mobile application, and in part because PATH needed to ensure their relationship with transit agencies remained focused on providing real time transit status data. Additionally, the information provided bus probes was originally intended for providing comparative trip times, but with the test's shift away from mode-shift alerts, they were no longer as necessary. Consequently, the single goal of the test was effectively to determine whether the PATH2Go tools can provide valuable information to transit riders.

5.1.3 Implementation challenges and how they were overcome

The overriding implementation challenges were related to re-scoping of the NT-T/SP test to minimize the likelihood of PATH2Go users being distracted while driving. To achieve this, PATH made some innovative modifications to the mobile application regarding when it could be safely used:

- Prevent use of the mobile application if the user was in a moving vehicle, while allowing use of the mobile application if the user was on a moving bus or train;
- Allow use of the mobile application if the user was walking, or waiting at a bus stop or rail station;
- In situations where use of the mobile application was prevented from being used, display a simple message that explained that use of the system had been intentionally blocked; and
- Ensure this approach worked consistently across all three smart phone platforms – Android, iPhone, and Windows Mobile.

These modifications to the mobile application became known as geo-fencing. PATH had to provide sufficiently compelling assurance to USDOT that a driver could not use the mobile application in a car. This assurance was a pre-requisite to publicly launching the test. Unlike traditional geo-fencing (using a device's location to trigger an action), the geo-fencing modifications developed for the NT-T/SP test had to effectively determine the mode of travel on which a device was being used to trigger an action. There was no off-the-shelf product or proven technique that could be used by PATH to help meet USDOT's requirements. Consequently, PATH developed and implemented an approach to geo-fencing from scratch. This activity occurred during February and March 2010. USDOT confirmed the PATH's approach was acceptable by the end of April 2010.

While this geo-fencing activity was a pre-requisite for the test to proceed to launch, it both added to the overall complexity of the design of the mobile application, and somewhat detracted from the end product.

Other minor deployment issues related to instrumentation of parking lots with appropriate sensors to accurately count entering/exiting vehicles and to enable robust, real time estimates of utilization. This activity was shared by PATH and Parking Carma, one of the test partners.

5.1.4 Methodologies for determining user needs

No formal process was followed with regard to determining user needs. In part the test was motivated by a desire to incentivize modal shift by increasing awareness of the transit travel options in the US-101 corridor, and the original NT-T/SP concept offered the potential to address this issue. Following the re-scoping of the test to minimize distracted driver concerns, the importance of determining user needs was somewhat diminished as the focus of the test moved away from drivers to transit riders. By this time, the schedule to conduct the test no longer provided sufficient time to conduct a comprehensive user requirements analysis.

Consequently, the development of the PATH2Go tools was mostly influenced by the need to establish a database of transit services, including real time status from multiple transit agencies, address the development requirements of three different smart phone platforms, including geo-fencing, integrate the three PATH2Go tools, and ensure the highest possible quality for the user interface and overall user experience. These issues were addressed through regular coordination between team members responsible for these respective areas. User interface and application design issues were identified and addressed by members of the project team during these coordination efforts.

5.1.5 Institutional challenges

The development, deployment, and operation of the NT-T/SP test required extensive cooperation from SAMTRANS/Caltrain and VTA. This activity was critical to the test, as PATH needed to install various forms of tracking devices on trains and buses. Previous working relationships facilitated this process, although supporting the NT-T/SP test was, understandably not the highest priority for the transit agencies given the many demands on their limited staff resources. The PATH project team was therefore very respectful of the requirements of the transit agencies, and the availability of their key staff. For example, when PATH installed the tracking devices on Caltrain's locomotives, this was done at weekends over several weeks to avoid any possible disruption to rail services.

5.1.6 Approaches for managing anonymity and privacy

PATH worked closely with UC Berkeley's Committee for the Protection of Human Subjects (CPHS) to protect the privacy of the registered users such as . PATH was required to submit an application to CPHS stating what personal information would be collected and who this information would be protected.

Based on the user survey conducted with the registered users, there were no particular concerns about privacy, even though they could be potentially tracked whenever they used the mobile application.

PART III: SUMMARY AND CONCLUSIONS

5.2 SUMMARY

The NT-T/SP test involved the deployment of real-time transit information and trip planner applications that serve travelers along the US-101 corridor in San Francisco, California. With the support of several regional partners, PATH developed a set of web-based and smart phone-based applications branded as “PATH2Go.” The primary purpose of the test was to provide information to travelers in real-time across all transit agencies that serve the US-101 corridor. This “one-stop shop” for traveler information was designed to help travelers make better pre-trip planning decisions in terms of mode selection and to serve as a tool for planning transit trips from any origin to any destination considering all transit options available.

