Increasing Ridership of Santa Fe Trails

An Interactive Qualifying Project Submitted to the faculty of Worcester Polytechnic Institute
in partial fulfillment of the requirements for the Degree of Bachelor of Science

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    Transportation in the Western United States – Kwok Chung Chong, Brian Strobel

    The City Different – Santa Fe – Kwok Chung Chong

    Santa Fe Trails – Yuchen Zhang

Methodology

    Characterizing Transportation in Santa Fe, NM– Kwok Chung Chong

    Designing a Feeder System to the Santa Fe Trails – Kai Brevig

    Improving Rider Tools – Brian Strobel, Yuchen Zhang

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    Feeder System to the Santa Fe Trails – Kai Brevig

    Google Transit File Generation – Yuchen Zhang

    Mobile Application – Yuchen Zhang

    Improved Bus Stop Signage – Brian Strobel

Recommendations

    Create a More Bike-Friendly Bus System – Kai Brevig

    Develop a More Comprehensive Mobile Application –Yuchen Zhang

    Finalize Google Transit Collaboration – Brian Strobel

Acknowledgements

Abstract

This project evaluated different methods that aimed to increase the ridership of the Santa Fe Trails public transportation system in Santa Fe, NM. Through the analysis of surveys given to both bus riders and non-riders, various improvements to the system were decided. To provide users with more information while riding the bus and waiting at bus stops, we designed improved signage as well as a web application for smartphone users. To provide residents and visitors of Santa Fe access to Google's public transportation trip planning, an Excel spreadsheet was created to generate the necessary files for Google. Finally, we proposed the addition of a new system that would extend the services of the Santa Fe Trails to the unserviced east of Santa Fe city. These solutions were well received by the Santa Fe Trails and have a high chance of being implemented in the near future.

Executive Summary

Santa Fe Trails is a public transportation agency in the city of Santa Fe, NM. To make public transportation convenient for citizens, it offers a wide variety of services, including the Santa Fe Trails fixed route bus service, the Santa Fe Ride paratransit service for seniors and handicapped, and the Santa Fe Pick-up shuttle around downtown. To keep its business operating smoothly, Santa Fe Trails recently invested in services from RouteMatch, a software company that provides passenger transit solutions. As a result, all Santa Fe Trails vehicles are equipped with a GPS systems, surveillance cameras, and a portable tablets.

Despite the Santa Fe Trails bus system having served more than one million passenger trips in 2012, the average ridership level was only 12%, and it was our goal to propose methods to increase ridership to levels like those in the graphic above. In order to identify some problems that may be hindering ridership, we conducted surveys of riders and non-riders. Based on the
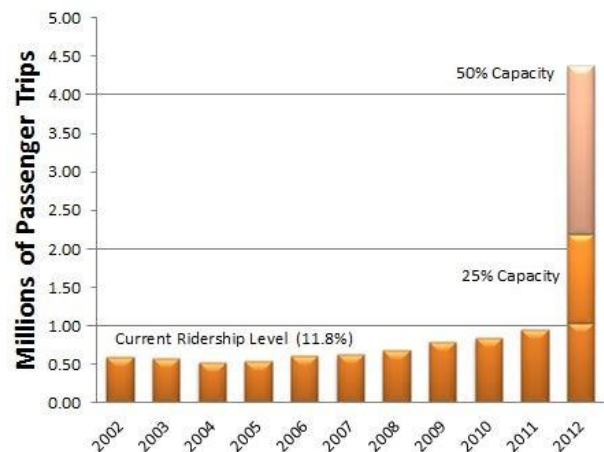
results of the surveys, we were able to address some of the problems. One issue was getting to and from the bus stops (the first and last mile), which could be solved through a feeder van to transport people to the bus. Another problem was inadequate information at stops, which can be aided by new signs which tell a rider nearly everything they'd need to know about the route that stops there and its location. The last problem uncovered by the surveys was the need for a mobile application, so a working prototype was designed and built.

In total, 36 surveys were collected from the general public and 273 surveys from users of the bus system. Nearly three quarters of bus riders responded that they don't have access to a car, so they must rely on the bus to get around. Most people ride to get to work or school as well. It was also found the average maximum walking time people were willing to walk to a bus stop to be around 21 minutes, which translates to about a mile.

Maximum Walking Time

71% of users are willing to walk up to a mile to a bus stop

Average Walking Time: 21.1 min
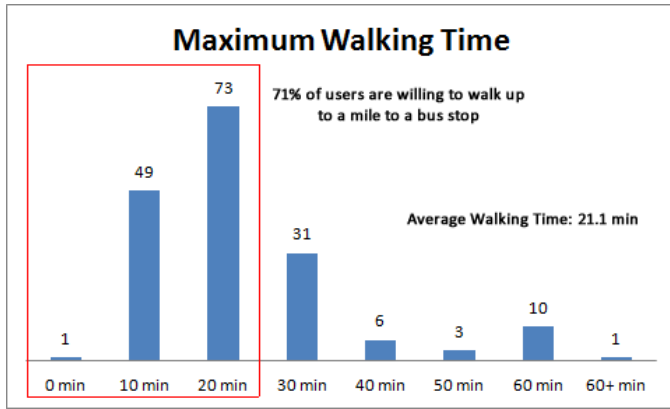
One of the problems discovered is the issue of the first and last mile from the bus. A solution to this is to ride one's bike to the bus and store them on the available bike racks on the front of the vehicles. However, only half of bike owners that were interviewed actually used the bus' racks. One possible reason why the racks are not used is "there are simply not enough bike racks," said one rider. "We are worried that bike racks are full quickly," said another. People don't use the bike racks because they may not be confident there will be space for their bicycle, especially on routes 21 and 22 which serve Santa Fe Community College students. Many of them ride a bike, and the lack of bike space hinders ridership. As an answer to the problem, three solutions were proposed. First, if there is room and money, Santa Fe Trails can add more bike racks inside the bus. Second, a van can be allocated to pick up bicyclers from their location to the nearest bus stop if the bike rack is full. Finally, with the creation of the mobile app, a bike rack reservation function can be created.

For residents who live outside of walking distance to the Santa Fe Trails, we designed a feeder system unique to the Santa Fe Trails. We believe that adding a fixed route feeder system such as the Santa Fe Trails Pick-Up would see little use as many of the bus routes do now and would not efficiently cover the large area we are considering. Instead we proposed the addition of a completely demand responsive system, in which vans Santa Fe Trails currently own would
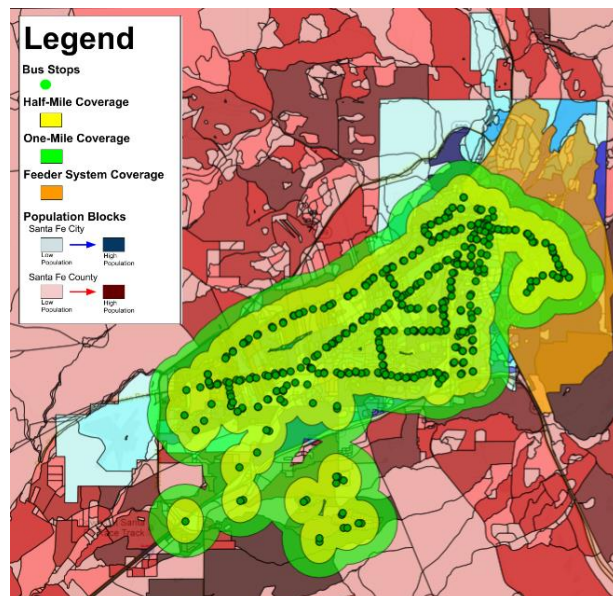
transport users to the bus system from addresses outside of a mile of the fixed route bus system and within the border of Santa Fe City. This system would be run very similar to how the Santa Fe Ride paratransit is operated but would require that a bus stop be either a starting point or destination of a trip. We proposed a coverage area in the northeast of Santa Fe where we found a large population that was outside of walking distance of the bus system. This area, outlined in orange in the figure below, houses around 11,000 residents in a 14 square mile area. With this feeder system, these residents will have a reliable form of public transportation around the entire city of Santa Fe.
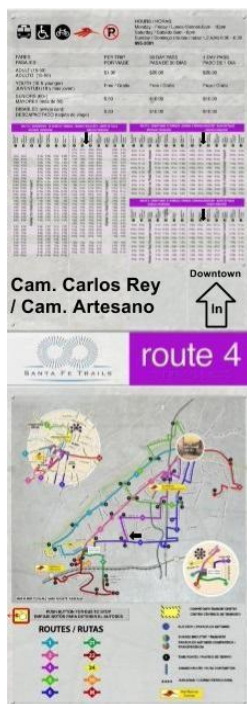
Another innovation being proposed to increase the ease of ridership is new and improved signage at stops. Since at some locations it is not stated which bus stops there, or the direction of the bus, getting around the city can be confusing for both residents and visitors. We saw comments saying "we want better bus stop signs" and "we had no idea where to get off [the bus]." In order to alleviate some of this confusion, new signs were designed that include indication of the route(s) that stops there, the direction, and the location of the stop through cross-streets or major area landmarks. We also developed a numbering system along

each route that utilizes current major stops, or time points. These ideas were also incorporated into the Santa Fe Trails' current designs of new signage planned to be implemented summer 2013.
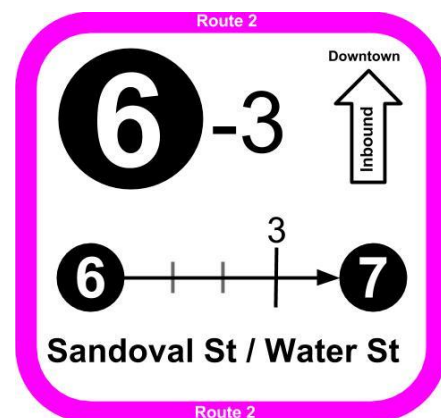
The third solution is an application that gives valuable information for riding the Santa Fe Trails. Over 60% of responders agreed with the creation of a Trails app. Because of this demand, a web-based mobile application was designed to display live information about bus and schedule. Since each bus is equipped with GPS system, the application can send requests to server to get those live bus location information directly. As a result, users can check live bus

locations as well as schedule times for each bus from the application. Furthermore, as the selected bus approaches, users can set up alarms to remind them of the incoming bus. Later, the functionality of the app was extended so that it can be used to place requests for pick-up service that was proposed by this team. From the application, users can easily place requests and the server will respond with an estimated arrival time so that the users can better plan their trips.
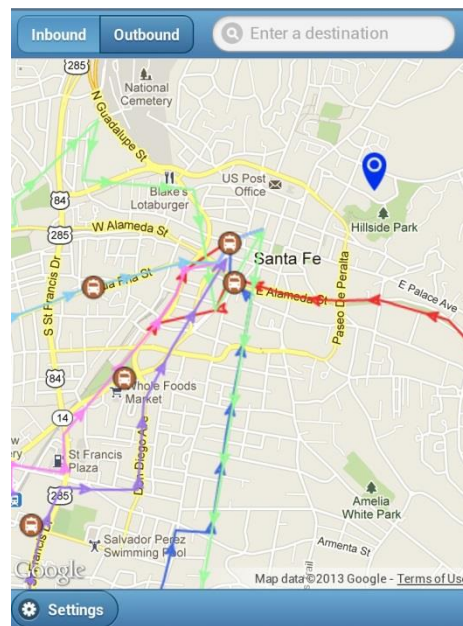
In the development of this web application, Google Transit Feed files served as one of our main resources. Google Transit Feed files store all the bus schedule data and on launching the application, the server would read the files and then display what users requested. Moreover, Santa Fe Trails will be contacting Google to submit the Google Transit Feed files to them so they could have Santa Fe Trails in the Google Transit function of Google Maps. People will be able to plan their trips in Santa Fe using public transportation in the near future using this function. In order to maintain the dataset that was used for Google Transit, a tool was built up for Santa Fe Trails to modify bus schedule easily. This was accomplished through an Excel workbook which recorded all the schedule information. Macros were set up in the Excel workbook so any changes will get updated to the Google Transit Feed files by simply running a program in the Excel workbook.

All of these proposals are being seriously considered by the governing body of the Santa Fe Trails, the Transit Advisory Board, and may be implemented in the very near future.

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1. Introduction

Public transportation plays an important role in cities throughout the United States. It serves as a necessity for many without cars as well as an alternative to traffic, pollutants, and the expenses of owning a car. Millions of people use methods of public transit each day, including more than twelve million passengers a day on the five most used public transportation systems in the United States. New York City's Metropolitan Transportation Authority alone services more than 8.5 million passengers per day, affording it the most used transit network in the U.S.

On an environmental scale, using public transportation can prevent millions of tons of greenhouse gas emission—that would otherwise be created by the use of automobiles—from entering the atmosphere and contributing to global climate change. When analyzing the gas emissions caused by the daily trip to work, the leader in efficient public transportation, heavy rail transit, is close to four times more efficient than the general automobile trip, which carries 1.63 passengers. The amount of greenhouse gases emitted by a single occupant vehicle is even more inefficient, adding almost one pound of carbon dioxide to the atmosphere every mile it travels. In recent years cars have become more fuel efficient, producing less CO_2 per passenger, yet they are still far behind public transit in terms of emissions. Overall, public transit creates far less greenhouse gas emissions than travel by automobile, saves users the money that would otherwise be spent on purchasing and maintaining an automobile, and saves valuable time during times of high traffic.[1]

Santa Fe, the capital of the state of New Mexico, is one of the oldest cities in the United States. It is often known to the public as the "city different" because of its 400-year history which dates back to its European colonization in 1610, and its blend of 3 cultures: Native American, Hispanic, and European. Because of this, Santa Fe is famous for its abundant museums and tourist attractions. Public transit is important to its residents, namely its commuting workers, as well as

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[1] Tina Hodges, 2010

tourists to the city. In fact, the city of Santa Fe offers several forms of public transportation options, including buses and trains.

The Santa Fe Trails Bus system, the primary bus system of the city, is one of the cheapest and most efficient methods of mass transit around Santa Fe. In particular, it is beneficial for the 8% of the residents who live below poverty line, defined as a personal annual income of less than $11,344[2], and most likely cannot afford personal cars.[3] The Santa Fe Trails bus system has grown to include 10 routes with 470 bus stops which are serviced by 36 full-sized compressed natural gas (CNG), wheelchair accessible buses. The system served over a million passengers in 2012[4], a 9% increase from 2011[5]. Santa Fe Trails also provides Americans with Disability Act (ADA) certified point-to-point transportation to the handicapped and seniors through its' Santa Fe Ride paratransit service (SFR).This group of individuals that accounts for close to 20% of the city's population cannot easily take the fixed route bus system and therefore benefit greatly by this paratransit system.[6]

The Santa Fe Trails bus system had the capacity to serve many more people in Santa Fe than it did upon the start of our project. Many of the bus stops were serviced infrequently, with six of the ten transit lines having scheduled buses only once every hour or longer. Of the remaining four lines, buses were still often more than 30 minutes apart[7]. This was a major drawback for those that wished to use the bus system at any time of the day without having to either refer to the schedule or wait exorbitant amounts of time. It would have been much more convenient for users to be able to arrive at a bus stop at any time and not have to worry how long it would take for a bus to arrive. Transportation by the Santa Fe Trails proved even more difficult when taking multiple lines to get from one place to another because connecting stops had buses from different lines occasionally arriving up to an hour apart.

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[2] C. DeNavas-Walt, B. Proctor, J. Smith, 2011
[3] Santa Fe, New Mexico
[4] Santa Fe Trails Stats, 2012
[5] Santa Fe Trails Stats, 2011
[6] Santa Fe, New Mexico
[7] Santa Fe 400, 2013

When compared to transit systems in other cities, some of the resultant shortcomings in usage become evident. In comparison to Scranton, PA, whose population is about the same as Santa Fe's at 76,000[8], Santa Fe Trails reported .88 million unlinked passenger trips (UPT) in 2010, as opposed to Scranton's bus service's 1.7 million UPT in the same year (an unlinked passenger trip is defined as the number of passengers that board a public transportation vehicle[9]). Also, according to the Santa Fe Trails annual report, in 2009 the operation cost per UPT was $6.58[10], compared to $0.93 for Boston's Massachusetts Bay Transportation Authority (MBTA)[11]. It costs the MBTA less per trip because MBTA services are used more per trip than Santa Fe Trails.

In addition the Santa Fe Trails bus system did not allow easy access to the entire city of Santa Fe before starting our project. Many areas were too far away from the transit system's stops, making the system not feasible to many of the city's residents and tourists. Increasing bus frequency as well as expanding the bus system to cover the entire city of Santa Fe was too large an investment for such as large city containing such a small population of only 70,000 residents[12]. Our project sought to address these problems and proposed unique methods by which the Santa Fe Trails agency could efficiently increase the use of their transit services. Our project team first conducted surveys to both non-riders and riders to establish the needs of both groups as well as gain an understanding of the demographics of Santa Fe and how that related to public transit usage. From the survey results we found a need for an extension of the public transit's service area as well as better access to information. Because of this, we proposed the creation of a new service that would transport individuals outside of walking distance of a bus stop to the fixed route bus system using the existing resources of the Santa Fe Trails. In addition we collected and analyzed data from the Santa Fe Trails—including route, schedule and stop information—to be integrated into one usable excel document. This document can be used to generate the Google transit feed files that are necessary for public transit trip planning in Google

[8] U.S. Census Bureau, 2013
[9] National Transit Administration, 2013
[10] Santa Fe Trails - City of Santa Fe (Santa Fe Trails), 2010
[11] MBTA n.d.
[12] U.S. Census Bureau, 2013

maps. A web application that reads these transit feed files was also developed to provide users with real time information for riding the bus. Lastly several recommendations were made to address the lack of signage at bus stops as well as the issue of bike racks filling up quickly on several routes. These recommendations were presented to the Transit Advisory Board of Santa Fe as well as the Santa Fe Trails agency and were being highly considered as cost effective solutions to increasing the efficiency and use of the Santa Fe Trails.

