Technical Report Documentation Page

1. Report No. SWUTC/11/161024-1	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle The Effect of Public Transit on Social Opportunities for Ethnic Minority Populations: Case Study of Huston-Tillotson University Students		5. Report Date March 2011
		6. Performing Organization Code
7. Author(s) Talia M. McCray, Ana Julita Gomez Sanchez, Myung Kyung Chung		8. Performing Organization Report No. Report 161024-1
9. Performing Organization Name and Address Center for Transportation Research University of Texas at Austin 1616 Guadalupe St. Austin, Texas 78701		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. 10727
12. Sponsoring Agency Name and Address Southwest Region University Transportation Center Texas Transportation Institute Texas A&M University System College Station, Texas 77843-3135		13. Type of Report and Period Covered
		14. Sponsoring Agency Code

15. Supplementary Notes
Supported by General Revenues from the State of Texas.

16. Abstract

Travel time to destinations in the Austin area continues to rise during both peak and off-peak hours. With increased congestion and higher gas prices, some individuals are traveling more selectively and viewing public transit as a cost-saving alternative to the automobile. However, a substantial number of Austinites remain solely dependent on their automobiles for transportation. This study analyzes the travel patterns of students attending Huston-Tillotson University (HT), an Historical Black College and University (HBCU). This population does not utilize public transit, and is mostly car dependent. Reasons given include the need to be independent, the inefficiency of Capital Metropolitan Transportation Authority bus (travel time and routes), condition of bus stops, and the fear of crime while waiting for a bus. During the Spring of 2009, focus groups were held on HT's campus, and surveys were distributed to the broader student body. From September 2009 – May 2010, an environmental analysis of the built environment surrounding 38 bus stops in three locations was performed using an established survey tool. The researchers determined that both studies were necessary to test whether an environmental analysis would support the findings of the focus groups and student surveys. Using GIS, a cluster analysis of bus stop environments, and cumulative distribution functions to explore bus travel time to reported destinations, the researchers found that the students' perceptions were not always consistent with the environmental analysis. The cluster analysis revealed spatial differences when identifying negative attributes. However, none of the bus stop structures in the three areas were in very poor condition. The researchers suggest that a transit training program for HT students would be beneficial in improving ridership.

17. Key Words Public Transit, Disadvantaged Populations, Bus Routes, Bus Safety, Environmental Safety Attributes, Cluster Analysis, University Students, GIS, Cumulative Distribution Function, Historical Black Colleges & Universities (HBCUs), Focus Groups, Bus Stops	18. Distribution Statement No restrictions. This document is available to the public through NTIS: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161

19. Security Classif.(of this report) Unclassified	20. Security Classif.(of this page) Unclassified	21. No. of Pages 159	22. Price

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

The Effect of Public Transit on Social Opportunities for Ethnic Minority Populations: Case Study of Huston-Tillotson University Students

by

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Research Report SWUTC/11/161024-1

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March 2010

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ACKNOWLEDGEMENTS

The authors recognize that support for this research was provided by a grant from the U.S. Department of Transportation, University Transportation Centers Program to the Southwest Region University Transportation Center which is funded, in part, with general revenue funds from the State of Texas.

A special thank you goes to Capital Metropolitan Transportation Authority: Todd Hemingson, Vice President for Strategic Planning & Development, for providing overall assistance in obtaining data and providing guidance; Dinita I. Caldwell, DBE/Community Outreach Coordinator, for providing and identifying leadership for the focus groups, Gerardo Castillo and Jennifer Golech for presentations during the focus groups, and Van Sutherland for providing GIS assistance in running shortest path algorithms connecting a selected group of HT student home locations to various destinations of choice. We also are indebted to Dr. Paul Anaejionu for co-leading the focus groups with Dr. Talia M. McCray.

ABSTRACT

Travel time to destinations in the Austin area continues to rise during both peak and off-peak hours. With increased congestion and higher gas prices, some individuals are traveling more selectively and viewing public transit as a cost-saving alternative to the automobile. However, a substantial number of Austinites remain solely dependent on their automobiles for transportation. This study analyzes the travel patterns of students attending Huston-Tillotson University (HT), an Historical Black College and University (HBCU). This population does not utilize public transit and is mostly car dependent. Reasons given include the need to be independent, the inefficiency of Capital Metropolitan Transportation Authority bus (travel time and routes), condition of bus stops, and the fear of crime while waiting for a bus. During the Spring of 2009, focus groups were held on HT's campus, and surveys were distributed to the broader student body. From September 2009 – May 2010, an environmental analysis of the built environment surrounding 38 bus stops in three locations was performed using an established survey tool. The researchers determined that both studies were necessary to test whether an environmental analysis would support the findings of the focus groups and student surveys. Using GIS, a cluster analysis of bus stop environments, and cumulative distribution functions to explore bus travel time to reported destinations, the researchers found that the students' perceptions were not always consistent with the environmental analysis. The cluster analysis revealed spatial differences when identifying negative attributes. However, none of the bus stop structures in the three areas were in very poor condition. The researchers suggest that a transit training program for HT students would be beneficial in improving ridership.

EXECUTIVE SUMMARY

This report represents the culmination of two studies addressing transit use and perceptions of safety among students at Huston-Tillotson University (HT), an Historical Black College and University (HBCU) in Austin, Texas.

Study-One (Fall 2008 – Spring 2009) was a collaborative effort involving Capital Metropolitan Transportation Authority and Dean Steven Edmond and Dr. Paul Anaejionu from Huston-Tillotson University. Seventy-five students, faculty, and staff participated in four focus groups. Focus group questions were designed to gain a better understanding of how HT constituents use and view public transit. UT students and HT constituents collected 243 campus surveys that explored the question: how do you ride? In addition to collecting information addressing modal choice, trip frequency, travel time of day, and socio-economic factors, we explored perceptions of safety, and the acceptability of embracing alternatives to the private vehicle. To determine whether the bus could be a viable alternative to one's private vehicle, the researchers compared the perceived travel time and costs, clock travel time and costs (using cumulative distribution functions), and a GIS analysis of access to bus service in order to determine where improvements can be made.

Study-Two (Fall 2009 – Spring 2010) was carried out as a response to data collected in Study-One. The majority of the students reported that they did not use public transit due to perceptions of safety and inefficient routes that connected their home locations, Huston-Tillotson, and destinations of choice. Some of the common complaints were related to the conditions surrounding bus stops and individuals who frequented bus stops, mainly derelicts and the homeless, who often gather at certain stops in the downtown area, near several homeless shelters. Study-Two is an environmental analysis of the built environment surrounding 38 bus stops in three locations; HT campus, Austin downtown 6th Street area, and East Riverside Drive, where a large portion of the HT students lived. A cluster analysis was used to compile bus stop environmental attributes to determine why students felt unsafe when standing at public transit stops and identification of the problematic areas. This information was compared to qualitative data obtained during the focus groups which were analyzed using Atlas-TI and a GIS spatial representation of crime incidents between 2007 and 2008.

There is a difference between how students perceive public transit and our analysis of the system. We found that the students' perceptions were not always consistent with the results of the environmental analysis. The environmental analysis revealed a more positive outcome than the students' safety report and their perceived travel time. The researchers suggest that a transit training program, including a discount card for HT students, could be beneficial in improving transit ridership. The training program would compare the City of Austin's system to other city's transit agencies of similar sizes. In addition, specialized sessions could be provided where students are taught how to use the transit system to access their personal destinations, and include training in self-defense when facing violence at bus stops. Lastly, students should explore sustainable energy use, including how their travel choices affect their health as well as that of future generations.

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PART I – PUBLIC TRANSIT USE

Introduction

Austin is one of the most automobile-dependent cities in the United States. Its spreading development, extensive highway system, and lack of public transportation options have contributed to an overwhelming automobile dependency.

According to the 2000 U.S. Census, over 80 % of Austinites used their personal vehicles as their primary mode of transportation, while less than 20% of Austinites used the bus for transportation. Despite the fact that Capital Metro has 76 bus routes, few Austinites use the bus as their primary mode of transportation, and those who do, live mostly near the downtown area where more bus routes exist. Approximately 15% to 20% of bus usage is clustered in the area near apartments for students of the University of Texas at Austin (UT), while another cluster of bus usage exists in the ethnically diverse east Austin area. Less than 15% of Austinites commute by walking or biking (Figure 1.1).

Overall, the method of transportation among Austinites varies by location as well as by socio-economic conditions (e.g. ethnicity and income level). According to the 2000 U.S. Census, the population of the Austin Metropolitan Statistical Area (MSA) is 1,249,763. In 2000, Whites made up the largest group (60.7%), which was lower than the national average of 69.1%. Hispanic and African American populations comprise the two largest ethnic groups in Austin; Hispanics comprised (26.3%), which is higher than the national average of 12.6%, and African Americans comprised (7.7%), which was lower than the national average of 12.1%.

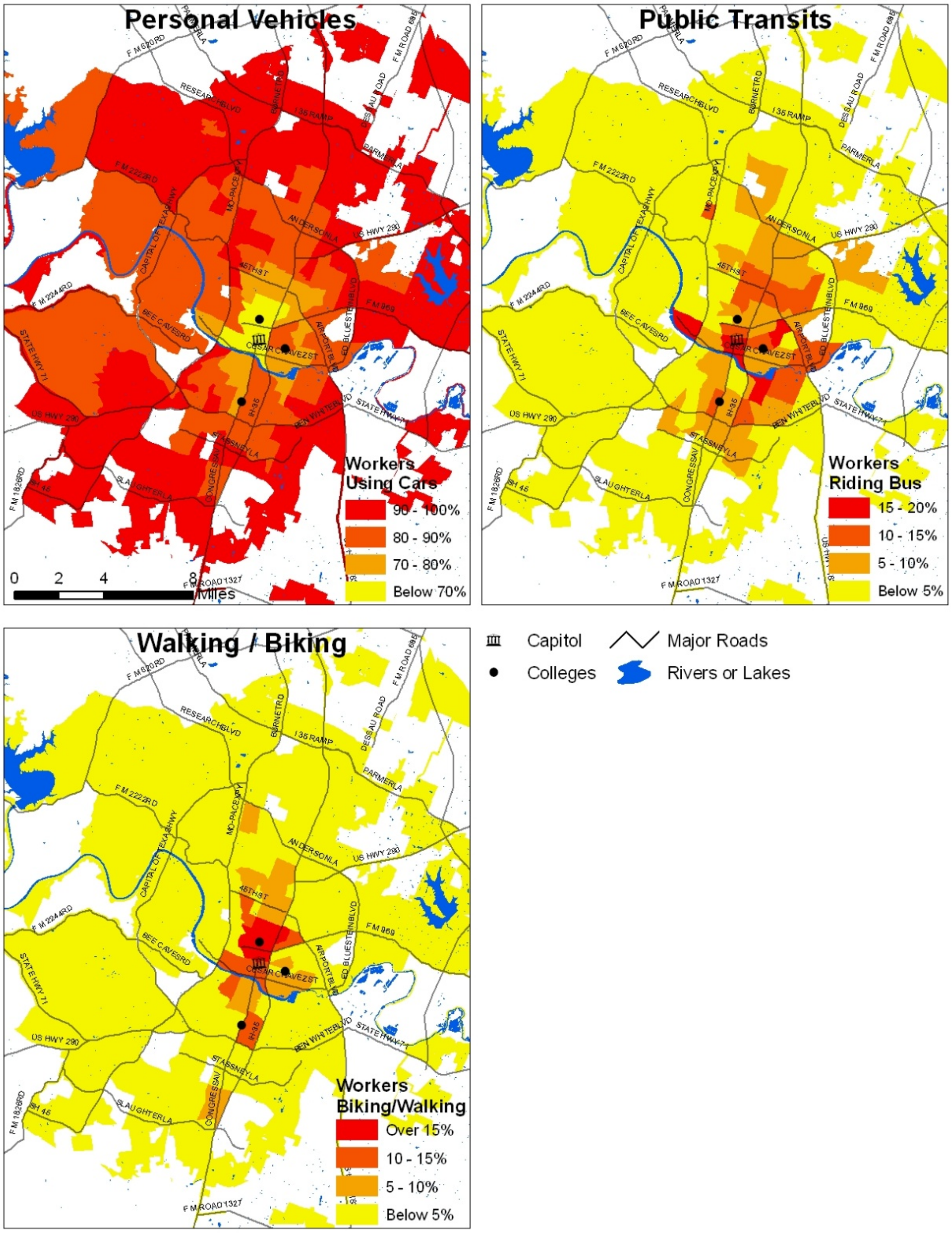


Figure 1.1 - Transportation Modes in Austin, TX (2000 U.S. Census)

Austin's geographic segregation is created by natural barriers (e.g. lakes and rivers) and by infrastructure (e.g. highways). Interstate Highway 35 (IH-35) divides Austin into western and eastern segments, and has created socio-economic divisions between the two areas. As shown in Figure 1.2, the majority of the Caucasian population resides west of IH-35, while African-Americans and Hispanics tend to reside east of the highway. However, even within east Austin, divisions occur between the African-American and Hispanic communities. In particular, the Hispanic population is located along East Cesar Chavez Street where this ethnic group has resided for over a century, while most African-Americans reside along eastern Martin Luther King Jr. Blvd. Huston-Tillotson (HT) University is located between Cesar Chavez and MLK Jr. Blvd.

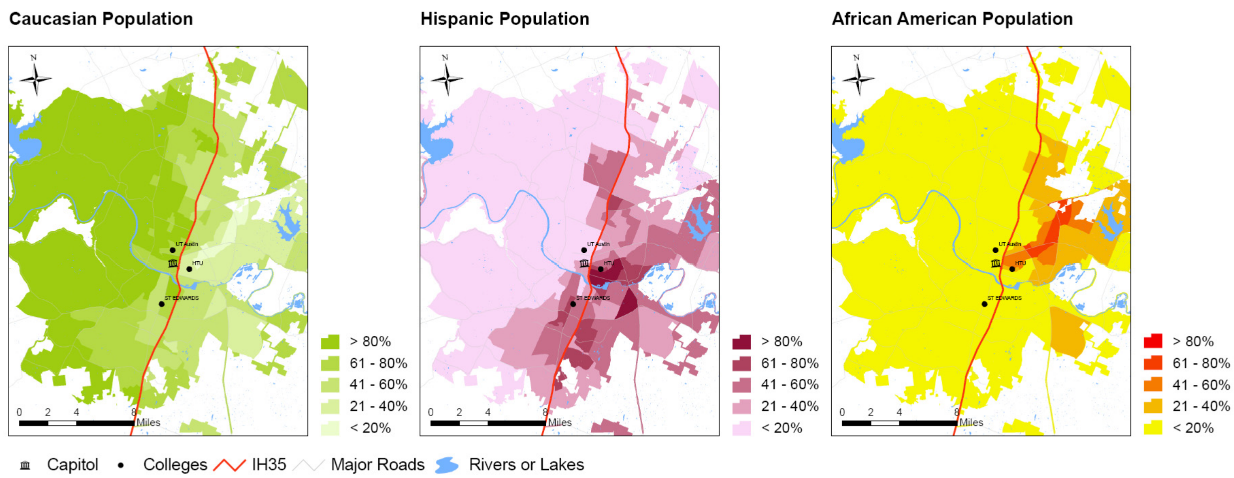


Figure 1.2 - Racial Distribution in Austin, TX (2000 U.S. Census)

To gain a better understanding of Austin residents' transportation behaviors, one needs to consider both the distribution of ethnicities and the ability of different ethnicities to access public transportation. According to the 2000 U.S. Census data, Austin residents, in general, spend an average of less than 60 minutes per day commuting. Despite the fact that residents in west Austin are geographically farther from the downtown area, the travel time from west Austin to downtown is substantively shorter (less than 30 minutes) than the travel time from the east Austin to downtown (30 to 60 minutes). Moreover, the largest proportions of people who travel between 60 and 90 minutes to the downtown area live in east Austin (2000 U.S. Census). The discrepancy between the commute time and geographic location appears to be caused by accessibility issues.

This study assumes that a higher travel cost, such as longer bus waiting time, problematic routes, long walking distance, because of poor street networks or poor bus transit facilities, foster Austin's high auto-dependency. To many participants, the lower value of bus travel time, "the cost of time spent on transport (VTPI, 2002)," was frustrating. We see the problem is associated with the gap between clock travel time and the perceived travel time. Clock travel time (CTT, also called systematic travel time) refers to the fixed bus schedule of a city, while the perceived travel time (PTT, also called socio/psychological travel time) is the travel time measured by one's experience travelling with a specific travel mode. Despite Austin's efforts to increase bus ridership, without narrowing the gap between CTT and PTT, it is not easy to change people's attitudes and behaviors associated with public transit service.

This report begins with a literature review of past and current research related to the three aspects determining public transit use: 1) Perceived travel time and travel cost (social/psychological aspects); 2) Clock travel time and travel cost (activity type and systematic travel cost); and 3) Accessibility analysis, particularly activity base. The methods section outlines the case-study sample and presents the process of data collection and data analyses. In the findings section, bus travel routes are analyzed based on the daily activity schedule of HT University students. The paper concludes with a discussion of how the findings could influence the city's consideration of a new public transportation policy/system that better embraces disadvantaged populations in Austin.

Literature Review

Travel Choice Based on Travel Cost: Car Ownership vs. Public Transit Ridership

Transportation engineers, urban economists, and urban planners have studied travel cost as a key indicator determining people's travel behaviors and choices. A broad definition of the travel costs is "the cost of time spent on transport, including waiting as well as actual travel" (Victoria Transport Policy Institute, 2009). Generally speaking, total travel time costs are measured as time spent traveling (as minutes or hours) multiplied by unit costs (measured as cents per minute or dollars per hour). However, the definition of travel costs varies by travel purpose, travel mode, and the traveler's personality (Victoria Transport Policy Institute, 2009).

Factors that influence travel costs have been addressed extensively in various reports (Daniels, 1980; Bhat, 1997; and Kitamura, 1981). These authors focused on the choice of travel mode, while Abu-Eisheh and Mannering (1981) studied the choice of travel route as a key indicator of travel choice. McFadden (1974) studied the relationship between travel demands of users, costs of cars, and costs and waiting time of public transportation. Interdisciplinary studies of land use (spatial relationship between home location and work/non-work location) and travel time also exist (Bhat, 1997; Clark, Huang, and Suzanne, 2003).

In this project, travel choices of HT students were measured in several ways: social/psychological aspects which are HT students' perceived cost (or benefit) of public transportation on the survey results, travel time (clock travel time) based on the fixed-route services, and comparison between travel time by car versus public transportation.

Activity Type and Public Transit Uses

This report examines the accessibility of bus routes to selective places, which are grouped in locations by activity types. Since Hansen's accessibility modeling was published in 1959, the concept of accessibility has been one of the most popular issues in transportation planning and human geography in the U.S. accessibility modeling and related works quantify potential opportunities and impedances for interaction (El-Geneidy and Levinson, 2006), and works as a basis for drawing optimized solutions in the transportation choice. There are three approaches to accessibility modeling: 1) Location-Based Model (e.g. cumulative or isochronic measures, Gravity model); 2) Individual Accessibility Measure (e.g. space-time constraints); and 3) Utility-Based model (e.g. Activity Based Model) (Handy, 2000; El-Geneidy et al., 2006).

A variety of studies have utilized activity-based models to evaluate the connections between socioeconomic groups, transportation mobility, and/or land use (Kitamura, Pas, Lula, Lawton, and Benson, 1986; Kitamura, 1988; Zhang, 2005; Shiftan, 2008). Kitamura (1988) assessed the contribution of activity-based modeling to travel-behavior forecasting. He categorized activity-based modeling into "science of travel behavior and into a planning tool" discussing its contributions and challenges. Shiftan (2008) utilized activity-based models to relate land-use policies and travel behavior discussing the advantages of activity-based models in analyzing the effects land-use policies have on travel behavior.

The study presented here focuses on the connection between a selective social group and its ability to access public transportation. Recognizing the advantages of activity-based studies in assessing travel behavior, we categorize popular places by 9 daily activity types (Figure 1.3) and analyze the bus travel time to those destinations using two statistical methods and geographic information system (GIS). McCray and Brais (2007) studied social exclusion of low-income women by analyzing their activity patterns and travel behavior with a technique that utilizes GIS to organize and assist self-mapping. By providing information on various aspects of actual travel patterns, the spatial and temporal networks helped refine an otherwise unknown pattern of activities. In our research, we employ GIS to examine activity-based travel modeling of HT University students.

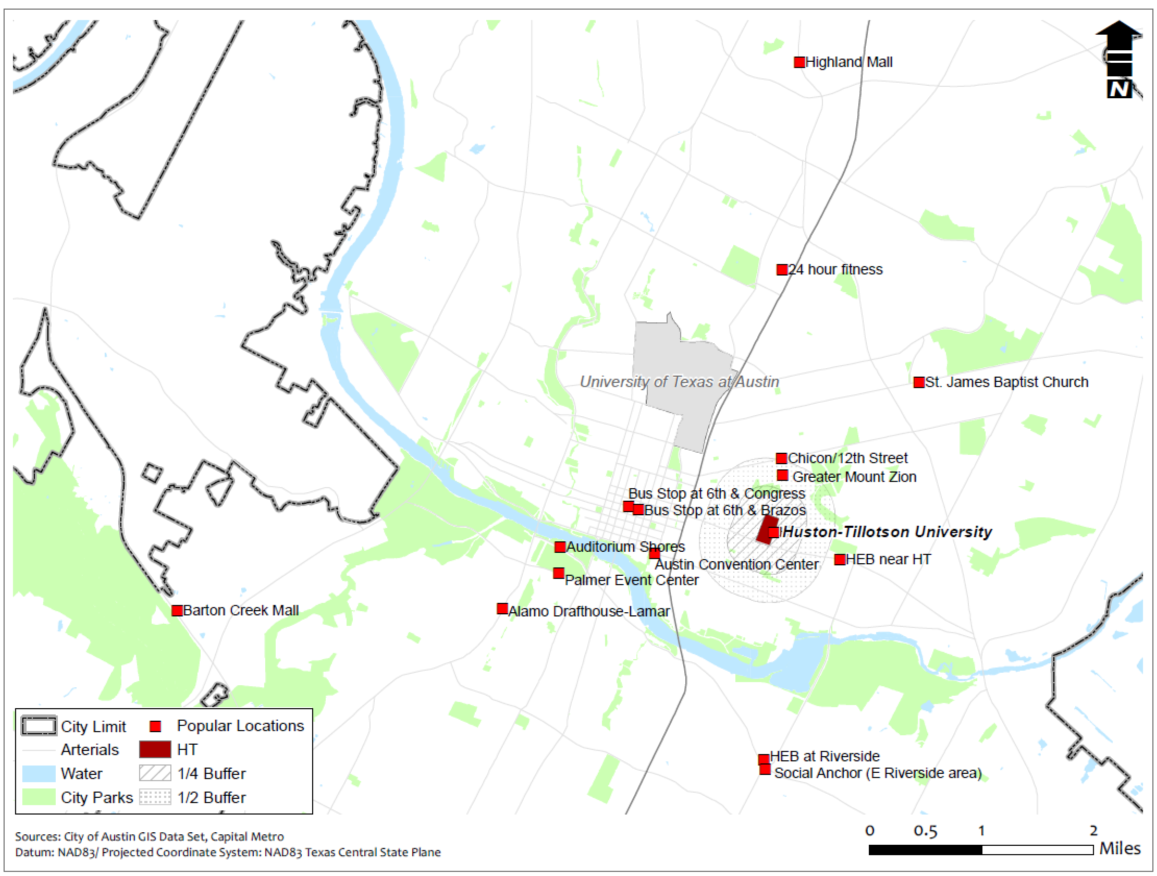


Figure 1.3 - Popular Areas Mentioned by Focus Groups

Socio Demographics and Travel Choice

For the past few decades, most accessibility modeling methods have focused on the transportation system itself, while research is now placing a greater emphasis on travel patterns based on activity types of disadvantaged populations (i.e. Sanchez, 2008; Shannon, Giles-Corti, Pikora, Bulsara, Shilton, and Bull, 2005; Hess, Brown, and Shoup, 2006) or on the *why* of demand or on varying degrees of satisfaction based on socio-economic conditions (McCray and Brais, 2007).

A considerable amount of research exists that has focused on travel patterns of college students, who are the most common users of public transportation (i.e. Haustein, Klockner, and Blobaum, 2009; Eom, Stone, and Ghosh, 2009; Shannon, Giles-Corti, Pikora, Bulsara, Shilton, and Bull, 2005; Hess, Brown, and Shoup, 2006). Shannon et al. (2006) assessed transportation mode and patterns of students and staff from the University of Western Australia. Their research indicated that when the actual and perceived travel time of a bus decreases, up to 30% of additional staff and students would switch to public transportation. Hess et al. (2005) evaluated bus riders' value of time and tolerance of wait time

Despite the significant amount of research analyzing travel behaviors/travel choices of low-income people and college students, most studies fail to consider key elements that may have strong correlations with modal choice. In our study, based on the survey results of our target population, we evaluated additional/empirical variables including: 1) travel cost, travel time, waiting time, and a comparison of travel cost by transportation mode; 2) access to the service such as waiting time and route choice; and 3) social/psychological factors such as types of activity at the destination and the city's transportation policy. We could not find research that has focused on Historically Black College and University (HBCU) student transportation choices based on the clock travel time and the perceived travel time created by their attitudes toward current public transportation services. In our study, we analyzed travel behavior based on a model to examine the untested assumptions related to the supply and demand in public transportation services. We considered various daily activities of HBCU students including: commute from home to school, shopping, grocery shopping, entertainment, church, socializing, and work.

Methodology

Study Sample

During a pilot study at HT University, data were collected in spring 2009 from students, faculty, and staff. We conducted a survey on travel patterns and safety perception to members of HT University. Survey participants consisted of 212 HT University students and 31 faculty/staff living in Austin. The survey is comprised of 38 questions with both multiple choice and short-answer questions. The questions in the survey query the current ridership and the reasons for that, as well as the perception of safety in buses and at bus stops.

Based on survey results, home locations and work locations of students were geocoded (Figure 1.4). Four students provided complete addresses (street number, street name, and city); 113 addresses had cross-road information and zip codes; 41 addresses had one road name only with a zip code; and the remaining 85 did not present any data. After correcting the addresses, 135 home addresses were matched. Among the 135 home addresses, 130 of them were ultimately used, which were located within the Austin city limits boundary. Forty-seven out of 130 (36.2%) students lived within a half-mile buffer from HT, and 32 homes out of 130 (24.6%) were clustered in the Riverside area.

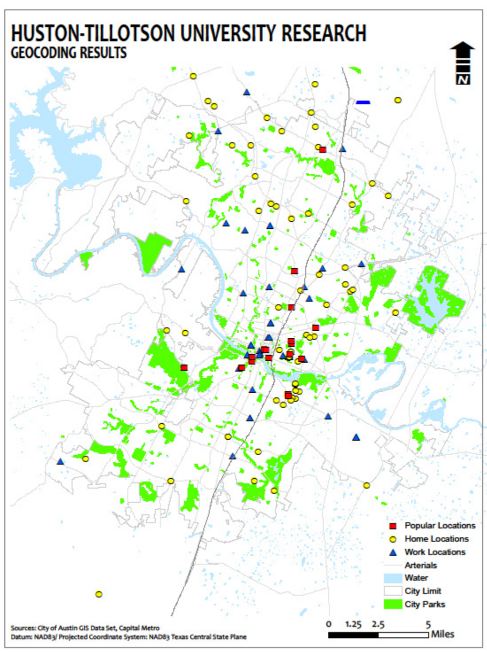


Figure 1.4 Geocoding Results

Data

Data from the questionnaires, focus group surveys, and individual bus travel routes were coded and geocoded. The participants' social factors, modal uses, and perceptions of the public transit services were stored in a database, as well. ArcGIS 9.3, Trip Planner, MS Excel, and GNUPlot version 4.4.0 were used to visualize and to analyze collected data.

To measure bus travel times, addresses of home locations and popular areas were geocoded. From the focus group survey results, we obtained 15 popular locations HT University students frequented. The locations were re-categorized as the 9 daily activities of students: Churches, exercise, entertainment, event centers, grocery shopping, school, shopping centers, social anchor, and work. Regarding the question of job locations, 99 students gave their job addresses.

Next, with the aid of Capital Metro using their Trip Planner program, 8,222 possible bus routes were created from 113 home locations to a maximum of 16 destinations each with one to four transfers. In the flow chart below (Figure 1.5), the data include origin, destination, itinerary, and leg. The origin is defined as the surveyed students' home locations, while the destination includes 15 popular areas, HT, and work locations, if applicable. One to 3 itineraries were returned for each trip plan. Each leg involves the separate bus route required to arrive at the destination; there are multiple legs only if transfer(s) are required. The itinerary takes into account walking time and bus travel time. Walking times are converted from the mileage from home to the first bus stop and from the last bus stop to destination; bus travel times are calculated from the exact boarding time and alighting time by the fixed bus schedule.