The NT-T/SP test is unique in several ways. First, the test integrated a broad range of real-time multi-modal transportation information, including transit and parking information. While this is not unusual for traffic information, or for transit information provided by individual transit agencies, the NT-T/SP test integrated real time traffic, transit, and parking information across multiple agencies. Second, the test incorporated a technique referred to as “geo-fencing” to prevent the use of the smart phone application while driving. PATH developed a geo-fencing technique which attempted to determine which mode the traveler was using, in order to allow transit users to continue to receive updates while on the move but prevent drivers from using the information while driving.

The NT-T/SP test successfully provided real time transit information to internet and smart phone users for the duration of the evaluation, with close to no service disruption.

For smart phone users, the geo-fencing technique developed by PATH appears to have been effective in preventing use of the application while driving. The 5 mph threshold set by the PATH project team appeared to block the application for all smart phones when the GPS signal was available. However, if a smart phone is unable to obtain a GPS signal for significant portions of time, the application may be open for use. Although this was primarily due to limitations in the smart phone capabilities, this situation as well as others where satellite connections are limited does identify a disadvantage to designing geo-fencing functionality that relies heavily on smart phone GPS data to prevent distracted driving. On arterials and local roads where speeds are more variable due to greater occurrences of red lights at intersections, congestion, or stop and go traffic; the smart phone application is constantly being blocked and unblocked as driving speeds fluctuate above and below 5 mph. The ability to access the information on the application at low speeds or while stopped does present the opportunity for distraction to drivers regardless of whether or not users recognize the 5 mph design threshold.

The geo-fencing design can distinguish between users driving along a transit route versus users taking transit. While occasionally a user may be able to access the smart phone application while driving along a transit route, the time and distance constraints as well as the route matching and trip history requirements implemented into the geo-fencing design were mostly successful at preventing drivers from mimicking transit trips to gain access to the applications. In practice, the likelihood of users going to these lengths to gain access to the smart phone application is probably low. It is highly unlikely that a normal user would a) know enough about the server logic to know geo-fencing exceptions, b) go to such lengths to access the application while driving, or c) stumble across this scenario during normal travel behavior.

The evaluation team did observe several instances where the smart phone application was blocked while truly riding transit. Although unrelated to distracted driving, implementing a geo-fencing design into the smart phone application that primarily provides transit information may detract from the user experience of actual transit riders.

The PATH2Go applications experienced steady growth in registered users throughout the evaluation period while daily use of the PATH2Go Smart Phone Application and the PATH2Go website applications fluctuated throughout the evaluation period. The initial targeted marketing efforts of advertising the applications on the MTC 511 website, distributing a press release, and handing out flyers at transit stops/stations were effective in attracting registered users and increasing awareness of the website applications. The most significant increase in usage of the website applications came as the result of a Twitter post on a popular account followed by transit riders that use Caltrain. The website traffic generated by the Twitter post increased the total number of absolute unique visitors by 104 percent and the total number of visits by 66 percent in the span of five days.

Over the course of the evaluation period, which began with the launch on July 29, 2010 and ended November 15, 2010, the PATH2Go applications attracted over 900 registered users, 67 percent of which downloaded and used the smart phone application at least once and may have also used the website applications. 34 percent of the smart phone application users downloaded the app and only opened it once without returning; leaving 66 percent that used it more than once. 33 percent of users registered on the project website, but only used the website applications. By the end of the evaluation period, the PATH2Go website applications attracted a total of 916 absolute unique visitors that accounted for 1,664 total visits to the website, and an average of 1.82 visits per user.

The usage analysis suggests that newer, more progressive forms of marketing like using social media websites such as Twitter can be significantly more effective in increasing awareness of real-time traveler information like the PATH2Go applications. Although still effective, more traditional forms of marketing like preparing a press release do not seem to generate the same level of exposure as quickly as a targeted social media effort without being covered by a major media source. Although the fluctuating website usage was greatly increased using Twitter, the impact was short-lived as usage quickly returned to its rolling pattern of approximately five to thirty website visits per day only a few days after the Caltrain tweet. While social media may have a greater ability than traditional marketing to attract a large number of visitors to a website quickly, the usefulness of or need for the information available on a website is generally what drives return visits.