2. Background

Motor vehicles are an essential part of everyday life. Many people rely on them for the transportation of goods as well as transportation to and from work. Vehicles since their invention have become more common in American households despite the price of cars being at an all time high.[13] The United States Census Bureau showed that at its highest rate in 2005, more than 86% of households owned one or more cars,[14] collectively creating more than 1 billion tons of greenhouse gases.[15] Transportation is the second leading cause of greenhouse gas emissions in the U.S., behind electricity production, accounting for 27% of all greenhouse gas emissions.[16] Because there are many forms of transportation, with some being much more efficient than others, greenhouse gas emissions caused by transportation are also the easiest to prevent.
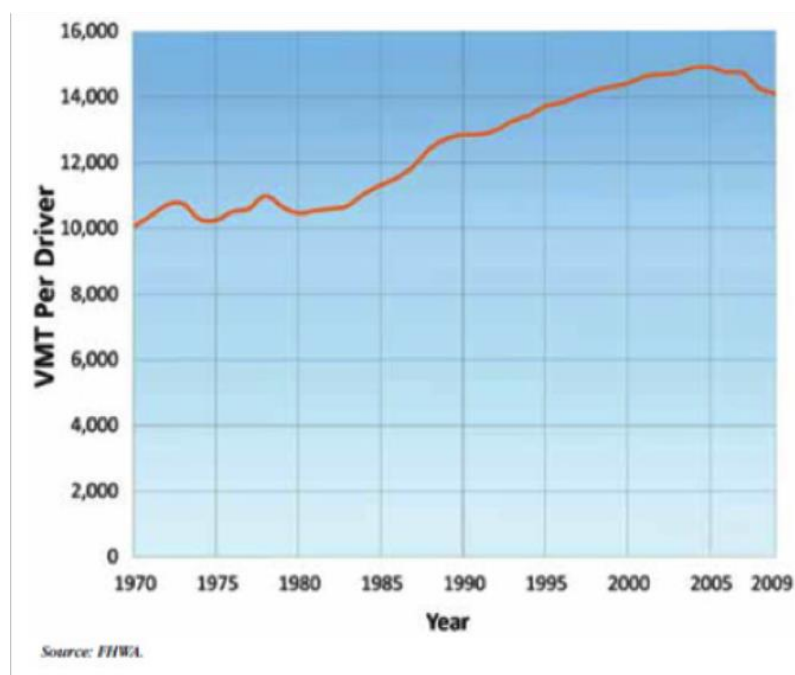
Figure 2-1 Vehicle Miles Traveled (VMT) per US Driver

By taking public transit rather than personal vehicles, individuals cut their carbon emissions in half. Recent years have shown a decline in vehicle ownership and usage in addition to increases in public transit usage. The latest

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[13] Chris Isidore, 2012

[14] United States Census Bureau, 2010.

[15] United States Environmental Protection Agency, 2010

[16] United States Environmental Protection Agency, 2010

census data from 2010 showed a 2% decrease in vehicle ownership as well as the average driver driving 7% less than they did in 2005.[17]

2.1 Transportation Related Greenhouse Gas Emissions

As one of the leading causes of greenhouse gas emissions, transportation has faced scrutiny in recent years. This scrutiny has led to a decrease in the number of large pick-up trucks and SUVs being driven as well as a large emphasis on the importance of hybrid and electric vehicles. As seen in Figure 2-2, greenhouse gas emissions are on a decline since the last peak in 2007 at just under 2 billion tons of carbon dioxide emissions. In addition to more fuel-efficient automobiles, public transit has also played a role in decreasing emissions.[18] Public transit is more than twice as fuel-efficient as the average household car and ridership has been increasing yearly due to improvements in transit systems and the increase in the price of gasoline. Public transportation within the U.S. recorded more than 10.4 billion total trips taken in 2011, the second highest reporting since 1957.[19]
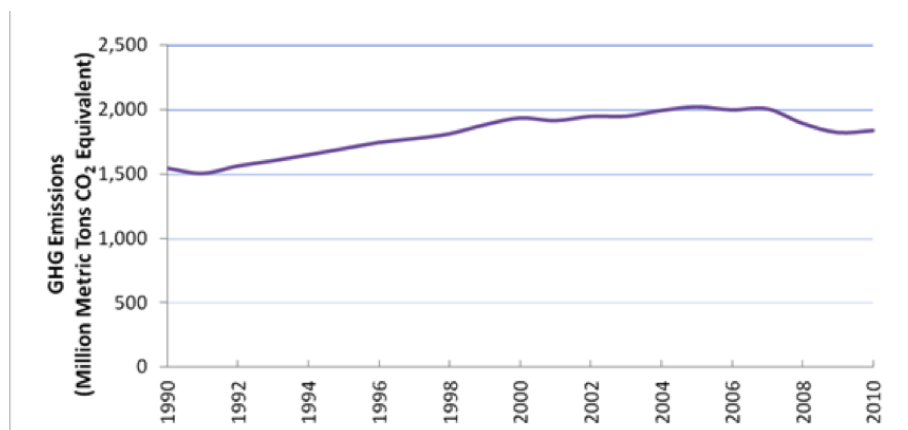
Figure 2-2 Greenhouse Gas Emission From Transportation

Computing the amount of greenhouse gas emissions produced by a certain form of transportation is very complex due to the different types of fuels, different fuel efficiencies of systems, and the varying amount of occupants for any given vehicle. The United States Department of Transportation Federal Transit Administration (FTA) performed a comprehensive study in 2010 to

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[17] Brian Lomax, 2010

[18] EPA, Sources of GHG Emissions

[19] American Public Transportation Organization, 2012.

determine just this. Data was collected by the FTA averaged fifty of the most used transit systems in the US to determine the average occupancy of a given method of transportation as well as its carbon emissions. Data from the 2001 National Household Transportation Survey and the EPA's 2005 estimate of the average fuel efficiency of the light-duty vehicle (car, SUV, pick-up truck) showed that the average work commute consisted of 1.14 passengers while the average fuel efficiency for these vehicles was 20.3 miles per gallon of gasoline. Their results confirmed that transit buses, the most common form of transportation, were still 25% more efficient than the average work commute despite the average occupancy of 28%, as seen in Figure 2-3. Among the most efficient public transit methods were heavy rail systems and vanpool systems which both proved to be 75% more efficient than the average work commute.[20]
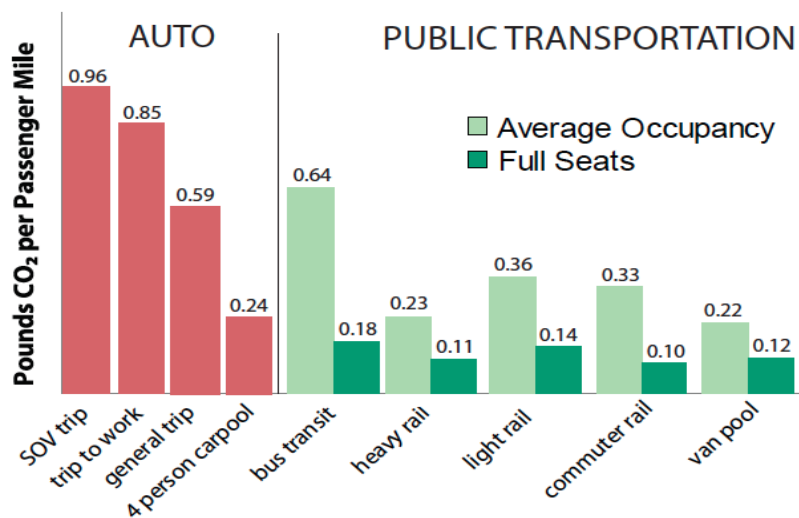
Figure 2-3 Estimated CO_2 Emission per Passenger Mile On Average and Full Occupancy

2.2 Transportation in the Western United States

Personal automobiles are being used more and more at an alarmingly increasing rate. The number of people driving to work by themselves has more than doubled in the last fifty years, as shown in Figure 2-4. This is contrary to the growth rate of other mobility modes, which either are being used less or have negligible growth compared to that of the car being driven alone.

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[20] Hodges. Tina, 2010
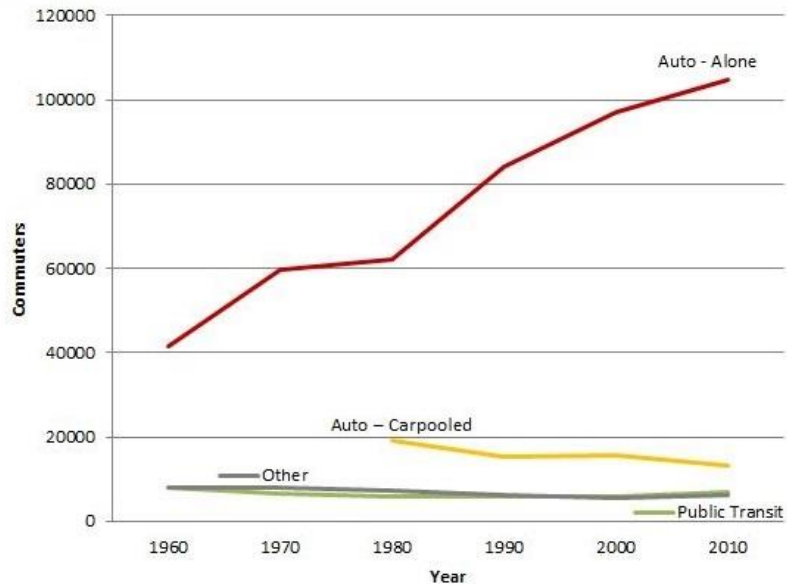
Figure 2-4 Usage of Different Transportation Methods Nationwide

2.2.1   Transportation Culture

The prevalent car culture that is established in the West has a major impact on the usage of public transit. The United States is often referred to "a country on wheels", with 812 cars per 1,000 people.[21] Of the fifty states, Colorado has only 350 cars per 1,000 people, while Wyoming has 1,140 cars per 1,000 people. Some western states are ranked on the top of the list, like Utah, North Dakota, South Dakota, and Nebraska. As populations become more spread out as they are in the West, car ownership generally increases while public transportation usage decreases. This can be attributed to several reasons including the difficulty of designing effective mass transit in areas of low population density.

One factor that affects the widespread use of cars is the knowledge of cars. Auto shows play a major role in educating the general public about the car, including the specific terminology, accessories and activities. Several big auto shows exist in the U.S., including Detroit Auto Show, New York Auto Show and LA Auto Show. They are all located in metropolitan areas, and LA has a greater impact on its peripheral areas since there are not many settlements next to it comparing to Detroit or NYC. Combining that with the diminutive population

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[21] U.S. Department of Energy, 2012

density of most of the western U.S. we can see the public transportation ridership in the West is much less than that in the East.

2.2.2 Population Density

A metropolitan region's population density may be a factor in effecting its citizens' use of public transit. A city that is large in area but small in population may encounter difficulties in designing an effective public transit system to serve all of its' inhabitants equally. Areas of low density can be expected to show lower ridership numbers—meaning emptier buses. This is contrary to a city which is smaller in area with a significant population. Efficient routes may be planned easier and cover more percentage of the city because of the smaller area, while at the same time serving more people simultaneously because there are more people per unit area.

Each of the regions in the United States can be generally characterized as having a similar population density in them. Each of the regions varies greatly, however. States in the Northeast are the most densely populated in America, as opposed to states in the Southwest which are ranked overall the lowest. Northeast states like Massachusetts, Connecticut, and Rhode Island, all rank in the top ten of U.S. states in 2010 by persons per square mile, with 840, 740, 1020 persons, respectively. In contrast, southwestern states like Arizona and New Mexico fall in the bottom 40% of states in this category, with only 56 and 17 persons per square mile respectively[22].

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[22] US Census, *Resident Population Data,* 2010
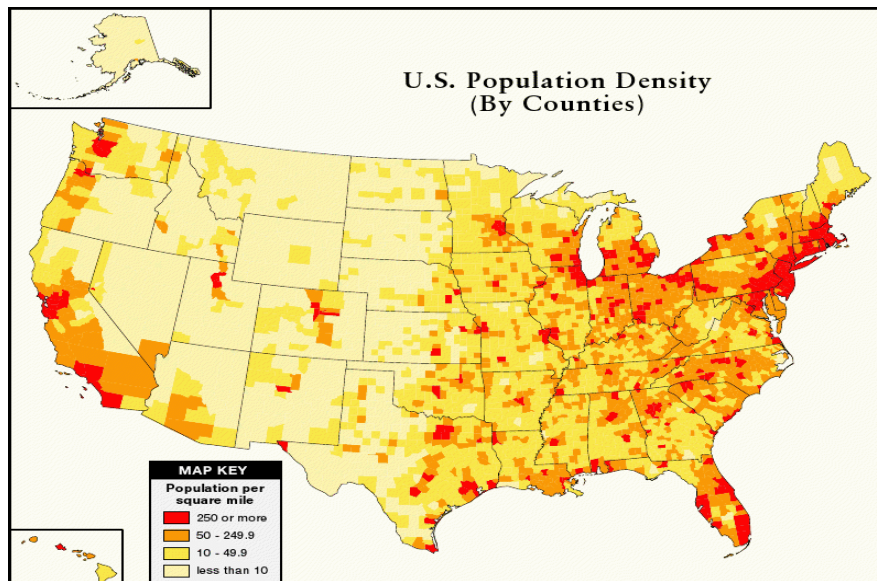
2.3 The City Different – Santa Fe

Santa Fe is the capital of the state of New Mexico. It is part of the larger Albuquerque-Santa Fe-Las Vegas Combined Statistical Area. The economy of Santa Fe influences the whole county and to a larger scale, to the whole state. One thing that is related to the economy is it tourism, which plays a significant influence on its economy.

2.3.1 Demographics of Santa Fe

16.5% of the Santa Fe population is below the poverty line. In Worcester, MA, that number is 19.0%, 21.4% in Boulder, CO, and 19.4% in New York City. The reason why different cities are compared is because we can see the relation between ridership and other factors. In Santa Fe, the percentage of workers 16 years and over who commute using public transportation (excluding taxicab) is 1.6%, 3.1% in Worcester, MA, 9.6% in Boulder, CO, and 55.4% in New York City. Among similarly sized cities, Santa Fe can be classified as having relatively low ridership. The following figure, Figure 2-6, illustrates the relationship between population density and work commute by public transportation.
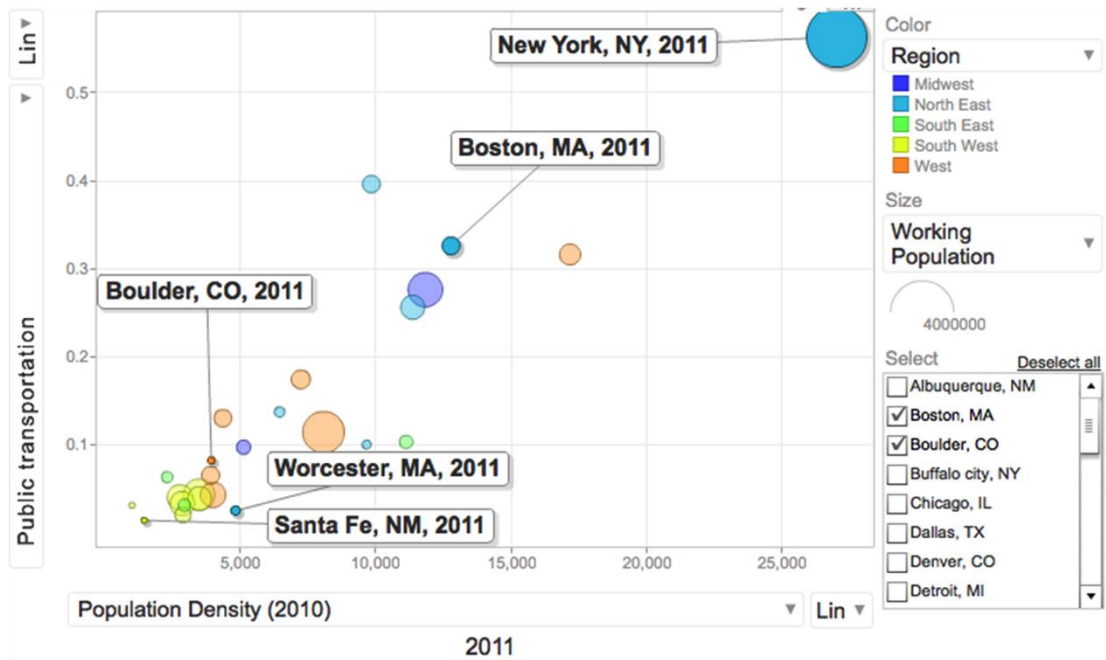
Figure 2-6 Population Density -- Transit Usage Relation
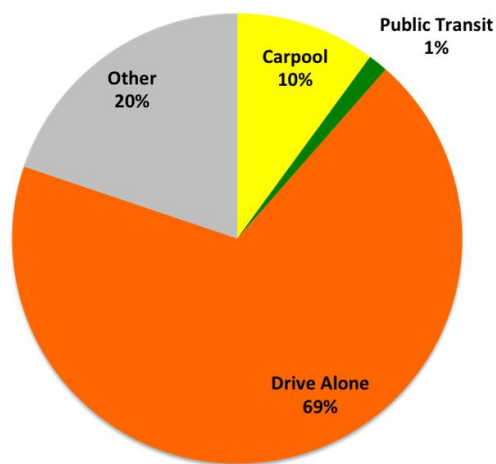
Figure 2-7 Santa Fe Methods of Transportation For Work Commute