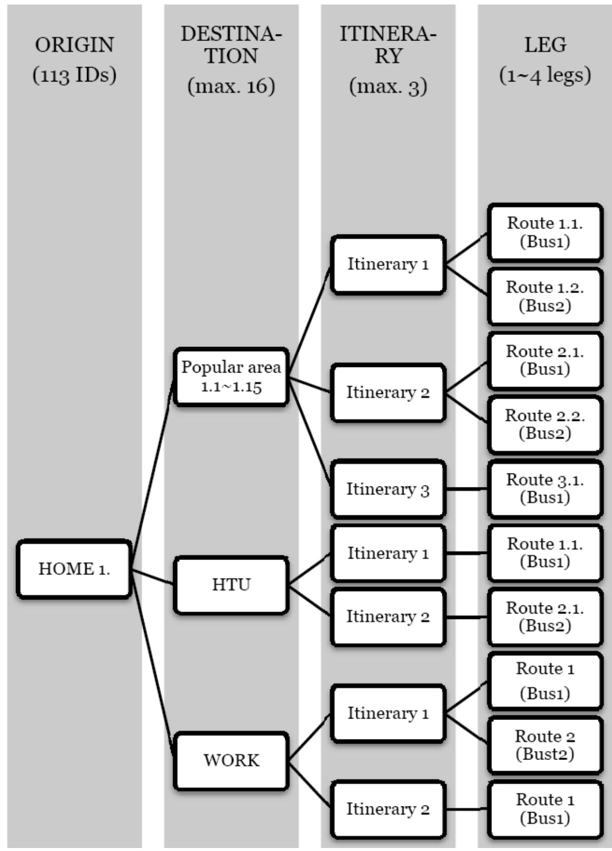


Figure 1.5 - General Scheme of Bus Travel Time Data

The next step was to select the most efficient routes to each destination from the provided alternative routes (itinerary) using MS Excel. That is, by each destination, the most efficient routes from each home location to the destination were picked (second and third efficient routes were deleted) and ranked from the shortest to the longest travel time, and the average travel times to each destination were calculated. (See Table 1.3)

To analyze the bus route data, GNUPlot and MS Excel were used. GNUPlot helped to draw the cumulative distribution function (CDF) graphs and Excel was used to plot the candlestick graphs for the 10^{th} – 90^{th} percentile analysis.

Measures

In order to test the accessibility of HT University students to bus transportation, the following items were analyzed:

1) Socio-Demographics and Modal Use: students' current travel choices
2) Perceived travel time and travel cost (social/psychological aspects): students' attitudes towards the services
3) Clock travel time: the distance and time of the trip for the primary activity (walking distances from/to bus stop and the average service duration of each leg of the trip) analyzed.
4) Access to services: students' perceived degree of access to the service, considering the secondary travel time (walking distance).

The followings are specific explanations of each item.

Socio-demographics and modal use - to understand students' current travel choices based on their socio-demographic background, potential control variables such as gender, number of cars, and student/employment status were obtained. To differentiate conceptual travel time and actual travel time, assorted types of questions were asked and analyzed. (See Table 1.1)

Perceived travel time and travel cost (social/psychological aspects) - to analyze HT students' attitudes and demands on public transit services, various perspectives on travel costs (both the financial value and perceived travel cost) were surveyed and analyzed. Through the survey questions, we asked participants to compare the efficiency and perceived cost of various travel modes and related questions regarding the public transit services.

Clock travel time - during the focus groups we asked students to provide the names of places they visit in a typical semester. Those places were categorized as 9 aggregated activity types: church, exercise, entertainment, event center, grocery, shopping center, social anchor, in addition to work and school, see Appendix A. The activity type allowed us to group the trip patterns and to understand students' modal choices.

Based on the geocoding results, we calculated the scheduled travel time (comparable to the perceived travel time of the attitudes section). The travel time was calculated based on the fixed bus schedules, which were provided by Capital Metro. The travel time equals the bus riding time (alighting time - boarding time) plus walking time to and from bus stop(s). The results were compared to car travel time.

We analyzed the results with 10^{th} – 90^{th} percentile travel times of the clock (bus) travel time, which reflects possible travel routes based on the current bus system of the city. Also, the Cumulative Distribution Function (CDF) was run to understand the overall travel time by activity.

Access to Service - to determine HT students' access to public transit services, a series of questions about factors preventing its use was included on the survey. Related answers from the focus groups were analyzed to understand people's perception of the accessibility to services. Also, using ArcGIS, the gap between current service operations and possible demands, based on the routes between home/HT and popular areas/work, were tested.

Results

Socio Demographics and Modal Use

The majority of the survey respondents were students (87.2%), and of these, 60.9% were female. Over 60% of the students answered that their families had 2 or more cars, while 5% of the families were without cars. Interestingly, the percentage of faculty or staff who did not have a personal car was approximately two times greater than students.

Table 1.1 Survey Results I: General Demographic Questions (selective)

Survey Item		n	%	
#1 Occupation	Student	212	87.2	
	Faculty / Staff	31	12.8	
	Total	243	100.0	
#2 Gender	Male	93	39.1	
	Female	145	60.9	
	Total	238	100.0	* Missing = 5
#4-1 Number of cars in family (Student)	None	11	5.3	
	1 car	64	30.9	
	2 cars or more	132	63.8	
	Total	207	100.0	* Missing = 36
#4-2 Number of cars in family (Faculty / Staff)	None	3	9.7	
	1 car	11	35.5	
	2 cars or more	17	54.8	
	Total	31	100.0	* Missing = 212
#11-1 First mode of transportation (Student)	**Drive**	**137**	**82.0**	
	Bus	16	9.6	
	Bike / Walk	12	7.2	
	Carpool / Vanpool / Other	2	1.2	
	Total	167	100.0	* Missing = 76

Even though many students at HT University hold a driver's license, the proportion of faculty or staff with a driver's license was higher than students. Among students, 18% did not have a driver's license, while only 3% of faculty/staff did not have a driver's license.

The majority of people (87.2%) arrived on campus before 10:00 am to study or work, and 66.8% of people left campus between 3:00 pm and 6:00 pm. The main purposes for being on campus were to attend class, study or conduct research (41.9% of total), and to teach or work (17.6%).

In terms of transportation mode, 82.0% of students and 96.7% faculty/staff used personal cars. Only 9.6% of students used public transportation. Relatively few people used a bicycle or carpooled to get to campus (see Table 1.1). Even though some students and faculty or staff mentioned public transportation or a bicycle as their mode of choice, the frequency of using these was very low. For instance, 78.7% of students and 76.7% of staff responded that they had never used a bicycle for transportation.

There were significant gaps between the ‘conceptual’ modal choice (i.e. participants’ claims about their ideal mode of transportation) and the ‘actual’ modal choice (i.e. reported modes they used for the activity). The actual use of public transit was lower than what people had answered to the question above. The results in Figure 1.6 show that 2.5 locations per person were visited the previous day and the major mode of transportation for the activity was the car (85%). To bike/walk was the second choice, but this mode accounted for only 6.2% of the responses (37 out of 595 locations were visited by bike/walk). Public transit was the least used mode for the actual activities (3.03%).

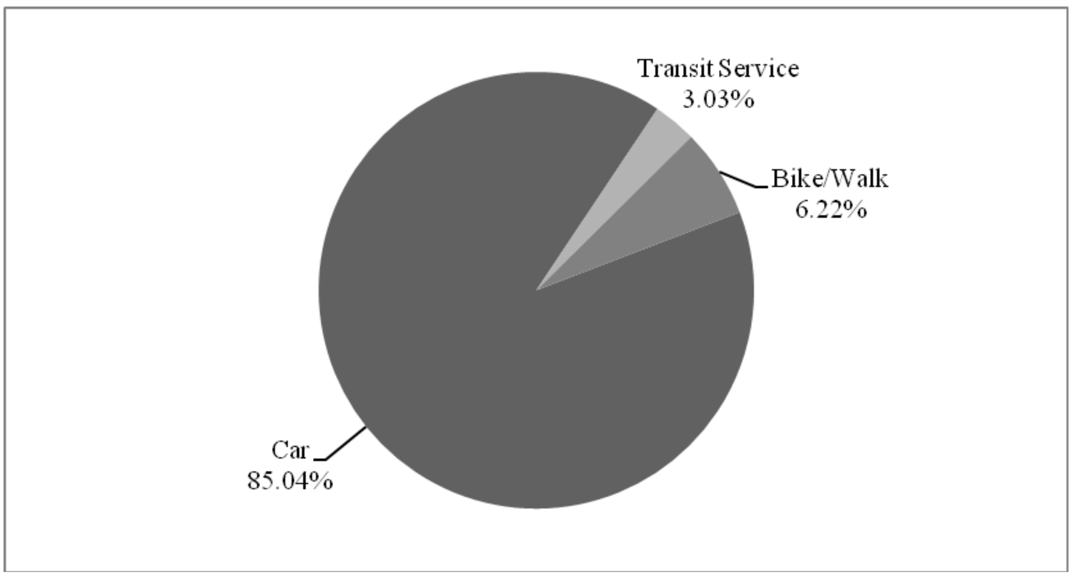


Figure 1.6 – Modal Choice for Non-Home Based Trips

The next section, Social/Psychological Aspects, supports and gives detailed explanations of the socio-demographics and modal use findings.

Perceived Travel Time and Travel Cost (Social/Psychological Aspects)

To better understand HT students’ social/psychological aspects (i.e., their attitudes on the public transit service), we asked questions pertaining to decision factors to drive rather than choose other modes. Reasons given that affect one’s decision to drive include convenience (63.4%), short travel time (29.6%), lower cost (16.9%), safety (15.2%), and inadequate public transit (10%).

Table 1.2 - Survey Results II: Social/Psychological Aspects (Attitudes)

Survey Item		n	%	
#18 Decision factors to drive	Cost	41	16.9	
	Safety	37	15.2	
	Child care	12	4.9	
	Disability access	1	0.4	
	Travel time	72	29.6	
	Convenience	**154**	**63.4**	
	Inadequate public transit	25	10.3	
	Other	22	9.1	
#21 If you currently drive to campus alone, would you consider public transportation if it was?	**Convenient**	**65**	**26.7**	
	Flexible to emergency /unexpected schedules	36	14.8	
	Short time to wait	**60**	**24.7**	
	Safe to walk to the bus, wait for the bus, and ride the bus	18	7.4	
	Clean	23	9.5	
	Improved bus schedule	39	16.0	
	Never would consider public transportation	35	14.4	
#22-1 Reasons why I use public transportation (Student)	Convenience	24	20.7	
	Low cost	**44**	**37.9**	
	It's my only alternative	**38**	**32.8**	
	Concern for the environment	3	2.6	
	Other	6	5.2	
	Total	116	100.0	* Missing = 127
#38 A personal vehicle is a symbol of social status	Disagree	49	20.94	
	Moderate	84	35.9	
	Agree	**101**	**43.16**	
	Total	234	100	*Missing = 9
#39 Public transportation has a negative image	**Disagree**	**92**	**38.98**	
	Moderate	70	29.66	
	Agree	74	31.36	
	Total	236	100	*Missing = 7
#40 Improving the image may increase ridership	Disagree	21	8.86	
	Moderate	54	22.78	
	Agree	**162**	**68.35**	
	Total	237	100.0	*Missing = 6

Most students who used the bus did so because there were no other options (32.8%) and because using the bus was relatively inexpensive (37.9%). Along with the "convenience" of driving, "travel time" was the next biggest decision factor in determining modal use. Students answered that if the bus service improved convenience (26.7%), shortened waiting time (24.7%), and had a better bus schedule (16%), they would use the bus more frequently. However, 14.4% answered they would "never consider public transportation" regardless of improvements to the service.

For our target population, the image of public transit functions as one of the factors influencing travel choice. Regarding the image of public transportation, 39% answered "not negative," 30% answered "moderate," while 31% said it has a "negative image." When the question was switched to ask whether "improving the image may increase ridership," 68.35% (162 out of 237 students) agreed with the statement and only 8% disagreed.

Clock Travel Time

We begin our study on clock travel time and travel cost by analyzing the distribution of bus travel time to each destination grouped by activity types. Based on the central limit theorem, we assume that the travel times of students of HT form normal distributions. Thus, we calculated the average bus travel times and their standard deviations for each activity type as shown in Table 1.3. Here, among the 1 to 4 choices of the alternative routes (itinerary in Figure 1.5) generated by trip planner program for each destination per student, we selected the most efficient route.

From Table 1.3, we observe that the average travel time to activity destinations were varied from 23.25 minutes to social anchor areas on Riverside to 65 minutes to three shopping centers). For the standard deviation, we found the value varied from 14.47 (work) to 33.25 (shopping center). One significant finding was that the shopping center had the highest values for both the mean (65 minutes) and the standard deviation (33.25). Our conjecture is that this finding is related to the condition of the location: shopping centers are usually built to attract a larger number of people than any other activity types we considered (e.g., churches, gyms, entertainment, and groceries). Their locations are usually off-center of a city to accommodate a large number of visitors and stores, as well as the need for large parking lots. Although event centers, school, and social anchors cover a large geographic space, these destinations generally exhibited shorter travel times due to the fact that these locations are near downtown, which has better accessibility by bus.

Another finding is that our results showed the variations of travel times for each activity type were fairly significant (Ambrose, Bukovsky, Sedlak, and Goeden, 2009) – reaching up to 33 minutes. The travel time for the most students (68%) to church, for example, ranges from 6.45 minutes to 47.07 minutes (26.76 minutes 20.31 minutes). Thus, we felt the need for better investigation in the distribution of clock travel times. In the subsequent subsections, we conducted finer grained evaluations for each destination in the activity types using two types of statistical analyses: 10th – 90th percentile analyses and the cumulative distribution function (CDF) analysis.

Table 1.3 - Travel Time by Activity Type

Activity Types	Average Travel Time	Std Dev
Church	26.76	20.31
Exercise	42.20	26.34
Entertainment	39.74	22.47
Event Center	32.43	26.14
Grocery	31.55	27.27
School	30.65	14.47
Shopping Center	***64.99***	***33.25***
Social Anchor	23.25	22.08
Work	40.45	27.11

10th – 90th Percentile Analysis

Given the high variance between students' travel times, we analyzed the entire distribution of travel times rather than simply considering the mean. In order to rule out the outliers of bus travel times of either too little (below 10th percentile) or too much time (above 90th percentile), we applied analysis on the 10th – 90th percentiles of travel times.

Figure 1.7 statistically shows the bus travel times to various destinations. The candlestick graphs for each destination represent travel times of 0, 10th, 90th, and 100th percentile trips, as well as the mean and median of the travel times: the lowest and highest tip of each candlestick correspond to 0 and 100th percentile students' travel times (see Figure 1.7). The bottom and top of the thin, long rectangles (body) correspond to 10^{th} and 90^{th} percentile travel times, and the red and blue dots correspond to median (50^{th} percentile) and mean, respectively.

We found that the outliers of the 10^{th} and 90^{th} percentiles should be considered separately from the group of students within the 10^{th} – 90^{th} percentiles (body). As illustrated in the candlestick graph, Figure 1.7, many destinations exhibit 0 – 10^{th} percentile trips (lower shadow) having 0-5 minutes in travel time, which indicates the travel time was mostly comprised of walk time to and from the bus stops. These cases would not need to take a bus to get to the destination; therefore, they formed a group of outliers. On the other hand, the 90^{th} – 100^{th} percentile (upper shadow) of students were assumed to take relatively longer travel times than the rest of students.

With the exception of Highland Mall, we found that the majority of the mean and median travel times are lower than 50 minutes ($x < 50$), meaning that most of the students surveyed can reach each destination within 50 minutes. Based on previous research and considering the distance to the destination, students would not take the bus if travel time exceeded 60 minutes, thereby incurring losses of bus ridership (Mokhtarian and Salomon, 2001), and thus, we regard these students as another group of outliers.

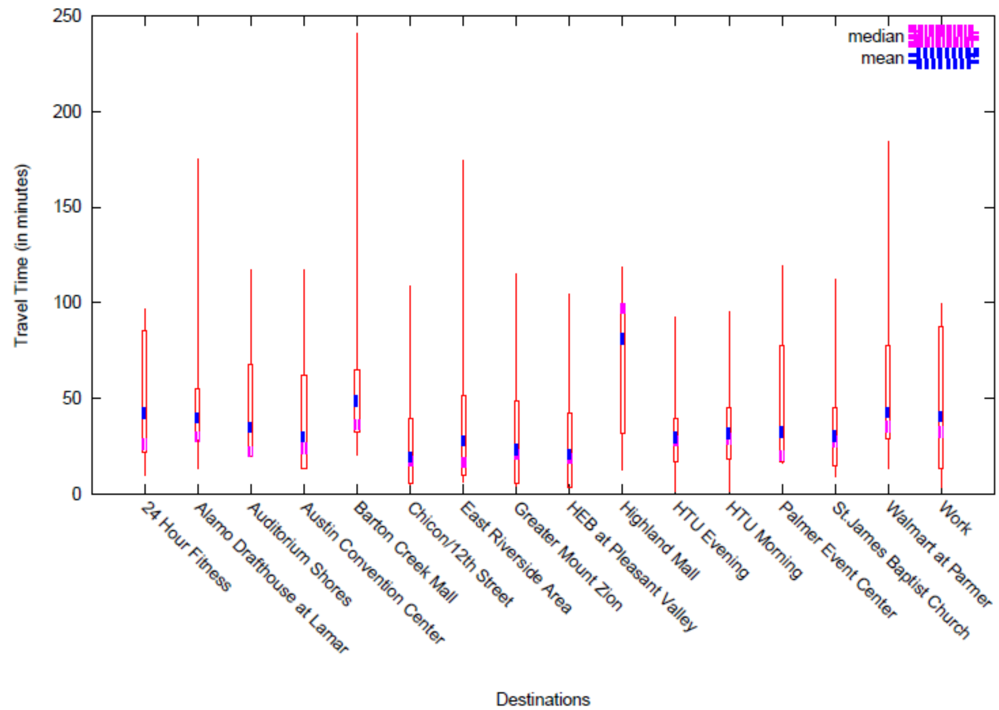


Figure 1.7 - Candlestick Graphs Representing 0, 10th, 90th, and 100th Percentile of Travel Times as well as Medians and Means

For all destinations except Highland Mall, we observed that the median value was lower than the mean, which indicates that the majority of the students' travel times are shorter than the average travel time, and we assume this is due to excessively long travel times.

<u>Cumulative Distribution Function (CDF)</u>

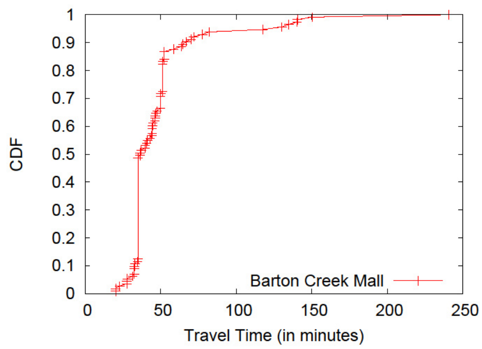
While the 10th – 90th percentile analysis provided ways to distinguish outliers, we needed further understanding on the clock travel time distribution to each destination. Our goal is to understand the amount of travel time bus users can tolerate: while bus riding should cover as many citizens as possible, there should clearly be an acceptable amount of travel time that users can tolerate. To understand the consequences of bus users tolerance, a simple comparison of car travel times (the students' currently preferred mode of transportation) and bus travel times from the clustered home locations to the destinations is used. Given that students' home locations and destinations were within a 10 mile radius of each other, through a rough calculation, travel time to the 16 destinations lies well within 20 minutes by car with an average speed of 30 mph. Empirical observations have suggested a tolerance zone for bus service at 30 to 45 minutes (Getis, 1969;

Clark et al., 2003). Considering the distance between the students' homes and destinations, we can take 40 minutes, twice the travel time by car, as a rough measure of students' tolerance for traveling to destinations (Clark et al., 2003).

The additional in-depth analysis of travel time was done using cumulative distribution function (CDF) because an important benefit of plotting the CDF is that it allows analyzing what fraction of students can reach a destination within a given time limit. In CDF graphs, the x-axis shows travel time in minutes, and the y-axis shows the fraction of the distribution from 0 to 1. The CDF of 0.1 (y-axis = 0.1) corresponds to the 10th percentile as seen in Figure A-5 in Appendix B. Likewise, the CDF of 0.5 and 0.9 corresponds to the median and 90th percentile, respectively.

The CDF first enabled us to see the overall trends and median bus travel time by location of each destination. Among the 16 CDF graphs (Appendix B), we focused on CDFs of two shopping malls (Highland Mall and Barton Creek Mall), school (HT Morning and Evening), grocery (Walmart Parmer), and work.

Shopping Centers: Barton Creek Mall and Highland Mall are two large shopping malls in Austin and were mentioned as popular shopping sites in the survey. Barton Creek Mall, located in southwest Austin, consists of five major department stores, dozens of shops, and a movie theater. Highland Mall in northeast Austin is slightly smaller. On average using a Euclidean distance, Barton Creek Mall is approximately 5.4 miles away from students' home locations while Highland Mall is approximately 4.6 miles away. The plot in Figure 1.8 showing the CDF of Barton Creek Mall is concaved downward as x increases to 60 minutes y increases very sharply from 0 to 0.9. The shape of the plot in Figure 1.9, showing the CDF of Highland Mall, is bending down as we increase x. We refer to this shape as *increasing concave upward*. In this case, we can assume that 1) those routes have excessive stops; or 2) bus connections or routes to the destination are poorly or loosely connected. Thus, most students might have difficulty reaching the destination within a short time period by bus. Figure 1.8 is bending up as we increase x. We refer to this as *increasing concave downward*, and in this case we can say that those bus routes would have fewer stops or better connections to the destination.



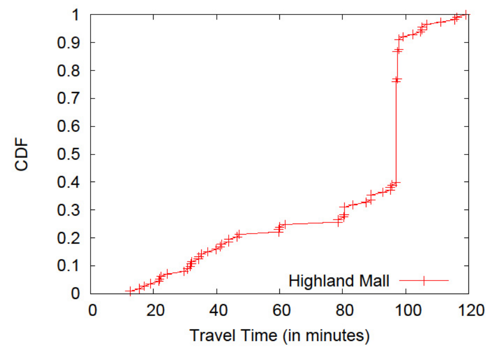


Figure 1.8 - Cumulative Distribution of Travel Times from Home to Barton Creek Mall

Figure 1.9 - Cumulative Distribution of Travel Times from Home to Highland Mall

When we consider the actual distance and time traveled by bus, as opposed to the Euclidean distance, we observe an interesting fact: while most of the destinations shown in the CDFs of Appendix B increased with *concave downward*, Figure 1.9, showing Highland Mall, was increasing with *concave upward*. In the case of Highland Mall, we observed that less than 20% (y = 0.2) of total students reached the mall within 40 minutes (x = 40) and 50% of the total students reached the mall within 70 minutes, suggesting that the mall was not a good place to travel by bus for the majority (80%) of the students. On the other hand, for Barton Creek Mall in Figure 1.8, 50% of total students were able to reach the destination within 40 minutes. Considering the fact that the Euclidean distance to Barton Creek Mall (5.43 miles) from HT is 19% longer than the Euclidean distance to Highland Mall (4.55 miles), the contrast in the travel time by bus between the two destinations suggests a possible traffic jam and/or an inefficient route.

Grocery: HEB at Pleasant Valley and Walmart at Parmer were two grocers mentioned on the focus group survey. Figure 1.10 illustrates the cumulative distribution of the students' travel time from home to HEB at Pleasant Valley and Figure 1.11 is for Walmart at Parmer. From the overall trend of the plots, we can see that the CDF is generally concaved downward, indicating that the majority of students had relatively short travel time while only a few students had prohibitively long travel time. Also, by measuring the fraction of students who think it is reasonable to use the bus, we observed that around 80% (y=0.8) of the total students could get to HEB within 40 minutes (x=40 in Figure 1.10) and to Walmart within 50 minutes (x=50 in Figure

1.11). In sum, the bus route to the grocers, HEB near HT and Walmart at Parmer, have appropriate bus connections from the majority of students' home.

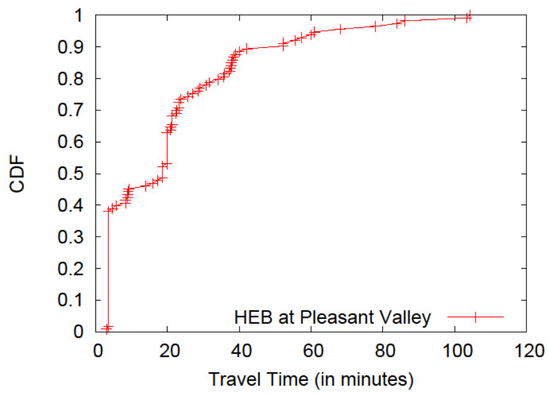


Figure 1.10 - Cumulative Distribution of Travel Times from Home to HEB at Pleasant Valley

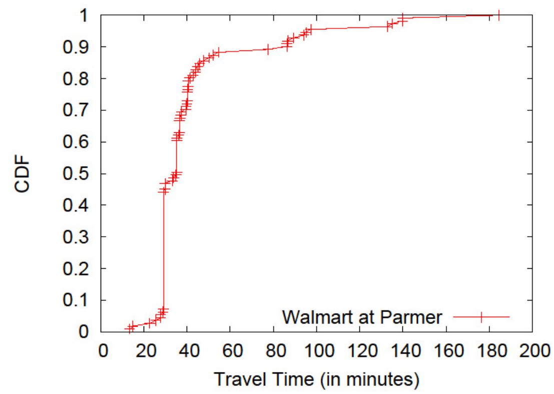
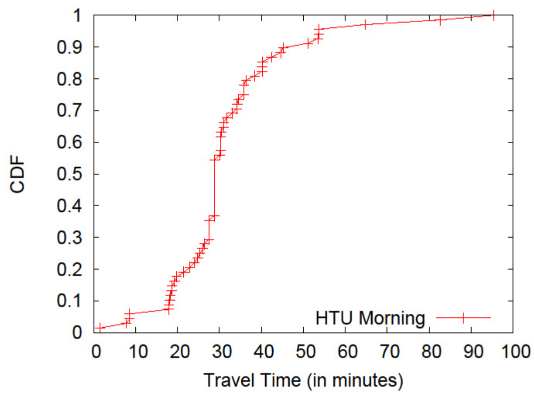


Figure 1.11 - Cumulative Distribution of Travel Times from Home to Walmart at Parmer

School: We analyzed morning bus travel time between students' homes to HT from (8:00 am to 10:00 am) and evening times (after 6:00 pm). The travel time distribution for mornings and evenings are very similar. Comparing the candlestick plots of HT mornings and HT evenings in Figure 1.7, the shortest travel times are a 1-9 minute range, and the longest are an 80-90 minute range. Both the average and 50th percentile of the morning and evening times are at around 30 minutes. Comparing the trends of CDFs illustrating commute time to HT for morning (Figure 1.12) evening (Figure 1.13) confirms the similarity between the two times. Despite the possible differences in traffic volume between the morning and evening, the similarity between the two travel times suggests consistency in commuting by bus. However, according to the focus group surveys, some students complained about overcrowded or unreliable bus services in the morning. This is addressed in the access to service section of this report.

For many students, the bus service is a timely option. The CDFs of Figures 1.12 and 1.13 show the proportion of students who can reach HT within 40 minutes (x = 40) is over 80% (y = 0.8). Two findings of current bus routes' consistency of travel times and timeliness confirm that the bus can be a good mode of transportation for commuting to HT.



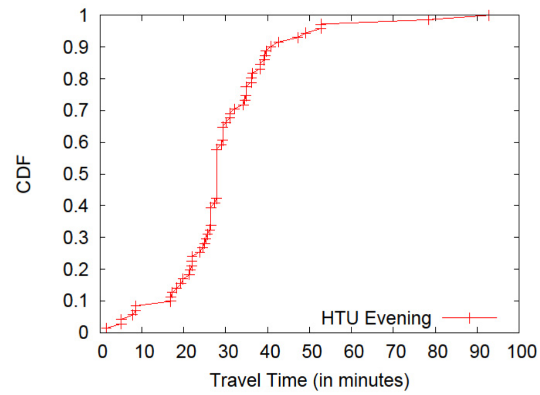


Figure 1.12 - Cumulative Distribution of Travel Times from home to HT (Morning)

Figure 1.13 - Cumulative Distribution of Travel Times from home to HT (Evening)

Work: The candlestick plot in Figure 1.7 could not show any unique patterns of travel time to work. The mean and median are around 35 minutes, the minimum travel time is less than 5 minutes, and the maximum is 100 minutes, just like many other destinations. However, the somewhat linearly increasing CDF of travel time to work in Figure 1.14 is quite different from that of many other destinations that exhibit a concave downward shape. The linear increase in the cumulative distribution from 3 to 40 minutes suggests that the students' distance to work is uniformly distributed in time, i.e., there is no spatial group of students taking the bus from the same bus stop to another. This is partially because the destination, 'work', is a collective term for the collection of various work places with unequal distances, while many other destinations we chose are a single location. As for the commutability by bus, we observe that around 70% (y=0.7) of students can commute to work in less than 40 minutes (x <= 40).