With over 55 percent of users having only visited the website one time, regular or return users of the website were not as common. User frequency can often be an indicator of user acceptance and need for a website, but a number of factors may explain why less than half of website users returned for another visit. Possible explanations for this trend include:

- Length of Evaluation Period.
- User Travel Frequency using Transit.
- Usefulness of Real-time Information.
- Perceived Value of Website.
- Website Functionality.

With the exception of possible insight from the user survey, there is no definitive way to determine which of these explanations is responsible for the greater number of one-time users versus return users. Regardless, a low visit frequency does not necessarily indicate low user acceptance or usefulness, but may more so be an indicator of how visitors use the information on the website.

Registered users provided valuable feedback on the PATH2Go tools. Most had heard about them from a web-based source (e.g., a web search, the MTC website, a link from another transportation site, or from an electronic message). A high proportion reported they heard it from a friend or colleague, which further indicates the importance of informing the public with “word of mouth” methods, especially as it comes from trusted sources.

Usage of the tools showed relatively low usage patterns, especially for the web-based applications. At least one-half of respondents reported never having used the Trip Planner or Traveler Information site and approximately one-fourth had not used either site in the week before completing the survey. Use of the Smart Phone application was slightly higher with only approximately one-half of respondents reporting they had never used it or had not used it in the past week. One-half of the respondents reported they use the applications to plan their transit trips and these are for regular trips (e.g., commuting to work or school).

While-half of the users reported having received the “Warning: Application Disabled While Driving” message, two-thirds of those who got the warning reported that it occurred relatively infrequently – less than 25 percent of the time. However, when it was received it was reported as annoying by 70 percent of users. This observation was borne out by respondent comments that focused on trying to use the application while riding on transit vehicles or as passengers in automobiles and “being blocked.”

When considering the attributes and value of all three applications, users were generally pleased with them though, there were areas where the applications could be improved such as retrieving the information. For instance, approximately one-third reported the applications were not trouble free; it was not easy to find the information they were looking for; and the information was not well presented. However, one-half of respondents reported the applications provided them with the information they were looking for and slightly more than half reported that the information on the applications is valuable. Almost 40 percent also reported the information is well organized.

There was also strong agreement that the ability to access multiple transit services and having reliable arrival and departure information was important. Finally, most respondents reported that having the transit information available to them made them more confident about using transit, though there was not overwhelming evidence that having this information would lead to them choosing an alternative mode to their usual transportation method.

The PATH2Go tools will remains operational through 2011, with new Caltrans funding.

5.3 CONCLUSIONS

The conclusions that follow are grouped according to the evaluation objectives for the NT-T/SP test.

5.3.1 Observe the consumer response to the NT-T/SP application

Overall, the NT-T/SP test was a success, as witnessed by the large number of registered users and website visits, and by the extent to which registered users provided positive feedback

(including infrequent users and those who wished to provide constructive suggestions on how to enhance the initial, beta, system.)

5.3.2 Understand the technical and institutional issues associated with distributing multi-modal information to smart phone users

The NT-T/SP test resulted in significant insight into the understanding of distributing real time transit information. The test demonstrated the ability to integrate transit, traffic, and parking information across multiple agencies in real time. The test highlighted the potential for distributing personalized information via the internet and smart phones, and to do so without causing driver distraction.

There were many technical challenges associated with the test, most notably the geo-fencing technique. While geo-fencing has existing for some time, the requirements for this test were different in that it had to prevent use of the smart phone application in one mode (cars) while allowing it in others (train and bus.) This was achieved by PATH, although arguably to the detriment of the overall user experience, essentially because users found it to be annoying and, at times, inappropriate.

5.3.3 Test the ability of geo-fencing as a method to prevent distracted driving

With few exceptions, the geo-fencing technique developed by PATH was effective at blocking the use of the smart phone application in cars, and by extension was therefore able to minimize distracted driving. However, the technique was not foolproof, in part because it depends upon smart phones being able to access a GPS signal. Without this signal, the geo-fencing technique will be unable to calculate whether the user is moving faster than the 5 mph threshold. Users with a detailed knowledge of the design of the geo-fencing technique may be able to mimic a transit vehicle while travelling in a car, although this is considered a remote possibility. What is more likely is for a user to be blocked from using the smart phone application while riding transit, as the user may not have planned a trip in accordance with the requirements of the geo-fencing design. Under these circumstances the application will assume any such riders are actually in a car, and consequently block access to the application.