As of 2011 estimates, Santa Fe has a population of 68,642. It shows a steady growing trend, with 57,267 people in 1990, 62,543 in 2000, and 68,642 in 2011. Suburban housing and settlements are in a sprawl. The Southwest of Santa Fe is more populated compared to the rest of the city.
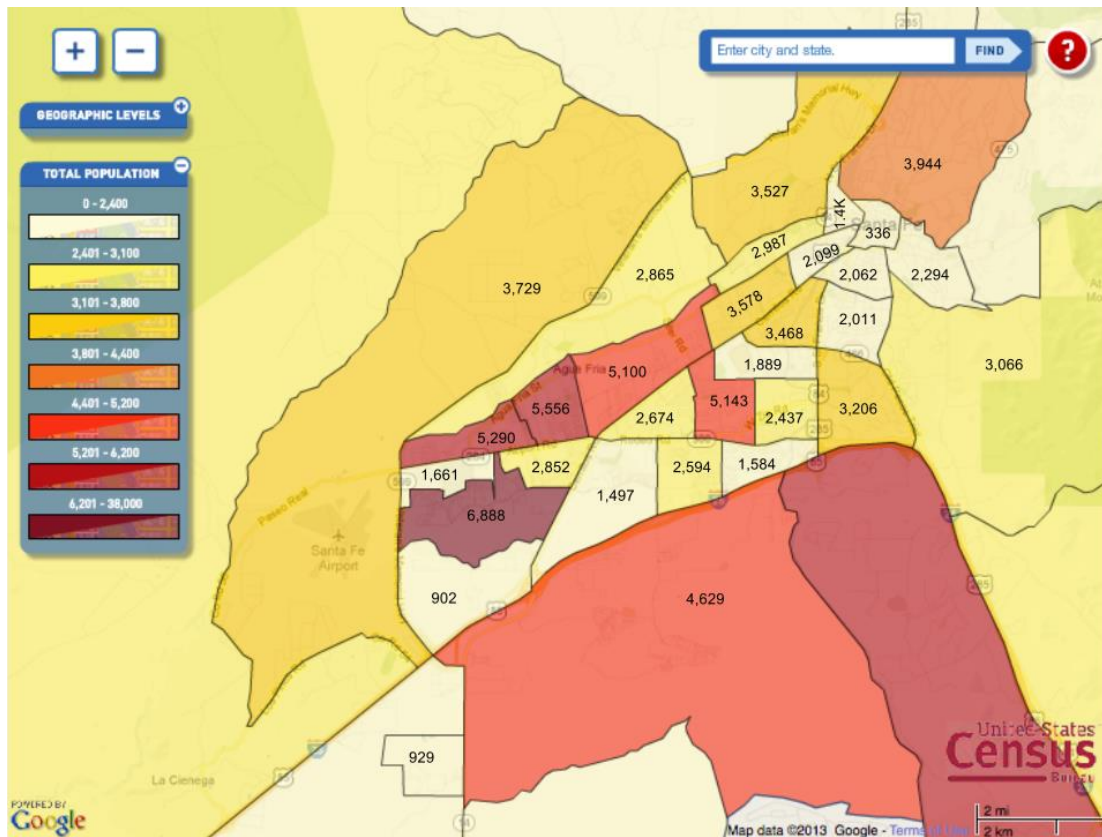
Figure 2-8 Population Distribution of Santa Fe

2.3.2 Tourism in Santa Fe

Another thing about Santa Fe is it richness in art and history, and the attraction in tourists make a big fluctuation in terms of population percentage. The city is well known as a center for arts that reflect the multicultural character of the city and its 400 years of history. It has been designated as a UNESCO Creative City of Crafts and Folk Art[23]. There are a significant number of museums, sculptures and art exhibitions in Santa Fe, including the Georgia O'Keeffe Museum, Francis of Assisi and his devoted animal sculptures and the Santa Fe Opera.

Being a small city, Santa Fe's economy relies heavily on tourism, and it can be seen from the report from New Mexico Tourism Department," In 2009, travelers to New Mexico spent $5.4 billion, which generated $769.8 million in taxes. This created 55,900 jobs and represented 6.9 percent of New Mexico's

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[23] UNESCO, 2008

non-agricultural employment. For every $1 million spent in New Mexico, 10 jobs are created."[24]
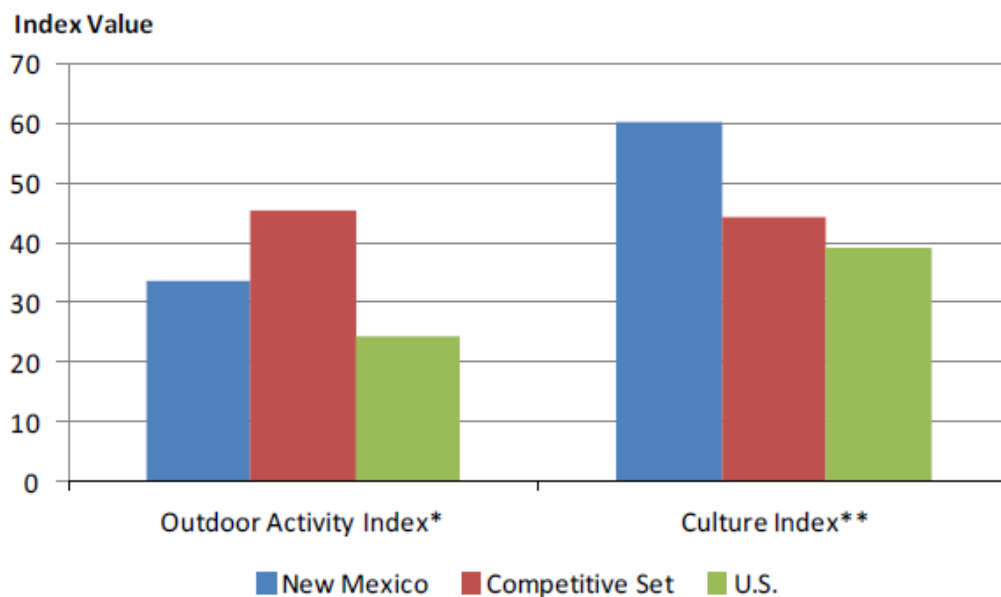
Figure 2-9 Outdoor Activity Index and Culture Index

As seen in Figure 2-9, different indices are compared in New Mexico, in the adjacent states (Colorado, Arizona and Utah, collectively called the competitive set).The U.S. Outdoor Activity Index is defined as the cumulative total of percentage of Primary overnight visitors who engaged in Hiking, backpacking, camping, fishing, mountain climbing, golf, skiing, snowboarding, hunting, biking or rafting. The Culture Index is defined as cumulative total of percentage of primary overnight visitors who attended either a museum, landmark, historic site, art gallery, winery, theater, fair, exhibition, festival, rock/pop concert, symphony, opera or rodeo. Although New Mexico trails the competitive set when talking about Outdoor Activity Index, New Mexico the highest culture index. [25]

2.4 Santa Fe Trails

For residents and visitors in Santa Fe who want to use public transportation to travel throughout the city, Santa Fe Trails is one of the greatest choices. Santa Fe Trails began bus service in January 1993; it has since grown to become one of the leading forms of public transportation in the city. It also offers

[24] U.S. Travel Association, 2009
[25] New Mexico Tourism Department

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ADA certified paratransit service for Santa Fe's disabled citizens through the Santa Fe Ride. The Santa Fe Trails also recently incorporated the Santa Fe Pick-Up, which is a free fixed-route service that offers quick and easy access to and around Downtown Santa Fe.

2.4.1 Fixed-Route Bus System

The largest entity owned and operated by the Santa Fe Trails is its fixed route bus system. The system has enjoyed a drastic increase in ridership over the past several years. In 2011, it served almost a million unlinked passengers trips, where an unlinked passenger trip is defined as trip from one stop to another on the same line. This number constitutes an eleven percent increase in passenger trips from 2010 to 2011, the largest level of ridership the company has experienced since its establishment. [26]

Santa Fe Trails Fleet

Santa Fe Trails is the first all clean energy fueled metropolitan transit fleet in the United States.[27] It operates a fleet of thirty two full-size, wheelchair accessible, compressed natural gas (CNG) buses.[28] The fleet consists of sixteen 2009 Model ElDorados, each of which can seat twenty seven passengers, fourteen 2001 Model Blue Bird, which are now being replaced and can seat twenty seven passengers each, and two 2009 Model Gilligs Low Floor buses, which were purchased at the end of 2011 and can seat twenty five passengers each.[29] On average, twenty-three buses out of this fleet are in operation during normal operation hours, contributing to around 2,700 unlinked passenger trips everyday.[30]

Santa Fe Trails Bus Routes

In order to reach out to as much places as possible in the city, Santa Fe Trails operates a total of ten bus routes between the hours of 5:00 AM and 10:00 PM on weekdays. Figure 2-11 shows the coverage of Santa Fe Trails over the city.

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[26] Santa Fe Trails, 2011
[27] Oldest US town uses cleanest US fuel for the purest of reasons
[28] Santa Fe, NM and its representatives, 2012
[29] City of Santa Fe Housing and Community Development Department. 2011
[30] Santa Fe Trails, 2011

These ten routes covers the city thoroughly including the metropolitan area, as the nearest bus stop is generally less than half a mile away. Among these routes, Route 2 is typically the busiest one, because it connects Downtown Transit Center with South Capitol Station that serves as the commuter rail station in Santa Fe, and with Santa Fe Place, one of the largest outlet malls in Northern New Mexico. Figure 2-10 displays the entire bus routes map of Santa Fe Trails.
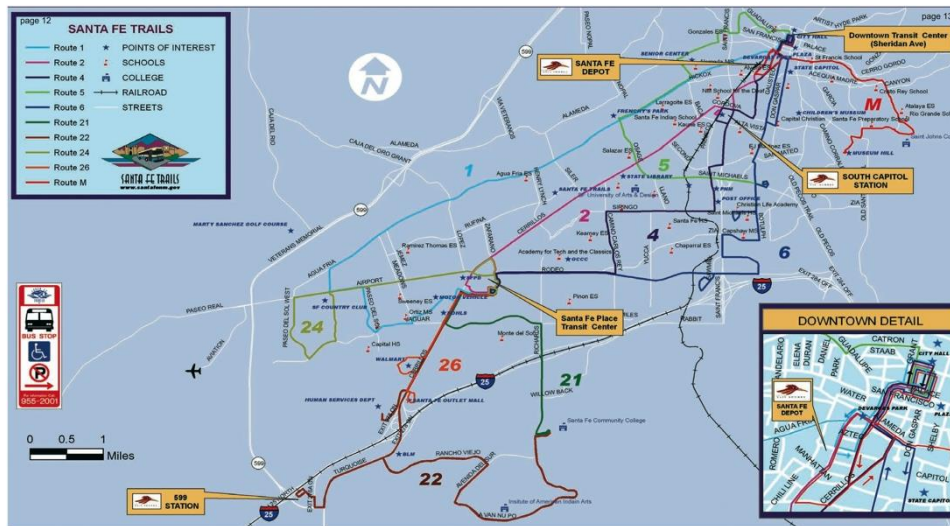
Figure 2-10 Santa Fe Trails Bus Route
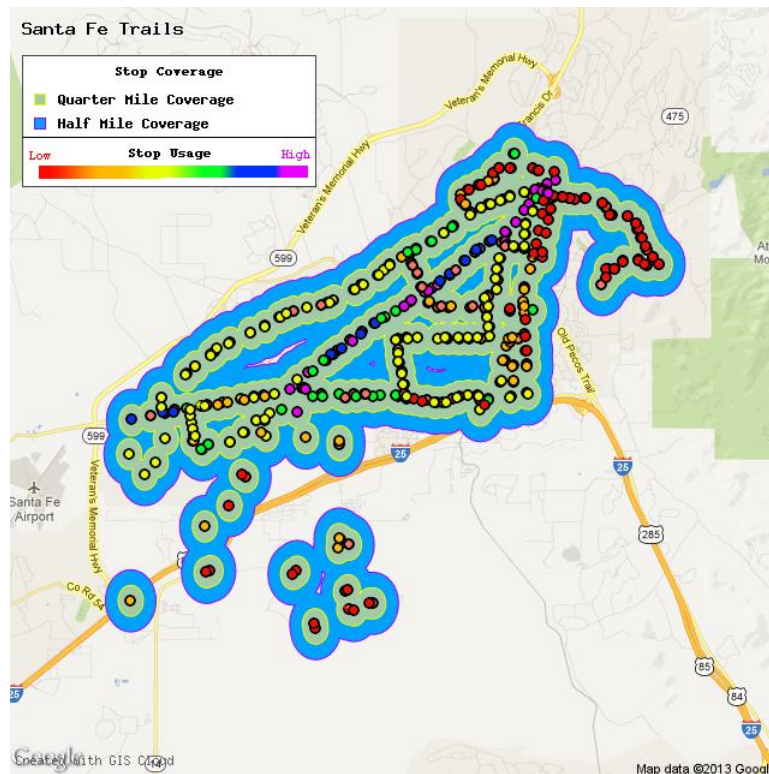
Figure 2-11 Santa Fe Trails Preliminary Coverage Map

2.4.2 Paratransit System

The Santa Fe Ride Paratransit Program is a request-respond public transportation service, run by Santa Fe Trails, for those with disabilities or those who are over the age of 60. The service is intended to pick up eligible passengers from their residences and transport them to a destination point that is within 3/4 mile of a regular Santa Fe Trails bus stop. In addition to carrying passengers to bus stops, the service can also make trips to the Santa Fe Factory Outlets, Santa Fe Community College, and the Santa Fe Municipal Airport. The fare for riders is $2 for disabled and $5 for elderly. If the rider is accompanied by companion riders, they must pay for the companion riders as well. [31]

2.4.3 Santa Fe Trails Technology

All Santa Fe Trails buses are equipped with several technological systems that can improve the interaction between headquarter and each bus en route. Currently, each bus is equipped with a non-live GPS, and seven cameras, as well as a payment system that allows passengers to pay with bus pass. Furthermore, through a contract with RouteMatch, a software company, the GPS information will soon be used for automatic vehicle location tracking, giving passengers live information about each bus. Moreover, based on the project done by WPI students in 2012, there is a prototype mobile application that will allow passengers to check the bus status and bus schedule, and to pay bus fares.

Camera System

Each bus at Santa Fe Trails are equipped with seven security cameras: two curbside, one driver view, two driver area payment monitors, and two covering the inside of the bus. Camera videos need to be downloaded manually in order to be reviewed and recorded.[32] Santa Fe Trails downloaded these videos everyday after work and keep record of all videos for surveillance purposes.

Payment System

All Santa Fe Trails buses have a fare box that accept cash, coins or bus passes. Upon payment, a confirmation sound is made. The system can perform a

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[31] Santa Fe, NM, 2012
[32] P. Wallace, et al., 2012

passenger count to some extent, as each payment is recorded. As for passengers under age 18, who can take bus rides for free, the driver can press a button on the fare box to make an increment on the passenger count,[33] which is an important indicator of the operating performance of Santa Fe Trails.

Mobile Application

In 2012, a mobile application prototype was designed by a project team from WPI. The application, designed under iOS environment, is a new approach to increase ridership. As it can provide live information about bus on every route, passengers with smartphone can check the bus status at any time, any place. This application can definitely increase ridership, as people are more aware of the status of each bus line.

Google Transit Feed

For years, Santa Fe Trails has been trying to join Google Transit, so users can plan their trips in Santa Fe using public transportation.

Google Transit can provide trip-planning services using public transportations if the city joins the Google Transit Partner Program. Every city can join the Google Transit Partner Program by submitting public transportation service information, including routes and schedules, via Google Transit Feeds. According to Google Transit Feeds documentation, steps to make it work are as follows:

- Prepare a list of comma-delimited text files and compress them in a zip file
- Validate the data in the files using Feed Validator and Schedule Viewer programs, provided by Google Transit Feeds
- Host the zip file on a web server and contact the Google Transit team to sign-up for the partnership
- Google will review the files and test the data in the private preview before launching the service to the public

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[33] P. Wallace, et al., 2012

Required Files

Table 1 displays a list of files required for Google Transit to identify the public transportation service. All of them need to be in comma-delimited text format.

Table 1 Files Required by Google Transit Feed

File Name	Description[34]
agency.txt	One or more transit agencies that provide the data in this feed.
stops.txt	Individual locations where vehicles pick up or drop off passengers.
routes.txt	Transit routes. A route is a group of trips that are displayed to riders as a single service.
trips.txt	Trips for each route. A trip is a sequence of two or more stops that occurs at specific time.
stop_times.txt	Times that a vehicle arrives at and departs from individual stops for each trip.
calendar.txt	Dates for service IDs using a weekly schedule. Specify when service starts and ends, as well as days of the week where service is available.