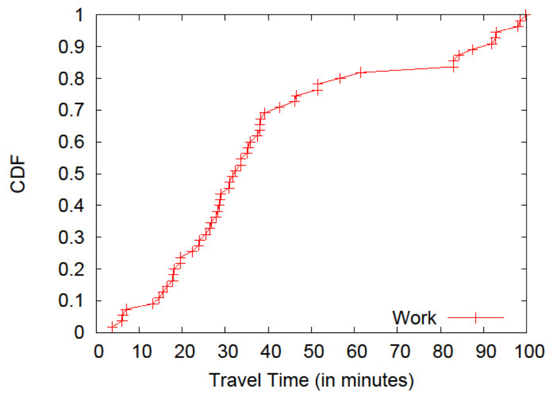


Figure 1.14 - Cumulative Distribution of Travel Times from Home to Work

The statistical methods used for analyzing the distributions of clock travel time have shown that the current bus system in Austin could generally accommodate most HT students to their popular places within a tolerable schedule (i.e., less than 40 minutes).

Access to Service

In the survey described in the methods section, we queried the perception of bus service and some of the focus groups replied that the accessibility was impaired (See Table 1.4). To further analyze the accessibility to bus service, in general, we used qualitative, quantitative, and spatial analyses: we coded survey answers and quantitatively measured the accessibility in the area using GIS (geographical information system).

The main reasons why students chose not to use the bus were related to accessibility issues, such as long travel times to reach their destinations (36.8%) and limited services coverage (28.8%). Faculty and staff also picked long travel times (41.9%) and limited routes (35.5%) as their main reasons not to ride the bus. For these reasons, many people (49.4%) at HT University considered a carpool or vanpool to be preferable alternatives to using the bus. In addition, shuttle services, like those operated at the University of Texas, were regarded as a preferable alternative (30.9% of total).

Table 1.4 - Survey Result III: Access to Service

Survey Item		n	%	
#22-1 Reasons why I use public transportation (Student)	Convenience	24	20.7	
	Low cost	**44**	**37.9**	
	It's my only alternative	**38**	**32.8**	
	Concern for the environment	3	2.6	
	Other	6	5.2	
	Total	116	100.0	* Missing = 127
#23-1 Reasons why I don't ride the bus (Student)	Doesn't go where I need to go	61	28.8	
	Doesn't go when I need to go	39	18.4	
	Doesn't serve my community	12	5.7	
	Doesn't seem safe	12	5.7	
	Doesn't run often enough	32	15.1	
	Takes too long to get to places	**78**	**36.8**	
	I have access to a car	**94**	**44.3**	
	The presence of homeless persons	5	2.4	
	Others	17	8.0	

The main factors that prevented people from riding the bus was the infrequency of bus service such as long waiting times (73.5% of total), followed by behaviors of other passengers on the bus (30.5%), lack of cleanliness (30.0%), and overcrowding (28.45%). At the focus group survey, students mentioned that waiting for a bus was scarier, and it was even more uncomfortable in winter months when it gets dark earlier. Also, one female student in the focus group said that she had needed to be at class at 9:30 am but had to get to the bus stop at 7:30 am (coming from Riverside and Pleasant Valley).

Quote 1:" The first bus that came was full so it didn't stop…then at the transfer spot there are layovers and you have to wait."

Also, inconvenient and inconsistent services were other factors that make the bus less accessible. Most focus group students complained about unreliable and the lack of user-friendly bus schedules.

Quote 2: "The bus does not adhere to the schedule."

Quote3: "The last bus doesn't come or you miss it by a few minutes; buses downtown stop at 5 pm—hard to catch when you get off at 5 pm; or bus doesn't run long enough into the evening."

Students, faculty, and staff agreed that the greatest factor preventing people from using bus services was poor built environments around the bus stops (23.1% for students and 34.4% for faculty). According to the focus groups, one student moved to Austin to attend HT, but the lack of sidewalks to and from the bus stops made the student stop using the bus services. Also, HT students, faculty, and staff suggested that, in order to encourage people to walk to bus stops, better lighting (34.4% of students and 25.8% of faculty), safer crosswalks (30.7% of students and 32.3% of faculty) and more sidewalks (24.5% of students and 38.7% of faculty) were needed.

Quote 4: "Lighting at the bus stops is not really an aid."

Some focus group students mentioned the bus route maps were difficult to read. One girl who moved to Austin from Michigan said it was difficult to know which buses to take, because the maps were too detailed and hard to understand. Another student suggested better and simpler maps were needed.

Among these issues, we tested the frequency of bus operations per day and possible bus service demands of HT students based on the travel time analysis, see Figure 1.15. According to the trip planner results, 71 bus routes (counting opposite directions as two separate routes) were indicated as possible services that HT students could use to reach their destinations. Among them, bus route 300 and route 320 were found to be the highest demand routes connecting HT students to popular areas within the city or to links between key bus routes. However, according to current bus operation data from the Capital Metro, those routes were classified as medium/low frequency for weekdays.

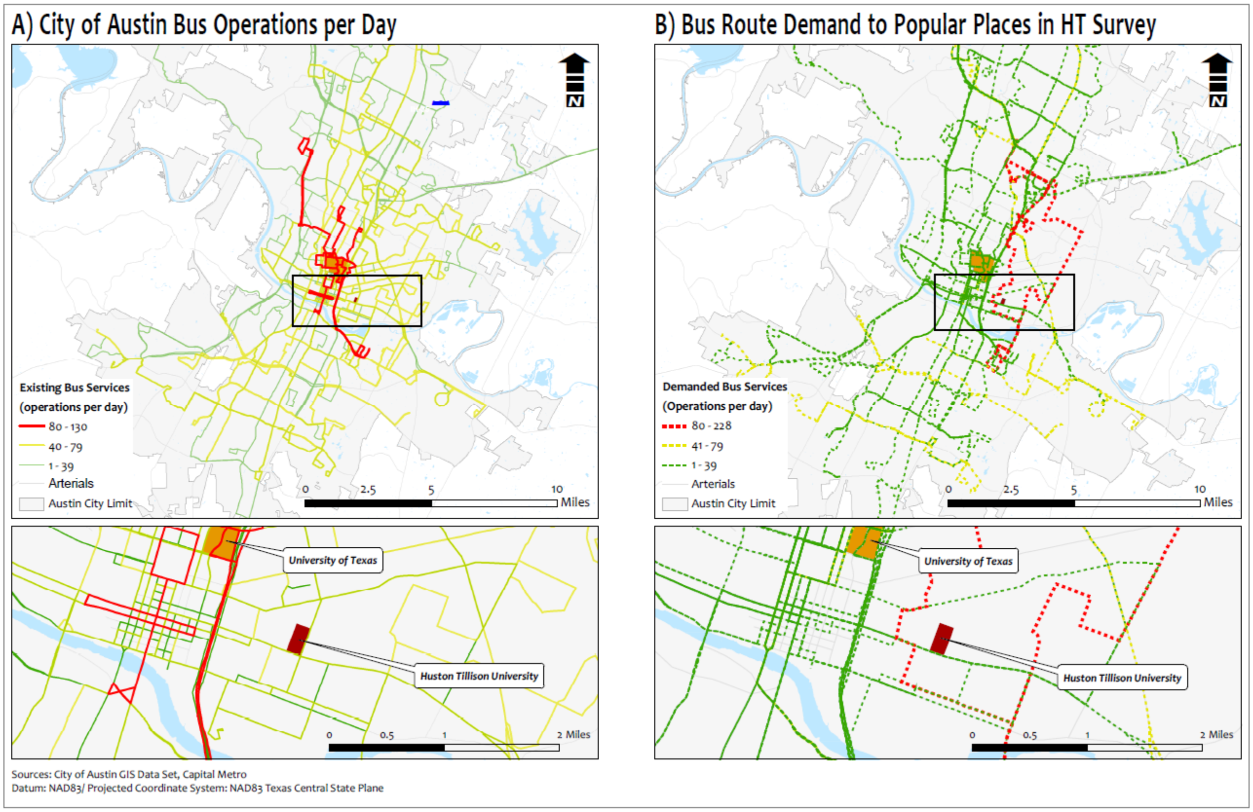


Figure 1.15 - Bus Route Demand of HT

Conclusions

This report measures the bus travel time of minority students in Austin, Texas. We studied the travel times of black college students with three different approaches: i) *perceived* travel time and cost, ii) *clock* travel time and cost, and iii) access to the service.

First, to understand *perceived bus travel time* and cost-based travel time, along with current travel behavior and modal choice, we analyzed survey answers from 243 Huston-Tillotson University (HT) students, faculty, and staff. The majority of the HT population chose cars as their main mode for their daily lives. Convenience, travel time (including bus waiting time), and route choice were the main reasons for their choice. The attitudes on the current public transportation service were somewhat negative. The lack of convenient or user-friendly services, unreliable scheduling, and inappropriate routes have prevented them from riding the bus on a daily basis. The social/cultural background of the focus group was another factor that makes them prefer cars to buses as their main mode.

Second, the *clock travel time* of HT students was analyzed by the route data based on fixed route schedules from home locations to 16 popular areas. We leveraged activity types to categorize the popular areas into a smaller number of activity groups. In analyzing the travel times to each popular area, we applied two statistical analyses: 10^{th} – 90^{th} percentile and cumulative distribution. From the 10^{th} – 90^{th} percentile analysis, we found that the bus route distance was significantly different from the Euclidian distance, i.e., straight-line distance. Cumulative distribution function enabled a more detailed analysis on the travel time by place. We were able to find the fraction of the focus group who would have been able to reach their destination within a given time deadline.

Third, the access to service is analyzed using GIS. By quantitatively measuring the accessibility of service, we were able to identify the aspects of the service that requires improvements. We find the bus schedules need to be more reliably maintained and safety for the built environments needs to be improved. Also, by inspecting the geographical proximity between the students' residents and the bus stops for their school, we find that there is room for improvement in bus routes.

From the three analyses, we were able to find that buses are indeed an acceptable mode of transportation with respect to the accessibility. However, travelers' social/psychological attitudes towards the service are one of the important factors determining their travel choice. Both systematic/environmental support and social attitudes should be considered in encouraging bus ridership.

There is a strong relationship between low-income families and public transportation (i.e. Sanchez, 2008). However, this research showed that most students in HT were using a car as their main modal choice. The city and transportation planners can encourage people to use public transit by highlighting the positive aspects of the services, such as environmental benefits, low costs, and amelioration of congestion. To encourage people to use bus services, however, various aspects of the travel time (not only clock travel time—fixed schedule—but also perceived travel time, and personal travel time) need to be studied carefully.

Our results confirm the findings indicating that merely shortened/reasonable bus travel times calculated by a computer program is not sufficient for encouraging HT students to use public transit. Without enough efforts to improve the image of public transit services or better built environments, people's attitudes toward bus or public transportation will remain as it is. Also, the improvement of possible bus networks among the main places for daily activities is another important element to be considered.

PART II – BUS ENVIRONMENTAL ANALYSIS

Introduction

The fear of crime and perception of safety can influence travel behavior (Sherman, Gartin, & Buerger 1998; Angel 1968; Loukaiatou-Sideris 1999; Wilcox, Quiesenberry & Cabrera 2004). For those that use or have used public buses as a primary mode of transportation, the perception of safety is subject to the conditions of the built environment at bus stops and surrounding areas. Crime is a significant element since certain characteristics in the built environment can lead to higher or lower crime rates. Thus, characteristics of the built environment and the context of crime can shape the perceptions of safety (Sherman, Gartin, & Buerger 1998; Loukaiatou-Sideris 1999, 2000, 2001; Wilcox, Quiesenberry & Cabrera 2004). A lack of security at bus stops, or the perception of a lack of security, has pushed many people to rely on private vehicles, which puts a strain on budgets for minorities. For those in disenfranchised communities or economically impoverished communities, when availability of transportation is limited, so are their opportunities. It is important to consider the function transportation plays as a tool for economic development and opportunity (Liggett, Loukaitou-Sideris,& Iseki 2001).

In a series of focus groups and surveys designed by Dr. Talia McCray and Dr. Paul Anaejionu, data revealed that Huston-Tillotson (HT) University students generally use private vehicles as their primary mode of transportation (n=62, 90%). Huston-Tillotson University is a member of the Historically Black Colleges and Universities (HBCUs), and thus, the majority of HT students are part of the African American ethnic minority group of Austin. Frequent studies have captured the socioeconomic variations of minority groups engaged in urban travel, and these data reveal an increasing demand for public transportation services. Socioeconomic variations include factors such as income, education, race, ethnicity, and historical economic trends. This social approach, aims to indentify the relationship between socioeconomic variations and the use of transit (Bullard, Johnson & Torres 2000; Liggett, Loukaitaou-Sideris & Iseki 2001; Sanchez & Brenman 2002; Litman 2007; Contrino & McGuckin 2009). However, few studies have addressed the role of safety, and its perception in determining travel behavior and transportation mode selection for minorities. Mainstream data tend to place minorities within the public transportation box because of their statistically significant economic limitations (Sanchez & Brenman 2002; Holzer, Quigley & Rafael 2003; Litman 2007; Ward & Hill 2008). This fails to address the role of safety in their transportation mode selection. This methodological gap prevents researchers from adequately answering questions like: 1) Why do students prefer their private vehicles to public transportation? 2) What frightens students away from using the bus? 3) How does the perception of safety, as it relates to public transportation, influence their travel behavior? And 4) what defines a safe or unsafe public place?

Overview

This study is designed to analyze the degree to which the perception of safety shapes travel behavior and influences bus riders' decisions to ride or not ride the bus. Huston-Tillotson University was the site where we gathered our data from the sample population. The study assumes that bus stop conditions can be defined by merging both physical characteristics and environmental attributes. In this study, focus groups are used to explore and identify what is considered safe and unsafe in public transportation. HT data are also useful in determining what environmental attributes are more influential on their perception of safety. Quantitative analyses, in the form of frequency analyses, correlation matrices, and a cluster analysis, are used to measure environmental variables and to develop a general scenario of the bus stops' micro and macro environment. In particular, the cluster analysis is helpful in identifying categories of bus stops. This is an important exercise that captures natural attributes of some bus stops, summarize the data, and develop prototypes of bus stops that can be related to specific locations and land uses. Land use data are used to describe the areas surrounding bus stops, define the development trends in the vicinity, and contextualize some of the comments related to the perception of safety made by HT participants. Austin crime data are used at study locations to define types of crimes and their proportions around bus stops. Ultimately, crime data are used to give a context of crime when referring to the perception of safety, land use, and these bus stops' conditions. The crime data complements the creation of scenarios when determining how the evaluated bus stops look, why they are perceived as safe/unsafe, and what attributes and land uses are more related to crime.

The study does not attempt to draw conclusions about which environmental attributes raise or decrease bus stop crime. Also, the study does not attempt to draw conclusions on whether perceptions and environmental attributes are a "cause" or "result" of crime rates. The study attempts to answer the questions: what frightens HT students away from using public transportation, and are HT perceptions of safety based on an actual crime context? If HT students were to use the buses around their areas of activities, would the bus stops be classified as safe waiting places given the design structure and the conditions of the surrounding built environment? Ultimately, the study can be used as a guide for policy makers when looking at bus stops and their micro and macro environment, and how this affects individuals' perception of safety in these areas.

Significance and Implications

The analysis of bus stop conditions, bus stop crime, and perception of safety is an important exercise to assess the needs of future bus riders, develop mechanisms to attract users, and offer a service that will be both safe and comfortable. Understanding what individuals define as safe and unsafe is important to designing and locating bus stops. Paying attention to these issues provides transportation planners with a clear idea of what design principles should be prioritized and which locations are considered suitable based on safety requisites.

By acknowledging the role that perceptions of safety play in transportation planning, decision makers can shape their policies and provide better services for bus riders. In addition, improving the bus system can increase the demand for the service by attracting users. Improving the services can generate better access to opportunities for transit dependents. For those who rely on a private vehicle, improving the system may create opportunities to reduce commuting costs, vehicle costs, and traffic congestion.

Part II begins by describing the literature review, data collection instruments, methods, and a description of the study group and study locations. A qualitative analysis is used to understand what is considered safe and unsafe in the built environment. This is done through focus groups and surveys with HT students. An evaluation of bus stops is based on a survey of the surrounding bus stop environment, which is analyzed in SPSS to look for frequency, correlation, and clusters. Bus stop crime is evaluated using 2009 Austin Police Department Crime Rates. These data are merged geospatially with bus stop locations and land uses, using the geographic information system (GIS) ArcGIS 9.3. This report concludes by discussing the findings and how they are related to the main research questions, the implications of these findings on travel behavior, and recommendations to transportation agencies on how to improve the services base on safety concerns.

Literature Review

The perception of safety affects all aspects of human activities, and it is intrinsically related to crime in the built environment. Angel (1968) was among the first researchers that framed and developed the bridge between crime and the built environment – both physical and social – by analyzing how urban physical planning and design can assist in discouraging crime. Angel discusses the existence of "Critical Intensity Zones" which he defines as areas where pedestrian circulation is intermediate (Angel 1968). Intermediate circulation refers to areas that have enough potential crime victims, but not enough as to provide an adequate surveillance function. As intensity of use increases and streets become more populated, they become safe again (Angel 1968). These zones tend to have specific physical environmental characteristics and land uses that provide opportunities for delinquents to commit a criminal offense, creating a perfect setting conducive to criminal mischief. Some examples are: open parking lots in isolated areas, commercial areas backing residential areas, structures that provide poor pedestrian circulation, flexible zoning ordinances, and un-centralized evening establishments (Loukaitou-Sideris 1999). Despite the wide application of his proposal, Angel's research seems to lack a discussion of the common physical elements of cities that also serve as crime deterrents such as, lighting, fences, building façades, surveillance cameras, alarms, etc. Among his assumptions, he does not consider crime against property a catalyst for crime against citizens. He frames crime only at intermediate levels of pedestrian traffic, and in his list of visible pedestrian public places he does not include bus stops or transportation hubs.[1]

Consistent with Angel's proposal, Wilson and Kelling (1982) also analyzed crime in the built environment. However, their research focused on the role of police as crime-fighters and how they can strengthen the informal social-control mechanisms in order to minimize fear in public spaces. Along those lines, they first put forth in 1982 the "Broken Window Theory" which is an

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[1] "The data suggest that passengers in moving vehicles are rather well protected against this class of offenses, unless they happen to be taxi drivers or bus drivers who are being robbed by passengers. Our study is directed to those public areas where pedestrians circulate." (Angel 1968:7) Perhaps, the main assumption is to consider bus drivers as the only victims of robbery by passengers and not include bus stop and transportation hubs as public pedestrian areas.

analogy to illustrate how the condition of the built environment influences crime and the fear of crime. The broken window theory suggests that serious street crime will happen in areas where disorder is unchecked. In this case, "one broken window becomes many" and unattended areas send the social signal that "no one cares" (Wilson & Kelling 1982:5). Thus, "muggers and robbers believe they reduce their chances of being caught or even identified if they operate on streets where potential victims are already intimidated by prevailing conditions" (Wilson & Kelling 1982:5). According to Wilson and Kelling, a well-maintained built environment will decrease minor crimes and criminal behavior. Thus, major crimes will be prevented. In their definition of the built environment, bus stops are included; however, they are not the primary focus.

Influenced by the studies of Angel and Wilson & Kelling, Anastasia Loukaitou-Sideris (1999) was among the first researchers that studied crime at a specific urban setting – the bus stop – and the perception of safety therein. She concluded that the fear of crime does influence how people live their lives and travel.[2] Loukaitou-Sideris' study, based on empirical observations and survey research, argues that there are several environmental factors that might create opportunities for crime at bus stops since bus stops often lack facilities that deter it (Loukaitou-Sideris 1999). These environmental attributes can be eliminated through changes in design. Loukaitou-Sideris states that: "the limited number of sites and situations constitute the loci for the vast majority of offenses and the concept of place seems central when the characteristics of the place affect the probabilities of crime*"* (1999:397-398). Loukaitou-Sideris utilized *Wil*son & Kelling's "Broken Window Theory" indicating many high-crime bus stops are full of "broken windows, literally and metaphorically." She concludes with a list of negative environmental attributes that are considered "crime generators" (Loukaitou-Sideris 1999:398). Examples of such crime generators are: abandoned commercial and industrial structures, broken benches, cracked sidewalks, uncollected trash and litter, poor lighting, easy escape routes, liquor stores, pawn shops, pool halls, and vacant lots.

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2 Leavitt, J. & Loukaitou-Sideris, A. (1995). A decent home and a suitable environment: dilemmas of public housing residents in Los Angeles. Journal *of Planning Education and Research, 12 (3), 221-239.* Introduction of the term "Transit crime" as crime on buses or train, or at bus stops or trail stations.

In 2001, following her initial research, Loukaitou-Sideris conducted a spatial analysis to measure the effects that urban forms (land use) and bus stop characteristics have on crime rates (Liggett, Loukaitou-Sideris & Iseki 2001). Using GIS, she was able to merge crime data and negative environmental attributes (visibility, litter, and liquor stores). She standardized the results by crime per bus rider. She found that areas with high crime rates share similar physical characteristics and attributes that can explain crime incidents. In this case, "most bus stop crimes tend to be in dangerous places," which often have negative environmental attributes and poorly designed structures (Liggett, Loukaitou-Sideris & Iseki 2001). To weigh her results Loukaitou-Sideris developed two regression models, each with separate spatial correlations. The regression analysis calculated the effects of environmental factors on the crime and uses crime per rider as the analysis unit. The regression formulas were unable to provide strong R-square coefficients to truly localize high crime clusters in specific corridors. Therefore, there was not a strong correlation between crime and specific environmental attributes. "Only one location variable contributed significantly to the regression model" (Liggett, Loukaitou-Sideris & Iseki 2001). In her research, Loukaitou-Sideris does not measure the effect that the perception of safety at bus stops has over travel behavior, neither has she correlated variables to identify a pattern or cluster categories.

In understanding perceptions of safety, Austin & Buzawa (1984), Ingalls & Owens (1994), and Needle & Cobb (1997) have concluded that "fear and anxiety about personal security are important detractors from using public buses," causing people to avoid specific transit routes, buses, or to not use public transit at all (Loukaitou-Sideris 2005:2). Also, the British Department of Transport in 2002 developed a report on people's perception of security and their concerns about crime on public transport. The report concluded that personal security is a major barrier to the use of public transport. The report discussed the causes of these fears and whether they stem from actual incidents of crime or from the attributes of the built environment of transportation locations, like bus stops. In an innovative approach which uses qualitative and quantitative data, the report discuses physical attributes and locations while evaluating perceptions of safety or fear of crime. This approach worked to develop a dynamic analytical method that took into account risk and a physical location (place and community). Results revealed that security concerns are more related to, and measurable, in terms of the physical environment the subject is in than the actual risk of a crime occurring.

When understanding the risk of a crime, the fear of being the victim of a property crime weighs more than being the victim of a personal crime (British Department of Transport 2002). In addition, the report compared minority groups (Asians and Blacks) with the White population to conclude that the perception of security on public transport is generally the same for all groups. A caveat of this report is that it had certain limitations to the gathering of highly detailed crime statistics such as percentage of crime by locations, and types of crime by locations.

In a follow-up study, Loukaitou-Sideris (2008) conducted her own study of transit riders' fear of crime. Her research looked into women's fear of victimization in bus transit by providing empirical evidence that women have different safety and security needs than men. This illuminates a "mismatch in the types, locations and strategies transit agencies use" when addressing safety needs (Loukaitou-Sideris 2008:573). Loukaitou-Sideris pointed out the general "ambiguity among transit operations" regarding security features for female passengers (Loukaitou-Sideris 2008:573). However, her research did not include statistical data to measure this mismatch or the perception of incidents as they relate to safety and the resultant influence on travel behavior and potential policy interventions.

Conceptual Model

Following (Angel, 1968; Wilson & Kelling, 1982; Loukaitou-Sideris, 1999, 2001 & 2008), and the British Department of Transport Report (2002), the HT study proposes a conceptual model (Figure 2.1). The model assumes that at a bus stop location, the perception of safety, its surrounding area, and the design of the bus stop itself are key to understanding the overall condition of the built environment. It was also developed to provide an accurate evaluation of the negative environmental attributes that, according to the above discussed literature, create conditions for crime to occur. This conceptual model provides a framework to analyze how one's perception of safety influences an individual's travel behavior and transportation modal choice. This framework is applied to the survey of HT students to determine their perception of safety, its relation to their travel behavior, and reasons for preferring private-owned vehicles to public transportation. Focus groups and survey data are used to understand and define perceptions of safety.

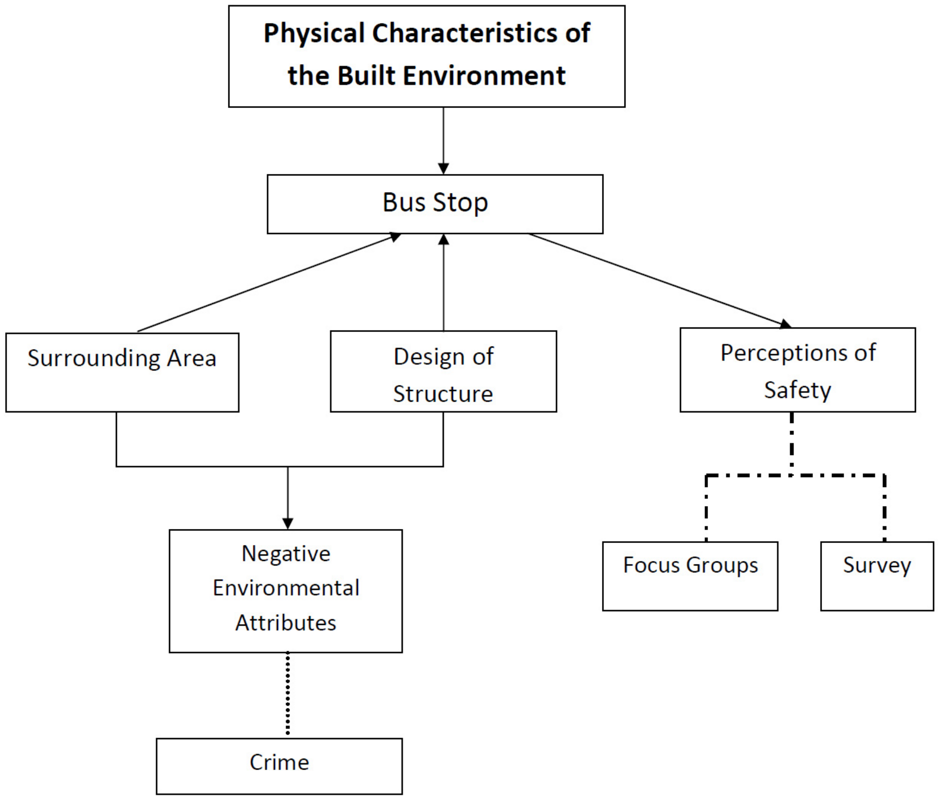


Figure 2.1 Conceptual Model

Understanding the Conceptual Model

The conceptual model considers the physical characteristics of the built environment as the common point and follows the line of researchers such as Sherman, Gartin & Buerger (1989), Angel (1968), Loukaitaou-Sideris (1999, 2001, & 2008), Wilson & Kelling (1982), and Wilcox, Quiesenberry & Cabrera (2004). Researchers agree that specific physical characteristics of the built environment can be conducive to crime. Angel (1968) considers citizen surveillance an important crime deterrent and the lack of "eyes on the street" creates more crime potential. Wilson & Kelling (1982) and Wilcox, Quiesenberry & Cabrera (2004) emphasize the importance of positive physical attributes to prevent crime. Sherman, Gartin & Buerger (1989) and

Loukaitou-Sideris (1999) highlighted the physical characteristics of hot spots or areas with high crime rate.

The primary focus of this study was the bus stops identified by HT students and Capital Metro, the Austin transit agency, along routes linking home locations, Huston-Tillotson University, and activity sites. The general characteristics of bus stops and the surrounding area have been analyzed in-detail by Loukaitou-Sideris (1999) and to some extent by Sherman, Gartin & Buerger (1989). They agree that negative environmental attributes around bus stops increase bus stop crime rates. Moreover, they also consider that negative environmental attributes affect citizens' perceptions of safety.

The literature review reveals that sometimes perceptions are not related to actual experiences with crime or the physical crime context (Wilson & Kelling 1982; Loukaitou-Sideris 1999). However, one's perception of safety is a powerful psychological factor that can limit the mobility of transit users and even deter them from using the transit services. The perception of safety is an abstract concept that is usually better understood through empirical evidence or qualitative data gathered from focus groups, surveys, and direct observation (Loukaitou-Sideris 2008, British Department of Transport 2002). Following these principles, the above conceptual framework applies the focus group and survey methodology to the HT students' case study to develop a general understanding of what students consider safe and unsafe while riding, or waiting for the bus, and whether these safety issues influence their transportation modal choice. "Perception" for this research is understood in terms of positive or negative environmental attributes.