5.3.4 Understand the development process and institutional issues associated with implementing a server-based geo-fencing method versus a client-based method on mobile devices

The NT-T/SP test adopted a design that implemented the geo-fencing technique that used a server-based method, rather than using a client-based approach on the smart phone devices. With any application design for smart phones, developers can decide whether to host the code and source information for certain application functionality on the server-side of the application or the client-side of the application. In other words, the decision-making can either take place on servers hosted by the developers or on the smart phone itself. The geo-fencing design was integrated into the PATH2Go Smart Phone Application using server-side logic, which allowed for a thin client-side design. Implementing a server side geo-fencing design prevented the design team from having to address differences in the operating systems of Windows Mobile, iPhone, and Android smart phones that could have an effect on geo-fencing performance. Client-based functionality would have required wrapping up all of the code and sources into the application download, which would have been demanding on the smart phone in terms of application size, processor speed, and battery life depending on complexity.

5.3.5 Measure usage of the NT-T/SP application

Overall, the PATH2Go tools experienced steady growth in the number of registered users – a possible indication of user acceptance. However it was clear that multiple approaches are necessary to raise awareness of the tools, rather than relying on a single approach. Equally, it was clear that repeated measures are necessary to retain momentum. It is likely that each marketing technique affects each user in a different way; therefore, many different efforts are usually required to reach out to a wide variety of users.

5.3.6 Analyze the perceived accuracy and usefulness of mode shift alerts and en-route transit information

Well over half of respondents "strongly agreed" or "agreed" that the information was valuable and this is contrasted with only 14 percent who "strongly disagreed" or "disagreed." In fact, when using the applications, respondents felt that having information for multiple transit services was very useful. Almost two-thirds "strongly agreed" or "agreed" that supplying information for multiple services (e.g., Caltrain, BART, SF Muni) was very helpful. This was especially true for those trips that were non-routine and may have involved multiple services or services they normally did not use.

Additionally, there was relatively strong agreement from respondents that the real-time departure and arrival information supplied on the application was valid. While one-fourth reported they did not have enough experience to rate this, 40 percent reported they "strongly agreed' or "agreed" that the schedule information was reliable. Only 12 percent "strongly disagreed" or "disagreed" that the information was reliable.

5.4 ACKNOWLEDGEMENTS

The evaluation team is very appreciative of the support it received from the PATH project team during the planning, conduct and analysis of the evaluation. Fully understanding the geo-fencing design and corresponding server logic was essential for the evaluation team to conduct a comprehensive assessment of the geo-fencing functionality. The PATH project team was tremendously accommodating in explaining the complex logic involved in the geo-fencing processes. Equally, the user survey would not have been feasible without the extensive cooperation and support of the PATH project team.

Special thanks are offered to the following Caltrans and PATH personnel for their assistance in interviews and document review in support of this project:

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- Greg Larson, Caltrans Headquarters
- Sean Nozzari, Caltrans District 4
- Wei-Bin Zhang, PATH
- Liping Zhang, PATH
- Kun Zhou, PATH

PART IV: APPENDICES

APPENDIX A: SCREENSHOT OF PATH2GO USER REGISTRATION SURVEY

Please help with our research by telling us a little about yourself:

1. What is your home zip code?

2. About how much is your yearly household income?
select an income level...

3. What industry do you work in?
select your industry...

4. For which of the following purposes did you sign up the Networked Traveler application?
- ☐ Commute to work or school
- ☐ Personal travel (e.g., shopping, medical appointments, recreation/vacation)
- ☐ Business-related travel (e.g., deliveries, business appointments)
- ☐ Other (specify)

5. Most days, about how long is your commute in miles (one way)?
select your commute distance...

6. Most days, about how long is your daily commute in minutes (one way)?
select your commute duration...

7. Most days, how to you typically commute (check all that apply)?
- ☐ Car
- ☐ Local Public Transit (Within a City, e.g., Muni)
- ☐ Regional Public Transit (Between Cities, e.g., Caltrain, BART)
- ☐ Private Transit (e.g., Company Shuttles)
- ☐ Carpool
- ☐ Other (specify)

8. Where do you normally get your traveler information (check all that apply)?
- ☐ I don't usually check traveler information
- ☐ Google Website
- ☐ 511.org Website
- ☐ 511 (phone)
- ☐ Radio
- ☐ Electronic message signs along my route
- ☐ Television
- ☐ Other Website:
- ☐ Other Mobile Phone Application:
- ☐ Other (specify)

9. How did you hear about us?
- ☐ 511.org Website
- ☐ iTunes Store
- ☐ Android Market place
- ☐ Google
- ☐ A friend or relative told me about it
- ☐ Other (specify)

Submit

APPENDIX B: GEO-FENCING TEST ITINERARY

Geo-fencing Test Itinerary – Set 1.