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[34] Google Transit Feed Specification Reference, 2013

3. Methodology

This project is aimed at increasing the use of the Santa Fe Trails public transportation services by assessing current conditions and evaluating various methods to entice new riders to use the services. We intend to help contribute to a solution through the following:

- To characterize transportation in Santa Fe, NM
- To design a feeder system to the Santa Fe Trails
- To consolidate bus stop data into a single usable document
- To improve rider tools

This project only applies to increasing the ridership of the Santa Fe Trails, and not to other external methods of mobility in and around Santa Fe. Also, we will only apply these techniques within the city of Santa Fe and its immediate surrounding areas, and not seek to expand ridership far outside of the city, or to any other city. We will also be considering the effect time plays in our data collection. We will be collecting our own data only while we are at the project center, from March 18th, 2013 through May 3rd, 2013. However, analysis will be done on data from past years information. Collecting our own data during this time will not give us information on changes in ridership between seasons, but we will be considering past information that may show trends over entire years. The following detail the methods by which we will complete this project.

3.1 Characterizing Transportation in Santa Fe, NM

The nature of mobility of Santa Fe is examined because the motives of why different groups of Santa Feans use different modes of transportation should be sought. In order to achieve this objective, surveys will be conducted to the Santa Feans at major public locations, e.g. Downtown Plaza, shopping centers, tourist attractions, as well as on buses and at bus stops. In addition, demographic information will be investigated to see how far people are located from the bus system as well as population density at different regions of the city, the age of public transit users and the population fluctuation between months because of tourism. The data can be obtained from the census. A copy of the surveys will be produced in Spanish for those people who are asked to complete the surveys and agree, but do not speak English and only can effectively

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communicate in Spanish. None of the project team members are fluent or know enough of the language to communicate, thus creating the need for a copy that can be understood and filled out by the individual responder. Native speakers in the area will be consulted to produce the Spanish language survey.

A copy of the surveys will be produced in Spanish for those people who are asked to complete the surveys and agree, but do not speak English and can only effectively communicate in Spanish. None of the project team members are fluent or know enough of the language to communicate, thus creating the need for a copy that can be understood and filled out by the individual responder. Native speakers in the area will be consulted to produce the Spanish language survey.

3.1.1   Survey of Current Bus Riders

One way of increasing ridership of public transit is to cater to the opinions of those who already utilize the system. Insight into the mindset of the typical rider can give valuable information to the transportation provider, revealing possible avenues of improvement for all riders. If their opinions are recorded and acted upon, it would give that person and others more reason to use the bus, thus potentially increasing its use. A possible method of gathering such rider opinions is a survey of current bus riders.

A survey of Santa Fe Trails riders could reveal methods to directly and positively impact the riding experience of everyone who uses the bus. Such a survey would comply with federal and WPI Institutional Review Board standards regarding human subjects. A number of questions will be asked to individuals on a voluntary basis; there is no obligation by anyone to answer. The following questions are a sample of the quick survey (See Appendix A.   Current Rider Survey):

- Please describe your residency: Resident/Visitor/Long-term Visitor *(Visitor - Hotel?)*
- Do you have access to a car?   Yes/No
- How many days per week do you use the bus?   _____
- How long a walk to a bus stop would cause you to seek other means of transportation?   _____minutes

- Would you use a mobile application that gives useful information for riding the Santa Fe Trails?   Yes/No
- Do you own a bicycle?   Yes/No
- What improvement to the Santa Fe Trails would you like to see most? -comment

The way this survey will be conducted is any of the four project team members will board any of the Santa Fe Trails buses with a clipboard, the survey of questions, and a sheet that we will take down. In order to obtain a wide variety of information and an adequate representation of the bus-using population, all ten bus routes must be covered, each at multiple times throughout the day, and different days of the week. This must be done because those who take the bus at different times of day, or those who use one line in particular, may represent only a small number of the different social and economic groups who use the bus. The team will also gather responses from the users waiting at the bus stops, particularly the major transit centers like Downtown (Sheridan Street) and the Santa Fe Place Mall stop. Besides being physically present on the bus, a condensed half-sheet survey will also be available on the bus. After they finish filling out the responses, they can hand in the surveys to the bus drivers. We gathered 273 current rider surveys totally.

Figure 3-1 Advertisements on Bus

3.1.2   General Public Survey

The project team developed a survey to administer to the general public of Santa Fe with the objective of revealing motives of why its citizens and visitors use their respective modes of transportation in the city. Once key reasons emerge, the Santa Fe Trails can be notified of possible target demographics for new riders, and could roll out advertising campaigns or programs to encourage

these people to ride the bus. Some of the key questions from this survey are as follows:

- (for someone who does not ride) What is the main reason you don't use the bus?
- How likely would you be to use the bus if an application were created for using the Santa Fe Trails?
- What is your primary method of transportation?

This survey also shares other key questions with the Bus Rider survey, like the following:

- How long would you be willing to wait for a bus?
- How long would you be willing to walk to a bus stop?
- Are you a Resident, Visitor, or Long-term Visitor?
- Would you use a mobile application that gives useful information for riding the Santa Fe Trails?

These questions are shared across the two surveys because it does not matter which group of people these are asked to, all responses provide relevant and important data.

This survey (See Appendix B.   General Public Survey) will be conducted at major public locations. Some of the places this survey will be taken at are the Santa Fe Place Mall and around Downtown Square. Individuals will be approached by a member of the project team and asked to complete a short survey to help improve the Santa Fe Trails service. As with the other survey, there is no obligation on any individual to complete the survey, it is completely voluntary.

3.1.3   WPI Project Team Survey

Some of the quality of and ease of use of a public transit system can be deduced by individuals who have never used the system before. If the bus can be used easily and effectively by one who has no prior experience using it, one can conclude it is user-friendly. To determine the user-friendliness of the Santa Fe Trails, the 23 members of the Santa Fe project team will be sent on a scavenger hunt around the city using the Santa Fe Trails bus. Because none of the project

team members have been to the city nor used the bus system in Santa Fe, they are qualified candidates to evaluate it after their first few rides.

A short survey (See Appendix C.   WPI Project Team Survey) has been prepared for completion after the scavenger hunt to gather input on how easily the system was used by first time riders. Numerical data will be gathered, such as their wait times each time they go to get on a bus and how long they were on the bus for, as well as comment based recommendations for improvements. Their most common improvement suggestions will be considered.

3.2 Designing a Feeder System to the Santa Fe Trails

The task of serving the largest amount of people with the least amount of resources becomes very difficult in Santa Fe due to its spread out population. The current fixed route bus system covers a majority of Santa Fe's fifty square miles but it is evident that many houses and businesses are outside of the range of the Santa Fe Trails Bus system. To solve this problem, we explored the creation of a demand responsive feeder system to the Santa Fe Trails fixed route system. As a form of demand responsive transit, the feeder system will be serviced by vehicles that are dispatched as users request them rather than running on a fixed route or schedule. We plan to service this feeder system with the available resources of the Santa Fe Ride paratransit, including cars, vans, and possibly drivers. What makes this proposed system unique will be the requirement that at least the starting point or destination be a stop along the bus system. In addition, only destinations outside of a certain distance to the bus system and within the city limits will be serviced by such a feeder system. By providing more individuals, who would otherwise be outside walking distance to a bus stop, we are effectively feeding customers to the Santa Fe Trails Bus system. Some important things we considered when designing this system included how spread out the population of Santa Fe was, the available funds of the Santa Fe Trails, and the fact that only 1.4% of residents used the bus system to commute to work.

The feasibility of this feeder system required us to map the coverage of the bus system, something that was very difficult when we considered that many people had different distances they would be willing to walk to a bus stop. To

work around this problem we asked users and non-users of the bus system how far they would be willing to walk to or from a bus stop. These results were averaged and used to form the coverage map we used to design the feeder system. From the coverage map we took note of how much area within the city was not within walking distance of the bus system, and how many people would be serviced by a feeder system.

Because it is not feasible to service the entire 50 square miles of Santa Fe, we are planning to have only a select area of Santa Fe covered. This covered area should be within the city limits and not overlap the coverage of the bus system too much. To describe this coverage area we used major roads to encircle the area rather than GPS coordinates. This allows dispatchers and possible users of the prototype feeder system an easy way to judge whether or not they have access to this service.

3.2.1   Mapping the Santa Fe Trails Coverage

Mapping the coverage of the Santa Fe Trails was accomplished through the use of Quantum GIS (QGIS), a free open source geographic information system (GIS). Using the GPS coordinates of every stop on the fixed route system and a google maps plugin, we can show the bus stops on an interactive map. We also implemented population block data from the 2010 Census to map the city boundaries of Santa Fe and analyze the population of certain areas within Santa Fe city and Santa Fe county. The population block data was downloaded as a shapefile, a data type that describes polygons in QGIS. Each block has a unique ID that can be used to lookup the number of residents of each population block and the corresponding median age of each. There exists additional data associated with each population block such as sex, race, tenure, and household size, however we did not believe these would be useful for the evaluation of a feeder system.
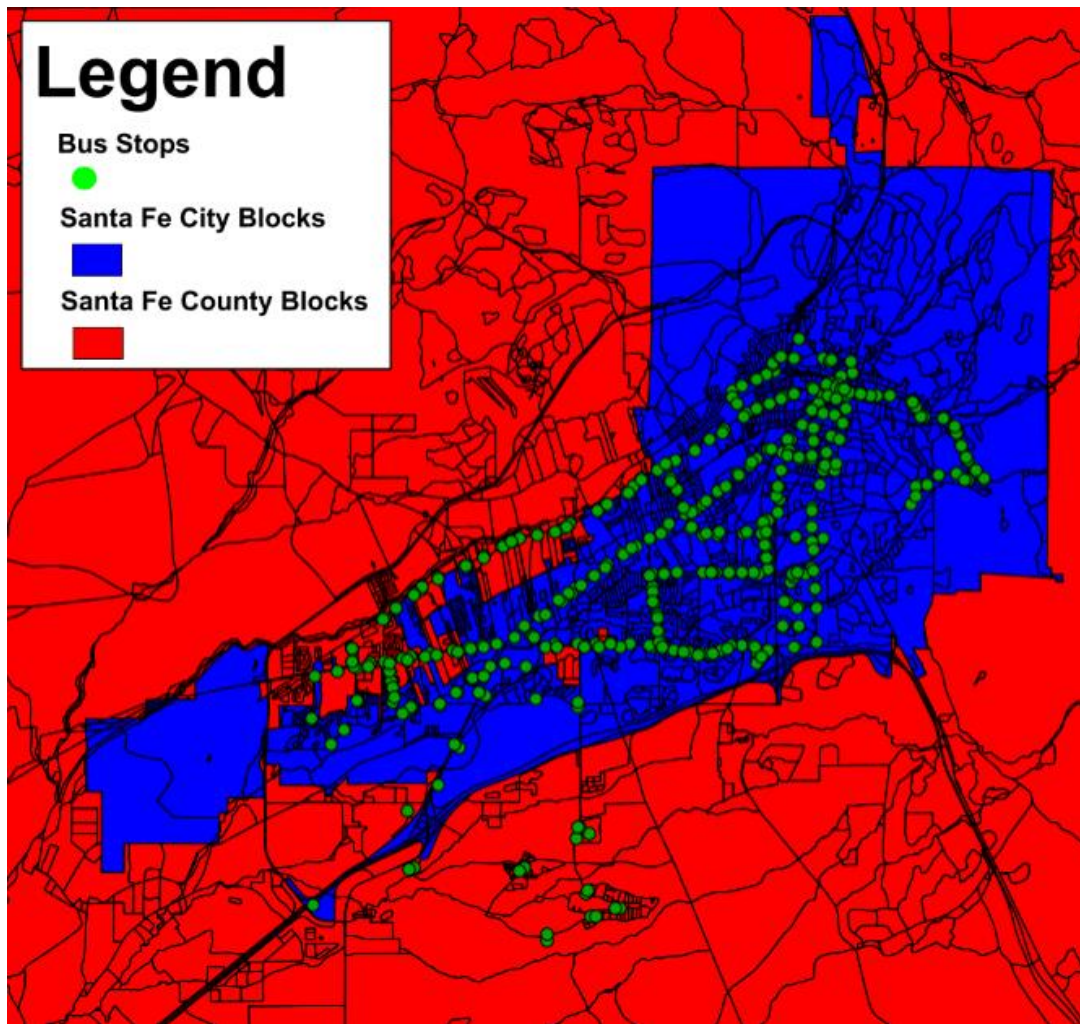
The coverage area of the feeder system was drawn into QGIS by outlining the area by hand. This results in a new shapefile that allows us to calculate area and perimeter. From this outlined shape, we were able to select the population blocks that lied within each area and determine the population and median age of our proposed coverage area.

3.3 Improving Rider Tools

Based on the results from the survey, which will be talked about in Section 4.1, we developed several tools to the current Santa Fe Trails bus system. Hopefully, these tools would greatly improve the rider experience both on and off the bus. If more and more people feel well served when riding with Santa Fe Trails, the ridership was definitely increasing. So we were trying to make the users feel that they were being taken care of all the way to their destinations.

3.3.1 Consolidating Bus Stop Data into a Single Usable Document

In a lot of cities, we are able to plan our trips on Google Maps using public transportation. This function is accomplished by each public transit agency to join the Google Transit Program. However, Santa Fe Trails is not yet a participating agency of Google Transit. So the first tool we developed is to have Santa Fe Trails join the Google Transit Program. This was done through Google Transit Feed, a data feeder program run by Google Inc. Each agency needs to submit a collection of files, which explain the stop information, route information and schedule information through Google Transit Feed. Then Google reviews this file and validate the data. After all these are done, they put the new agency data on their server and users will be able to plan their trip using public transit.

First, we needed to prepare for the files that are required by Google Transit. We used the data provided by the Santa Fe Trails and built up a Microsoft Excel workbook to store all the data and to generate these text files using Macro. Macro is a programming tool developed by Microsoft for users to program in Microsoft Office product to do repetitive jobs. As introduced before in 2.4.3, Google Transit requires six files for Google Transit Feed to identify the public transportation service, so the Macro we designed would generate them all at once. Moreover, to reduce the workload of people who maintain this dataset, the Macro would automatically create a compressed file with all six text files in it. (This generating compressed file function is only available under Windows system.) As a result, for people who maintain this dataset, once any changes were made in this excel workbook, they only needed to run the Macro, and copied the generated compressed file to the server.

After these files were ready, Santa Fe Trails needs to have a place to hold these files online, and then they can contact Google about joining the Google Transit Program.

3.3.2 Developing Web-based Mobile Application

Another issue we found from our surveys is that users of Santa Fe Trails do not have access to live information about the system. So we decided to design a mobile application, which will serve as an information exchange platform between passengers and Santa Fe Trails officials.

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Santa Fe Trails posts the en route buses information over the application, making it convenient for passengers to get updated live information and to schedule their trip throughout the city. Also, the passengers are able to make reservation for pick-up services and pay bus fares through the application.

This web-based application is programmed completely in JavaScript. And some JavaScript libraries used in this application are listed below.

Table 2 External Libraries Used in Mobile Application Development

Name	Usage
JQuery Mobile	Mobile application CSS template
Google Map API	Google map display and location tracking.

Because there is limited time for programming and testing the application, by the end of the project, only a couple of functions are implemented. But all these functions were already proposed and, hopefully, would be mostly released in the next version of the application after next year's project. We will go into more details about the application in Section 4.4.

3.3.3 Improving Signage

Based on the responses from the surveys that were conducted in accordance with Section 3.1, it became apparent the available rider information located at stop signs was inadequate. As shown in Figure 3-3 and Figure 3-4, there is little or no information given to the rider. A generic sign indicates every stop, but has no specific information. For some stops, this is all there is. For the others, there is a cylinder with the schedule and map of the route that stops there. Though this gives the rider indication of the route that passes through that

Figure 3-3 Current Signage

location, there is no indication of where the rider is relative to the map or schedule. Thus, the rider cannot deduce even an approximate time of when the next bus may arrive. Improved signage, which provides the rider with their

location on a map and on the schedule, as well as other indications of their location, would increase the ease of ridership to both residents and visiting tourists. An increased ease in riding the bus would by extension increase the use of the bus.

Figure 3-4 Current Signage with a Cylinder

Designing a Stop Numbering System

Because of such comments as "I had no idea where to get off [of the bus]" from the surveys that were conducted, we sought to design an effective system that would allow users on the bus to know which stop they should depart at. Each Santa Fe Trails bus stop already has its own unique identification number, but each is four to five digits long and for internal use only. There is also no inherent logic behind the numbers, so using them as the stop identifiers for the public would not help. These numbers had to be ruled out.

This left us with assigning new numbers for each stop. Having each stop assigned 1—430 kept the digits low, but would not make sense to the user. There is no uniqueness to the route, and adding or removing stops would prove difficult in maintaining the system. From this iteration, we narrowed down the enumerating idea to be unique within each of the ten routes. Based on this and the first overall plan for numbering consecutively every stop in the system, the next design consisted of each route's stops being numbered starting at 1 and rising consecutively to the number of stops on the route, which varies between each. The same problem would arise however. If stops were to be added or removed along any particular route, every other stops' number beyond the one that were to be changed would also have to be updated well, resulting in the same maintenance issues.

Retrofitting Signs

In order to most easily incorporate a new sign design into the current Santa Fe Trails infrastructure, it was an objective to base new signs as much on existing images and layouts as possible. We wanted to change as little as possible

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in the system, but just make the information organized and clear for the users. Because of this, we chose not to change route numbers or colors, or change the route indication from a number to exclusively a color. Also, we chose to not change the current schedule or time points so there would be little disruption in service. However, we wanted to incorporate somehow the current time points as well as their indicator (white number inside black circle) into the new designs. In addition, the new additional sign would be able to be bolted underneath the current generic signs already in place at every stop for easy installation.