When considering a bus stop's microenvironment, little attention has been given in the literature to design and how it may influence one's perception of safety (Loukaitou-Sideris 1999; Wilcox, Quiesenberry & Cabrera 2004). The Americans with Disabilities Act of 1990 (ADA) provides city planners, traffic engineers, developers and other public officials with guidelines to improve bus stop placement, safety and design. One example to measure this is detailed in Hosen's Transit Agency Participation in Medicaid Transportation Program (2006). Other than ADA, bus stop designs do not commonly take into account personal safety. Loukaitou-Sideris (2001) briefly introduces the links between the physical design of bus stops and perception of safety by analyzing the significance of bus stop shelters over bus stop crime rates. However, the subject of actual physical design is not the focus of her research. Our study goes a step further by analyzing bus stop structures using elements of Hosen's survey to identity negative or positive environmental attributes shaping bus stop microenvironments. The design of the bus stops, along with their positive and negative attributes, is then linked to the crime rates within each bus stop microenvironment.

Methodology

Study Sample and Perception of Safety

Data Collection

The study was carried out through four focus groups of HT students, faculty and staff. Sixty-nine (69) persons participated in the focus groups. Approximately 90% of the participants were students, and the remaining 10% were faculty and staff members. The focus groups and surveys were designed by Dr. Talia McCray, professor at the University of Texas at Austin (UT) in the Community and Regional Planning Program, and Dr. Paul Anaejionu, professor at HT in the Political Science Department. Capital Metro employees in the Community Involvement Section and six UT Community and Regional Planning Graduate students volunteered to support the design and implementation of the focus groups.

Each of the four focus groups met separately for a total of four meetings with each lasting approximately two hours. During that time, four data collection instruments were put into practice to gather information on what HT participants consider "safe" and "unsafe" in the built environment. These instruments were:

1. A long survey with close-ended questions administered to approximately 200 persons including focus group participants. The survey explored some travel behavior patterns, areas of activities, safety concerns, and demographic information.
2. A perceived safety short survey. The survey addressed the perception of safety and safety concerns linked to whether or not the respondent had been physically attacked.
3. Focus group Post-it Notes. The Post-it Notes were used during the focus group discussions to record specific reactions to questions made by the moderators such as:

difficulties in taking public transportation and benefits of changing daily commuting patterns.

4. Focus group transcripts from UT note-takers. Transcripts of all the meetings were recorded for use and analysis. Table 2.1 presents the data collection instruments in detail.

Table 2.1 Focus Group Data Collection and Instruments

Perceived Safety Short Survey Questions: - Male/Female? - Have you ever been physically attacked? - Do you know of any family members or friends who have been physically attacked? - What sorts of things in the built environment communicate a sense of security? - What sorts of things in the built environment cause you to feel insecure/unsafe?
Post-it Notes Specific questions posed by the moderator and recorded on Post-it Notes by the focus group participants: - What difficulties do you have in taking public transportation? - What benefits do you see in changing your daily commuting patterns? - What would it take for you to leave your car at home and travel via another mode? What changes would you have to make in your life? What changes would you like to see Capital Metro make? Would you consider carpooling to work? - What image does the city's bus service convey in your mind? Is it cool to ride or just for certain types of folks? Is it just for people who don't have cars? Is it safe?
Focus Groups Transcripts Notes Questions posed to guided focus group discussions: - What types of things do you typically do on a regular basis? - How do you typically access your activities? - Do you use public transit? - What types of activities do you access via bus? - What difficulties do you have in taking public transit? - Do you know where the nearest bus stop is to your home? - What would it take for you to leave your car at home and travel via another mode? - What benefits do you see in changing the patterns of your daily travel to and from work and school? - If commuter rail serviced your community, would you use it? - What image does the city's bus service convey in your mind? - Do you have as much safety concern waiting for the bus as you have walking to and from the bus stop? - Do you believe there is a gender difference in perceptions of safety? Explain. What fun places would you like bus access to?

Method of Analysis

To understand what HT subjects consider safe and unsafe in the built environment and the importance they give to some of these elements, a qualitative analysis of the transcripts, Post-it Notes, and surveys was conducted. In this study, two methods were used to analyze qualitative data: MS Excel and Atlas-TI. These methods were selected because they allow a flexible interpretation of the qualitative data and they are user-friendly. Using simple tabulation principles, we counted the number of times a topic appeared and kept track of how many respondents highlighted different themes. Atlas-TI software allows users to code, locate and annotate findings of primary data and evaluate their importance, look for frequencies, and visualize the relations through network connections.

MS Excel Analysis - MS Excel was used to identify topics related to perceptions of safety and to calculate how many comments were made while subjects were addressing those topics. The comments recorded in Excel described what HT participants consider safe and unsafe about the built environment around the bus stops and about the actual bus stops. First, a matrix was created with the most common topics gathered from the focus group transcripts and Post-it Notes. Then, the perceived safety short survey was used to relate comments and participants to the topics. Table 2.2 shows the formulas used to calculate comments by participants and by topics.

Table 2.2: Calculations / Formula

Step 1	Determine the N value or total number of participants for all focus groups
Step 2	Locate topics under the categories of perceptions of security and insecurity using transcript and Post-it Notes as references.
Step 3	In each focus group, create an individual worksheet. Then, using the perceived safety short survey, quantify the number of comments made by each participant and place those comments under its related topic.
Step 4	Calculate the total amount of comments by topic for both categories, perceptions of security and insecurity.
Step 5	Calculate the percentage of comments by topic for the two categories. i. Total the amount of comments in each category ii. Then, apply the next formula: (Topic total comments/grand total comments)*100%
Step 6	Calculate the percent of comments by topic and total of participants in each focus group iii. The calculations are based on proportion, thus the 100% rule does not apply. iv. Apply the following formula: (Number of comments in each topic/total of participants in each focus group) v. Apply the following formula to calculate the average of comments: (Total comments for category/total of participant in each focus group)

Atlas-TI - Atlas-TI was used to calculate the frequency or number of times specific words were utilized to describe perceptions of safety and to graphically display the connection of words to the concept of perceptions. This method complements the MS Excel analysis in determining what focus group participants consider safe and unsafe in the built environment.

To conduct the frequency and word connection analysis, data from the focus group surveys, Post-it Notes, and transcripts were separated into independent MS Word files. These files were then exported into Atlas-TI. The words used in the frequency and word connection analysis are the top three topics for perception of security and insecurity identified in the MS Excel analysis. However, "Hot Spots" (3rd in the perception insecurity analysis) was replaced with "a poorly-built environment" because HT participants often define and relate hot spots to the condition of the built environment (vandalized, run-down, dirty, etc). The word relation criteria used to define the words in Atlas-TI are presented in Table 2.3.

Table 2.3 – Word Relations

Police	Police, patrol patrolling, policemen, policeman, guard, officer, enforcement
Lighting	Lighting, light, streetlight, lamps, lit, illumination, visible, visibility, open areas
Built Environment	Good environment, friendly environment, clean, beautiful environment
Isolated Dark Areas	Dark, low lit, dim, isolated, far, distant, deserted, solitarily, darkness, obscure, isolate.
Suspicious People	Homeless, drunk, drunks, drug, dealers, addicts, prostitutes, crackhead, whores, violence, gangs, weirdos, weird, crazy, crazies
Poor Built Environment	Filthy, dirty, moldy, broken, damp, abandoned

To determine the frequency of specific words associated with perception of safety, ATLAS-TI gives five types of coding techniques: open coding, code-by-list, in-vivo coding, auto-coding, and quick coding. After several tests, auto-coding allowed us to analyze multiple primary documents at the same time and to trace the relationship between the documents. It not only produced frequencies, but also created family groups, the number of concepts or topics to which the word is related.

Atlas-TI generated an output report that gives details of frequencies and produced a network connections graph visualizing the relationship between words.

Bus Stop Survey

Data Collection

In 2008, as part of the Easter Seals Project ACTION, Austin-based KHF Consulting Group developed a "Toolkit for the Assessment of Bus Stops Accessibility and Safety." Transportation Planner, Ken Hosen, led the development of a bus stop checklist or bus stop survey as part of the toolkit. The KHF bus stop checklist was used as a reference, then was revised and adjusted to fit the needs of the study and the City of Austin. As a result, a new bus stop survey was developed that focused more on safety aspects of bus stops than on accessibility conditions. Loukaitou-Sideris' (1999) description of negative environmental attributes was also incorporated into the bus stop survey to enhance the analysis with a focus on safety perceptions.

The survey was divided into 1) Bus Stop Location and Transit Experience, and 2) Safety and Security Measures. Using this division, the bus stop survey assessed important components of infrastructure design such as shelter, seating, landing area, trashcans, and lighting. Also, it targeted aspects of the surrounding area that are considered influential when understanding perceptions of safety such as: bus stop setting, traffic controls, traffic hazards, signage, landscaping, and environmental attributes. Using the newly revised bus stop survey as an instrument, data were collected on thirty-eight (38) bus stops within three study areas. The complete bus stop survey is located in Appendix E.

To identify the thirty-eight (38) bus stops, an accessibility study was conducted. Using HT focus group transcripts, Post-it Notes, surveys, and bus routes; bus stops and areas of activities were identified. In addition, a list of places and locations was produced and a bus route study was conducted to identify which buses HT students might use to reach their destinations. Out of this analysis, three areas of activities were identified:

- Downtown: from 12th Street to 2nd Street, and from San Antonio to Red River.
- HT Area (location of Huston-Tillotson University main campus): from 12th Street to 2nd Street and from Chalmers to Pleasant Valley.
- East Riverside: from East Riverside to Oltorf and from Tinning Road to Crossing Place.

The three areas provide specific amenities attractive for students. Most HT student participants live in the Riverside area. Downtown was identified as an entertainment area, especially for nighttime activities, and the HT area was identified as the school study area and an after-school entertainment area.

Using walking time, bus routes, and proximity to identified destinations; the thirty-eight (38) bus stops selected were spread throughout the three activity areas. The bus stops were distributed as follows: eleven (11) bus stops in downtown, fifteen (15) bus stops in the HT area, and twelve (12) in Riverside.

Since the bus stop survey included the analysis of the bus stops' surrounding area, a 400-foot, or approximately 0.05 mile, buffer was applied to the defined bus stop boundaries. The calculation was then made using the average distance between two bus stops. According to data provided by Capital Metro, the average distance between two bus stops is 0.1 mile. Thus, the study assumes that between two bus stops, 0.05 miles is the space belonging to each one separately.

The maps of the three study areas define the land uses and development patterns that make each area unique. The downtown area is mainly composed of parking lots, garages, public and private office buildings, and a constantly growing commercial zone. Single-family houses, small developing offices and commercial zones along the 7th Street corridor characterize the HT area. In contrast, multi-family houses and apartment complexes, vacant lots, and medium sized commercial districts distinguish the East Riverside corridor. Figures 2.2 to 2.4 show the Land Use Map and Bus Stop Locations.

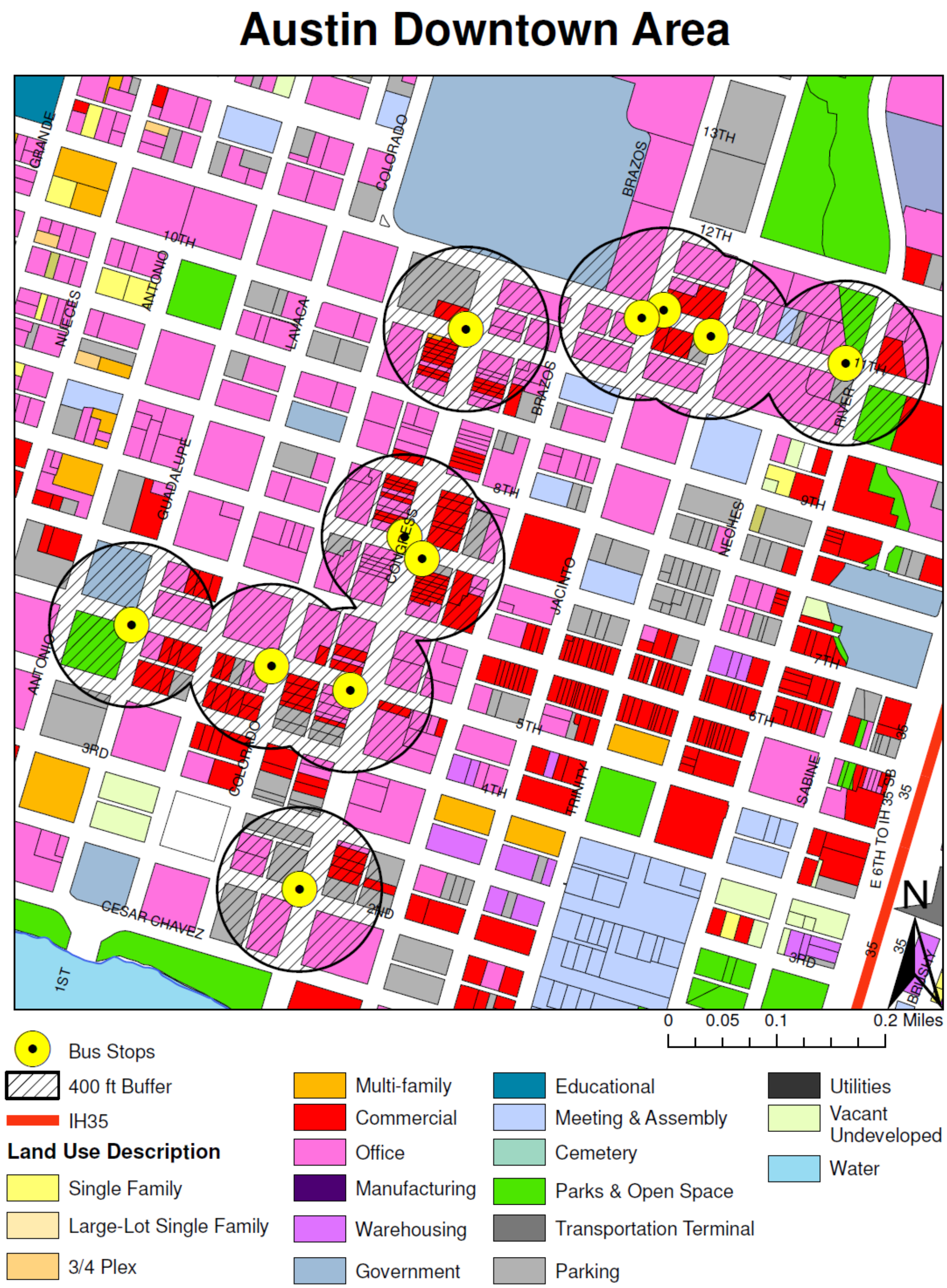


Figure 2.2 - Downtown Land Use and Bus Stops

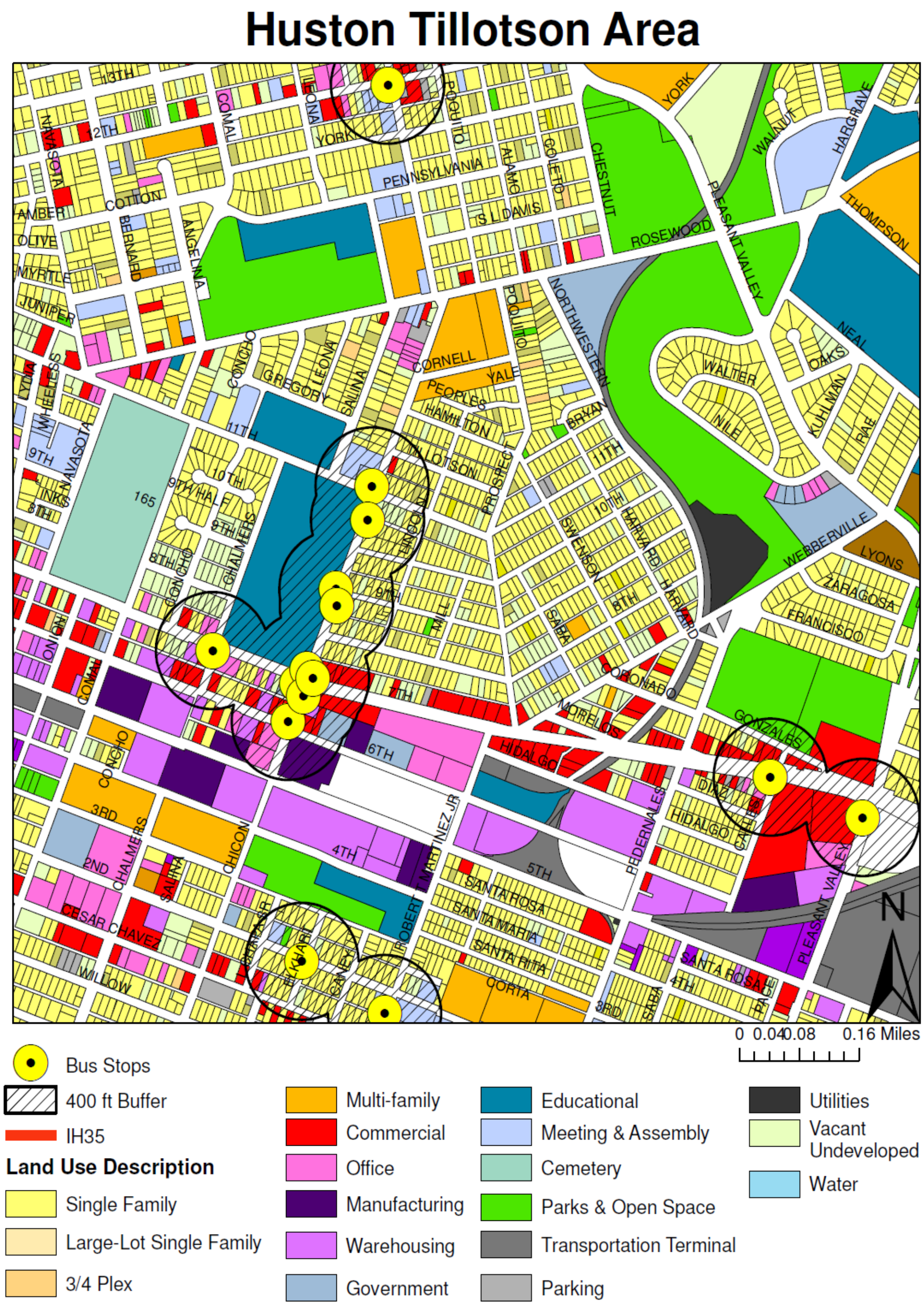


Figure 2.3– HT Area Land Use and Bus Stop Locations

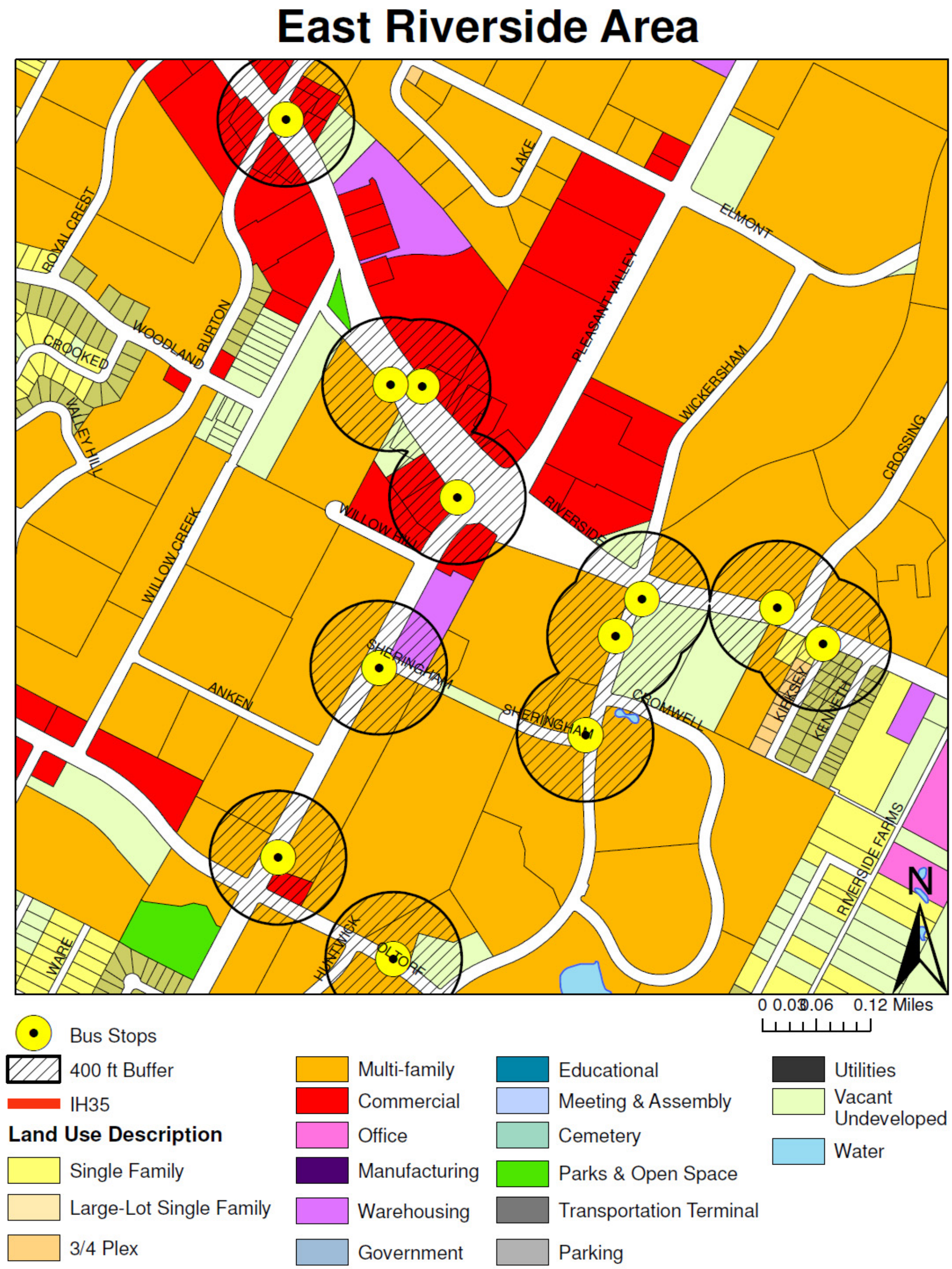


Figure 2.4– Riverside Land Use and Bus Stop Locations

Method of Analysis

The survey responses were processed in Excel using discrete categories of data having multiple choices and yes/no formats (1-0). Each bus stop was given a unique ID number, and matched with Capital Metro's bus stop IDs to determine the exact physical address. Once the data collection processing and recording was completed, all data were exported into SPSS. Using SPSS, a frequency analysis was developed. Also, using SPSS, a correlation analysis and a cluster analysis were performed. Both of these will be described below.

A frequency analysis is used when finding out how often certain phenomenon occurs in a sample. In this case, how often are specific bus stop amenities found among the surveyed bus stops? The frequency analysis measures the central tendency of the data and then determines the dispersion/distribution of the variables around this central tendency.

A correlation analysis is then used to measure the strength of the relationship between two variables solely based on the physical elements of bus stops and their negative attributes. Also, the correlation is used to determine if changes in the physical elements of bus stops are associated with changes in the negative attributes and vice versa. Finally, a cluster analysis was used to capture categories of bus stops by grouping the most significant variables (amenities). In general terms, a cluster analysis is a "descriptive tool" that was chosen to give a rich, "meaningful representation" of how variables group together and to "make classifications" of bus stops (Romesburg 1984; Waits, Rex, & Melnick 1997). Based solely on variables ascribed to physical elements and negative attributes, the cluster can help determine the condition of bus stops. Also, the categories/classifications can help identify prototypes of bus stops and relate them to the study area and land uses, giving a general picture or scenario. Ultimately, the cluster analysis is a "tool for a method of inquiry" that identifies which variables are key for determining types of bus stops (Romesburg 1984).

Frequency Analysis - As technical criteria for the frequency analysis, all the category responses or variables were mutually exclusive and exhaustive, meaning the same observations cannot be counted twice nor belong to another variable. The construction of the frequency distribution involved the total number of observations, the number of responses that fall within each response category or variable, and accumulative frequencies to which a bus stop was identified with each variable. The frequency analysis helped in determining the condition of the bus stops in the survey and which amenities were present at each.

Correlation Analysis - The correlation analysis measured the strength of the relationship between negative attributes and physical elements of the bus stops. By looking at each of the variables individually, the analysis weighed the strength of the linear association and hypothesized on the type of relationship. When the relationship is examined, the correlation determines to which extent changes in the value of physical attributes are associated with changes in the value of environmental attributes. The strength of the relationship is measured in terms of < or = to +/- 0.5. Thus, all the values within these boundaries are considered in the analysis. Since the study has a small sample, values that can be rounded to 0.5 are included in the study.

The correlation analyses complement the frequency analysis by providing evidence on the degree of association of the variables. The correlation analyses cannot interpret cause-effect relationships, but merely measures the significance of the strength of variable associations. Ultimately, the correlation analyses also contribute to the creation of scenarios and to the general description of the surveyed bus stops.

Cluster Analysis - The cluster analysis reveals natural groups and similar patterns (composition) between the physical elements of the bus stops and the negative attributes of the surrounding areas. The results determine types of bus stops using their physical conditions and negative attributes as the main criteria to "standardize the data" (Romesburg 1984:4-5). Also, the results provide evidence to describe bus stops and their condition. In simpler words, by grouping variables, the clusters will identify and describe categories/classifications of which negative attributes are commonly related to the different bus stops' physical amenities such as shelter and seating.

Overall, the cluster analysis evaluates the variables individually, and then as subsets, so that similar variables are grouped and similar patterns identified. By viewing the patterns, different categories/classifications are developed. These groups describe how many bus stops share common elements and identify elements that are shared. Ultimately, the cluster analysis builds a bridge between physical elements and negative attributes to provide evidence of the different types of associations.

To design an accurate and rational cluster analysis, the multivariate statistical cluster method was applied using a hierarchical cluster classification, K-mean cluster recalculation, and a discriminant function for cluster optimization. The hierarchical clustering method was chosen primarily because it not only allows "for pattern recognition and automatic classification, but also allows the researcher to determine the limits of the clusters" (Romesburg 1984). By offering this flexibility, the process can adapt the clustering technique to the research needs and use other elements of the analysis to rationalize the categories.

The distance measure, which determines how similar two or more elements are, is in the cluster and calculated by using the "hierarchical logic methodology" and presented in a "dendogram" (Romesburg 1984:3). In this sense, the hierarchical cluster allows the researchers to determine the distance measures by giving them several distance functions to choose from, such as: Euclidean distance, maximum norm, Mahalanobis distances and Hamming distance, among others. With these options, the researcher has the power to influence the shape of the cluster to fit the research needs. For this study, the Euclidean distance was chosen because it is the most common and ordinary distance measure given by the Pythagoras formula. It is also referred to as the geometric measure of two points.

In the hierarchical cluster, the distance and metric units are flexible. The metric used to measure the similarity between pairs of variables/observations is asymmetrical and it progressively merges clusters as they get closer together (Romesburg 1984). The distance is constantly updated and changed. As the distance between observations increases, so does the distance between the clusters. At the end, each pair of variables has a greater distance than the previous one (Romesburg 1984). Hence, the researcher can stop clustering whenever the distance between variables is too big or too small. The decision is contingent on the researcher's discretion.

In determining when to stop clustering, "the number of classifications we want to have needs to be previously established" (Romesburg 1984:31). The dendogram (also called tree) serves to make the cut and determine the distance measure where the cut needs to be made. "Deciding where to cut the tree resolves the trade-off between the desire for detail (many classes/clusters) and the desire for generality and simplicity (few classes)." "The decision is subjective" (Romesburg 1984:31-32). The interaction to determine clusters was made considering average distance linkage between groups.