Step	Individual	Scenario Tested	Mode of Transportation	Transit Route	Trip Instructions for Application	Start Address	End Address
1	Driver & Passenger	4	Driving	A	Plan trip A prior to departing start address.	Doubletree – Berkeley Marina 200 Marina Blvd, Berkeley, CA	Downtown SF 4th St and King St
	Passenger	4	Walking	A	Upon arrival at end address, exit car and walk to transit station.	-	-
2	Passenger	6	Riding transit	A	Board Caltrain – San Francisco to San Jose/Gilroy and ride one stop to 22nd Street.	San Francisco Caltrain stop	22nd St Caltrain stop
	Driver	-	Driving	-	Depart Caltrain station and drive to 22nd St & Penn Ave. Pick up passenger.	Downtown SF 4th St and King St	Downtown SF 22nd St and Pennsylvania Ave
3	Driver & Passenger	4	Driving	B	Plan trip B prior to departing start address. Take Penn Ave south towards Cesar Chavez St. Take a left on Cesar Chavez St. Take a right on 3rd St. Arrive at Marin St.	Downtown SF 22nd St and Pennsylvania Ave	Downtown SF 3rd St and Marin St
	Passenger	4	Walking	B	Upon arrival at end address, exit car and walk to transit stop. Return to car without boarding.	-	-
4	Driver & Passenger	5, 6	Driving	B	After identifying SF Muni light rail, attempt to follow the route of the train/bus. Drive on 3rd St following the route of the train/bus.	Downtown SF 3rd St and Marin St	Downtown SF 4th St and King St
5	Driver & Passenger	1	Driving	C	Do not plan a trip before departing start address. Take 4th St away from the water to Townsend St. Upon arriving, plan trip C.	Downtown SF 4th St and King St	Downtown SF 4th St and Townsend St
	Passenger	4, 5	Walking	C	Upon arrival at end address, exit car and walk to transit stop. Return to car without boarding.	-	-
6	Driver & Passenger	5, 6	Driving	C	After identifying SF Muni bus, attempt to follow the route of the train/bus. Drive on Townsend St toward 3rd St.	Downtown SF 4th St and Townsend St	Downtown SF 4th St and King St

Geo-fencing Test Itinerary – Set 2.

Step	Individual	Scenario Tested	Mode of Transportation	Transit Route	Trip Instructions for Application	Start Address	End Address
7	Driver & Passenger	1	Driving	D	Do not plan a trip before departing start address. From US-101 S, take exit 404B to Willow Rd. Turn left onto Middlefield Rd. Turn right at University Ave. Turn right toward Mitchell Ln. Take second left onto Mitchell Ln.	Any location.	Downtown SF 4th St and King St
	Passenger	4, 5	Walking	D	Upon arrival at end address, exit car, plan trip D, and walk to VTA 522 BRT stop.	-	-
8	Driver & Passenger	5, 6	Driving	D	After identifying VTA 522 BRT, attempt to follow the route of the bus. Exit transit center on Palm Dr. Take a left onto the entrance ramp to El Camino Real. Drive on El Camino Real toward California Ave while following bus.	Palo Alto, CA Palo Alto Transit Center	Palo Alto El Camino Real and Showers Dr
9	Passenger	4, 5	Walking	E	Exit car upon arrival at El Camino & Showers stop. Plan trip E and identify VTA 22 bus stop. Return to car.	-	-
10	Driver & Passenger	5, 6	Driving	E	After identifying a VTA 22 bus, attempt to follow the route of the bus. Drive east on El Camino Real towards Hollenbeck Ave.	Mountain View, CA El Camino Real and Showers Dr	Mountain View, CA El Camino Real and Hollenbeck Ave
11	Driver & Passenger	4	Driving	F	Plan trip F prior to departing start address.	Mountain View, CA El Camino Real and Hollenbeck Ave	Mountain View, CA Mountain View VTA Station
	Passenger	4, 5	Walking	F	Upon arrival at Mountain View VTA Station, exit car and walk to station.	-	-

Geo-fencing Test Itinerary – Set 3.