4 Results and Analysis

After implementing our methodology from Chapter 3, the following results have been produced. Over 250 surveys were collected, and areas for improvement for the Santa Fe Trails were identified through them. Many people felt Santa Fe Trails' coverage did not reach them well enough, so areas around the city were identified where a proposed feeder van would give rides from their residence to the nearest bus stop. It was discovered as well that rider informational tools were lacking, resulting in the need for improved signage at stops and mobile application. Such a mobile application should give live locations for the bus, the nearest stop to your location, and directions to the stop in addition to timers and alarms for getting on the rider's next bus.

4.1 Survey Results

Of the 270 surveyed passengers, over two-thirds (2/3) responded they don't have access to a car. Their mobility is hindered because they lack personal transportation. This leaves them to rely on alternative methods of getting around, such as public transportation. When asked for what reason they used the bus, two-thirds of the surveyed passengers

Figure 4-1 Access to Cars
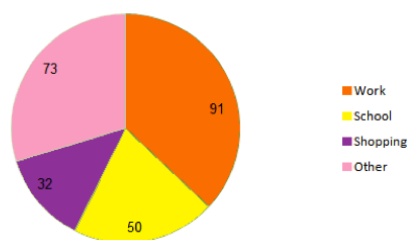
Figure 4-2 Usage of Santa Fe Trails Bus System

responded with either work or school. We concluded that many residents are reliant on the bus system because they either do not have access to a car or they use the bus for important activities.

It is also apparent that riders regularly depend on the Santa Fe Trails based on the number of times per week. The average number of rides is 7.6 per week, and most people say they ride it every day of the week.
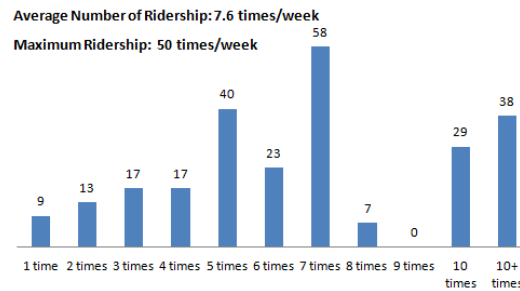
Figure 4-3 Number of Rides per Week

To help with the Santa Fe Trails evaluation of its bus drivers and system, we asked riders how they would rank them. We found that riders are generally satisfied with the quality of Santa Fe Trails' drivers, with over 85% of riders rating them good or great. The overall system was also rated favorably with almost 75% of ratings being good or great.
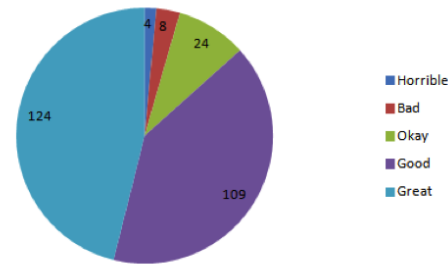
Figure 4-4 Ratings on Santa Fe Trails Bus Drivers

Many suggestions for improved service were offered by riders as well, such as better connection times and weekend service—especially service to the Community College.
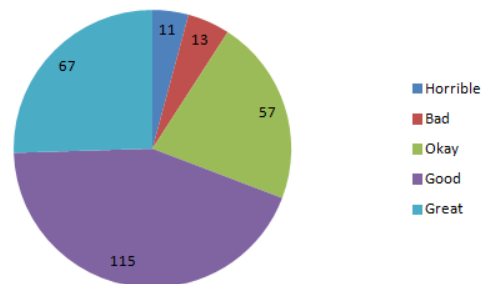
Figure 4-5 Ratings on Santa Fe Trails Bus System

Bicycle usage as a means to travel to and from a bus stop was also explored. More than one third (1/3) of bus users responded that

Figure 4-6 Bicycle Ownership

they owned a bike however less than 50% of these bike owners do not use their bikes to travel to the bus system. Survey Responses and observations showed that many bike owners were fearful of encountering a bus with a full bike rack

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and not being allowed access onto the bus. This often discourages bike owners from taking their bike to a bus stop and, in the case where these owners deem themselves outside of walking distance to a stop, may encourage them to seek alternative methods of transportation.

To determine what people considered too long a walk to a bus stop, we asked users how long a walk would cause them to seek alternative means of transportation. These results were averaged to show that residents considered any time over 20 minutes too long a walk. This time was equivalent to one mile and provided us with a good understanding of the coverage of the Santa Fe Trails bus system. Outside this one mile radius, we found that only 30% of users would be willing to walk to a bus stop.
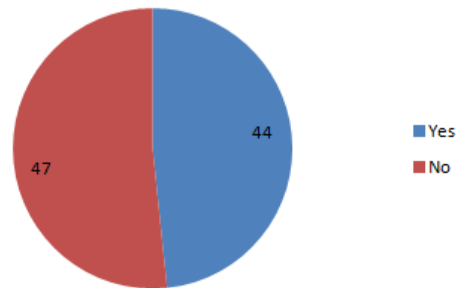
Figure 4-8 Use of Bike to Bus Stop
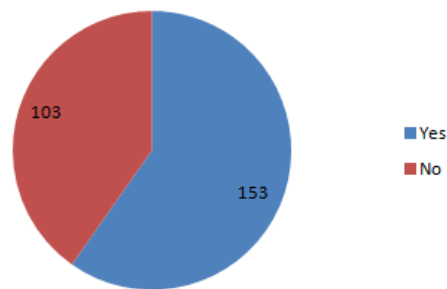
Figure 4-7 Interest to the Mobile Application
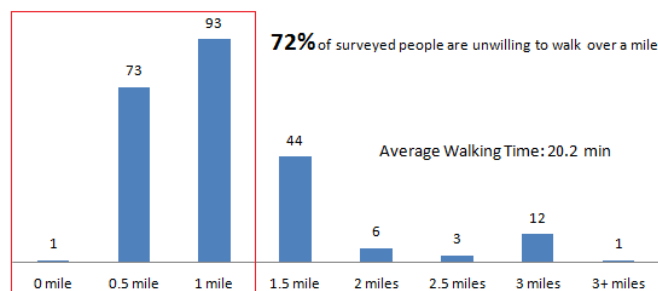
Figure 4-9 Maximum Tolerable Walking Distance

4.2   Feeder System to the Santa Fe Trails

For residents who live outside of walking distance to the Santa Fe Trails, we designed a feeder system unique to the Santa Fe Trails. We believe that adding a fixed route feeder system such as the Santa Fe Trails Pick-Up would see

low ridership as many of the bus routes do now and would not efficiently cover the large area we are considering. Instead we proposed the addition of a completely demand responsive transit, in which vans would transport individuals to the bus system from addresses within our proposed coverage area. In addition, users of the bus system could get a ride from downtown transit center to an address within our proposed coverage area. By having downtown transit center be the only starting point of rides from a bus stop, we can make sure the feeder vehicles only have to visit one stop to pick up individuals traveling away from the bus system. This ensures that the seats within the vehicles are as full as possible and spend the least amount of time picking up individuals.

The coverage area we are considering was designed by observing areas of Santa Fe City that were outside one mile of the bus system. Analysis of the Santa Fe Trail's city coverage was done in QGIS by coloring population blocks of Santa Fe city in blue and county blocks in red and plotting the bus system with its half-mile and one-mile coverage on top. As shown in Figure 4-10, a significant amount of Santa Fe is within one mile of the bus system. To see which uncovered areas of the city would have a high demand for a feeder system, we then grouped blocks by their populations and shaded them from light to dark, as shown in Figure 4-10. The lightest of the blues and reds represent populations from 0 - 20, whereas the darkest of the blues and reds represent populations over 400. From these maps, we determined that the highest demand was in the north east of Santa Fe. Areas such as the southwest and northwest of Santa Fe were uncovered

however their populations were too low to implement an efficient feeder system.
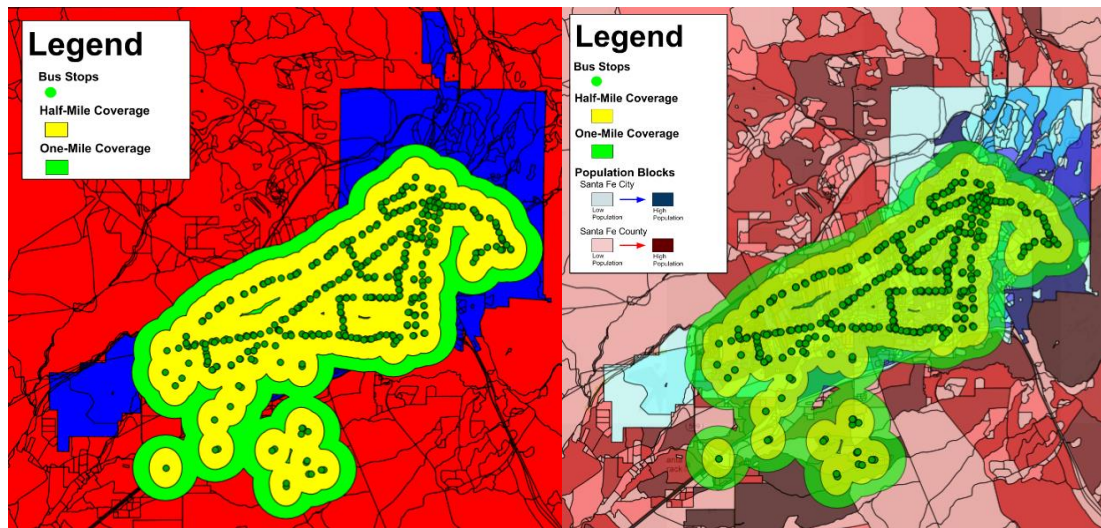
Figure 4-10 City and Population Coverage

In addition, we considered including areas covered by route M of the bus system into our feeder system. Route M consistently shows the lowest ridership of the ten routes and was in discussion for being removed during our time in Santa Fe. Route M runs once every hour, making it unreliable for use without knowing the schedule. For this reason, we believe that many residence within walking distance of route M are more prone to take other modes of transportation. Providing a feeder system to these residence can provide a more reliable form of public transportation at a slightly higher price or it may replace route M completely in the future.

4.2.1   Feeder System Coverage Areas

We decided upon creating one coverage area for the initial feeder system. This area, shown in Figure 4-11, covers a 14 square mile area with a perimeter of 20 miles and is home to about 11,000 residents. Our two primary concerns when designing this area where servicing as much as the city as possible while keeping the end-to-end distance of the coverage area relatively small to prevent feeder
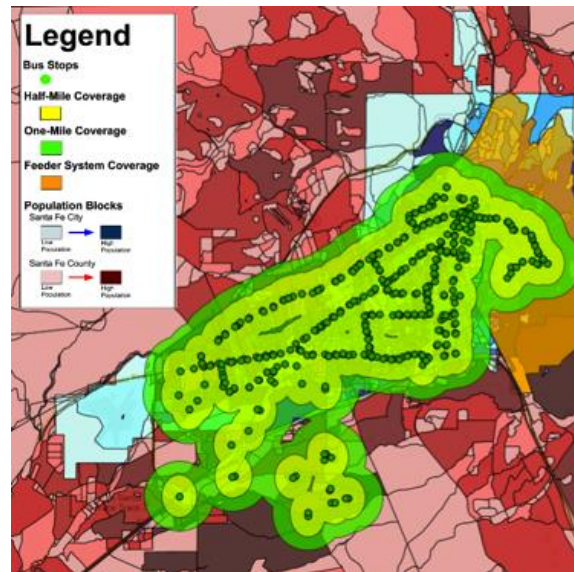
Figure 4-11 Proposed Feeder Coverage Area

vehicles from having to drive long distances between multiple customers. We used major roads to encircle our coverage area when possible, as shown in Figure 4-12, but found that many of the roads were very windy and ended in cul de sacs. By using major roads to define the coverage areas, we hope to make it easier for users and dispatchers to easily determine whether or not an address has access to this feeder system. The alternative to this, using gps coordinates or a GIS shapefile to define the coverage area, would require some software or tool for determining eligibility of an address. Many times there did not exist a major road that followed the boundary of the bus system's one-mile coverage. To solve this, we determined that some areas that were within walking distance to a bus stop would also have the option to reserve a ride on the feeder system. These customers would be easier to transport to a bus stop and would often choose walking to a bus stop over spending additional money that would be required to use the feeder system.
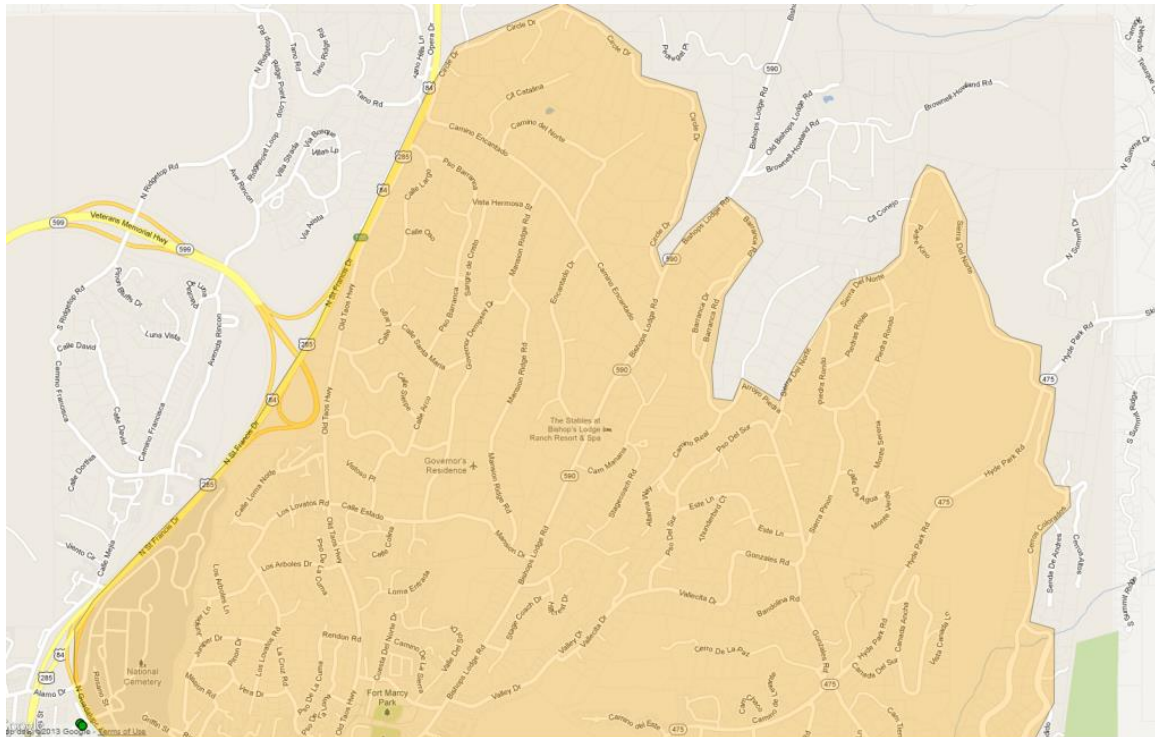
Figure 4-12 Drawing Feeder Coverage Area

4.2.2   Feeder System Operation

The vehicles that will be servicing the Santa Fe Trails Feeder system will be pulled from the available resource pool of the Santa Fe Ride paratransit. These vehicles are meant for small groups of users and can navigate the narrow roads of the areas we are considering. The 14 square mile area we are considering would be serviced by two vehicles ideally, one operating in the north of our coverage area and one in the south. If any vehicle had no requests in their part of the coverage area, they could be used to service the other feeder vehicles part. If there was a low demand for the feeder system on a certain day, the vehicle could also be used to service the Santa Fe Ride paratransit, which operates within three quarters (3/4) of a mile of the fixed route bus system. Like the the Ride, which charges $2 for disabled and $5 for seniors, the Feeder system will cost between $3 and $5 to account for the premium service.

4.3   Google Transit File Generation

We used the data provided by the Santa Fe Trails and built up a Microsoft Excel workbook to store all the data and to generate these text files using Macro as mentioned in 3.3.1. The Excel workbook contains 22 spreadsheets. There are 2 spreadsheets for each of the 10 bus routes, one for inbound direction and the

other for outbound direction. There is one spreadsheet that has all the stops information to be used as a look-up table. And the last spreadsheet is a home page with a button to run the Macro and instructions to maintain the dataset as shown in Figure 4-13.

Google Transit Feed Generator

Generate Google Transit Feed Files

Instructions on maintaining data in this workbook

This Excel workbook contains 22 spreadsheets, including a home page, a stop info table and 20 route-related tables.

There are 2 spreadsheets for each of the 10 bus routes, one for inbound direction and the other for outbound direction.

The last spreadsheet has all the stops information to be used as a look-up table.

Each of the route related spreadsheet is well formatted in a way shown in Figure below, so that macros can read all these spreadsheets in a universal method.

Stop Information section includes 7 rows.

The first line marks the ID of each stop.

The next 2 rows are latitude, longitude, which are look-up rows where raw data are from the stop information spreadsheet.

The 4th row is the name of the stop. It came with previous project and those data are provided by Santa Fe Trails directly. (It can be made to a look-up field as well, bu

The rest 3 rows are used for calculating estimated travel time between 2 stops, where the fifth row marks the distance from the previous stop, and the seventh row ma

The sixth row is a calculated field of how long it takes to travel between 2 stops, using the distance and speed stated above.

Service Type section specifies if the corresponding schedule is for Weekday service, Saturday service or Sunday service. For those blank cells in the first column, use "-

Time Point Schedule section is from the data provided by Santa Fe Trails. Those are departure time of the stops showing on their printed schedule booklet.