Upon completion of the hierarchical cluster analysis, and based on the dendogram, four strong clusters were identified. These four categories were straightforward, broad, and appear natural. Thus, they responded to the desired number of classifications considering the three areas of study. The cut in the dendogram was then made at the distance of 18. The goal was to relate one or two classifications of bus stops per study area to make the representation simple and general. Thus, the selection process was made "to best achieve this planning objective" (Romesburg 1984: 68). A new field of classification was created based on the dendogram results, and a cluster number was assigned to each of the cases. Figure 2.5 shows the dendogram with the clusters and rescaled distance.

```
* * * * * * H I E R A R C H I C A L  C L U S T E R  A N A L Y S I S * *
 Dendrogram using Average Linkage (Between Groups)

                     Rescaled Distance Cluster Combine

   C A S E    0         5        10        15        20        25
  Label  Num  +---------+---------+---------+---------+---------+

          34   -+-----+
          38   -+     +-------+
          12   -------+       I
          36   -+             +---------+
          37   -+-----+       I         I
          33   -+     +-------+         +-----------+
          14   -------+                 I           I
           7   -------------+           I           +-----+
          35   -------------+-----------+           I     I
           4   -------------+                       I     I
          10   -------------------------+-----------+     I
          32   -------------------------+                 I
           9   -------+-------+                           I
          31   -------+       +---------+                 +-+
           1   -------------+-+         I                 I I
          11   -------------+           +---------+       I I
          18   -+-------------+         I         I       I I
          19   -+             +-----+   I         I       I I
           2   -------+-------+     +---+         I       I I
          23   -------+             I             +-------+ I
          27   -------------------+-+             I         I
          28   -------------------+               I         I
          20   -------------+-----+               I         +---+
          24   -------------+     +-----------+   I         I   I
          22   -------------------+           +---+         I   I
          21   -------------------------------+             I   I
          13   -------------+-------+                       I   I
          26   -------------+       +-----+                 I   I
           5   -------------------+-+     +-----+           I   I
          29   -------------------+       I     I           I   I
          16   ---------------------------+     I           I   I
          15   -+-----+                         +-----------+   I
          17   -+     +---------+               I               I
          30   -------+         +---+           I               I
           8   -----------------+   +-----+     I               I
           6   ---------------------+     +-----+               I
           3   ---------------------------+                     I
          25   -------------------------------------------------+
```

Figure 2.5 Cluster Dendogram

The hierarchical cluster serves to identify natural clusters and to assign a classification to the cases. The assigned classification is an early group and it represents an approximation of the initial groups or K-points / K-clusters (MacQueen 1967). Upon assigning a classification to each of the cases, the distance measure and centroids are recalculated using a K-means analysis. “The centroid is the average value of a group of objects in a cluster and is defined by the dimensions of the cluster. In a sense, it is the center of gravity for the respective cluster. The distance between two clusters is determined as the difference between centroids” (Sneath and Sokal 1973:359)

K-means is one of the simplest unsupervised learning algorithms that analyses clustering challenges (MacQueen 1967). It classifies a given data set through a certain number of clusters (assume k-clusters) fixed a priori. In this case, clusters are fixed a priori using the hierarchical cluster dendogram (MacQueen 1967). In SPSS, “each datapoint/variable finds which cluster center it is closest to. Thus, each cluster center owns a set of datapoints/variables” (Moore 2001). In addition, each center finds the centroid of the points it owns. The K-mean analysis is important to determine if the original approximations from the hierarchical cluster are accurate, and if not it recalculates the cluster centers until the numbers of clusters is reduced to the desired number of clusters. In other words, it serves to discover the correct number of clusters and eliminate cluster errors by calculating the average of each cluster and changing the cluster centers by their average (Kumar & KhrishanWasan 2010). The K-means method also produces a summary statistics for each group.

To find the optimal clusters and determine cluster membership, discriminant analysis is conducted. “The main purpose of a discriminant function analysis is to predict group membership based on a linear combination of the variables, and the procedure begins with a set of observations where both group membership and values are already known.” (Stockburger, 1997:3).

In this case, the results from the hierarchical classification and K-means cluster center recalculations are used as the basis for the discriminant function. A second purpose for the discriminant function is to reveal a general understanding of the dataset by giving an insight of the relationship between a group’s membership and the variables associated with the clusters.

The discriminant function maintains the four desired clusters and helps to distinguish the differences between them. Table 2.4 shows the cluster memberships with recalculated distances and Figure 2.6 shows the discriminant function with the optimal distribution of variables with each cluster and centroids.

In summary, the cluster analysis can be described as follow:

1) The hierarchical cluster dendogram is used to identify four clusters (desired clusters). This step is important to reveal natural groups and recognize initial classifications.
2) Match cluster classifications with cases (approximation of groups). This step is important to provide a priori classification for the K-means and give an approximation of clusters per case.
3) Then K-mean analysis is used to recalculate the position of the clusters (cluster centers) and verify the cluster classifications. This step is important to determine if the original clusters previously identified are accurate. If not accurate, the cluster centers must be recalculated until they match the desired cluster numbers.
4) A canonical discriminate analysis is conducted to find the optimal clusters, distinguish cluster differences, and determine cluster memberships.

Ultimately, the multivariate cluster analysis adds to the findings of the correlation analysis by providing a common ground in the association of variables. The correlation reveals an association for the cluster shape and the cluster gives further meaning to this correlation association by creating categories based on the distance between observations. Generally speaking, these categories will have an instrumental role in defining bus stops, the relevance of the correlation, and highlight the significance of the study as a whole.

Table 2.4 - Cluster Membership

Case Number	Cluster	Distance
1	1	1.541
2	1	1.173
3	3	1.658
4	4	1.449
5	3	1.718
6	3	1.533
7	4	1.395
8	3	1.323
9	1	1.173
10	4	1.717
11	1	1.307
12	4	1.449
13	4	1.552
14	4	.933
15	3	1.072
16	3	1.533
17	3	1.072
18	1	1.021
19	1	1.021
20	2	1.155
21	1	1.791
22	1	1.646
23	1	1.369
24	2	.816
25	2	1.414
26	3	1.245
27	1	1.429
28	1	1.307
29	3	1.597
30	3	.975
31	1	1.021
32	4	2.081
33	4	.697
34	4	1.250
35	4	1.552
36	4	.697
37	4	.697
38	4	1.250

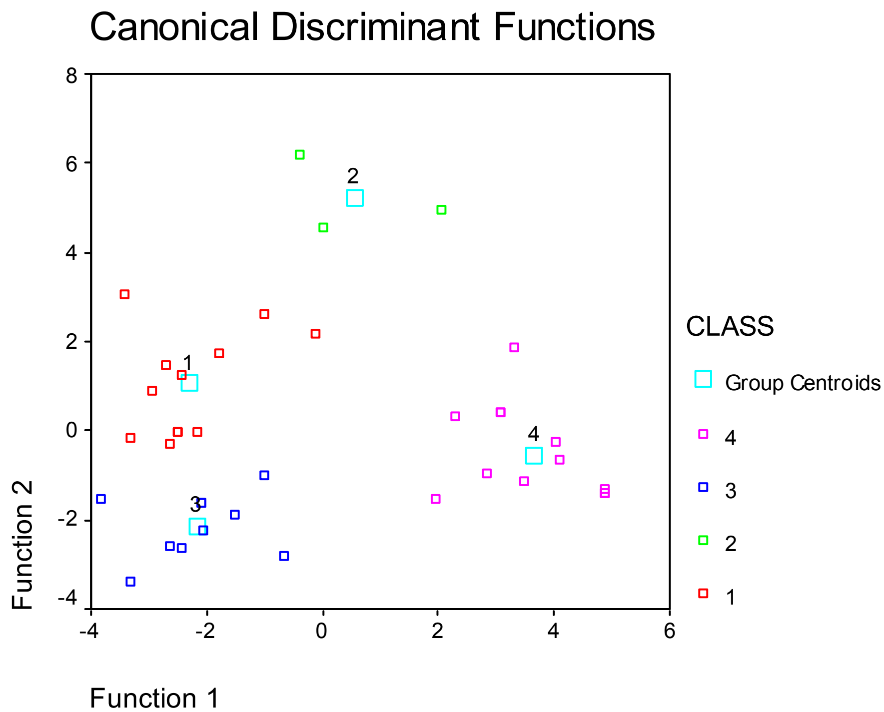


Figure 2.6 - Discriminant Function Cluster Distribution and Group Centroids.

Variables Selection and Limitations

The data collected from the survey present two main limitations for the correlation and cluster analysis. First, the sample size is too small (38 cases) in comparison to the total number of variables in the bus stop survey (40 questions produced 198 variables). Second, not all the variables had significant responses. For example, for some variables the result was 0 because no data were reported for that field in the surveys. For other variables the result was a number below 10% and even as low as 0.1%, meaning that only one or two bus stops reported results in that field. These kinds of responses give little information to the study. Because of these two limitations, the numbers of variables to be analyzed in the cluster and correlation analyses were reduced.

For both the correlation and the cluster analysis (multivariate), only the variables that described physical elements and characteristics of bus stops such as shelter, seating, sidewalk, landscape, lighting, landing area, and security measures and negative environmental attributes with five or more responses per field were selected. Upon the selection process, a total of sixteen variables were analyzed: eight for physical elements and eight for negative attributes.

Crime Analysis

Data Collection

One limitation of the Austin Police Department (APD) data is that they do not indicate whether crime incidents are at transit settings or not. So there is no record of reported crimes on buses or at bus stops. However, APD does record the exact location of crime incidents. Thus, as a data collection instrument, 2007-2008 Austin crime incidents were compiled. Approximately, 65,535 crime cases were found in Austin and sorted by their proximity to bus stops using the ArcGIS spatial analysis tool. After sorting, a total of 36,503 crimes around bus stops were identified. The results revealed all types of crimes, including family and residential crimes. In the literature, bus stop crime is defined as "non-residential and non-family/dating crime," which includes crimes against property or a person within the bus stop open environment (Loukaitou-Sideris 1993, 2001, 2005).

Based on this description of bus stop crime, APD data were then sorted in terms of non-residential and non-family/dating crimes. Therefore, non-residential and non-family/dating crimes were selected. To accurately determine if non-residential and non-family/dating crimes can be considered bus stop crimes, a 400-foot buffer was calculated to define bus stop crime boundaries. The buffer was calculated using similar criteria from the bus stop survey that determines an average distance of 0.1 miles between two bus stops. In totality, 3,191 incidents were reported within the bus stop buffers. Because of the proximity to the bus stop and the type of incidents, the 3,191 cases were considered "bus stop" crimes. Bus stop crimes contribute to perceptions of safety.

Method of Analysis

The analysis of the crime data provides evidence of the real context of crime around bus stops in Austin. In addition, it supports developing a general scenario of safety conditions and whether or not HT participants' perceptions can be corroborated with real crime data. Ultimately, it provides information on what frightens HT participants away from using the bus based on real safety threats or concerns. As mentioned above, ArcGIS 9.3 was used to identify, sort, classify, and analyze the crime data.

Crime identification and selection by proximity to bus stops - A GIS shapefile with 2007-2008 crime incidents and their exact geospatial location was provided by the Austin Police Department. This GIS shapefile was downloaded into ArcMap. Then, a general crime incidents layer was created from the shapefile's data set. This layer was merged with the bus stop locations and selected by its proximity to the bus stops. Using the spatial analysis tool, a buffer layer was created. This buffer layer included all the crime incidents reported within 400 feet from each of the bus stops.

Crime Data Classification - The goal of the crime analysis was to determine which types of crime incidents were reported around the surveyed bus stops. For this purpose, a new layer with the incidents located within the bus stop buffers was created. Using this layer, crimes were subsequently categorized into Type I and Type II. Loukaitou-Sideris (2001) explains that Type I crimes are serious crimes and it includes crimes against a person (robbery, harassment, rape, assault). Type II crimes are mild-minor crimes and include crimes against property and general offenses (pick-pocketing, purse snatching, public nuisance, public intoxication, drug dealing, etc). Although relevant, these two categories are too general and limit the analysis of what kinds of crime are more frequent in bus stop settings. Therefore, to better define, identify, and locate crime incidents, the subcategories in Table 2.5 were created using incident annotations. It is important to note that the subcategories have been separated extensively. This is due to the APD's theory that all mild-minor crimes have the potential to become serious crimes, depending on the circumstances, proportion of the incident, and Texas Criminal Law.

Table 2.5 Crime Classifications

TYPE I: SERIOUS CRIMES		TYPE II: MILD TO MINOR CRIMES			
Harassment, Physical Assault, or Murder	**Robbery or Theft**	**Crime against Property, Property Damage, or Criminal Mischief**	**Vehicle Burglary, Theft, or Abandonment**	**General Offenses or Misdemeanors Class A, B, or C**	**Other**
Aggravated Assault	Aggravated Robbery by Assault	Arson	Abandoned Vehicle	Accidental Injury	Deadly Conduct
Assault	Aggravated Robbery with Deadly Weapon	Burglary non-residential	Abandoned Vehicle (Store Facility)	Alcohol Consumption Violation	Documented Window Peeping
Assault by threat	Pocket Picking	Criminal Mischief	Auto Theft	Civil Disturbance	Emotional Disturbed Person
Assault Juvenile on Juvenile	Purse Snatching	Criminal Mischief by Arson	Burglary of Vehicle	Criminal Trespass	Interfere Public Duties
Assault on Peace Officer	Robbery by Assault	Damage of City Property	Junked Nuisance Vehicle	Criminal Trespass/Hotel	Resisting Arrest or Search
Assault with Injury	Robbery by Threat	Graffiti	Suspicious Vehicle	Criminal Trespass/Transient	Retaliation
Assault with motor vehicle	Shoplifting	Littering	Theft from Auto	Dang Drug Violation/Other	Sexual Performance by a Child
Assault by contact	Theft	Tentative Burglary non-residential	Theft of Auto Parts	Delivery Alcohol to a Minor	Suspicious Person
Child Abuse	Theft from Building	Violation of Park Curfew	Theft of Bicycle	Delivery Controlled Substances/Narcotics	Suspicious Vehicle
Documented Abuse or Threat	Theft from person		Theft of License Plate	Disturbance	Terrorist Treat
Felony Enhancement/ Assault with Injury	Theft of Public Servant		Theft of Vehicle/Other	Documented Abusive Language	
Harassment	Theft/appropriate stolen property			Documented Exposure	
Harassment of Public Servant				Documented Fighting	
Homicide				Documented Unreasonable Noise	
Injury to Child				Evading/Foot	
Injury to Disabled Individual				Found Controlled Substances/Narcotics	
Injury to Elderly				Indecent Exposure	
Intoxicated Assault				Manufacture Controlled Substance/Narcotics	
Murder				Noise Ordinance Violation	
Possession/Promotion of Child Pornography				Obtain Controlled Substance by Fraud	
Rape and Aggravated Rape				Obtain Dang Drug by Fraud	
Rape of a Child				Pedestrian on Roadway	
Serious Injury of a Child				Possession of Controlled Substances/Other	
Sexual Assault				Possession of Controlled Substances/Sin Narcotic	
Sexual Assault of Child				Possession of Dang Drug	
Stalking				Possession of Marijuana	
Statutory Rape of a Child				Possession of Prohibited Weapon	
				Possession of Alcohol/Age 16 and Under	
				Possession of Alcohol/Age 17 to 20	
				Possession of Firearm by Felon	
				Possession of Controlled Substances/Narcotics	
				Possession of Drug Paraphernalia	
				Prostitution	
				Public Intoxication	

To categorize crime in the GIS data set, a new field was added and a value was assigned to each of the subcategories allowing better defined categories. Upon completion of the grouping process, the layer was modified to present the crime incidents in terms of these subcategories. A specific symbol was assigned to each subcategory and the symbols were shown in ArcMap.

Analysis and Quantification of Crime Data - Using the crime classification and subcategories, crime data were quantified. Most crime incidents fell within the general offenses subcategories followed by robbery, vehicle burglary, and physical assault subcategories. The difference in the number of incidents between general offenses, robbery, and physical assault is large. There were approximately 1,298 general offenses, 705 robberies, 484 vehicle burglaries, and 358 physical assaults. Using the attribute table, a new field was created and a value, indicative of the type of crime, was assigned to each of the incidents within the general offenses subcategory. Specific symbols were assigned to each of the crime incidents in ArcMap.

At the end of the analysis, two GIS maps were created per study area. The first map shows all the crime subcategories within the bus stop buffer. The other map shows all general offenses within the bus stop buffer. The crime maps help visualize the concentration of crime and types of crimes around bus stops.

Results and Observations

Huston-Tillotson Study Group

A total of 69 faculty, staff and students participated in the study. Approximately 90% of the participants were students, and the remaining 10% were faculty and staff members. Out of 69 focus group participants, only a few admitted using the bus all the time or often (n=7), none of the participants used bikes (n=0). The majority of participants used cars as their main modal choice; either in their own vehicle or by carpooling (n=62), they reported using the bus sometimes to almost never. More females (n=45) than males (n=24) participated in the study (see Table 2.6).

Table 2.6 - Focus Group Composition

	Total Participants	Males	Females
Focus Group 1	15	7	8
Focus Group 2	12	5	7
Focus Group 3	22	4	18
Focus Group 4	20	8	12
Total	**69**	**24**	**45**

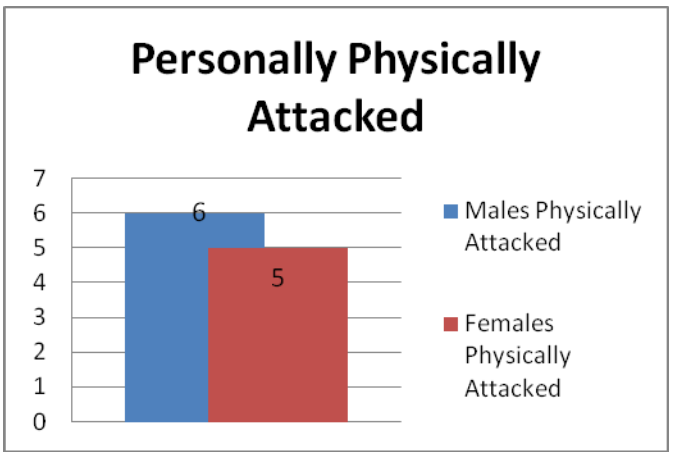
Out of the 69 participants of the study, only 54 participants in groups 2, 3, and 4 completed the perceived safety survey[3]. This survey links gender to perception of safety and experience with crime. Out of the 54 perceived safety survey responses, 20.37% (n=11) reported being personally physically attacked. Five of those physically attacked were females and six were males. These participants were clearer on the level of danger they felt. Participants related their fear to the presence of suspicious and violent people around their areas of activities. For example, a female student when asked what makes her feel unsafe in the built environment replied, “Too many homeless people or drunks and drug addicts make me feel unsafe because I have something they don’t (i.e. money, shoes, etc)”. In general, the participants mentioned that perceptions of insecurity prevent them from using public transit and waiting for the bus in areas perceived as dangerous.

Half of the group participants (n=27) reported knowing someone (a close friend or family member) who had been physically attacked. Sixteen of those responses came from females and 11 from males. Out of the 54 responses recorded, 27% (n=15) reported not being physically attacked and not knowing of any physical assault victims. This statement clearly shows the relationship between the perception of safety and the actual experience with crime. It is in this evidence that perception becomes an abstract factor that limits the use of transit services (Loukaitou-Sideris 2008, British Department of Transport 2002). Table 2.7 and Figure 2.7 present some general results from the perceived safety short survey.

[3] The short survey was not administered in Focus Group 1.

Table 2.7 - Participant Distribution

	Total Participants	Males	Females	Physically Attacked	Friend or Family Attacked
Focus Group 2	12	5	7	2	5
Focus Group 3	22	4	18	4	13
Focus Group 4	20	8	12	5	9
Total	54	17	37	11	27



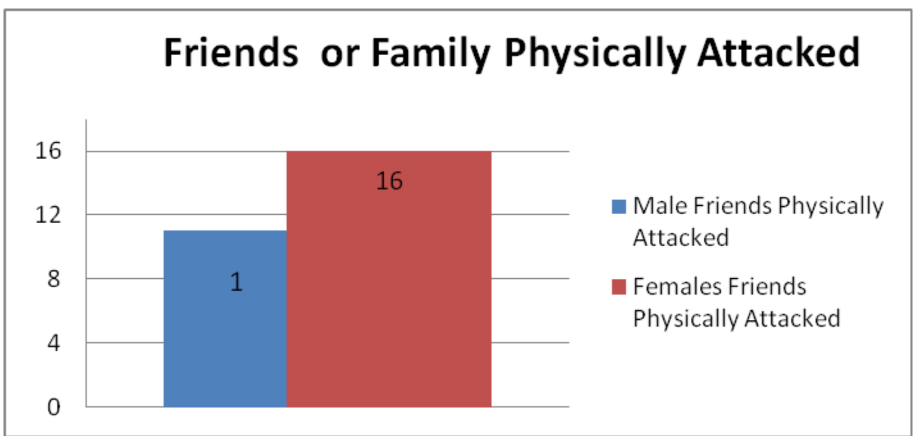


Figure 2.7 - Experience with Assault

Ninety percent of participants, who reported being physically attacked, expressed feeling unsafe in areas with insufficient lighting (dim light, poor lighting, and dark areas) and where suspicious people were loitering in the streets. Suspicious people is a term applied in this research to a group of people described by respondents as, "drug addicts, homeless, drunkards, drug dealers, prostitutes, mentally-disturbed people, bums, violent people, and gangs." Twelve (22%) participants mentioned the homeless as a safety concern. None of those 12 participants reported being victims of physical assault. One male and one female reported that gangs make them feel unsafe. The female participant stated "I feel insecure when there are a lot of gangs on the bus representing their colors." These two participants reported being physically attacked.

Ten of the eleven (90%) participants who had been physically attacked stated that a police presence in the area makes them feel safe. Three females responded that they felt insecure in areas where males outnumber females. When asked directly what sort of things in the built environment cause them to feel insecure they responded: "More men than women," "Lots of men because they're sometimes scary," and "I feel unsafe around a lot of males with no one around that I know. I feel this way because of all the things that I hear happen to women walking alone."

One of the three females in this particular group reported being the victim of a physical assault and knows at least one person who was the victim of a physical assault. The other two females reported not having any personal experience with physical assault incidents; however, one female reported knowing at least one person who was the victim of a physical assault.

Wilson and Kelling (1982) argued that in general, people seem to be frightened of crimes involving sudden and violent attacks by strangers. In addition, they have other sources of fear, such as the fear of being bothered by suspicious persons. "These people are not necessarily violent nor are they criminals, but they are unpredictable and intimidating to the average person" (Wilson & Kelling 1982:9).

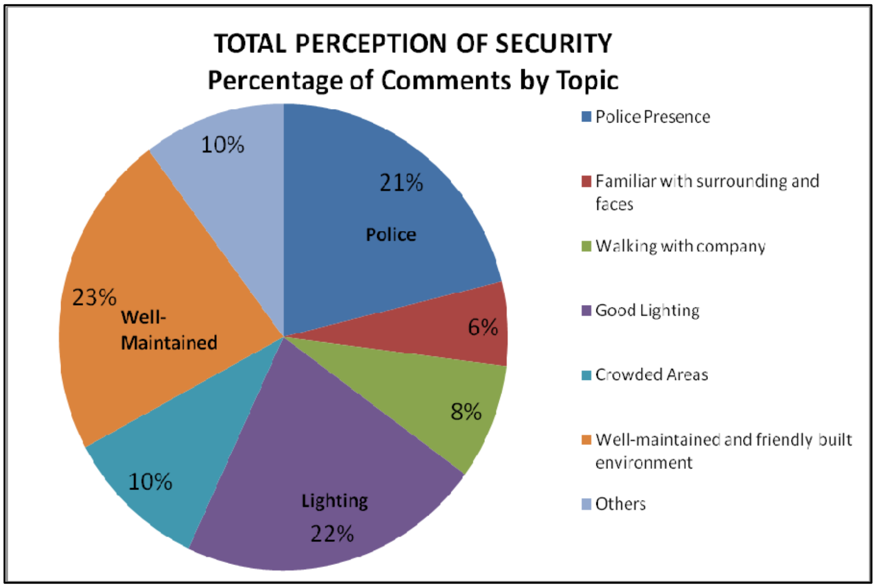
Most participants reported being afraid of homeless persons and suspicious people. Their association of these persons with physical attacks also amplifies this fear. Two females, not part of the physically attacked group, reported fear of attacks from homeless people. When asked what sort of things make them feel unsafe, one reported that "[An] environment with homeless people, people hanging out in the street drinking/smoking makes me feel insecure because I feel that intoxicated people may attack me" and "Homeless people make [me] the most insecure because they can steal from you, hurt you, or simply attack you."

The Post-it Notes revealed that HT participants' perceptions of insecurity are often related to suspicious people and not to actual physical attacks. Two other females, not physically attacked, reported being afraid of potential harassment from homeless persons. One of the females stated: "There are a lot of homeless people walking around and they are quick to harass females." Another female went one step further by stating: "Some homeless people [scare her] because they harass [people] for money if they think they have it." Two other female participants reported feeling unsafe in low-income communities because in "low-class communities the danger is high and even just the looks of the area scare me" and "A lower economic neighborhood is scary, not knowing people's intentions." These females reported not having any personal experience with assault, but knew at least one person who had been a victim. The women agreed that, "Vandalized neighborhoods seem less secure because there is evidence that criminal activity has and does take place where you are."

Perception of Security and Insecurity

To understand safety perceptions, it is important to look into the different sources of fear. For this study, one hundred and thirty-seven (137) comments on safety perceptions were collected from the perceived safety short surveys, transcripts, and on Post-it Notes, which averaged 6.9 comments per participant. Comments were organized into themes and in relation to safety perceptions. The topics with the highest percentage of comments were: well-maintained environment, good lighting, and police presence.

Thirty-one comments (23%) on perceptions of safety addressed the condition of the built-environment, supporting the idea that a well-maintained environment is perceived as safe. Thirty comments (22%) referred specifically to good lighting and (21%) to police presence as characteristics of a safe place. On specific topics, the study found that 57% of the participants made comments regarding a well-maintained environment (sidewalk condition, landing area, bus stop seating area, and landscaping, among others), 56% of the participants referred specifically to good lighting and 54% to police presence as environmental characteristics that sway their perceptions of safety. A well-maintained environment, good lighting, and police presence are the top three topic areas which participants commented on when defining what makes them feel safe. Figure 2.8 presents these findings.



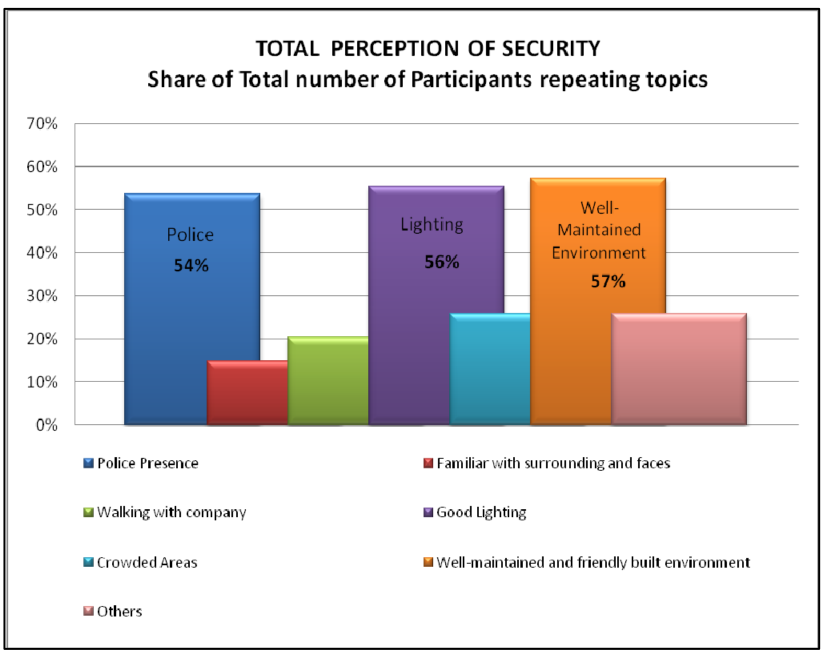
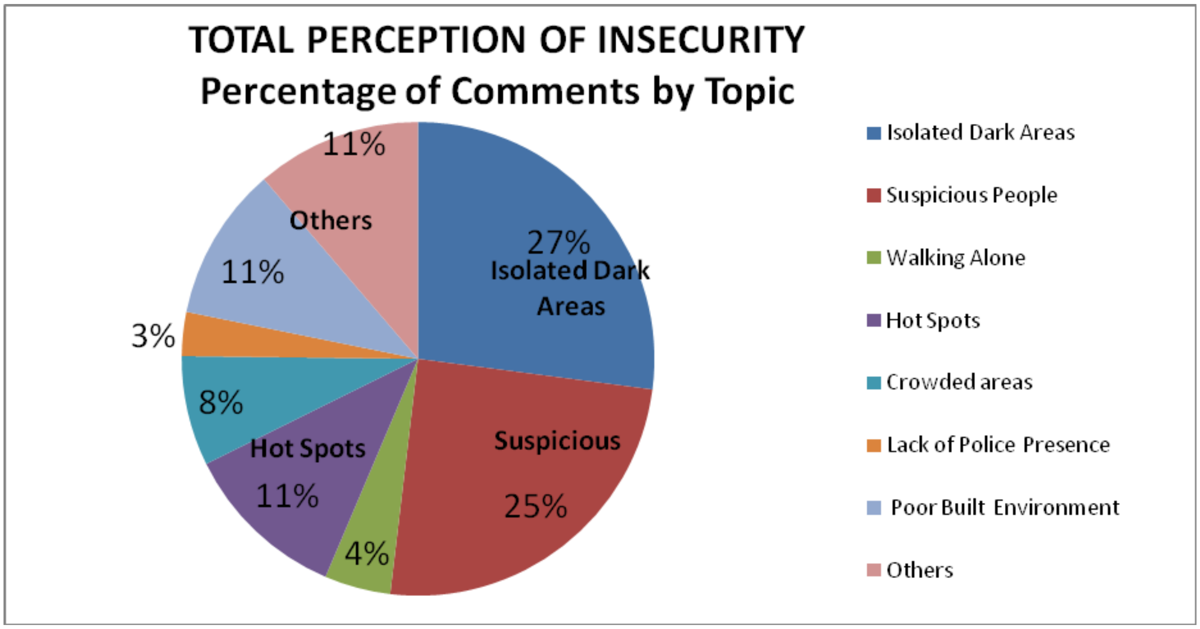


Figure 2.8 – Total Perception of Security

One hundred and thirty-three comments regarding the perception of insecurity were collected from the perceived safety survey, transcripts, and on Post-it Notes. An average of 6.0 comments per participant was made. Comments were organized in topics and in relation to insecurity perceptions. The topics with the highest percentage of comments were: isolated dark areas, suspicious people, and hot spots.