Step	Individual	Scenario Tested	Mode of Transportation	Transit Route	Trip Instructions for Application	Start Address	End Address
12	Driver & Passenger	4	Driving	G	Plan trip G prior to departing start address. Take US-101	Any location.	Milbrae, CA Milbrae Transit Center
	Passenger	4, 5	Walking	G	Upon arrival at Milbrae Transit Center, exit car and walk to BART station.	-	-
13	Passenger	4, 5	Walking	H	Before departing Milbrae Transit Center. Plan trip H nd identify SamTrans 391 bus stop. Return to car.	-	-
14	Driver & Passenger	5, 6	Driving	H	After identifying a SamTrans 391 North bus, attempt to follow the route of the bus. Drive along El Camino Real following bus.	Milbrae, CA Milbrae Transit Center	San Bruno, CA San Bruno BART station

APPENDIX C: ITS BERKELEY PRESS RELEASE

ITSBerkeley Institute of Transportation Studies

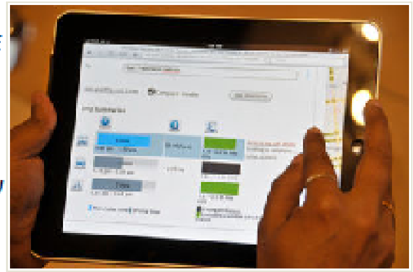
PRESS RELEASE

- FOR IMMEDIATE RELEASE -

UC Berkeley researchers launch high-tech transit study in Bay Area commute hot-spot

By Ann Brody Guy | August 31, 2010

BERKELEY - A new pilot project by transportation researchers at the University of California, Berkeley, seeks to determine whether commuters will use transit more often if they are provided with accessible, current and information-rich transit, parking and traffic options before they start their journeys. The field test takes place along the US 101 corridor between San Jose and San Francisco, one of the busiest commute routes in the Bay Area, and provides a comparison of real-time traffic, bus and Caltrain information for custom-selected routes. *(Above: The pre-trip planner compares modes. Photo by Jay Sullivan, PATH)*



The pilot, called the Networked Traveler, formally launched today, Tuesday, August 31, with an invitation for the public to use the free online trip planner at www.networkedtraveler.org and/or download the mobile phone application, called PATH2Go. The technology allows travelers between San Francisco and San Jose to select the best commute option based on personalized priorities of cost-efficiency, time-efficiency or a low-carbon footprint. The mobile application is also available in the mobile apps section of www.511.org.

Researchers said that the study's multi-agency cooperation was key to attaining real-time, region-wide data for multiple modes of transportation. "Commuters can compare driving, Caltrain and the bus based on the up-to-the minute status of traffic and transit," said Liping Zhang, the lead developer on the project, which is being conducted at the California Partners for Advanced Transit and Highways

(PATH), a research center at the UC Berkeley Institute of Transportation Studies. Zhang said Networked Traveler aggregates information from a variety of sources – including live next-train and next-bus information from Caltrain, SamTrans, San Francisco Municipal Railway (Muni), BART, the Santa Clara Valley Transportation Authority (VTA) 522 bus rapid transit line, and real-time traffic conditions from traffic.com and SpeedInfo. "Smart parking" – instrumentation that counts and transmits the number of available spots – displays current parking availability at the Millbrae, Redwood City, Menlo Park and Palo Alto Caltrain stations.

Networked Traveler has two main features: a trip planner for multimodal pre-trip planning, and, for people who already know their routes, a menu of transit agencies for quick access to next-bus/next train information. There are also a series of alerts to help transit riders navigate their trips. For driver safety, "geofencing" technology is used to block the cell phone application while a driver is in a moving automobile.

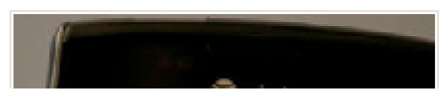
The trip planner functions much like Google's trip planner, with a simple screen where users enter a starting point and a destination. But the results show comparative routes for different modes of transport, including a color-coding system that enables a quick visual comparison. "Blue shows the time people can spend working or relaxing on transit, and green shows actual CO2-emission savings over driving, Zhang said, noting that the selection of brown to indicate driving was not arbitrary. "Are we sending a message that transit is greener? Absolutely." *(Above: Clicking on the Caltrain icon on a trip map yields parking availability and next-train information.)*

For shorter trips, entering an urban segment into the trip planner will yield a bicycle or walking option with estimated times that users can compare to transit and driving. Zhang concedes that sometimes driving will be the best option – for example, when traffic is clear and a traveler is in a hurry. "The larger goal of the Networked Traveler project is to allow travelers to make informed choices," Zhang said. The comparisons also include cost estimates.