Figure 4-13 Home Page of the Excel Workbook

Each of the route related spreadsheet is well formatted in a way displayed in Figure 4-14, so that Macro can read all these spreadsheets in a universal method. Stop Information section includes 7 rows. The first line marks the ID of each stop. The next 3 rows are latitude, longitude and name of the corresponding stop, which are look-up rows where raw data are from the stop information spreadsheet. The rest 3 rows are used for calculating estimated travel time between 2 stops, where the fifth row marks the distance from the previous stop, and the seventh row marks the average travel speed of bus between 2 time points. The sixth row is a calculated field of how long it takes to travel between 2 stops, using the distance and speed stated above. Service Type section specifies if the corresponding schedule is for Weekday service, Saturday service or Sunday service. For those blank cells in the first column, use "-" to note it is not applicable. Time Point Schedule section is from the data provided by Santa Fe Trails. Those are departure time of the stops showing on their printed schedule booklet. Estimated Schedule for Stops Between Time Points section is calculated using the Time Point Schedules and the travel time calculated in Stop Information section.

Figure 4-14 Format for Route-Related Spreadsheets

All six files required by Google can be generated automatically from running the Macro, GenerateTxtFiles13. To make it work, there should be no blank cells in the first 4 rows and the first column. In order to maintain the Excel workbook and Macro, all further changes need to keep the workbook in the current format.
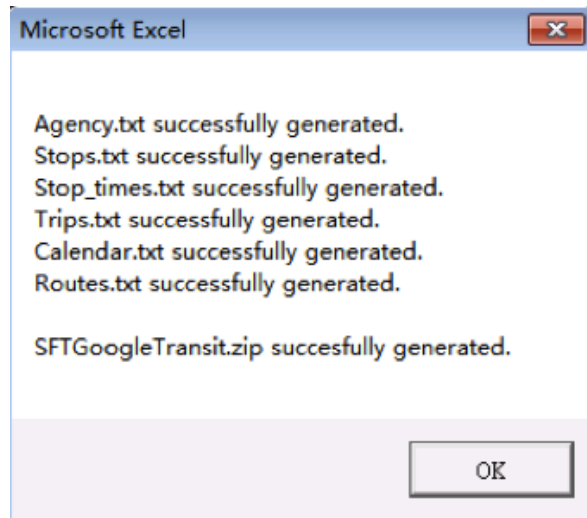
Figure 4-15 Successful File Generation Message

Macro is launched by clicking on the button on the home page of the workbook. If all the spreadsheets are well formatted as it is and all the data are correct, the Macro will generate all six files together with a compressed file (under Windows system only) and inform the user of successful generations, as is shown in Figure 4-15. Otherwise, it will display the error in a message box. Based on the volume of dataset, it will take up to a couple of minutes for the Macro to finish all file generations.

4.4   Mobile Application

As we mentioned in Section 3.3.2, this web-based mobile application would serve as an

Figure 4-16 Home Page of Mobile Application

information exchange platform between passengers and Santa Fe Trails officials. Thanks to Google Transit Feed files we talked about in Section 4.3, we were able to build up this application. On launching the application, it will read the Google Transit Feed files either from a server or from a local drive. A lot of functions in this application were built up using the information from Google Transit Feed files. Next, we will talk about functions implemented in this version of the web-based application.

Bus Location Display

Since Santa Fe Trails has contract with RouteMatch, a software company that provides public transit solutions, their vehicles are equipped with GPS and tablets, as we talked about in Section 2.4.3. However, the GPS location information is recorded by RouteMatch directly, and therefore, Santa Fe Trails has no direct access to those data. After checking with RouteMatch technical support, we realized that they don't have the location published anywhere, so we figured out a way to send AJAX requests to RouteMatch server directly and then get live GPS location of each vehicle. As a result, users can check location of buses directly on the map displayed on the Home Page of the application, as are marked by the bus icons in Figure 4-16.

Stop Location and Schedule Display

Besides live bus locations, the Home Page of the application also shows the nearby bus stops of the current location of users. These data are from Google Transit Feed files directly. Stops are differentiated by color of lines. On clicking on any of the stops, the schedule of coming bus at that stop will pop up, as shown in Figure 4-17.
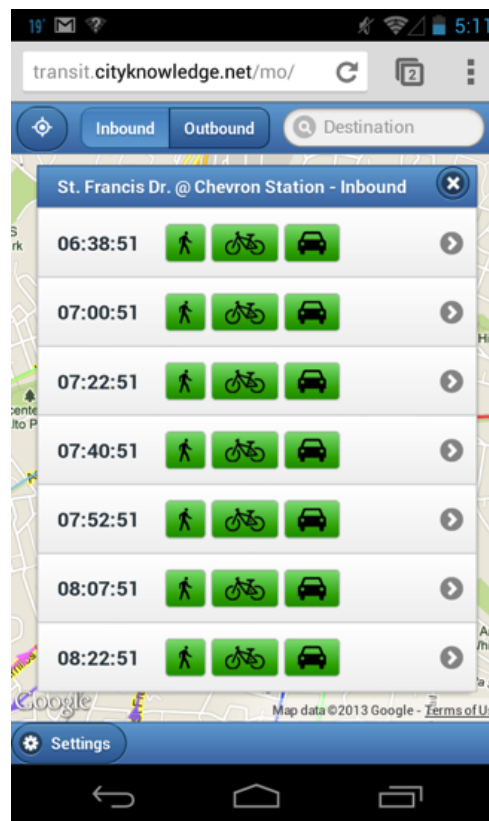
Figure 4-17 Bus Schedule Displays
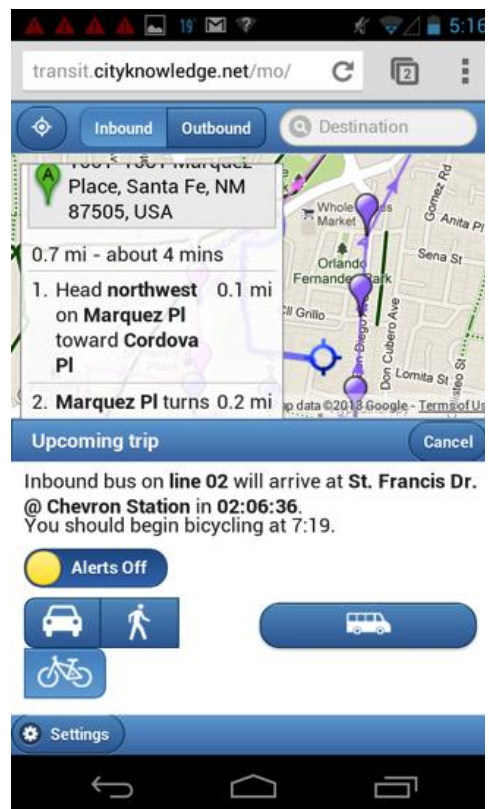
Figure 4-18 Directions to Bus Stops

Directions to Bus Stops

On selecting any of the schedule time displayed in Figure 4-17, the system will tell the users the directions to the bus stop from their current locations, based on the means of transportation the user want to use to get to the bus stop. Here, we provided 3 options: walking, biking and driving. The directions may vary with different means of transportation according to road conditions. Also, the approximate leaving time will change accordingly with the means of transportation. As shown in Figure 4-18, users are also able to enable alerts or request pickup service from the Feeder System we talked about in Section 4.2.

So above are the major functions implemented in the application currently. We also proposed how requesting pickup page looks like and how to incorporate a payment system in this application, but they are not yet implemented due to lack of time. As more projects work on this application, it will definitely become more comprehensive and user-friendly with more functions.

4.5   Improved Bus Stop Signage

One of the reoccurring comments that was encountered when evaluating the suggestions for improvements to the Santa Fe Trails was that users were generally unaware of when and where to get off the bus to get to their destination. Our solution to this problem is to design stop signs and integrate them to the existing poles already at all stops. The purpose of these signs is two-fold: some of the information included is intended for passengers on the bus, and other is for those waiting at the stops.

For individuals on the bus waiting to get off, they will notice the large numbers centered high on the sign. The first number, in white surrounded by a black circle, corresponds with the most recent time point. We modeled the format of this number after the existing format of the time point number, which is a white number inside a black circle, and can be already found in any map or brochure of the Santa Fe

Trails. The second number, after a hyphen where there is one, indicates the consecutive stop after the time point, or how many interpolated stops are left before the next time point. Those stops which only contain the time point number and no hyphenated number indicate that stop is the time point. Passengers will be able to use this feature to know for certain which stop to depart the bus at, since they will be able to see the numbers going by consecutively and will be able to confidently request the bus to stop after they see the stop number before their intended departure number. The numbering system will greatly enhance the ease of ridership by removing the uncertainty of where to get off.
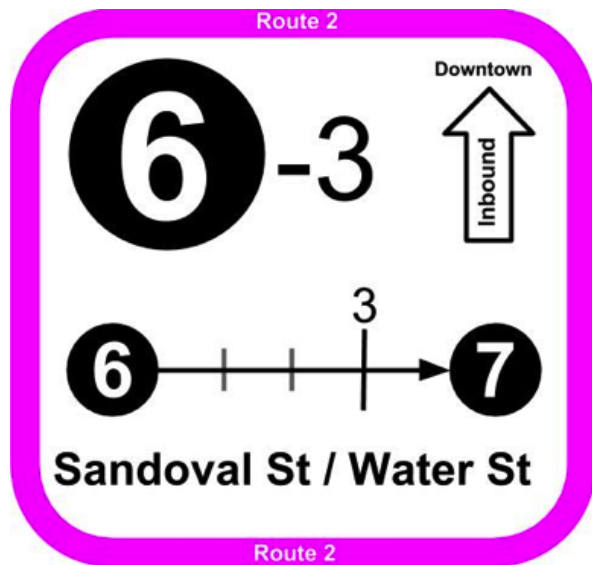
Figure 4-20 Retrofitted Signage for Time Points

Also included for the passenger on the bus is the short diagram in the middle of the sign, depicting two time point numbers as described above, connected by an arrow with a number of tick marks. This on board passenger tool shows the direction of travel, indicated by the arrow, as well as the number of stops between the two time points on either end. The large tick mark connected above to a number shows the passenger at what current stop the bus is at relative to the time points it is between as well as the other stops between them. The rest of the tick marks are smaller and grayed, to indicate they are not the current location of the bus, as well as to show how many and where the rest of the interpolated stops are relative to the current location and the time points on either end. The raised tick number, in conjunction with the time point number, also serves as reinforcement to the large numbers above, further indicating the meaning of the two

Figure 4-21 Santa Fe Trails Project Signage

numbers as the major stop and minor stop. This depiction will not be included on signs at the time points, however. For further information for the stop location, the major crossroads the stop is located at or major landmarks, such as shopping centers, schools, places of interest, etc., are indicated on the bottom of the sign as well.

Some information on the sign is also intended for the passenger waiting at the stop. Currently, upon arrival to any given bus stop, there is no way to immediately know which route stops at that location. To alleviate this problem, each sign will be outlined in the color of the route that stops there as well as indicate in writing inside of the border the route number. Another problem occurs similarly when you happen across any particular stop and you are unfamiliar with the city, you cannot deduce in which direction the bus you would get on would be travelling, inbound or outbound or the name of the endpoint

stop. To solve this, there will be an arrow, pointing either up or down, on the sign with the direction in words inside of the arrow ("inbound" or "outbound") so as not to leave the direction of the arrow ambiguous. The name of the final stop in that direction is also stated at the point of the arrow for further clarification.

To cleanly incorporate these new signs into the existing infrastructure at Santa Fe Trails' stops, the width of the sign will equal that of the current generic sign: 12 inches. The height of the sign at stops that are not time points will be 12 inches, making it square. The sign height at time points will only be 8 inches, due to the lack of the line and tick mark indicators on the bottom.

5 Recommendations

Overall, Santa Fe Trails offers a wide variety of public transportation solutions that are capable of serving the entire city of Santa Fe. However, based on the research done during the project, the system can still be improved to offer better services to its users. Therefore, we are providing useful suggestions to be considered by Santa Fe Trails and future WPI project groups to build a more user-friendly public transportation system in Santa Fe.

5.1 Create a More Bike-Friendly Bus System

From the survey results and comments from bus users, we found that less than half of bike owners used their bike to travel to a bus stop and concluded that bike owners were often fearful of not having a spot on the bus' bike rack. In the case that a bus with its bike rack full arrived to a stop that had a bike rider waiting, this bike rider would have to wait for the next bus which can often take n often take over an hour on the less frequent routes.

We looked into several solutions and found that some could be more effective than others. The solutions that we ruled out included adding a bike rack to the back of the bus, having users carry their bike onto a bus unsecured, and adding the ability for users to reserve a spot on a bike rack prior to departing for a bus stop. Adding a bike rack on the back and allowing bike riders to carry their bikes on a bus were ruled out for safety reasons. The Santa Fe Trails has considered these solutions before and concluded that having users behind the bus and in the driver's blind spot as well as having bikes falling or moving around inside of a bus proved a greater risk than reward. We considered having the ability to reserve a spot on a bike rack but believed it would be much too complicated when bus drivers would have to tell bicyclist that even though the

Figure 5-1 Percentage of Bike Owners per Route

rack was empty, they could not board the bus. If a reservation system was

45

developed bicyclists without a reservation could possibly use a reserved bike rack if they were getting off the bus before the individual with a reserved spot got on. In addition, bike racks that were occupied by a bicyclist on the bus would be reservable if that bicyclist was getting off before the person reserving the spot got on. All these cases would require bicyclists to let the driver know their destination which would need to be recorded in a database. This and the anger that bike owners may show when being denied a spot on an empty bike rack have led us to believe that a first come first serve system is much better.
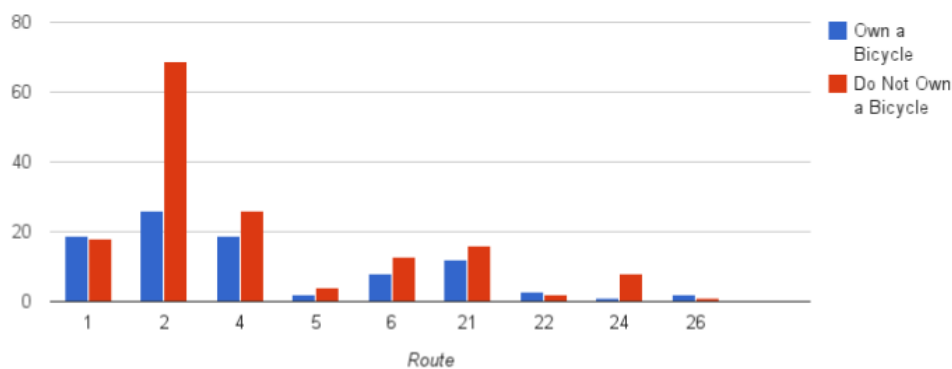
Figure 5-2 Bike Owners per Route

Two solutions that we believe should be pursued include adding bike racks inside some or all of the buses and the dedication of a van to transport bicyclists when they encounter a bus with all the spots on the bike rack full. The addition of bike racks inside buses could be beneficial to some routes but may remove needed seats on some of the more used routes. From our surveys we found that routes 1, 4, 21, 22 and 26 each showed more than 40% of their riders owning a bike and route 2 and 26 being the only routes that showed under 30% of users owning bikes. Both routes 22 and 26 received 5 or less survey responses, making any results inconclusive. From the surveys and the rush hours we've observed on route 2 where every

Figure 5-3 Interior Bike Racks for Buses

seat is occupied, we recommend that only a few buses be equipped with extra

bike racks. These buses can be used solely on routes 1, 4, and 21. The bike rack that will be installed on these select buses, shown in Figure 5-3, would take up two seats and would require bikes to be carried through the main aisle of the bus or through the back door.

The second solution involves the addition of a floating van to the bus system. This van will be equipped with a bike rack and will serve the purpose of transporting bicyclists who cannot get a spot on the bike rack. When a bus with a full bike rack arrives at a bus stop where bicyclists are waiting, the driver will contact dispatching and notify the bicyclist how long he or she can wait for the floating van. This van can also be used to service the Santa Fe Ride paratransit during times of low demand.

5.2   Develop a More Comprehensive Mobile Application

As mentioned in Section 4.4, we did not finish implementing all the functions we proposed. As a result, in the future versions of the application, those functions should be implemented. Also, some of the designs of pages in the application can be improved so that they are more user-friendly and easy to use. Adding functionalities and improving the user interface should be pursued by future WPI project groups and the Santa Fe Trails.

5.3   Finalize Google Transit Collaboration

The first and most complicated step of incorporating the Santa Fe Trails bus system into Google Maps' public transportation trip planning tool, generating the Google Transit Feed files, has been completed in this project, as mentioned in Section 4.3. The rest of the steps should be completed by Santa Fe Trails officials. These steps include:

- Hosting the Google Transit Feed files on their server
- Contacting Google representatives regarding adding the Santa Fe Trails agency to the Google Transit service
- Awaiting confirmation from Google of the successful beta testing of public transportation trip planning on Santa Fe Trails bus system

Upon completion of these steps, individuals will be able to plan their trips in Santa Fe using public transportation through Google Maps.