Out of a total of 133, 36 (27%) comments addressed a concern about isolated dark areas, and considered bus stops with poor lighting unsafe. Thirty-three (25%) comments addressed suspicious people as a characteristic of unsafe bus stops. Particularly, the comments demonstrated a common fear of being disturbed or bothered by homeless people and drug addicts. For example, a female, when asked in the short survey what makes her feel unsafe stated: "Too many homeless people or drunks and drug addicts. They make me feel unsafe because I have something they don't (i.e. money, shoes, etc.)." When asked about safety concerns, a group of students stated that while waiting for the bus or riding a bus: "most could see people dealing drugs or soliciting prostitution." Fifteen (11%) comments reported crime at hot spots as a safety concern. Hot spots are defined as high-crime bus stop locations, where danger is high, and vandalism occurs. See Appendix C for a summary.

In addition, out of the 69 participants of the study, approximately 57% commented on isolated and dark areas, 61% on suspicious people, and 28% on hot spots as characteristics of unsafe bus stops. Isolated areas, suspicious people, and hot stops are the top three topics. Often hot spots are associated with low-income neighborhoods. For example, one female participant mentioned feeling insecure in "Low-class communities where danger is high and even just the looks of the area scare me." A male reported not feeling safe in vandalized areas stating: "Torn down areas, drug usage spots. A lot of bad people stay around these areas." Figure 2.9 shows these findings.



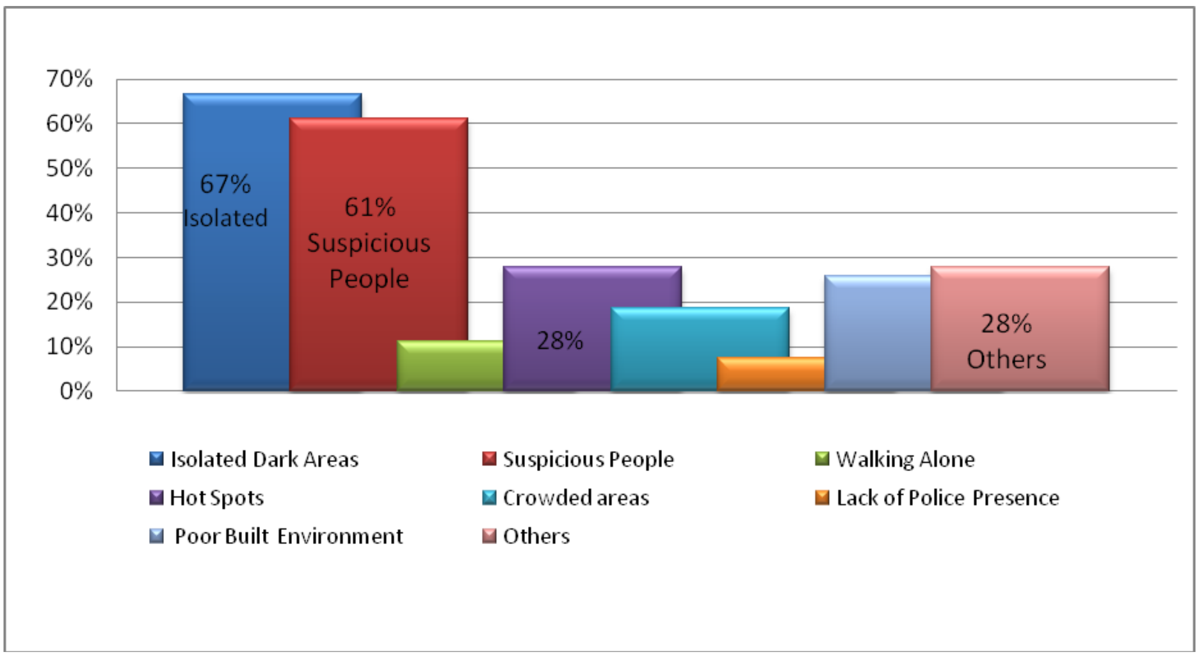


Figure 2.9 Total Perception of Insecurity
Share of Total Number of Participants Repeating Topics

Also, participants were able to identify some areas and bus stops considered unsafe. These bus stops are: 6th Street and Congress, 6th Street and Brazos, and 12th Street and Chicon. Downtown bus stops in general were associated with homeless persons, violent persons, drunken persons, and drug addicts. The focus group transcript notes defined downtown as a place where *"bums and drunk people are [a] barrier/deterrent."* In the short survey, a female stated that she felt unsafe on 6th Street. When asked what sort of things make her feel unsafe she replied: “Sixth street at night, because they shoot [guns-firearms].”

The 6th Street and Congress bus stop was mostly associated with people drinking and smoking marijuana. Transcripts revealed: *“Bus stop at 6th and Congress [is] dangerous because of people drinking and smoking weed.*” Transcript notes also reported one person harassed by an intoxicated older man on 6th Street and Congress: *“One person was followed by a ‘weirdo’ at the 6th and Congress bus stop, also one person was hit-on [harassed] by [a]drunken older man.”* Several participants in the transcript notes identified the 6th Street and Brazos bus stop as unsafe. “[The] Bus stop at 6th and Congress/Brazos is horrible, it smells bad, illegal activity occurs all around it, and also the benches are filthy, and people linger around the stop.”

The 12th Street bus stops were noted as having poor lighting, isolated areas, drunken persons, mentally disturbed persons, and drug addicts. In the short survey, a female stated the following: “I feel safe on HT’s campus but as I walk towards 12th I get insecure.” This female also reported experiencing a personal physical assault. One female participant, also physically attacked, expressed her safety concern about 12th street, stating: “I don’t like 12th street, although our school is so close. I get my hair done there and I want to do a cleanup project, so our school won’t be judged by its surroundings.” Another female, not physically attacked, expressed her concern for the HT area, in general. She stated: “[there is] violence in the neighborhoods around us. Every night I hear a bunch of police and ambulance sirens. Sometimes I hear gunshots.”

Overall, the results of the focus group data revealed what HT participants consider safe and unsafe in the built environment in the study areas. Data traced the linkages between perceptions and personal experiences with physical assault related crimes. In addition, specific bus stops considered unsafe, and why they are unsafe, were identified. HT participants’ bus stop descriptions provide a qualitative look at how some bus stops are designed and also describe their physical conditions and environments.

HT focus group data revealed that walking to/from or waiting for the bus in an area perceived as unsafe is a factor that weighs heavily on their decision to use or not to use the bus services. In addition to perceptions of safety, other factors such as waiting time, riding time, and bus routes are also relevant and influential in decisions to ride the bus. Despite admitting the high cost of owning a personal vehicle, the inconveniences of taking the bus and the perception of insecurity riding the bus out-weighed the cost of car ownership. In the transcript notes, when participants were asked what they would do if their car broke down, only four persons out of the sixty-nine chose the bus as an option, and it was not even the first option for many. Most of the participants would choose to call a friend, carpool, or even rent a car before riding the bus. Some stated that they would definitely "Rent a car (if I had money) – carpool if not money." When asked why they would not ride the bus, besides perceptions of insecurity, participants mentioned:

> *"[The] Bus isn't convenient, takes too much time—only runs every hour, dirty buses, doesn't pass often enough, quicker to walk than catch the bus. I don't know how extensive the bus system is, no service in some areas, unreliable, inconvenient, inconsistent, and bus drivers are not helpful, among others."*

On the other hand, the survey participants mentioned that safer bus stop environments would encourage more frequent use of the service. About 60% of the participants agreed that if the bus stops were perceived as safe, they would ride the bus. Among the benefits to changing their commuting patterns to utilizing the bus, participants listed benefits such as: "less environmental pollution, less noise, less time spent in traffic jams, saving money on insurance, one can do other things while traveling such as reading or catching up on sleep, no need to find parking lots, and help save on gas."

Word Frequency and Network Connections

Survey data provided physical and urban attributes associated with perceptions of security and insecurity while walking to/from or waiting for the bus. In weighing the relationship between perception of safety and physical characteristics of the built environment around bus stops, a simple word frequency analysis of all the comments made by participants during the focus groups and surveys, uncovered three main characteristics: poor lighting (repeated 75 times), police presence (repeated 63 times) and suspicious people (repeated 61 times)[4]. The results determined the relevance given to some words or concepts when describing their perceptions. The Appendix D ATLAS-TI report (output –results) shows these findings.

[4] Using ATLAS-TI, about 262 words were coded in 2300 lines from Focus Groups transcripts, Post-it Notes, and survey.

In conducting the word frequency analysis, word family groups were also created. These word family groups were automatically calculated by ATLAS-TI software and represent the number of concepts or topics to which each word is related. For example, the term "isolated areas" is only related to a poorly built environment since it is often used by participants to describe a negative condition. The term "suspicious people" is also only related to a poor environment. In contrast, lighting and police presence are both terms used to describe both a good and a poor environment. Thus, lighting and police presence share two family groups. For example, the lack of police presence is related to a poor environment, while police presence is related to a good well-maintained environment. A well-maintained environment is related to three family groups: police presence, lighting, and poor environment. A poor environment is related to five family groups: lighting, isolated areas, suspicious people, police presence and well-maintained environment. The reasoning behind these relationship words can be used to describe both a poorly maintained environment and a well-maintained environment.

The word family group connection is relevant to determine the context in which some words are used by HT participants when defining what is considered safe and unsafe in the built environment. To visualize these connections, a schematic layout was created between the selected words (or terms). The nodes describe the relationships based on logical association patterns with family groups. Figure 2.10 illustrates these results.

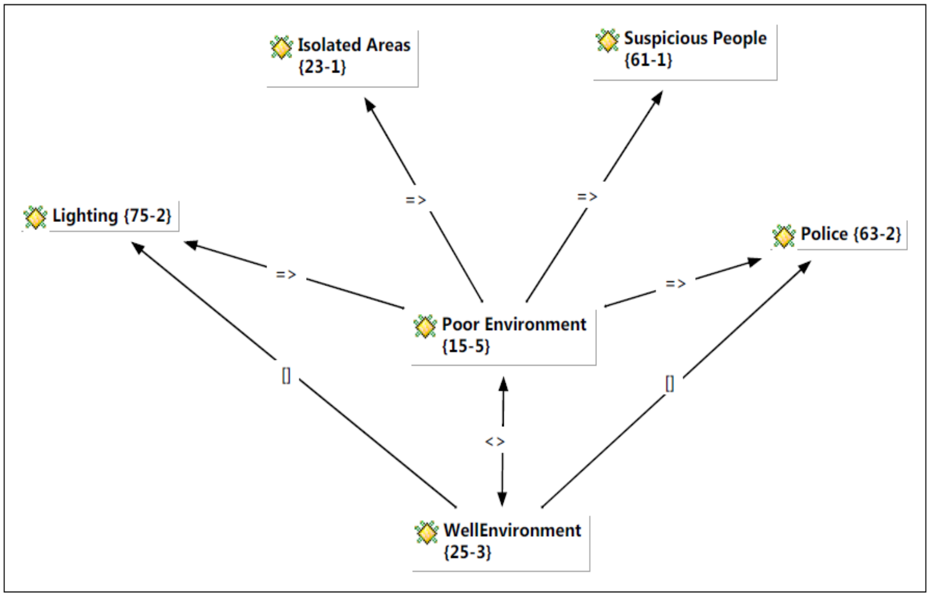


Figure 2.10 Semantic Layout for Network Connections

The schematic layout described the connection between words in terms of family groups. A well-maintained environment and a poorly maintained environment are *"contrast/opposite* ***(< >)****"* to each other. Police presence, lighting, isolated areas and suspicious people *"shared a relation (=>)"* with a poor-maintained environment." On the other hand, Atlas-TI considered that police and lighting *"are part of"* ***(Ⅱ)"*** a well-maintained built environment. These results contribute to the conceptual model presented in this report and corroborate with participants' description of safety.

Bus Stop Analysis

<u>Frequency</u>

There is a belief that certain characteristics in the built environment are related to peoples' fear, perceptions of the built environment, and even criminal actions (Loukaitou-Sideris 2001). Considering the paper's argument concerning safe and unsafe physical attributes, the bus stop evaluation was designed to collect data on multiple bus stops, and micro/macro environments through direct observation.

Focusing on the three study areas, the survey identified different types of land use within a buffer of 400 feet around each bus stop. In this study, land use was defined by the type and condition of adjacent properties. A dichotomous variable (0-1) was used to measure the presence or lack of establishments belonging to a particular land use classification. The resulting data of the frequency analysis follows: Office buildings (39.5%), apartment complexes (23.7%), bars and pubs (21.1%) and vacant lots (15.8%). These are the most recurrent property classifications found around the 38 bus stops. In contrast, there were no daycares, hospital clinics, industrial sites, libraries or nursing homes found within the bus stop areas. Analyzing the results by bus stop locations; office buildings, bars and pubs appear to be primarily in downtown; apartment complexes are primarily in the Riverside area; and vacant lots are primarily in the HT and Riverside areas.

Focus group participants said that, “bus stops in poor condition make them feel unsafe,” identifying bus stops on 6th Street and Brazos and 6th Street and Congress as being in poor condition. However, their argument is challenged by the results of the bus stop survey. In general, the frequency analysis results found that the majority of bus stops were in good to fair condition, including downtown bus stops. Most of them (71.0%) have a seating area or freestanding bench for bus riders with overall seating considered to be in good-fair condition (70%), and do not represent a hazard for bus riders. On the other hand, most of the bus stops (71.0%) did not have shelters. This can be due to limited public space dedicated to bus stop infrastructure or to private ownership conflicts. Nevertheless, of the bus stops having shelter, all were in good condition and almost all of them were accessible to persons in a wheelchair (91%).

The results of the frequency analysis also found that the physical characteristics of bus stops are different in the three study areas. Riverside has the highest percentage (92%) of bus stops with a seating area and has one of the lowest percentages of seating areas with problems (25%). Riverside also has the highest percentage of bus stops with shelter (58%), and all the bus stops have sidewalks. Only two of the bus stops have sidewalk barriers that limit accessibility; however, only one stop was considered inaccessible to persons in a wheelchair. Street lighting is present at 92% of the bus stops on Riverside with one exception; the bus stop near the corner of E. Riverside and Kirksey has no lighting whatsoever. The block between East Riverside and Wickersham down to Riverside and Kirksey intersection, have “vacant lots” and “apartment complexes” as the main land use characteristics. The Riverside-Kirksey bus stop does not have shelter, a seating area, or security measures, and the bus stop is inaccessible to people in wheelchairs. Thus, this bus stop is considered to be in poor condition, but is still not hazardous to bus riders. Hazardous is defined as something dangerous or something that could hurt bus riders from normal use.

Most of the Downtown bus stops (72%) have seating areas in good-to-fair condition; in fact, only two bus stops have seating problems. On the other hand, only 9% of the bus stops were reported to have a shelter, and particularly one that is accessible to persons in a wheelchair. All downtown bus stops have sidewalks; however, 72% of the bus stops have sidewalk barriers, such as sign poles obstructing the pathway, and trees or bushes over the sidewalk. Also, street lighting is present at all downtown bus stops (100%) and some bus stops (36%) are also illuminated by adjacent properties' lighting systems. Regarding security measures, 81% of downtown bus stops have some kind of indirect security measure such as traffic cameras near bus stops, adjacent property surveillance cameras, and/or landing platforms.

The HT area has the lowest percentage (53%) of bus stops with a seating area among the three areas surveyed and the highest percentage (63%) of seating problems. Only three (20%) bus stops have shelter and two (67%) reported having shelter problems. In addition, all bus stops in the HT area have sidewalks, but 46% of the sidewalks have some kind of physical barrier obstructing the pathway. Streetlights are present at every bus stop and 40% of the bus stops in the area have some kind of indirect safety measure such as landing platforms, recess walls, and/or traffic cameras.

The bus stop survey also addressed the bus stop's physical location and amenities. The results of the frequency analysis demonstrated that bus stops are often located within the travel lane (94.8%) and most of the bus stops have problems with the landing area (73.7%). Travel lane locations can represent a safety hazard for those getting on or off the bus. Landing area problems are often related to wheelchair mobility as described by ADA accessibility requirements for fixed-route bus services. Out of 28 bus stops with landing area problems, the majority (+50%) would be considered not accessible or minimally accessible to individuals in wheelchairs. The majority of the bus stops are nearside (60.5%), and have pedestrian amenities such as: visible crosswalks (73.7%), traffic lights (55.3%), pedestrian crossing signals (57.9%), and curb cuts at both corners (60.5%) for elders and persons with physical disabilities. Nearside are bus stops located immediately before street intersections.

Pedestrian amenities are not the same across the evaluated areas. For example, the HT area lacks continuous sidewalks, thereby, lacking crosswalks and curb cuts at all corners. The Riverside Area lacks connectivity between crosswalks and the nearest intersections and the walking distance between bus stops increases from 0.1 miles (average distance between bus stops) to approximately 0.5 miles. Downtown is the only area that has reliable and consistent pedestrian amenities among all the bus stops assessed; however, it faces other traffic hazards for bus riders such as buses straddling crosswalks when stopping, bus stops immediately before crosswalks, and high speed traffic. Complete frequency analysis results of the survey are in Appendix F.

In regards to the physical attributes of the bus stops, a comprehensive description of the negative environmental attributes was collected from the focus groups and survey data. The bus stop survey identified several negative attributes within a buffer zone of 400 feet around each bus stop. Dark spots (56.3%), poor lighting (46.9%), lack of visibility (43.8%), and the presence of suspicious people (37.5%) are the most frequent negative attributes found at bus stops. The presence of suspicious people around bus stops is an issue brought forward repeatedly by HT participants during the focus group discussions. These factors influence the perception of safety and discourage participants from using the bus. It must be noted, however, that no sex shops, motels, strip clubs, or XXX Video stores/theaters were found around the bus stops analyzed. These findings are consistent with Austin's cultural and development patterns, which often locate these kinds of facilities along IH-35 and away from urban populated centers. To better visualize and locate the negative attributes around the bus stops surveyed, a GIS map was created (Figure 2.11).

Just as the physical characteristics of the bus stops differ in the three study areas, so do the negative attributes. The GIS Map (Figure 2.11) reveals a pattern among the three areas. Seven of the eleven downtown bus stops have one or more negative attributes. Suspicious people, dark spots, cantinas/bars, parking lots, and poor visibility characterize downtown bus stops. Suspicious people are concentrated along Congress, and 2^{nd} Street to 5^{th} Street. Dark Spots, parking lots, and cantinas/bars are at almost every bus stop. Poor lighting was only identified at two stops near parking lots, and poor visibility is at four bus stops, which are also near parking lots. Out of fifteen bus stops in the HT Area, thirteen have one or more negative attributes of vacant lots, suspicious people, dark spots, poor lighting, mainly along Chicon Street, and buildings with broken windows. Suspicious people are mostly located near 7th Street and Pleasant Valley and 12th Street and Chicon bus stops. All twelve bus stops in the Riverside study area have one or more of these negative attributes: suspicious people, poor lighting, dark spots, poor visibility, or vacant lots. Notably, suspicious people are mostly concentrated on E. Riverside towards IH-35, poor lighting and poor visibility are at almost all (84%) bus stops in the area, and vacant lots are located in E. Riverside Drive near Pleasant Valley, Wickersham, and Kirksey.

These results evidence bus stops' negative physical attributes affecting HT participants' perceptions of safety, and relates land use to physical conditions and attributes. By identifying patterns in the GIS Map, the results show the different characteristics of each area and the bus stops within those areas, thereby allowing the identification of various scenarios based on safety conditions.

In the GIS analysis of negative attributes, a pattern within the three areas was identified. Downtown bus stops show a predominant pattern of bars/cantinas/clubs, parking lots, suspicious people, and dark spots. HT bus stops appear to be more diverse, but with the largest concentration of vacant lots/stores. In contrast, East Riverside bus stops have a major problem related to poor lighting and poor visibility. The map shows a pattern of bus stops with dark spots. Liquor stores and dirty streets seem to also be mostly present in the East Riverside area. The negative attributes map is congruent with the land use development pattern of the areas, as well as with the HT focus groups' description of negative attributes of bus stops.

Correlation

Previous studies have indicated a connection between negative attributes and physical characteristics of bus stops (Ingalls & Owen 1994, Needle & Cobb 1997, Loukaitou-Sideris 2001 & 2008). To determine the strength and type of relationship between negative attributes and physical conditions of bus stops in this study, a correlation analysis was performed using Pearson's coefficient test. Pearson's correlation measures the linear relationship and the degree of association between two variables. The closer the coefficient gets to +1 or -1, the stronger the correlation. The sign of the correlation indicates how variables are related. Positive values indicate that low values on one variable are related to low values in the other, and vice versa.

Negative values indicate that low values on one variable are related to high values on the other, and vice versa. The correlation gets weaker as the values get close to 0; thus, for this study < or = +/- 0.45 is considered the threshold (Xiong, Shekhar, Tan, & Kumar 2004; Johnston 2000).

The results of the correlation analysis help in defining how bus stops look. They also support the identification of different types of bus stops and their conditions. Ultimately, it assesses which negative attributes are mostly related to specific bus stop characteristics. Land use development patterns allow for the contextualizing of the results in the study areas. The results show a positive correlation (.562) between landing area and sidewalk. This means that when landing area values increase, sidewalk values will increase, as well. According to the bus stop frequency analysis, 91.4% of the bus stops' landing areas are below the street level, but also share space with the sidewalk. In other words, the sidewalk is often used as a landing area. Thus, it is rational to believe that more landing areas will mean more sidewalks.

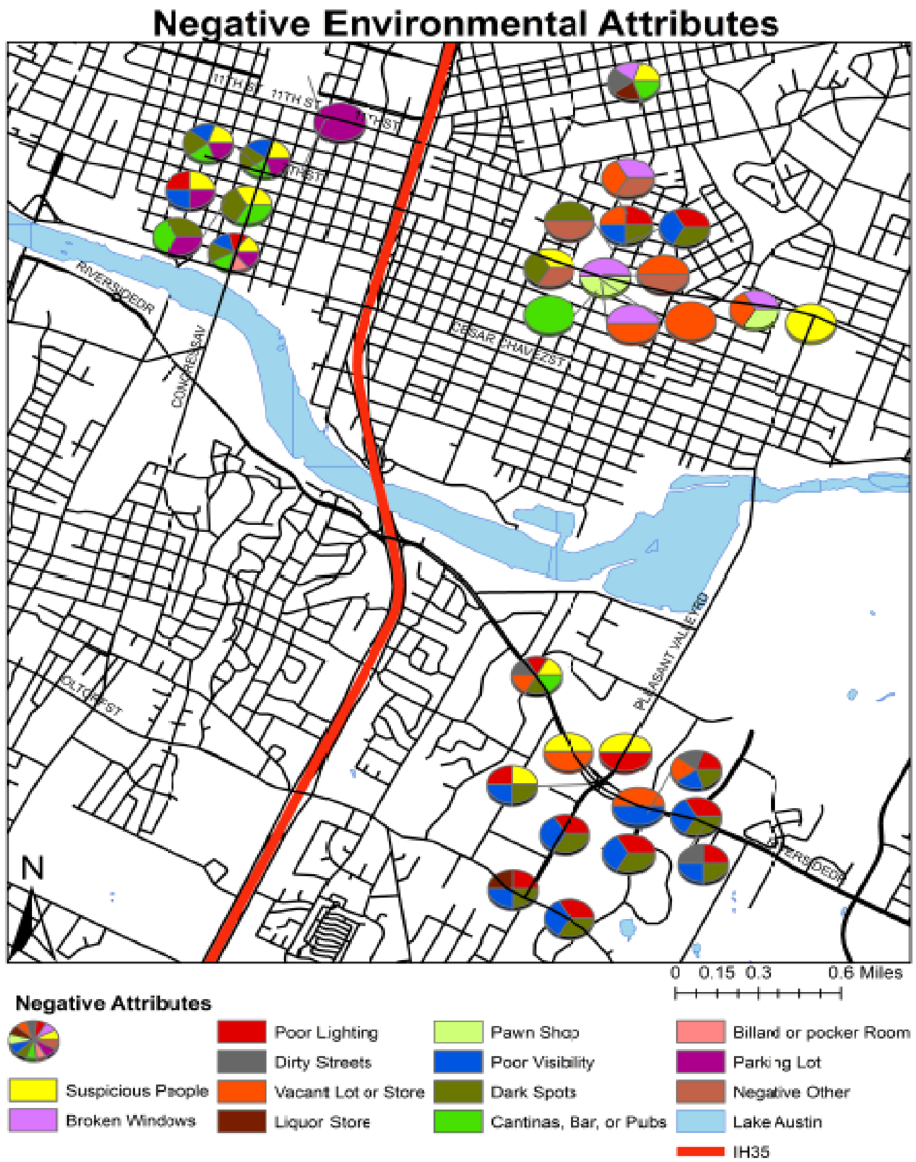


Figure 2.11– Negative Environmental Attributes

Poor lighting and poor visibility also share a strong positive correlation (.723). When the lighting conditions deteriorate in the study areas, visibility will deteriorate as well. The negative attributes map illustrates this relationship since most of the places with poor lighting also have poor visibility, and vice versa. In the frequency analysis, 93% of the bus stops with poor visibility also have poor lighting. The Riverside area is a good example of this phenomenon. Riverside shows the highest concentration of these elements of the three areas.

Another positive correlation was found between poor lighting and dark spots (.587). In other words, as poor lighting increases at bus stops, so do dark spots that bus riders will encounter. The frequency analysis supports the correlation analysis; 78% of the bus stops with dark spots also have poor lighting. The Riverside area shows the highest concentration of dark spots and poor lighting per bus stop. Alternatively, a negative weak correlation was found between poor lighting and security measures (-.430). If security measures increase, poor lighting will likely decrease. Improving security measures usually includes improving good lighting conditions. Based on the frequency analysis, most of the bus stops evaluated having one or more security measures (84%) do not show poor lighting as a negative attribute.

A positive correlation was found between suspicious people and cantinas/bars/pubs (.482). The more these kinds of establishments proliferate, the more suspicious people will wander around the area where these establishments are located. Downtown and East Riverside Drive provide a good example for this correlation. Downtown showed the highest percentage of suspicious people in the area. The land use analysis shows downtown with the highest concentration of cantinas/bars/pubs. Whereas the land use analysis of the East Riverside Corridor shows a high concentration of commercial offices, bars, and restaurants towards the IH-35 exit, the negative attribute analysis reveals a concentration of suspicious people at bus stops located in this area, as well.

Cantinas/bars/pubs also share a positive correlation with vacant parking lots (.484). If the number of cantinas/bars/pubs increases in a specific area, such as in downtown, so will the number of parking lots, garages, or open spaces assigned for parking. During the day, most of the parking spaces are used for office and commercial business. However, at night most of the parking spaces in downtown are related to specific cantinas/bars/pubs with many open to the public for a fee, often being associated with a business for valet parking services. The land use analysis also indicates that parking lots are often associated with commercial zones, including cantinas/bars/pubs. The frequency analysis supports these findings, as 75% of the cantinas/bars/pubs also have parking lots nearby to serve their businesses. The correlation matrix in Table 2.8 shows these findings.

The results of the correlation analysis give evidence to the strength of the relationship between variables when describing negative attributes and the physical elements of bus stops. As a result, the correlation analysis provides guidance on defining how bus stops look, how they are related to the study areas, and how they differ from each other within the study areas. Physical conditions are helpful when determining the relevance of negative attributes and how they affect the condition of the area as a whole.