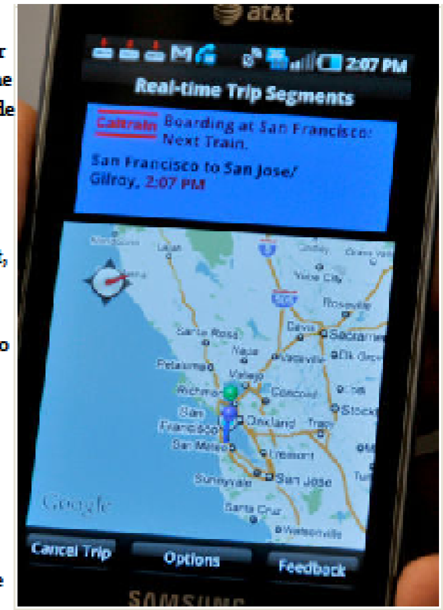
The transit routes menu on both the website and phone application provides live next-bus/next-train information that includes BART, SamTrans, Muni, Caltrain and VTA (route 522 only; researchers expect to expand live VTA data system-wide beginning in the fall).

Commuters who register their GPS-activated smart phones at www.networkedtraveler.org can opt to receive a number of in-transit screen alerts – with audio and vibrate options – telling them where the nearest stop is, and, after they are already in transit, how many minutes are left on their trip and when their destination is approaching. Zhang said these features were designed to aid regular commuters who may be absorbed in work or music, as well as people with hearing and vision disabilities and those traveling in unfamiliar territory.

The California Department of Transportation (Caltrans) is sponsoring the pilot with the aim of developing tools that will reduce traffic congestion and alleviate traveler stress.



"Prior research performed at PATH shows that informed travelers are likely to be safer and more efficient travelers," said Greg Larson, the Networked Traveler project manager at the Caltrans Division of Research and Innovation. "Broadcasting information about the options travelers have available to them empowers them to decide on the best route, mode and time of travel, which also helps to balance demand across these three dimensions."



Larson added that the Networked Traveler project does provide help for drivers already on the road. Message signs along US 101 display current travel times and available parking at the Caltrain stations. "We are encouraging the public to consider using transit, even after they have begun their trip," Larson said.

Project partners include the Metropolitan Transportation Commission (MTC), San Mateo County Transit District (SamTrans), Caltrain, VTA, NAVTEQ, ParkingCarma and SpeedInfo. *(Above: The PATH2Go mobile application gives transit riders real-time information while they are enroute.)*

Phones that currently support the Networked Traveler's PATH2Go mobile application include the iPhone, Android, Palm Treo and Treo Pro, LG Incite, Samsung Omnia and Intrepid, and the HTC Touch Fuze, Touch Cruise, Touch Diamond, Tilt 2, Imagio, Pure, Touch Pro. An up-to-date list of supported phones are available on the Mobile Apps page of the Networked Traveler website.

Sign-up is required to receive the PATH2Go mobile application, so that the research team can contact participants for surveys and feedback. The study will not save cell phone numbers or associate the numbers with user names.

The field test is slated to continue for several months. To learn which information is most likely to influence traveler behavior, researchers will study how and when people use the services and which services people find most helpful.

Berkeley's Liping Zhang emphasized that the study is testing a hypothesis, not a product. "We will use surveys, evaluations, and website metrics to determine whether high-value comparative information can improve mobility, decrease traveler stress and ultimately, help to decrease congestion on the roadways."