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Appendix A.   Current Rider Survey

WPI · SANTA FE TRAILS

Date_____   Route/Location_____

1. Please describe your residency: Resident/Visitor/Long-term Visitor *(Visitor - Hotel?)*
2. Do you have access to a car?   Yes/No
3. How many times per week do you use the bus?   _____

4. What is your primary use of the bus?   Work/School/Shopping/Leisure/Other
5. Does your primary trip include a transfer?   Yes/No
6. How long is your primary trip?   _____minutes

7. How long do you typically walk to a bus stop?   _____minutes
8. How long a walk to a bus stop would cause you
   to seek other means of transportation?   _____minutes
9. How long a wait for a bus would cause you to
   seek other means of transportation?   _____minutes

10. How would you rate the Santa Fe Trails
    staff, i.e. Drivers?   Horrible/Bad/Okay/Good/Great
11. How would you rate the Santa Fe Trails'
    bus system?   Horrible/Bad/Okay/Good/Great
12. Would you use a mobile application that gives
    useful information for riding the SFT?   Yes/No
13. Do you own a bicycle?   Yes/No

13y Do you ride it to/from the bus stop, utilizing   **13n** Would you buy an eligible bicycle if you
    each bus' bike rack?   Yes/No   could get free bus passes?   Yes/No

14. What improvement to the Santa Fe Trails would you like to see most? -comment

1	2	3	4	5	6	7	8	9	10	11	12	13	13*	Time	Riders

Appendix B.   General Public Survey

WPI   **SANTA FE TRAILS**

Internal use only:

Date:____/____/____   Time:_____   Location:_____   Interviewer:_____

1. How often do you use Santa Fe Trails Bus System?
☐Never   ☐Occasionally   ☐Every Week   ☐Every Day

If you have used the SFT:	If you have never used the SFT:
2. What is the primary purpose you use the bus for? ☐Work ☐Shopping ☐School Other:_____ **3. What improvements of the SFT would you like to see most?** _____ _____ **4. Would you use a smartphone application that gives useful information for riding the SFT?** ☐Yes ☐No	**5. What is the main reason you don't use the bus?** _____ _____ **6. How likely would you be to use the bus if a smartphone application were created for using the SFT?** ☐Not likely ☐Possibly ☐Likely **7. Are you aware that buses are equipped with bike racks?** ☐Yes ☐No

7. How long would you be willing to wait for a bus?   _____minutes

8. How long would you be willing to walk to a bus stop?   _____minutes

9. What is your primary method of transportation?   ☐Car   ☐Walking   ☐Bicycle

10. How long and how far do you commute to work?   _____minutes   _____miles

11. Is it possible for you to commute to work by public transit? ☐Yes   ☐No   ☐Don't Know

12. Do you have access to a car?   ☐Yes   ☐No

13. How many days of the week do you use a car? ☐0 ☐1   ☐2   ☐3   ☐4   ☐5 ☐6   ☐7

14. What category do you fit in?   ☐Resident   ☐Visitor   ☐Long Term Visitor

15. What area do you live in?   ☐Santa Fe City   ☐Santa Fe County   Other:_____

Appendix C. WPI Project Team Survey

Bus Route	Direction	Time Getting On	Time spent waiting for bus	Time spent on bus	# of passengers (other than IQP students)
Ex. Route 26	Outbound	11:26am	15 min.	30 min.	10

Longest you would you be willing to wait for a bus?
_____minutes

Farthest long would you be willing to walk to a bus stop?
_____minutes

How would you rate your experience with the bus system?

Unusable	Bad	OK	Good	Great
☐	☐	☐	☐	☐

What can be improved?
_____
_____

Comments: _____
_____

Appendix D.   Ridership Data of Santa Fe Trails 2012

SANTA FE TRAILS   **FY2013**

RIDERSHIP BY ROUTE

December 2012

DATE	DAY	Route 1	Route 2	Route 4	Route 5	Route 6	Route M	Route 21	Route 22	Route 24	Route 26	TOTAL
1-Jan-12	SU	0	0	0	0	0	0	0	0	0	0	0
2-Jan-12	MO	192	883	108	56	87	11	0	0	90	8	1435
3-Jan-12	TU	364	1673	411	146	157	32	63	27	214	10	3097
4-Jan-12	WE	447	1302	394	161	185	37	26	26	184	4	2766
5-Jan-12	TH	394	1413	437	170	141	27	120	57	182	82	3023
6-Jan-12	FR	142	1312	276	0	0	0	71	26	124	0	1951
7-Jan-12	SA	84	127	68	86	78	10	0	0	71	14	538
8-Jan-12	SU	154	1021	163	61	80	21	0	0	209	20	1729
9-Jan-12	MO	591	1812	404	315	228	34	79	33	224	6	3726
10-Jan-12	TU	467	1764	498	178	237	38	90	15	163	6	3456
11-Jan-12	WE	281	1102	357	163	166	64	34	21	188	28	2404
12-Jan-12	TH	509	1843	424	198	155	25	67	51	257	6	3535
13-Jan-12	FR	328	2409	527	68	29	14	63	41	266	30	3775
14-Jan-12	SA	110	948	185	109	76	27	0	0	32	16	1503
15-Jan-12	SU	68	227	79	0	0	22	0	0	0	0	396
16-Jan-12	MO	106	711	126	58	59	22	0	0	25	0	1107

Date	Day											Total
17-Jan-12	TU	294	1757	325	269	241	75	104	75	250	50	3440
18-Jan-12	WE	507	1652	449	206	148	35	104	57	230	61	3449
19-Jan-12	TH	139	1394	418	74	102	25	93	53	204	22	2524
20-Jan-12	FR	722	1152	421	62	34	3	96	56	263	30	2839
21-Jan-12	SA	136	1358	195	166	155	60	0	0	151	55	2276
22-Jan-12	SU	84	838	95	0	0	42	0	0	72	20	1151
23-Jan-12	MO	427	1804	439	245	332	65	157	146	204	19	3838
24-Jan-12	TU	523	1652	423	127	179	57	58	144	195	32	3390
25-Jan-12	WE	346	1656	296	183	214	36	127	152	306	51	3367
26-Jan-12	TH	414	1385	560	196	185	30	136	120	285	14	3325
27-Jan-12	FR	388	940	176	125	162	46	86	98	248	39	2308
28-Jan-12	SA	157	1596	355	70	85	28	0	0	120	30	2441
29-Jan-12	SU	70	309	90	0	0	9	0	0	83	13	574
30-Jan-12	MO	472	2288	469	198	194	74	40	215	214	39	4203
31-Jan-12	TU	499	1116	325	186	203	47	160	79	320	23	2958
1-Feb-12	WE	479	2351	570	176	159	35	124	110	279	27	4310
2-Feb-12	TH	123	2020	301	236	223	37	134	146	124	0	3344
3-Feb-12	FR	260	1572	441	4	8	0	121	48	282	0	2736
4-Feb-12	SA	455	828	204	156	203	49	0	0	183	61	2139
5-Feb-12	SU	138	1075	87	56	49	48	0	0	53	25	1531
6-Feb-12	MO	425	1364	240	170	146	24	0	139	226	61	2795
7-Feb-12	TU	420	1822	665	165	168	55	181	165	227	44	3912
8-Feb-12	WE	390	1531	436	209	149	45	143	177	264	56	3400
9-Feb-12	TH	477	1315	472	223	145	30	85	141	266	50	3204
10-Feb-12	FR	246	2118	365	207	147	41	97	103	254	39	3617
11-Feb-12	SA	173	1197	270	97	113	37	0	0	116	20	2023

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12-Feb-12	SU	116	435	113	0	0	20	0	0	62	19	765
13-Feb-12	MO	394	1718	276	46	37	2	46	8	76	17	2620
14-Feb-12	TU	203	1294	435	85	117	20	121	46	30	0	2351
15-Feb-12	WE	605	1829	507	427	318	116	105	146	369	76	4498
16-Feb-12	TH	395	1545	290	240	175	32	0	364	370	30	3441
17-Feb-12	FR	293	1838	299	162	159	38	209	61	259	4	3322
18-Feb-12	SA	341	997	293	86	120	52	0	0	80	45	2014
19-Feb-12	SU	97	689	237	0	0	26	0	0	52	19	1120
20-Feb-12	MO	292	1424	239	98	97	35	17	109	154	84	2549
21-Feb-12	TU	456	1528	449	216	178	47	78	165	221	28	3366
22-Feb-12	WE	409	1833	472	184	149	116	233	157	232	19	3804
23-Feb-12	TH	385	1209	404	106	77	17	113	95	110	0	2516
24-Feb-12	FR	647	1970	286	175	189	48	90	26	222	63	3716
25-Feb-12	SA	186	1316	180	173	164	65	0	0	104	10	2198
26-Feb-12	SU	120	673	119	0	0	36	0	112	152	9	1221
27-Feb-12	MO	429	712	112	139	151	21	157	0	82	37	1840
28-Feb-12	TU	0	249	0	17	48	6	0	0	0	0	320
29-Feb-12	WE	723	3058	776	325	337	116	257	68	169	75	5904
1-Mar-12	TH	447	1623	631	187	150	32	0	86	77	0	3233
2-Mar-12	FR	526	1848	554	129	99	38	203	139	282	16	3834
3-Mar-12	SA	154	1190	184	89	85	48	0	0	81	22	1853
4-Mar-12	SU	102	990	94	50	45	38	0	0	137	43	1499
5-Mar-12	MO	329	1495	178	140	137	41	0	399	580	11	3310
6-Mar-12	TU	135	1521	864	146	142	59	251	100	225	22	3465
7-Mar-12	WE	0	0	0	0	0	0	0	0	0	0	0
8-Mar-12	TH	817	3204	364	329	349	99	128	306	475	39	6110

Date	Day											Total
9-Mar-12	FR	703	1642	513	137	159	33	101	54	242	11	3595
10-Mar-12	SA	172	803	118	75	88	38	0	0	87	16	1397
11-Mar-12	SU	102	864	133	0	0	23	0	0	54	41	1217
12-Mar-12	MO	354	1366	491	123	185	57	101	81	223	10	2991
13-Mar-12	TU	362	2128	436	242	234	120	112	97	290	9	4030
14-Mar-12	WE	264	1656	628	131	148	38	110	125	214	26	3340
15-Mar-12	TH	292	1643	298	108	173	64	0	137	216	43	2974
16-Mar-12	FR	295	1662	525	139	188	25	62	81	189	50	3216
17-Mar-12	SU	185	1058	197	60	81	34	228	0	78	13	1934
18-Mar-12	SU	57	469	87	0	0	24	0	0	44	4	685
19-Mar-12	MO	639	1511	386	185	152	47	55	6	142	22	3145
20-Mar-12	TU	327	1252	458	112	140	41	78	4	261	11	2684
21-Mar-12	WE	423	1327	516	193	207	54	82	9	208	10	3029
22-Mar-12	TH	233	2028	424	161	171	58	89	10	207	23	3404
23-Mar-12	FR	375	1473	310	74	75	31	50	16	151	0	2555
14-Mar-12	SA	171	1485	203	85	117	31	0	0	19	18	2129
25-Mar-12	SU	168	581	114	29	34	64	9	0	130	38	1167
26-Mar-12	MO	458	1950	583	204	201	44	106	89	333	46	4014
27-Mar-12	TU	412	1015	359	220	244	62	105	90	294	14	2815
28-Mar-12	WE	358	1792	558	213	195	80	112	156	385	48	3897
29-Mar-12	TH	426	1700	479	158	200	50	104	131	217	18	3483
30-Mar-12	FR	423	1676	451	137	185	49	90	76	307	30	3424
31-Mar-12	SA	265	960	168	78	79	31	0	0	101	20	1702
1-Apr-12	SU	148	735	133	0	0	44	0	0	79	7	1146
2-Apr-12	MO	373	859	482	113	58	16	102	104	185	11	2303
3-Apr-12	TU	503	1727	324	127	178	58	119	112	221	21	3390

Date	Day											Total
4-Apr-12	WE	281	1717	583	306	320	90	115	157	259	14	3842
5-Apr-12	TH	663	1201	188	148	150	42	0	90	405	22	2909
6-Apr-12	FR	158	2100	724	50	58	19	54	4	21	0	3188
7-Apr-12	SA	315	1296	169	131	144	58	0	30	263	23	2429
8-Apr-12	SU	194	589	74	21	33	21	0	0	32	4	968
9-Apr-12	MO	324	1253	417	185	205	79	239	85	318	18	3123
10-Apr-12	TU	315	1902	474	138	231	82	126	128	250	19	3665
11-Apr-12	WE	709	1504	425	135	236	56	106	118	213	7	3509
12-Apr-12	TH	138	1644	325	212	175	89	149	30	48	0	2810
13-Apr-12	FR	655	1614	609	68	95	20	83	173	221	0	3538
14-Apr-12	SA	267	953	161	70	110	51	0	0	282	52	1946
15-Apr-12	SU	135	802	235	11	13	69	0	0	31	24	1320
16-Apr-12	MO	359	1662	514	188	197	41	114	103	183	9	3370
17-Apr-12	TU	406	1763	509	139	156	106	168	131	184	17	3579
18-Apr-12	WE	282	1576	566	224	223	73	117	108	211	41	3421
19-Apr-12	TH	446	1730	428	148	108	65	114	122	155	0	3316
20-Apr-12	FR	549	1651	370	113	97	40	0	55	653	38	3566
21-Apr-12	SA	179	1017	181	58	80	43	0	0	106	45	1709
22-Apr-12	SU	134	604	286	129	157	108	0	0	59	14	1491
23-Apr-12	MO	520	1687	475	286	182	69	108	57	160	23	3567
24-Apr-12	TU	428	1876	371	136	147	35	154	128	222	35	3532
25-Apr-12	WE	379	1677	521	309	179	68	123	105	187	12	3560
26-Apr-12	TH	319	1051	298	105	0	0	135	127	0	0	2035
27-Apr-12	FR	199	868	322	0	0	0	0	157	379	35	1960
28-Apr-12	SA	150	1979	299	247	260	135	25	0	79	5	3179
29-Apr-12	SU	142	634	156	48	39	41	0	0	73	7	1140

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Date	Day											Total
30-Apr-12	MO	245	1448	431	200	253	81	176	111	114	0	3059
1-May-12	TU	830	2189	486	245	363	91	114	107	475	44	4944
2-May-12	WE	474	1780	448	108	117	49	110	136	256	21	3499
3-May-12	TH	0	347	0	0	0	0	14	0	2	0	363
4-May-12	FR	705	2388	802	421	480	156	74	166	463	40	5695
5-May-12	SA	104	1950	319	117	153	67	0	0	113	52	2875
6-May-12	SU	284	702	145	0	0	42	0	0	54	40	1267
7-May-12	MO	426	1370	484	114	157	50	122	30	148	10	2911
8-May-12	TU	0	393	0	1	9	2	0	0	2	0	407
9-May-12	WE	666	3129	919	152	157	52	234	265	478	41	6093
10-May-12	TH	693	1642	278	227	194	57	85	102	193	29	3500
11-May-12	FR	203	1530	613	138	202	76	114	72	174	45	3167
12-May-12	SA	266	1498	103	67	67	103	0	0	101	19	2224
13-May-12	SU	76	522	90	36	32	46	76	0	59	21	958
14-May-12	MO	495	1636	407	158	153	64	101	73	244	16	3347
15-May-12	TU	546	1818	393	194	224	92	112	132	178	52	3741
16-May-12	WE	409	1731	505	434	353	172	100	73	250	32	4059
17-May-12	TH	443	1505	373	194	140	59	111	38	167	12	3042
18-May-12	FR	544	949	344	180	175	79	0	49	245	26	2591
19-May-12	SA	206	1270	311	99	77	87	0	0	102	14	2166
20-May-12	SU	67	516	106	0	0	15	0	0	50	23	777
21-May-12	MO	579	1801	272	158	164	42	130	31	187	15	3379
22-May-12	TU	542	1584	500	100	180	47	90	32	299	33	3407
23-May-12	WE	452	1709	222	222	313	85	70	0	121	20	3214
24-May-12	TH	263	1284	448	155	169	59	69	0	62	47	2556
25-May-12	FR	500	2508	347	122	142	32	55	46	374	12	4138

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Date	Day											Total
26-May-12	SA	107	1013	129	64	97	16	0	0	76	36	1538
27-May-12	SU	125	682	94	0	0	5	0	0	94	32	1032
28-May-12	MO	0	0	0	0	0	0	0	0	0	0	0
29-May-12	TU	513	1647	510	130	183	38	55	83	261	0	3420
30-May-12	WE	400	1828	506	230	254	92	68	33	287	69	3767
31-May-12	TH	409	1707	482	131	160	27	94	32	237	23	3302
1-Jun-12	FR	345	1700	380	173	147	55	58	42	150	35	3085
2-Jun-12	SA	145	934	166	98	130	22	0	0	90	31	1616
3-Jun-12	SU	99	543	82	0	0	33	88	0	56	22	923
4-Jun-12	MO	369	1648	385	108	129	39	100	78	196	20	3072
5-Jun-12	TU	379	1957	522	149	229	37	19	101	368	33	3794
6-Jun-12	WE	284	1714	591	132	166	65	154	81	207	27	3421
7-Jun-12	TH	391	1252	340	135	138	53	63	46	226	18	2662
8-Jun-12	FR	407	2498	505	191	191	62	6	29	247	6	4142
9-Jun-12	SA	48	0	33	0	0	0	0	0	0	0	81
10-Jun-12	SU	0	0	0	0	0	0	0	0	0	0	0
11-Jun-12	MO	649	3071	558	228	279	126	165	26	172	30	5304
12-Jun-12	TU	489	2045	538	132	188	55	99	138	474	63	4221
13-Jun-12	WE	386	2644	373	89	93	41	80	88	220	55	4069
14-Jun-12	TH	326	1767	534	182	210	114	91	35	143	10	3412
15-Jun-12	FR	289	1734	264	0	0	0	0	118	256	17	2678
16-Jun-12	SA	269	1024	195	220	216	112	0	0	115	11	2162
17-Jun-12	SU	107	491	112	0	0	39	59	0	62	9	879
18-Jun-12	MO	394	1789	487	289	233	84	84	83	235	19	3697
19-Jun-12	TU	351	1762	391	186	186	59	43	70	215	11	3274
20-Jun-12	WE	322	1934	478	141	162	69	98	119	255	29	3607