TABLE 2.8 Correlation Matrix

		Shelter	Seating	Side-walk	Light-ing	Security Measures	Landing Area	Land-scape	Traffic Hazard	Sus-picious People	Broken Windows	Poor Lighting	Vacant Lot/Store	Poor Visibility	Dark Spots	Cantina/ Bar/Pub	Parking Lot
Shelter	Pearson Correlation	1	-.188	.105	.105	-.192	.187	.159	-.109	-.184	.095	.234	.409*	.078	-.024	-.187	-.117
	Sig. [2-tailed]		.258	.531	.531	.249	.261	.339	.513	.269	.571	.157	.011	.641	.884	.260	.483
Seating	Pearson Correlation	-.188	1	.226	.226	.030	.402*	.024	-.096	.410*	.019	-.014	-.183	-.024	.135	.133	.176
	Sig. [2-tailed]	.258		.173	.173	.858	.012	.889	.568	.011	.908	.935	.272	.889	.420	.426	.292
Sidewalk	Pearson Correlation	.105	.226	1	-.027	.140	.562**	.204	-.039	.112	.064	.126	-.275	.133	.156	.085	.071
	Sig. [2-tailed]	.531	.173		.872	.401	.000	.220	.817	.504	.703	.453	.095	.427	.350	.612	.671
Lighting	Pearson Correlation	.105	.226	-.027	1	.140	-.048	-.133	-.039	.112	.064	-.215	.098	-.204	-.173	.085	.071
	Sig. [2-tailed]	.531	.173	.872		.401	.774	.427	.817	.504	.703	.194	.557	.220	.298	.612	.671
Security Measures	Pearson Correlation	-.192	.030	.140	.140	1	.052	-.293	-.276	.338*	.141	-.430**	-.268	-.362*	-.275	.213	.215
	Sig. [2-tailed]	.249	.858	.401	.401		.756	.075	.093	.038	.398	.007	.104	.026	.094	.198	.194
Landing Area	Pearson Correlation	.187	.402*	.562**	-.048	.052	1	-.037	-.069	.199	-.175	.224	-.047	.236	.278	-.088	.127
	Sig. [2-tailed]	.261	.012	.000	.774	.756		.826	.681	.231	.294	.177	.781	.153	.091	.599	.448
Landscape	Pearson Correlation	.159	.024	.204	-.133	-.293	-.037	1	-.190	-.262	.155	.170	.116	.212	.096	-.375*	-.241
	Sig. [2-tailed]	.339	.889	.220	.427	.075	.826		.252	.112	.353	.307	.489	.202	.564	.020	.145
Traffic Hazard	Pearson Correlation	-.109	-.096	-.039	-.039	-.276	-.069	-.190	1	-.093	-.257	.180	-.127	.190	.224	.122	.102
	Sig. [2-tailed]	.513	.568	.817	.817	.093	.681	.252		.577	.119	.279	.448	.252	.177	.467	.542
Suspicious People	Pearson Correlation	-.184	.410*	.112	.112	.338*	.199	-.262	-.093	1	-.097	.068	-.149	.030	.149	.482**	.327*
	Sig. [2-tailed]	.269	.011	.504	.504	.038	.231	.112	.577		.563	.685	.372	.856	.371	.002	.045
Broken Windows	Pearson Correlation	.095	.019	.064	.064	.141	-.175	.155	-.257	-.097	1	-.297	.298	.314	-.369*	-.010	-.169
	Sig. [2-tailed]	.571	.908	.703	.703	.398	.294	.353	.119	.563		.070	.069	.055	.023	.952	.312
Poor Lighting	Pearson Correlation	.234	-.014	.126	-.215	-.430**	.224	.170	.180	.068	-.297	1	-.085	.723**	.587**	-.127	-.031
	Sig. [2-tailed]	.157	.935	.453	.194	.007	.177	.307	.279	.685	.070		.613	.000	.000	.448	.851
Vacant Lot/Store	Pearson Correlation	.409	-.183	-.275	.098	-.268	-.047	.116	-.127	-.149	.298	-.085	1	-.116	-.208	-.162	-.259
	Sig. [2-tailed]	.011	.272	.095	.557	.104	.781	.489	.448	.372	.069	.613		.489	.210	.331	.117
Poor Visibility	Pearson Correlation	.078	-.024	.133	-.204	-.362*	.236	.212	.190	.030	-.314	.723**	-.116	1	.636**	-.021	.241
	Sig. [2-tailed]	.641	.889	.427	.220	.026	.153	.202	.252	.856	.055	.000	.489		.000	.901	.145
Dark Spots	Pearson Correlation	-.024	.135	.156	-.173	-.275	.278	-.096	.224	.149	-.369*	.587**	-.208	.636**	1	.286	.167
	Sig. [2-tailed]	.884	.420	.350	.298	.094	.091	.564	.177	.371	.023	.000	.210	.000		.082	.315
Cantina/ Bar/Pub	Pearson Correlation	-.187	.133	.085	.085	.213	-.088	-.375*	.122	.482**	-.010	-.127	-.162	-.021	.286	1	.484**
	Sig. [2-tailed]	.260	.426	.612	.612	.198	.599	.020	.467	.002	.952	.448	.331	.901	.082		.002
Parking Lot	Pearson Correlation	-.117	.176	.071	.071	.215	.127	-.241	.102	.327*	-.169	-.031	-.259	.241	.167	484**	1
	Sig. [2-tailed]	.483	.292	.671	.671	.194	.448	.145	.542	.045	.312	.851	.117	.145	.315	.002	

*Correlation is significant at the 0.05 level [2-tailed]. ** Correlation is significant at the 0.01 level [2-tailed].

Cluster

It is possible to summarize the bus stop survey data by grouping bus stops into clusters solely based on physical and environmental attributes of stops. This study attempts to use clusters to define the relationship between variables by developing categories of bus stops. To reveal natural and optimal groups, and similar patterns (composition) solely between the physical conditions and negative attributes of the bus stops, a multivariate cluster analysis was conducted, using a hierarchical cluster classification, K-mean recalculation, and discriminant function cluster optimization. The results revealed that the clusters are based on significant variables that have an effect on the conditions at the bus stops (dependent variables).

After narrowing the bus stop survey variables to only those ascribed to the physical elements and negative attributes of bus stops, four categories were clearly visible in the hierarchical dendogram. These four categories are straightforward and broad; thus, they respond to the number of classifications desired considering the three study areas. The cut in the dendogram was then made at a rescaled distance of 18. These four categories or classifications were then recalculated using the K-means analysis. The K-means allows one to determine if the original approximations from the hierarchical clusters are accurate and to recalculate the clusters' centers until the number of clusters is reduced to the desired four clusters. The four clusters' classifications that resulted from the K-means were then analyzed using the discriminant function to optimize the clustering process. The discriminant analysis helps to distinguish the differences between the four desired clusters.

Based on the multivariate cluster analysis, these four categories share some common elements, but also differ from one another. Cluster #1 is characterized as seating areas, sidewalks, poor lighting, security measures, landing areas, landscape, traffic hazards, and suspicious people. Cluster #2 is described as seating areas, sidewalks, poor lighting, security measures, landing area, traffic hazards, suspicious people and poor visibility, dark spots, cantinas/bars/pubs, and parking lots. Cluster #3 is composed of sidewalk, poor lighting, security measures, landing area, landscaping, and traffic hazards. Finally, cluster #4 is characterized by bus stops with shelters, seating areas, sidewalks, poor lighting, landing areas, landscape, traffic hazards, poor visibility, and dark spots. The attributes in the data matrix were scored on an ordinal scale of 0-3 for their ability to perform in each cluster type. However, seating area was the only attribute containing 2 and 3 scores; since seating area is an attribute present at most of the bus stops independent of its land use.

When the data matrix is cluster-analyzed, it is possible to relate clusters to the study areas if land use characteristics are considered. "The elements that are not clustered together in one branch are represented in the next one" and considering the land use, a pattern is revealed (Romesburg 1984: 48). For this cluster analysis, land use is used as a functional attribute to locate the clusters/classifications of bus stops and to narrow the cluster choices to the three study areas.

In accordance with the frequency analysis, only a few bus stops (28%) have shelter, and most of the bus stops with shelter are located in Riverside. Cluster#4 is the only one grouping of bus stops that have shelters available to users. Cluster #4 composition also reveals other elements strongly related to Riverside. It has poor lighting, dark spots, poor visibility, and no security measures. The results of the bus stop survey reveal that all these variables are grouped together in Riverside; thus, making a natural cluster. On the other hand, cluster #4 classification in Riverside is also supported by the findings of the correlation analysis. For example, the correlation analysis explains that poor visibility and poor lighting are strongly related and that most of the bus stops with poor visibility also have poor lighting. In contrast, poor lighting and security measures are negatively correlated. So, often bus stops that have high (severe) lighting problems might have low security measures. Cluster# 4 defines these correlations and makes them rational within the study area.

Most of the bus stops (71%) have a seating area; however, most of the bus stops without seating areas are located in the HT area. Cluster #3 composition is the only cluster with a low score (1) of seating area representation, meaning that most of the bus stops in that group do not have a seating area. This phenomenon can be fairly related to the HT area. Nonetheless, cluster #3 shares similar and compatible elements with cluster #1. Seating area and the presence of suspicious people are the attributes that differentiate between the two. For example, both categories share sidewalks, poor lighting, security measures, landing areas, landscaping, and traffic hazards. Based on these findings, cluster #1 and cluster #3 can be equally related to HT area bus stops. HT area bus stops near Chicon and 12th Street and 7th and Pleasant Valley present different attributes than the rest of the bus stops in the area. Chicon and 12th Street and 7th Street and Pleasant Valley are commercial corridors and suspicious people are among the attributes. The commercial land use supports seating at bus stops due to high pedestrian traffic. The rest of the HT area is mainly single residential. Observation in this area revealed the number of bus users is low, pedestrian traffic is low, and bus stops often do not have a seating area. Hence, two types of bus stops can be identified in the area and the clusters help to reveal this finding and identify their characteristics.

The clusters also present some general attributes related to all bus stops in the study. Sidewalk and landing areas are present at almost every bus stop, so they are part of all four clusters. Traffic hazards, poor lighting, and landscaping are also present in the four clusters; however, these attributes can be subject to the physical circumstances at the bus stops and in the study area. Most of the traffic hazards are related to high-speed traffic in habitually pedestrian areas (94.7%), bus stops right before crosswalks (94.7%), and bus stops with no near crosswalks (27.8%). Poor lighting is present at several bus stops (43.8%); however, it is a condition that affects the study area as a whole. Study participants often related poor lighting to the area, not to specific bus stop locations. People's perceptions of safety are ascribed to particular scenarios not single locations. Landscaping (60.5%) is present at most of the bus stops. It can be used to make the bus stop attractive; yet, trees and bushes can create dark spots and shadows during nighttime, presenting a danger to bus riders waiting at the stops.

In summary, it is possible to identify types of bus stops available to riders within the study areas based on negative attributes and physical characteristics. Considering the different elements and composition of the clusters, they can be distributed in the three study areas as the following: downtown has cluster #2 type bus stops, Riverside has bus stops similar to the ones presented in cluster #4, and the HT area has a mix of cluster #1 and cluster #3 types. Table 2.9 shows the distribution of the clusters and their elements.

Table 2.9 - Clusters Distribution

	Clusters			
Related Study Areas	HT Area Commercial Zones	Downtown	HT Area Single Residential	Riverside
	Cluster 1	Cluster 2	Cluster 3	Cluster 4
SHELTER	0	0	0	1
SEATING	1	1	0	1
SIDEWALK	1	1	1	1
POOR LIGHTING	1	1	1	1
SECURITY MEASURES	1	1	1	0
LANDING AREA	1	1	1	1
LANDSCAPING	1	0	1	1
TRAFFIC HAZARDS	1	1	1	1
SUSPICIOUS PEOPLE	1	1	0	0
BROKEN WINDOWS	0	0	0	0
POOR LIGHTING	0	1	0	0
VACANT LOT	0	0	0	0
POOR VISIBILITY	0	1	0	1
DARK SPOTS	0	1	0	1
CANTINAS / BARS/ PUBS	0	1	0	0
PARKING LOTS	0	1	0	0

The results of the cluster analysis are valuable because they help develop significant groups of bus stops based on physical conditions and other attributes. It is a meaningful representation of how variables dynamically interact and collaborate in defining bus stop details (Romesburg 1984). It reveals the interdependence of some variables; for example, cantinas/bars/pubs with parking lots, as well as suspicious people and poor lighting. It effectively determines which variables are often associated and shared under different categories. The cluster also reveals a tendency for association between parking lots and cantinas/bar/pubs, and landing areas and sidewalks. When related to the frequency and correlation analyses, the clusters can be localized into the specific study areas. Overall, the analysis facilitates the creation of scenarios when determining what bus stops look like in the study areas, and how the sum of the elements affects these bus stops. Clusters #1 and #3, together, describe the types of bus stops found in the HT area and what negative attributes are often present in relation to physical conditions. In this case, the HT area has two types of bus stops. The result is supported by the land use of the area that determines two types of development: a commercial zone near 12th Street and 7th Street, and a single residential zone in between. Therefore, two scenarios can be identified while only having small differences, but these differences are relevant when making recommendations for improvements. The identification of these small differences was only possible through the cluster analysis.

Crime Analysis

Incidents and Context of Crime

In analyzing the crime data, subcategory 1 (robbery or theft) and subcategory 5 (general offenses or class a, b, or c misdemeanors) have the highest overall number of incidents in the Austin surveyed bus stops. To determine a pattern of crime incidents by bus stop study areas, two GIS maps were created for each of the three study areas. The map set indicates the six crime subcategories in the three study areas and within the 400-foot bus stop buffer area. The second map set indicates the different types of general offenses and misdemeanors in the study areas within the 400-foot bus stop buffer area.

The GIS physical analysis reveals that the downtown area has the highest spatial concentration of Type I, or serious crimes, of all the three areas. Most of the crimes recorded are physical assault, harassment, rape, theft, robbery by assault, aggravated robbery, purse snatching, and shoplifting. Although the data provided by the Austin Police Department include incidents of murder and homicide, none of these crimes were reported in the downtown area. Data revealed serious crimes are spatially clustered between 6th Street to 4th Street and Guadalupe Street to Congress Avenue, specifically concentrated along Congress. This data is congruent with the HT focus groups' observations of hot spots in the downtown area and corroborate their perception of safety with real incidents of crime. Figure 2.12 shows the bus stop crime incidents in the downtown Austin area.

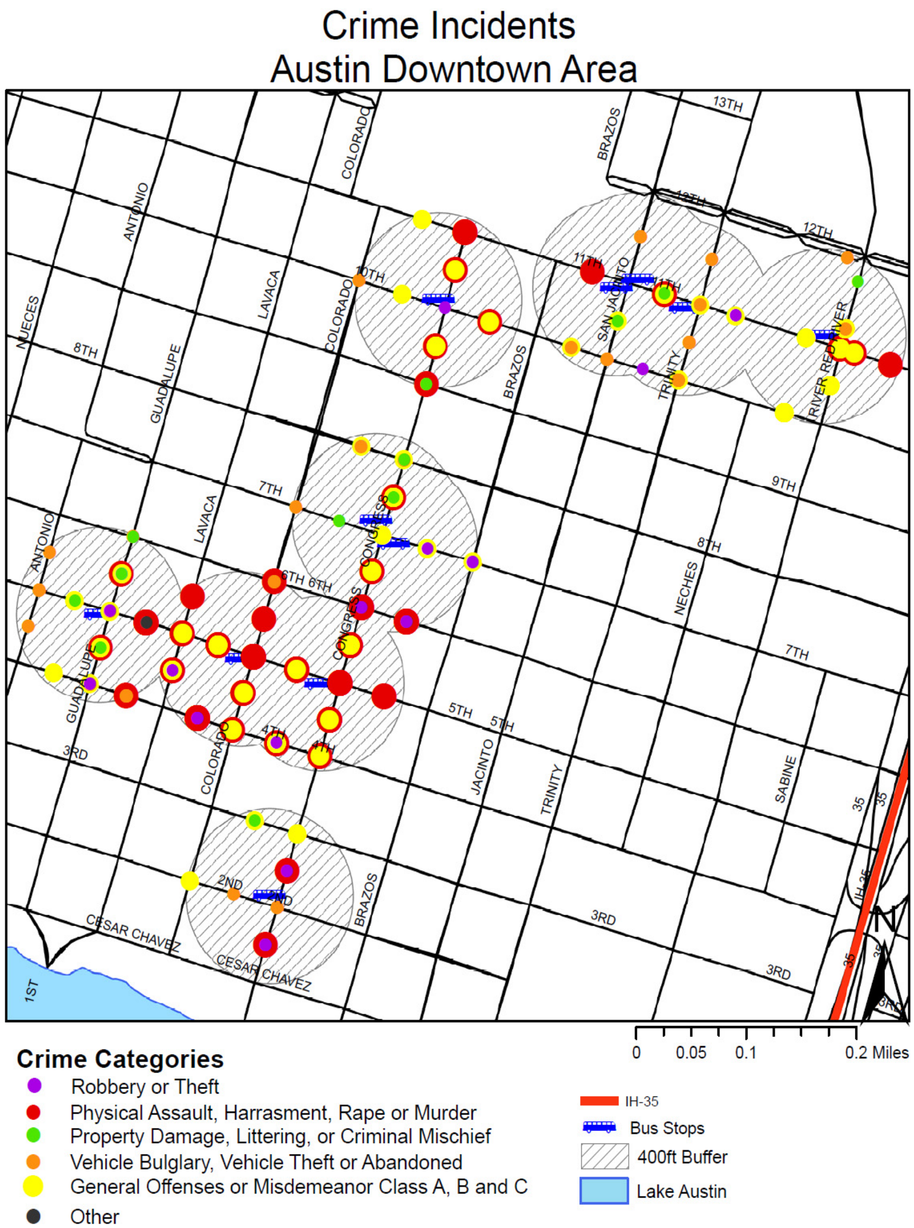


Figure 2.12 Downtown Bus Stop Crimes

Downtown also shows a moderate concentration of vehicle burglary and auto theft around Trinity Street, 11th Street, San Antonio Street, and 2nd Street bus stops. These four bus stop areas have a land use characterized by parking lots, parking garages, and open parking spaces.

The downtown area reported the highest concentration of general offenses and misdemeanors. The data showed a primary spatial cluster of disturbances including, fights, public intoxication, and drug related offenses between 4th Street and 6th Street and Guadalupe Street to Congress Avenue. These same crimes seem to be present throughout Congress Avenue. In addition, Colorado Street and 6th Street bus stops reported the highest public intoxication incidents from all the surveyed bus stops. Congress Avenue reported one crime incident related to prostitution, or promotion of prostitution, near 11th Street. The 11th Street bus stops present a spatial concentration of drug related offenses, particularly from San Jacinto Street to the Red River Street intersections. The HT focus group data identified theses zones in downtown Austin as unsafe and even dangerous. Observations revealed that HT students avoid these bus stops and consider them unsafe due to suspicious people loitering in the area. Therefore, HT participants' perceptions of insecurity for those particular locations are corroborated by real context or incidents of crime. Figure 2.13 shows the distribution of general offense.

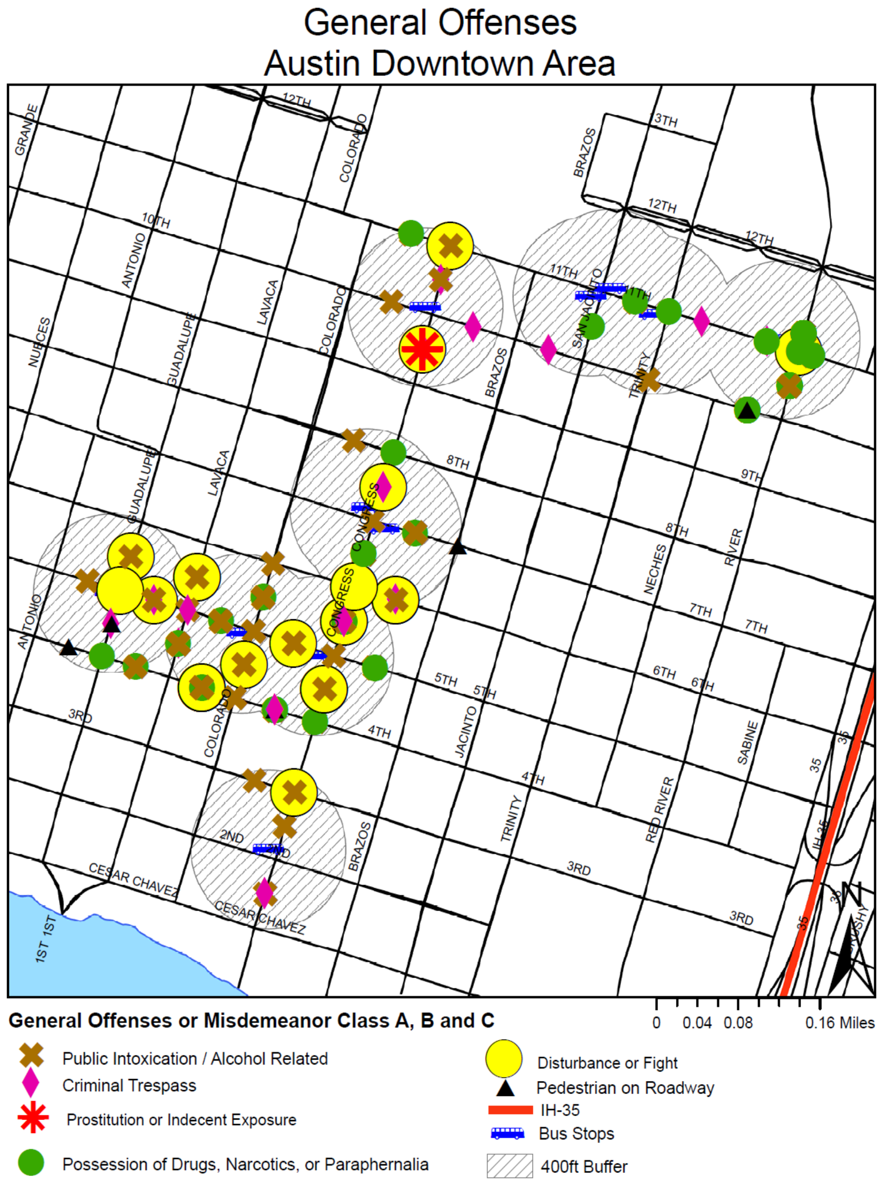


Figure 2.13 – Downtown General Offenses

The HT Area showed a high to moderate concentration of serious crimes. The data revealed a spatial cluster of physical assault related crimes around bus stops on 12th Street to Chicon and 7th Street to Pleasant Valley. The rest of the serious crimes are mainly robbery, including theft, robbery by assault, aggravated robbery, and purse snatching. Theft crimes are spatially clustered throughout Chicon Street and 7th Street. A few incidents of robbery were reported between 2nd and 3rd Streets, but without sufficient numbers to follow a pattern or be considered a cluster. The Austin Police Department reported a murder in the HT Area between the bus stops of 7th Street and Pleasant Valley. In addition, there are not many shoplifting crimes since the land use indicates it is primarily a single family/residential area. Figure 2.14 shows HT Area Bus Stop Crimes.

Regarding general offenses and class a, b and c misdemeanors, the HT area showed a high spatial concentration of these crimes, especially drug related offenses, located along the 7th Street corridor and Chicon Street. The intersection between Chicon Street and 12th Street showed a particular cluster of drug possession offenses and public intoxication. Three prostitution incidents were reported on Chicon Street: one near 12th Street intersection and two immediately across from the HT campus (near the 11th Street intersection). In addition, data revealed a small cluster of drug possession and public intoxication offenses near the 2nd Street and Robert Martinez intersection. A small cluster of criminal trespass offenses were identified near 7th Street and Pleasant Valley. Figure 2.15 shows the HT Area distribution of general offenses.

The focus group participants closely analyzed the HT area where some bus stops were avoided due to safety concerns. Specifically, the participants' observations identified bus stops on 12th Street and Chicon and 7th Street and Pleasant Valley as unsafe. Twelfth Street, in particular, is considered dangerous due to poor lighting and suspicious people loitering. Theft incidents are considered common at 7th Street and Pleasant Valley. In general, HT area crime results support the HT focus groups' perceptions of real incidents of crime.

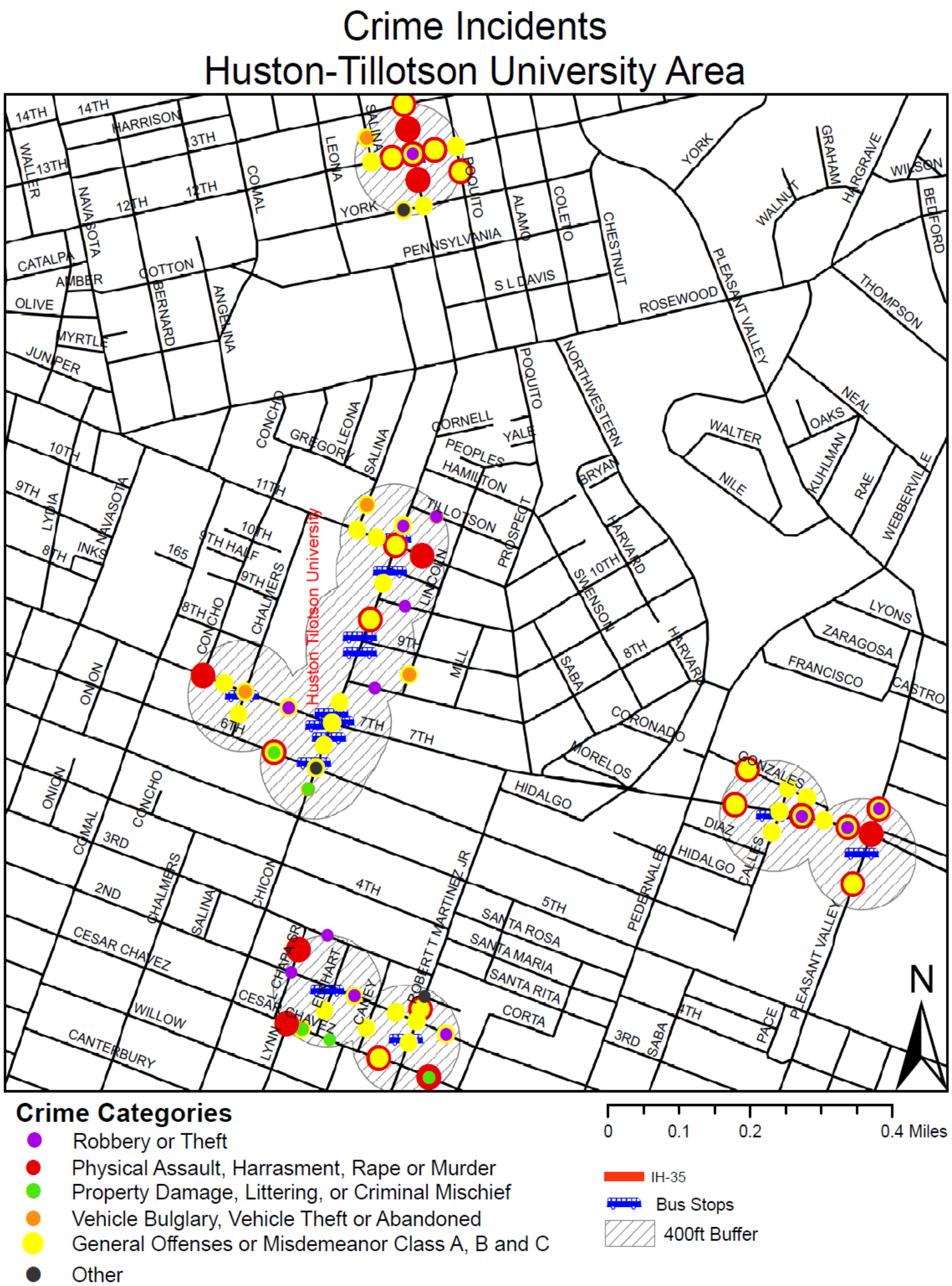


Figure 2.14 – HT Area Bus Stop Area Crime

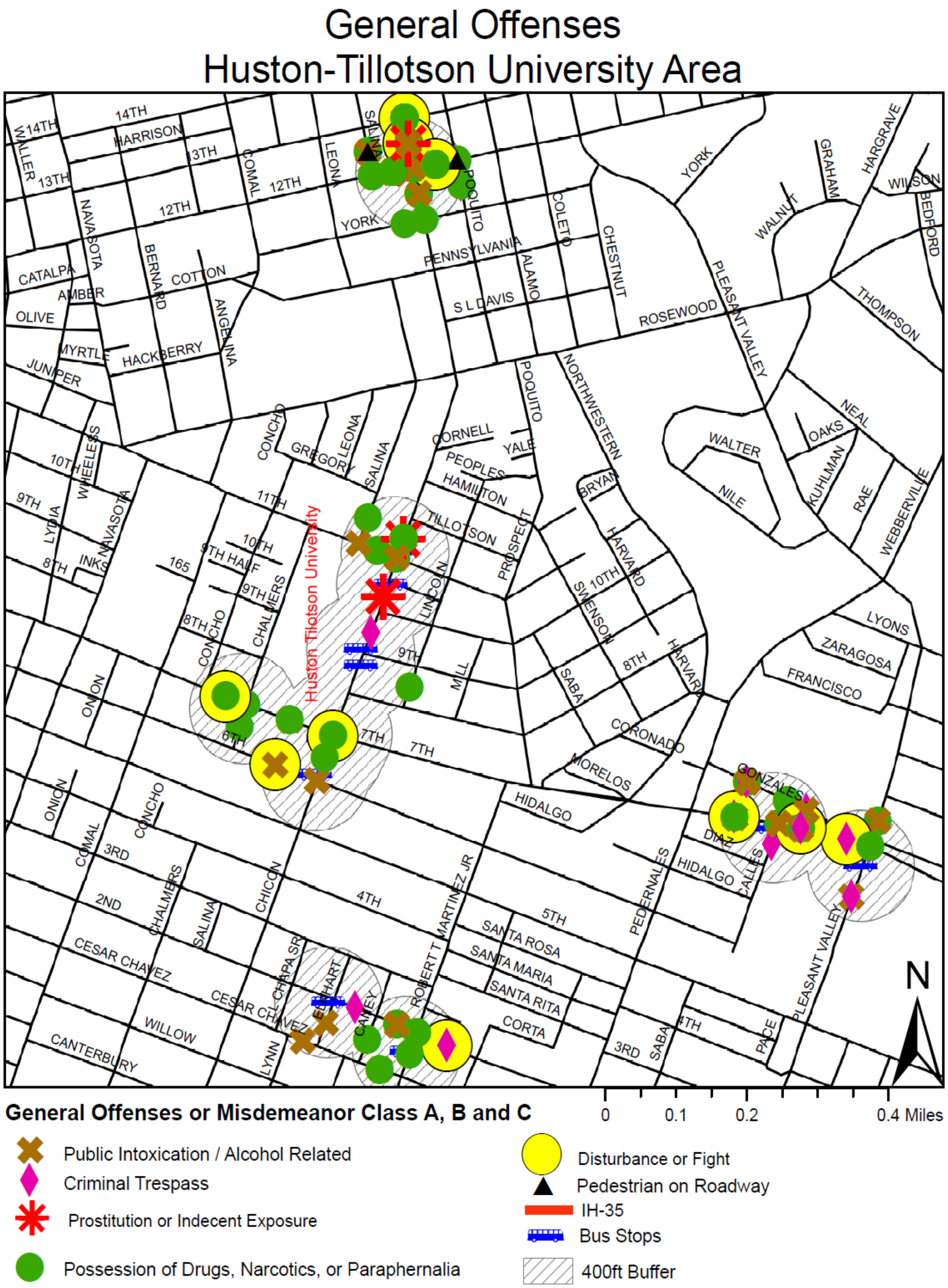


Figure 2.15 – HT Area General Offenses

East Riverside presents a different crime scenario than HT and downtown by showing a moderate to rather low spatial concentration of crime around the surveyed bus stops. This might be due to the urban form characteristics (unfriendly for pedestrians), lack of bus stops, and the increased distance between bus stops. Physical assault related crimes are present at almost every bus stop location. The corner of Wickersham and East Riverside Drive reports having a murder. In general, most of the crime incidents are concentrated along the four major arterials that border the study area: Pleasant Valley Road, Oltorf Street, Wickersham Lane, and East Riverside Drive. Figure 2.16 shows Riverside Bus Stop Crime and Figure 2.17 shows Riverside General Offenses.