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APPENDIX D: SPECIFIC PATH2GO MEDIA COVERAGE

Date	Activity	Notes
29-Jul-10	Targeted Marketing	PATH2Go applications advertised on MTC's 511 website (www.511.org). Displayed on homepage for 4-5 weeks.
8-Aug-10	Media Coverage	Mass Transit blog - **http://www.masstransitmag.com/interactive/2010/08/05/there%E2%80%99s-an-app-for-that/**
31-Aug-10	Targeted Marketing	Press release launched by UC Berkeley Institute of Transportation Studies (ITS) - **http://its.berkeley.edu/about**
31-Aug-10	Media Coverage	UC Berkeley News Center - **http://newscenter.berkeley.edu**
31-Aug-10	Media Coverage	Transportation Communications Newsletter - blog post - **http://transport-communications.blogspot.com/2010/08/tuesday-august-31-2010.html**
1-Sep-10	Targeted marketing	Distribution of flyers at transit stations - the PATH team handed out flyers 2 times or more per week from the beginning of September into early October.
1-Sep-10	Media Coverage	Traffic Technology Today blog - **http://www.traffictechnologytoday.com/news.php?NewsID=24390**
2-Sep-10	Media Coverage	UC Berkeley - Daily Californian web article (Student-run Newspaper) - **http://www.dailycal.org/article/110191/uc_berkeley_researchers_launch_new_trip-planning_p**
2-Sep-10	Media Coverage	The Transit Wire blog - **http://www.thetransitwire.com/2010/09/02/researchers-to-test-impacts-of-traveler-info/**
3-Sep-10	Media Coverage	AASHTO Journal Online - Weekly Transportation Report - **http://www.aashtojournal.org/Pages/090310california.aspx**
6-Sep-10	Test Launch Date	Android application released into Google Android Marketplace - **http://www.android.com/market/#app=basesign.alltie**
15-Sep-10	Targeted Marketing	Tweet on *caltrain* Twitter Account – 4,997 followers as of 11/17/2010 – **http://twitter.com/#!/caltrain**
7-Oct-10	Media Coverage	SF Examiner article - Local Section of Web - **http://www.sfexaminer.com/local/Muni-working-on-app-for-smart-phone-users-104469069.html**

APPENDIX E: PATH FLYER DISTRIBUTED AT TRANSIT STATIONS

JOIN UC BERKELEY'S FIELD TEST

FREE REAL-TIME TRAVELER INFORMATION DELIVERED TO YOUR MOBILE PHONE OR INTERNET CONNECTION

WHAT DOES PATH2GO OFFER?

PATH2Go gives you real-time information to enable you to reduce waiting time, relieve stress, and help the environment. Access PATH2Go via http://www.networkedtraveler.org

PATH2Go Trip Planner

- *Compare driving, transit, driving to transit, and bicycling options*
- *Choose among travel options based on current travel time, fare, and carbon footprint*
- *Send trip plan to your smart phone*

PATH2Go Smart Phone Application

- *Available on iPhone, Windows Mobile smart phones and (coming soon) Android with GPS*
- *Search for real-time bus arrivals at nearby stops*
- *Plan your transit trip on your phone*
- *When you're waiting at a station, get an alert about the approach of your train or bus*
- *When you're on a train or bus, get an alert as it approaches your destination*

A screenshot of PATH2Go mobile phone interface

PATH2Go Web-Based Transit Information

- *Find out precisely when your bus or train will arrive*
- *See parking availability at selected Caltrain parking lots*
- *Search for arrival info using route name, stop name, or nearby address*
- *Set up one-time or recurring reminder of train or bus arrivals at your favorite stops via email or SMS*

PROJECT OVERVIEW

The Networked Traveler research project offers travelers an innovative web-based trip planner and mobile applications, based on real-time information about conditions on US101, Caltrain, BART, buses operated by SF Muni, Samtrans, and VTA (Line 22), and selected Caltrain parking lots.

Researchers will evaluate, through the experiences of volunteers like you, whether and how real-time information can encourage and assist travelers to make better travel decisions.

PROJECT PARTNERS

This research is conducted by the California Partners for Advanced Transit and Highways (PATH), Institute of Transportation Studies at University of California, Berkeley, partnering with:

- Research and Innovative Technology Administration (RITA), U.S. Department of Transportation
- California Department of Transportation (Caltrans)
- Metropolitan Transportation Commission (MTC)
- Santa Clara Valley Transportation Authority (VTA)
- San Mateo County Transit District (Samtrans) and Caltrain
- NAVTEQ
- ParkingCarma
- SpeedInfo

HOW DO I PARTICIPATE

Sign up: *Visit the Networked Traveler website* www.networkedtraveler.org

Download phone apps: *iPhone, Windows Mobile Smart Phones and (coming soon) Android phones .*

Provide Us with Feedback: *Registered users can take a survey on the Networked Traveler website and be entered into a monthly drawing for a $100 gift certificate.*

For Questions Contact PATH2Go@lists.berkeley.edu

Visit the Networked Traveler Website http://www.networkedtraveler.org