Date	Day											Total
21-Jun-12	TH	214	986	97	204	196	85	95	0	108	20	2005
22-Jun-12	FR	0	0	0	0	0	0	0	0	0	0	0
23-Jun-12	SA	0	0	0	0	0	0	0	0	0	0	0
24-Jun-12	SU	0	0	0	0	0	0	0	0	0	0	0
25-Jun-12	MO	1286	5894	1614	466	420	180	168	152	709	97	10986
26-Jun-12	TU	253	1764	354	158	167	79	75	64	250	7	3171
27-Jun-12	WE	220	1940	440	145	193	71	99	104	249	15	3476
28-Jun-12	TH	290	1593	442	189	170	58	79	66	209	11	3107
29-Jun-12	FR	531	1848	389	156	152	57	51	25	187	26	3422
30-Jun-12	SA	187	777	131	64	108	46	0	0	110	34	1457
1-Jul-12	SU	48	448	33	0	0	30	0	0	50	9	618
2-Jul-12	MO	178	914	220	0	0	0	0	70	100	0	1482
3-Jul-12	TU	502	3115	427	275	259	78	166	68	329	34	5253
4-Jul-12	WE	0	0	0	0	0	0	0	0	0	0	0
5-Jul-12	TH	345	1752	479	153	150	42	0	0	65	19	3005
6-Jul-12	FR	388	1718	501	190	178	54	133	94	347	12	3615
7-Jul-12	SA	140	780	144	124	110	31	0	0	100	19	1448
8-Jul-12	SU	23	249	49	0	0	0	0	0	68	22	411
9-Jul-12	MO	533	2353	561	137	144	130	33	70	277	43	4281
10-Jul-12	TU	431	2360	313	117	151	48	105	52	254	63	3894
11-Jul-12	WE	395	1754	323	123	259	150	167	60	257	35	3523
12-Jul-12	TH	237	1297	246	37	32	14	0	15	61	0	1939
13-Jul-12	FR	367	4773	382	275	217	124	0	53	369	108	6668
14-Jul-12	SA	328	11843	521	128	117	67	0	0	90	21	13115
15-Jul-12	SU	94	12298	110	0	0	35	0	0	90	75	12702
16-Jul-12	MO	354	2436	315	148	168	92	74	60	228	43	3918

17-Jul-12	TU	369	2058	400	195	210	72	270	9	109	124	3816
18-Jul-12	WE	183	953	116	93	126	47	87	117	291	26	2039
19-Jul-12	TH	582	1885	504	186	158	49	86	64	205	16	3735
20-Jul-12	FR	491	2487	538	180	165	155	55	36	237	66	4410
21-Jul-12	SA	196	1333	164	74	75	38	0	0	113	88	2081
21-Jul-12	SU	114	884	115	0	0	30	0	0	44	66	1253
23-Jul-12	MO	277	1679	543	151	163	46	30	40	219	19	3167
24-Jul-12	TU	233	662	132	134	120	59	144	0	222	34	1740
25-Jul-12	WE	90	0	0	0	0	0	0	0	0	0	90
26-Jul-12	TH	746	5492	1119	267	364	112	115	236	542	38	9031
27-Jul-12	FR	341	1500	344	77	72	44	22	6	27	0	2433
28-Jul-12	SA	306	1541	249	153	214	92	48	0	240	134	2977
29-Jul-12	SU	91	1066	283	36	22	67	0	29	257	40	1891
30-Jul-12	MO	419	1448	403	141	159	70	130	40	238	32	3080
31-Jul-12	TU	475	2468	263	192	196	88	84	43	264	21	4094
1-Aug-12	WE	357	2000	520	135	137	60	87	18	145	57	3516
2-Aug-12	TH	257	265	109	123	165	71	80	0	128	28	1226
3-Aug-12	FR	433	3290	573	196	166	69	12	85	409	129	5362
4-Aug-12	SA	54	391	160	41	35	25	0	0	0	0	706
5-Aug-12	SU	0	0	0	0	0	0	0	0	0	0	0
6-Aug-12	MO	449	3420	691	115	133	102	152	25	427	75	5589
7-Aug-12	TU	775	1752	502	221	238	212	76	34	245	29	4084
8-Aug-12	WE	98	1716	425	180	167	92	79	33	117	0	2907
9-Aug-12	TH	322	1849	440	57	48	22	58	51	253	14	3114
10-Aug-12	FR	191	928	285	54	76	49	0	46	140	0	1769
11-Aug-12	SA	681	762	181	140	136	65	0	0	164	17	2146

12-Aug-12	SU	215	0	0	0	0	0	0	0	44	8	267
13-Aug-12	MO	648	3440	643	366	438	284	144	34	376	45	6418
14-Aug-12	TU	475	2077	230	191	225	87	4	43	369	18	3719
15-Aug-12	WE	473	1728	503	34	60	10	94	0	108	17	3027
16-Aug-12	TH	197	1016	188	0	0	9	0	29	205	17	1661
17-Aug-12	FR	715	1068	521	413	386	170	0	113	403	20	3809
18-Aug-12	SA	185	3050	465	160	201	76	137	0	187	58	4519
19-Aug-12	SU	200	1364	156	13	10	34	93	22	181	8	2081
20-Aug-12	MO	536	1564	367	73	52	32	141	67	200	3	3035
21-Aug-12	TU	734	1740	393	316	330	96	153	151	308	19	4240
22-Aug-12	WE	288	1420	198	152	118	48	0	171	178	0	2573
23-Aug-12	TH	484	1488	975	243	304	90	0	191	306	23	4104
24-Aug-12	FR	215	1188	353	25	48	13	0	77	205	3	2127
25-Aug-12	SA	458	1112	168	131	99	63	428	0	264	29	2752
26-Aug-12	SU	160	579	93	27	66	66	0	0	68	3	1062
27-Aug-12	MO	501	2099	544	190	232	35	158	146	274	32	4211
28-Aug-12	TU	470	1941	515	267	241	60	77	165	257	39	4032
29-Aug-12	WE	473	1945	555	207	185	55	1	112	240	39	3812
30-Aug-12	TH	427	1577	550	225	145	44	294	162	294	16	3734
31-Aug-12	FR	615	2075	510	217	179	45	162	86	301	6	4196
1-Sep-12	SA	198	1123	184	60	64	28	0	0	123	13	1793
2-Sep-12	SU	141	602	112	0	0	37	0	0	76	17	985
3-Sep-12	MO	0	0	0	0	0	0	0	0	0	0	0
14-Sep-12	TU	470	2044	463	201	165	46	181	166	299	13	4048
5-Sep-12	WE	220	1584	139	51	54	10	0	0	160	157	2375
6-Sep-12	TH	711	2113	906	541	352	78	324	132	376	41	5574

Date	Day											Total
7-Sep-12	FR	235	1189	327	201	169	45	98	96	289	4	2653
8-Sep-12	SA	219	1501	494	66	89	45	0	0	62	0	2476
9-Sep-12	SU	177	826	186	0	0	32	0	0	130	51	1402
10-Sep-12	MO	536	973	338	165	219	58	0	106	261	18	2674
11-Sep-12	TU	440	2380	561	213	199	57	318	138	329	41	4676
12-Sep-12	WE	312	1516	556	63	96	12	0	61	59	0	2675
13-Sep-12	TH	570	1788	486	358	217	65	284	255	354	15	4392
14-Sep-12	FR	601	1654	533	159	154	63	114	107	318	81	3784
15-Sep-12	SA	219	1102	273	57	68	42	0	0	148	16	1925
16-Sep-12	SU	116	647	167	0	0	32	0	0	39	17	1018
17-Sep-12	MO	461	1356	328	156	130	25	0	207	350	19	3032
18-Sep-12	TU	451	2025	663	251	286	113	313	156	258	14	4530
19-Sep-12	WE	531	1462	328	227	165	69	136	146	429	32	3525
20-Sep-12	TH	517	1252	447	148	131	78	0	133	301	12	3019
21-Sep-12	FR	693	2072	708	96	85	55	223	67	193	0	4192
22-Sep-12	SA	173	896	285	165	208	107	0	0	181	21	2036
23-Sep-12	SU	142	725	107	10	0	59	0	0	202	35	1280
24-Sep-12	MO	453	1619	418	188	124	30	166	128	309	20	3455
25-Sep-12	TU	560	1871	641	184	188	88	163	149	300	36	4180
26-Sep-12	WE	542	2183	419	182	184	49	59	145	318	36	4117
27-Sep-12	TH	507	1360	510	220	197	45	215	144	291	33	3522
28-Sep-12	FR	278	2048	553	217	157	44	91	63	264	42	3757
29-Sep-12	SA	10	1189	47	41	21	29	0	0	161	31	1529
30-Sep-12	SU	450	1312	316	23	9	43	0	0	41	10	2204
1-Oct-12	MO	550	1867	443	274	225	48	135	109	270	17	3938
2-Oct-12	TU	368	1764	412	51	24	14	60	110	314	14	3131

3-Oct-12	WE	731	1909	668	231	208	53	232	74	218	51	4375
4-Oct-12	TH	0	0	0	0	0	0	0	0	0	0	0
5-Oct-12	FR	0	0	0	0	0	0	0	0	0	0	0
6-Oct-12	SA	62	0	154	0	0	0	0	0	0	0	216
7-Oct-12	SU	612	3132	211	43	143	40	0	0	106	30	4317
8-Oct-12	MO	738	2508	496	281	312	56	228	122	569	76	5386
9-Oct-12	TU	644	1503	395	611	479	147	147	143	260	49	4378
10-Oct-12	WE	522	2498	923	216	171	83	130	290	477	81	5391
11-Oct-12	TH	397	1418	270	103	102	27	161	112	431	47	3068
12-Oct-12	FR	538	2175	1095	161	229	67	71	52	262	4	4654
13-Oct-12	SA	62	891	192	38	83	22	0	0	0	0	1288
14-Oct-12	SU	99	693	88	0	0	35	0	0	77	25	1017
15-Oct-12	MO	0	254	0	0	0	0	0	0	0	0	254
16-Oct-12	TU	502	2770	618	201	156	62	264	194	547	83	5397
17-Oct-12	WE	760	2250	831	165	276	65	108	92	224	6	4777
18-Oct-12	TH	511	1757	587	33	37	8	130	91	193	0	3347
19-Oct-12	FR	766	1763	627	636	560	144	90	26	280	8	4900
20-Oct-12	SA	173	942	162	76	104	38	0	0	33	1	1529
21-Oct-12	SU	115	899	281	49	19	46	0	35	202	83	1729
22-Oct-12	MO	305	1499	412	45	0	0	44	102	170	0	2577
23-Oct-12	TU	589	1977	425	185	144	38	204	140	305	18	4025
24-Oct-12	WE	443	1643	352	296	320	112	133	124	264	37	3724
25-Oct-12	TH	494	899	488	62	10	0	129	120	332	68	2602
26-Oct-12	FR	520	2132	458	216	326	101	84	52	410	37	4336
27-Oct-12	SA	98	752	314	44	50	33	0	0	106	12	1409
28-Oct-12	SU	172	813	156	131	102	43	0	0	71	9	1497

Date	Day											Total
29-Oct-12	MO	161	1340	308	0	0	0	129	90	280	0	2308
30-Oct-12	TU	566	1531	349	335	461	84	0	109	434	75	3944
31-Oct-12	WE	607	1750	507	40	35	7	225	115	209	0	3495
1-Nov-12	TH	460	1526	180	128	79	25	86	126	247	17	2874
2-Nov-12	FR	496	1814	902	57	55	15	92	77	240	19	3767
3-Nov-12	SA	220	1116	143	77	94	44	33	0	90	6	1823
4-Nov-12	SU	150	594	138	151	104	78	0	0	96	17	1328
5-Nov-12	MO	485	1742	531	141	211	38	140	88	235	26	3637
6-Nov-12	TU	525	953	531	402	460	98	0	62	339	41	3411
7-Nov-12	WE	379	1728	295	70	35	26	262	234	377	37	3443
8-Nov-12	TH	546	2091	513	262	360	73	71	160	313	12	4401
9-Nov-12	FR	250	993	387	171	226	42	0	58	249	14	2390
10-Nov-12	SA	150	1416	326	46	66	23	162	0	87	8	2284
11-Nov-12	SU	118	680	244	0	0	24	0	0	66	15	1147
12-Nov-12	MO	270	1137	198	98	102	19	0	0	105	15	1944
13-Nov-12	TU	613	1607	455	211	169	34	157	129	253	30	3658
14-Nov-12	WE	405	1772	378	38	34	6	0	57	182	31	2903
15-Nov-12	TH	171	1502	354	0	0	0	284	97	209	0	2617
16-Nov-12	FR	223	1899	504	157	144	27	94	102	232	0	3382
17-Nov-12	SA	453	821	153	157	217	47	0	0	264	67	2179
18-Nov-12	SU	266	484	45	172	123	52	0	0	68	25	1235
19-Nov-12	MO	397	892	597	165	179	24	0	113	277	29	2673
20-Nov-12	TU	194	1083	427	89	86	24	246	121	180	2	2452
21-Nov-12	WE	549	2064	149	0	0	0	67	69	181	38	3117
22-Nov-12	TH	0	0	0	0	0	0	0	0	0	0	0
23-Nov-12	FR	116	1222	153	183	255	86	0	0	169	48	2232

24-Nov-12	SA	237	800	328	131	157	83	0	0	119	11	1866
25-Nov-12	SU	277	612	135	0	0	26	0	0	58	28	1136
26-Nov-12	MO	181	2239	655	59	22	5	114	80	132	0	3487
27-Nov-12	TU	231	1707	371	0	0	0	136	101	141	0	2687
28-Nov-12	WE	669	1206	443	368	343	63	126	125	228	21	3592
29-Nov-12	TH	748	1806	720	390	407	87	109	69	403	64	4803
30-Nov-12	FR	502	1530	523	0	0	0	102	120	268	0	3045
1-Dec-12	SA	212	1672	190	52	48	26	0	0	228	26	2454
2-Dec-12	SU	146	608	119	53	47	33	0	0	66	12	1084
3-Dec-12	MO	309	1581	506	345	324	68	142	73	213	18	3579
4-Dec-12	TU	316	1889	313	233	188	86	129	59	143	27	3383
5-Dec-12	WE	859	1682	616	195	150	31	157	80	210	27	4007
6-Dec-12	TH	475	1157	392	147	110	32	134	52	170	9	2678
7-Dec-12	FR	164	1442	493	79	78	24	91	118	319	16	2824
8-Dec-12	SA	316	1763	142	76	87	28	0	0	91	27	2530
9-Dec-12	SU	64	239	72	0	0	28	0	0	46	12	461
10-Dec-12	MO	233	1343	72	0	0	0	93	33	128	41	1943
11-Dec-12	TU	481	2158	451	247	301	69	0	49	203	10	3969
12-Dec-12	WE	747	1633	631	154	131	22	136	66	192	17	3729
13-Dec-12	TH	284	1302	296	60	113	11	0	9	70	0	2145
14-Dec-12	FR	322	1136	510	176	205	45	0	49	185	14	2642
15-Dec-12	SA	162	1027	226	93	112	19	0	0	140	76	1855
16-Dec-12	SU	108	728	154	0	0	20	0	0	50	6	1066
17-Dec-12	MO	357	2252	527	369	267	64	119	9	94	0	4058
18-Dec-12	TU	353	1396	316	0	0	0	103	20	334	82	2604
19-Dec-12	WE	600	1135	259	0	0	0	46	9	192	25	2266

DATE	DAY	Route 1	Route 2	Route 4	Route 5	Route 6	Route M	Route 21	Route 22	Route 24	Route 26	TOTAL
20-Dec-12	TH	399	1999	455	185	366	19	66	16	183	16	3704
21-Dec-12	FR	370	1605	209	62	124	8	48	9	208	35	2678
22-Dec-12	SA	0	0	0	0	0	0	0	0	0	0	0
23-Dec-12	SU	109	1833	162	190	178	97	0	0	117	18	2704
24-Dec-12	MO	127	741	327	121	166	47	0	0	94	7	1630
25-Dec-12	TU	0	0	0	0	0	0	0	0	0	0	0
26-Dec-12	WE	364	1616	314	55	95	11	37	65	293	49	2899
27-Dec-12	TH	101	1763	324	13	21	2	9	8	105	0	2346
28-Dec-12	FR	362	1847	362	60	59	32	60	10	317	77	3186
29-Dec-12	SA	110	799	122	195	218	86	0	0	90	21	1641
30-Dec-12	SU	125	600	109	0	0	30	0	0	53	9	926
31-Dec-12	MO	304	855	261	65	89	16	12	11	119	12	1744
Totals		122898	544890	127457	47877	49064	17653	25591	21727	70110	9228	1036495
Average		336	1489	348	131	134	48	70	59	192	25	2832
Ratio		11.86	52.57	12.30	4.62	4.73	1.70	2.47	2.10	6.76	0.89	100.00

Route 21 2.5%
Route 22 2.1%
Route 24 6.8%
Route M 1.7%
Route 26 0.9%
Route 6 4.7%
Route 1 11.9%
Route 5 4.6%
Route 2 52.6%
Route 4 12.3%