Property damage, littering and criminal mischief related crimes seem to be spatially clustered at the corner of Wickersham Lane and East Riverside Drive. This corner can be considered a hotspot for transit crime. This finding is consistent with the land use of the area which reported several vacant lots at that corner and along Wickersham Lane; thus, setting the ideal conditions for crime to occur. On the other hand, the East Riverside Area also has a moderate to low spatial concentration of general offenses and misdemeanors. Civil disturbance offenses are present along the four major arterials (E. Riverside, Pleasant Valley, Wickersham, and Oltorf) following the pattern of serious crimes. Prostitution offenses are present in Pleasant Valley and are particularly prominent near the Oltorf intersection.

In contrast to the rest of the study areas, “pedestrian on roadway” offenses are recurrent in Riverside, particularly throughout the East Riverside corridor. East Riverside Drive also shows a concentration of public intoxication offenses. Drug related crimes are mostly present around Pleasant Valley Road bus stops with a few incidents near Wickersham Lane bus stops. HT focus groups’ observations do not address Riverside as an unsafe area, but focus group participants did acknowledge the negative attributes of the area, such as poor lighting, poor visibility, and the lack of a police presence. According to the focus groups, the agglomeration of negative attributes at bus stops, in general, can make an area unsafe. The Austin crime data supports these perceptions.

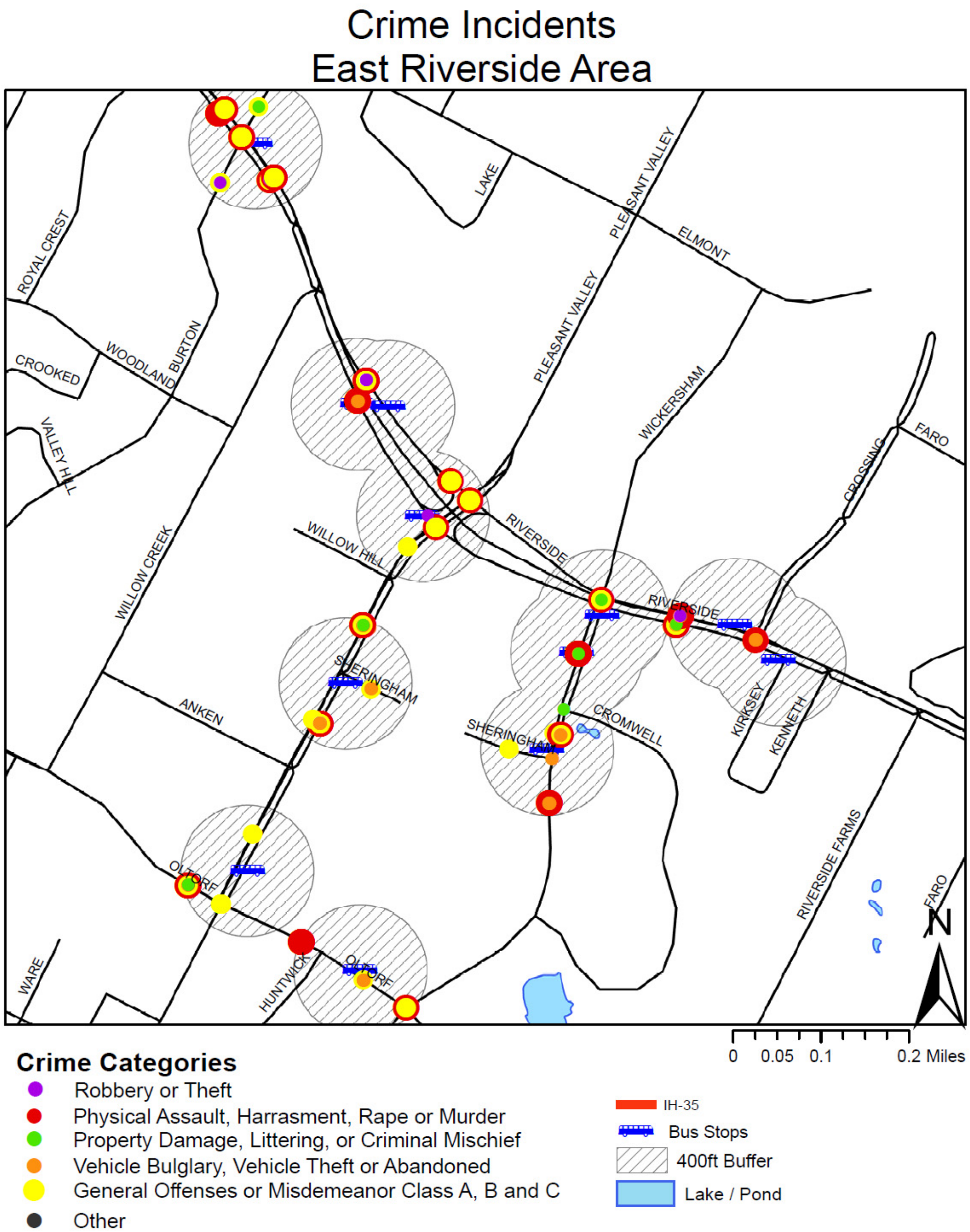


Figure 2.16– Riverside Bus Stop Area Crime

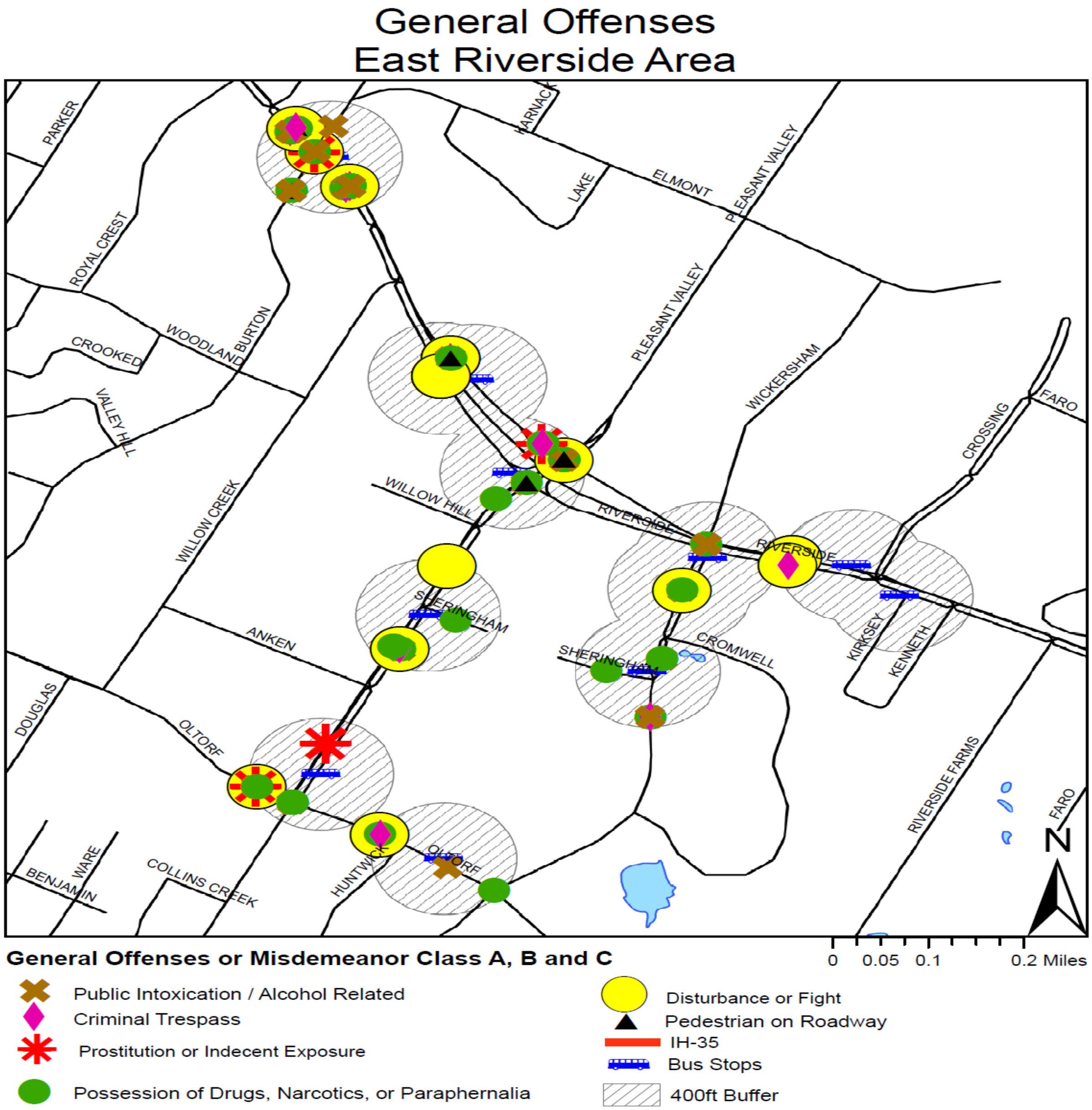


Figure 2.17 – Riverside General Offenses

Conclusions

What Frightens HT Participants from Using the bus?

Literature explains that negative attributes at bus stops can affect the incidents of crime (Wilson & Kelling 1982, Loukaitou-Sideris 1999, and Liggett & Loukaitou-Sideris 2001). These negative attributes can influence bus riders' perception of security, with or without a real context of crime. Following these arguments, the data in this study analyze environmental attributes, crime, and perceptions as isolated independent variables, but conditional on each other. It finds the different kinds and agglomerations of negative attributes at bus stops' micro and macro environments, considering the physical infrastructure of the bus stops. It also finds the different types of crimes that occurred within the surveyed bus stops' buffer areas and what HT students, faculty and staff consider safe and unsafe bus stops through direct observation, survey, and focus group methodologies.

Viewed city wide, Austin bus stops do not look less safe than bus stops in other cities (Loukaitou-Sideris 1999). However, this is not a comforting response for citizens who are afraid of riding the bus or who have been victims of transit crimes. In fact, after compiling all the results and maps, it is possible to identify a pattern within the three study areas; one can observe that crimes and negative attributes are not equally distributed and are concentrated in certain hotspots. These hotspots were the same areas previously identified by HT focus group participants as being unsafe. When analyzing the data cumulatively, individual scenarios for the three study areas can be designed to address safety concerns and discover what frightens HT participants from using the bus in terms of the physical characteristics, safety, and conditions of the surrounding areas of the identified bus stops.

Scenario I: Downtown Area

The focus group data provided evidence of safety concerns while waiting for the bus, influencing participants' travel decisions and modal selection. Waiting times, accessibility issues, and lack of bus routes were also factors considered. Participants considered downtown, particularly 6th Street and Congress and 6th and Brazos, as the most unsafe of the study areas. They also reported that some of the bus stops in downtown were in poor condition or the infrastructure was poorly maintained. The bus stop survey analysis results show that in fact, downtown bus stops have an abundance of negative attributes. However, none of the bus stops were actually in poor condition or poorly maintained based on the evidence of the bus stop survey. The infrastructure, including seating, sidewalk, landing areas, landscaping, and shelter, were actually in fair to good condition.

Most of the surveyed bus stops (72%) in the downtown area have seating, although only one reported having a shelter.

Streetlights are present at all downtown bus stops (100%) and 36% of the bus stops also have illumination from adjacent property. In addition, downtown has the highest percentage (81%) of security measures of the three study areas. In the correlation analysis a negative relation was found between security measures and poor lighting. This means that if security measures increase, poor lighting will decrease. The downtown bus stops are a good example of this phenomenon. On the other hand, despite having fair lighting conditions, downtown also has a significant amount of dark spots near some bus stops. These dark spots are usually due to the trees and bushes of landscaping and can create shadows and limited visibility.

Wilson & Kelling (1982); Sherman, Gartin, & Buerger (1989); Loukaitou-Sideris (1999); and Liggett, Loukaitou-Sideris, and Hiroyuki (2001) identified suspicious people as a negative attribute that strongly alters an individual's perception of safety, contributing to a powerful psychological deterrent, limiting or preventing bus use. Wilson & Kelling (1982) recorded examples of persons who admitted switching to the opposite side of the street in order to avoid an encounter or to avoid walking close to a person that looked suspicious.

HT participants, also, mention that the presence of homeless persons and derelicts around downtown bus stops make them feel unsafe. Congruent to what HT participants reported, downtown bus stops, in general, have a fair amount of loitering by homeless, vagrants and derelicts. In the correlation analysis, a strong positive correlation was found between suspicious people and cantinas/bars/pubs. The land use of the downtown area is characterized by cantinas/bars/pubs, including some more upscale nightclubs, mixed with a few homeless shelters.

The cluster analysis provides details on the types of bus stops located in downtown. These results match the HT participants' perceptions, as well as the detailed correlation and frequency analyses. Cluster #2 provides an important depiction of how bus stops look in downtown; they have suspicious people, landscaping, sidewalks, landing areas, cantinas/bars/pubs, parking lots, seating areas, poor visibility and dark spots. All of these elements were addressed by HT participants and supported by the bus stop survey results.

When considering the negative attributes already identified, some bus stops might actually create conditions conducive for crimes to occur. There are serious safety concerns regarding downtown bus stops that limit riders from using the bus services, especially at night. When looking at crime data and incidents in downtown, the negative attributes and the presence of suspicious people weigh even more on HT participants' perceptions of safety. The results of the crime analysis confirm that downtown has the highest concentration of incidents and most of these incidents are related to physical assaults, robbery, and general offenses/misdemeanors, such as disturbances/fights, public intoxication, and possession of drugs. The crime observations, land use, and environmental attributes are complementary and the compositional outlook can explain HT focus group participants' perceptions of insecurity in downtown bus stops.

Scenario II: Huston-Tillotson University Area

The HT participants considered HT bus stops unsafe because of the "drug addicts, homeless persons, and the mentally disturbed persons wandering around the area." The lack of a police presence was also a factor that made some of the participants feel unsafe. Trees or bushes obstructing visibility and vacant lots were also considered a safety concern. The HT participants mentioned, specifically, fear due to the lack of visibility and inability to see "who is hidden in the bushes or vacant lots (which happen to be poorly maintained) that surround some of the bus stops in the area." Within the area, HT participants identified 7^{th} and 12^{th} Streets as unsafe. However, they did not make any comments regarding bus stop infrastructure.

The bus stop survey results found that most of the bus stops in the area were in fair condition and had fair seating areas; however, most lacked shelter, accessible sidewalks and landing areas, especially at bus stops located on Chicon Street. The results also show that most of the bus stops have one or more negative environmental attributes. The bus stop survey was able to identify suspicious people, vacant lots, poor lighting, dark spots, and broken windows at the majority of the bus stops surveyed. These findings agreed with the HT focus group observations of the area.

Wilcox, Quisenberry, & Cabrera (2004); Taylor, Loukaitou-Sideris, Liggett, & Fink, et.al (2005); and Loukaitou-Sideris & Fink (2008), considered lighting and poor visibility as a safety concern and as an important element conducive to crime incidents. For HT participants, poor lighting and poor visibility in the HT Area, along with the presence of suspicious people, are real safety concerns as well. A positive strong correlation was found between poor lighting and poor visibility. The HT area illustrates this phenomenon. The negative attribute map of HT shows that most of the places with poor lighting also have poor visibility. Suspicious people and cantinas/bars/pubs correlation can also be applied to the HT Area; in particular, the intersection between Chicon and 12th street and 7th Street and Pleasant Valley.

The land use of the area develops conditions for these types of negative attributes. Seventh Street and 12th Street are developing as commercial corridors. Twelfth Street presents an agglomeration of bars/pubs/cantinas. It is common to see suspicious people in the area. Single-family residential areas and vacant lots characterize the rest of the area, with some locations having visibility limiting bushes and trees. In the HT area, bus stops near vacant lots and residential areas do not always have adequate lighting, creating a safety concern.

The cluster analysis also describes types of bus stops in the HT Area and tracks the tendencies of the area's land use. Clusters #1 and #3 give a representation of how bus stops look in this area. Cluster #1 identifies the types of bus stops located near commercial zones. These types of bus stops often have a seating area, sidewalk, landing area, landscaping, suspicious people, and poor lighting. Cluster #3 identifies the types of bus stops located near single residential areas. These bus stops do not have seating areas and do not have suspicious people; however, they do have landscaping, sidewalks, and landing areas. Thus, their attributes are similar to Cluster #1 bus stops.

Crime data and crime incidents relate the perception of insecurity to a real crime context. The results of the crime analysis confirm that HT has a high concentration of serious crimes, mostly related to physical assaults and robbery. The intersection between 12th and Chicon has the highest cluster of incidents in the entire area. The intersection between 7th Street and Pleasant Valley, near HEB, present the second largest cluster where one isolated murder was also identified along with multiple incidents of robbery. General offenses and misdemeanors were also present within the HT area. Possession of drugs, public disturbance, and public intoxication are the most common offenses. Again, bus stops at 12th Street and the Chicon intersection and 7th Street and Pleasant Valley developed the highest concentration of offenses. Drug related offenses are predominantly on 12th Street. Overall, these findings match the results of the survey, land use, and focus group observations. The crime data supports HT participants' perceptions of insecurity in a real context of crime, and the results of the study corroborate with the land use and negative attributes of the area.

Scenario III: East Riverside Area

The HT focus group participants didn't give much detail about Riverside and they did not identify the area as unsafe. However, they do associate the area with poor lighting, poor visibility, dark spots, and having a lack of police presence. For HT participants, a police presence is vital to preserving a safe environment. No particular bus stops were identified in this area and no comments were made on the bus stop conditions.

The bus stop survey results reveal that East Riverside bus stops are actually in good condition. Most of them have seating areas, accessible sidewalks, and good landing areas. Some of these bus stops are in excellent condition since they are shared with the University of Texas shuttle. In addition, most of the bus stops with shelters are located at East Riverside and Wickersham. The bus stop survey identified the distance between bus stops as being greater than in other bus stops in the study areas. Thus, walking distances are greater.

The results also show that Riverside has one or more negative attributes around the surveyed bus stops. Suspicious people are very common on the East Riverside corridor, especially towards the IH-35 exit. Poor lighting is an issue found at almost every bus stop in the area and it is linked to poor visibility and dark spots. A strong positive correlation was found between dark spots and poor lighting. When poor lighting conditions increase, so do the dark spots that bus riders encounter in the area. The frequency analysis shows that 78% of the bus stops with dark spots also have poor lighting. In the negative attributes map, most of the bus stops in Riverside have poor lighting, dark spots, and poor visibility. These issues contribute to the HT participants' perceptions of insecurity overall.

Loukaitou-Sideris, & Iseki (2001), explain that urban forms (land use) influence bus stop characteristics and crime rates. East Riverside is a good example of this relationship. The land use of the area contributes to criminal incidents, which in turn contributes to the negative attributes in a criminal context. East Riverside Drive is considered a developing commercial corridor, especially to the west of Pleasant Valley Road, where most of the stores, restaurants, bars, and grocery stores are located. The rest of the area is still developing and is characterized by vacant lots and apartment complexes with open spaces and/or abundant landscaping. As in the HT area, bushes and trees can obstruct visibility and create dark spots which are often perceived by bus riders as unsafe, and can in fact, present a danger to bus riders, especially at night.

The results of the cluster analysis were used to identify the types of bus stops along Riverside. These results relate to land use and negative attribute tendencies. Cluster #4 provides an important description of how bus stops look along Riverside. As the bus stop survey revealed, Riverside bus stops often have shelter, a seating area, landing area, and landscaping. However, the cluster reveals that these types of bus stops also lack sufficient security measures, in that they have poor lighting, poor visibility, and dark spots. These results are supported by the correlation analysis, HT participants' observations, land use assessment, and bus stop frequency results.

Similar to the other two areas, crime data give a real context to HT participant's perception of insecurity. However, Riverside has a moderate to low spatial concentration of crime. This can be related to the relatively few bus stops in the area and the increasing distance between bus stops. As in the other study areas, serious crimes are present at almost every bus stop. In fact, the corner of Wickersham and East Riverside Drive reported one murder and several incidents of property damage and criminal mischief. Vacant lots surround the bus stops near this corner with several negative attributes, including poor lighting and poor visibility; therefore, offering specific conditions for crime to occur.

General offenses and misdemeanors are also common in Riverside. Disturbance and drug possession offenses appear to be at almost every bus stop. Public Intoxication is mostly common on west Pleasant Valley, following the land use pattern of the area. These crime findings, in general, match the results of the bus stop survey on negative attributes and the land use description. Despite the above, HT focus group participants' observations on perception of safety do not predict danger in this area; however, crime incidents and negative attributes indicate otherwise.

Conclusions

Several factors come into play when determining what frightens HT participants from using the bus. Negative attributes shape their perception of safety, and these negative attributes have a real context of crime. The reviewed literature makes the argument that negative environmental attributes influence perceptions. This argument becomes feasible when analyzing HT participants' observations and the bus stop survey results of negative attributes (Loukaitou-Sideris 1999; British Department of Transport 2002).

Overall, the surveyed bus stops are, for the most part, in good to fair condition. However, the negative attributes, such as poor lighting and suspicious people weigh more than the aesthetics of the bus stops and have a direct influence on perceptions of safety. Perceptions, after all, are important personal detractors from using the bus. In the case of HT participants, perceptions are so essential as to completely deter them from using the bus service and to avoid certain bus stops. This particular finding matches the conclusions developed by Austin & Buzawa (1984), Ingalls & Owens (1994), Needle & Cobb (1997), and Loukaitou-Sideris (2005), that "fear and anxiety about personal security are important detractors from using public buses," causing people to avoid specific transit routes, buses, or to not use public transit at all (Loukaitou-Sideris 2005:2).

The empirical data presented in this study reveal that HT participants' perceptions are supported by a real crime context that corroborates many of their assumptions and beliefs. Also, the data provides empirical evidence that if HT students were to use the buses around their areas of activities they would be classified as unsafe based on HT perceptions of safety, negative attributes, and crime. Ultimately, perceptions are a big factor of why they prefer their private vehicles to public transit.

It can be concluded that the presence of certain attributes in the bus stops' micro and macro environments affect perceptions and are associated with crime incidents. This explains why the bus stops considered unsafe had at the same time negative environmental attributes and high concentrations of crime. Also, the analysis partially explains that perhaps the higher crime incidents at some bus stops are the result of the compositional characteristics of the built environment (land use, urban form, infrastructure, and attributes). The literature explains that indeed there is a strong correlation between the design and layout of the physical environment and the creation or reduction of opportunities for criminal activity (Loukaitou-Sideris, 2001). However, in the case of HT participants, the perceptions are the ones that influence their decisions to drive private vehicles instead of using public transit. It is not exactly how the area and the bus stops look in terms of design and layout, but rather how people feel at the bus stops, while riding the bus, waiting for the bus, and walking to the bus stop.

Transportation agencies and policy makers can certainly learn from the findings of this study. The results of this study demonstrate that providing bus service is not enough. It is also a matter of addressing the future bus riders' needs in terms of security and tailoring security strategies around those needs. As presented in this study, crime data can be used to predict which bus stops tend to invite criminal activities and which attributes of the environment are the most influential ones for crime. In addition, policy actions can be complemented with design options. For example, providing adequate illumination at bus stops and trimming bushes and trees that might obstruct visibility improves the surrounding bus stop environment. Also, transportation planners should locate bus stops away from empty spaces and vacant lots. Based on direct observation, sometimes relocating the bus stops to a safer place can mean just moving the bus stop a few feet up or down the street (Loukaitou-Sideris 2001). If it is not possible to do so, at least create sufficient security measures at those specific bus stops to enhance a sense of security among bus riders.

The design of bus shelters can provide extra protection if, for example, a simple police call box is placed inside. The police call box has proven to be vital in preventing criminal activities. Keeping the landscaping of the bus stops clean, trimming bushes and removing tree branches can also assist in creating a safer environment by sending the message that someone cares and is watching the bus stops. Regarding negative attributes, factors such as lighting, poor visibility, and litter are easy to deal with in terms of design. However, suspicious people are not something that can be controlled, especially in the Austin downtown area; but perception of safety can be improved by providing additional security services at those bus stops. For example, foot or bicycle patrolling police, surveillance cameras, or warning signs can reduce the fear bus riders have of suspicious people. These measures send the message that someone is watching and in case of an emergency you can call for help.

The cluster analysis also provides useful information for policy-makers to develop strategies suitable for bus stops in each of the three study areas. By defining clusters, policies can be made to assess resources of the city to specific locations and provide evidence of the regional needs. The clusters related to the land use identify which kinds of activities tend to concentrate in specific bus stop locations; so policies for the improvements of bus stops can outline specific needs.

Finally, transportation agencies can develop fixed-route training courses for bus riders. A problem with the HT participants' utilization of the Metro is that they were not aware of the services provided by Capital Metro. With few exceptions, participants did not know bus routes and schedules. So, during the focus group it was hard for them to give more information about the services than the area where some bus stops are located. A fixed-route training course would solve these problems by creating a sense of awareness, helping diffuse transit options provided by Capital Metro. The training courses will educate bus users on safety concerns, security strategies, and accessibility alternatives. Courses can help identify the needs of certain populations, such as persons with disabilities, the elderly, and students. These courses can serve to gather as well as disseminate information by developing security strategies at some bus stop locations with direct citizen input. Ultimately, it can help shape the perceptions of safety, perhaps making citizens feel more secure while riding the bus and waiting at bus stops.

As for future research, it would be beneficial to see if the conditions can change by increasing the sample size of both HT participants and participants at bus stops. Additionally, a survey can be conducted at bus stops or with bus riders while riding the bus. Perhaps while in direct contact with the bus and the bus stop environment, participants' perceptions will be different.

Riverside presents a unique scenario where bus stops are shared with the University of Texas Shuttle. Thus, bus stops are in better condition. However, it would be interesting to determine if at these specific "shared" bus stops locations, perceptions between HT Shuttle users and Capital Metro bus users are different or similar.

The results of this study show that there is a fear of suspicious people, particularly the homeless. Perhaps it would be interesting to explore how homeless persons, in particular, perceive the bus stops and the bus services, what they fear, and how they perceive other bus stop users. Ultimately, a pilot bus stop can be used to implement all the design and attribute recommendations presented in this study. This pilot bus stop can be used as a control group, and a new analysis can be drawn on the perceptions and crimes to determine if, in fact, improving the attributes and conditions will perhaps improve the perception of safety and the crime rate. The results of the pilot bus stop can be contrasted to the results of this study and new recommendations can be developed.

Also, a pilot group of participants can be used to determine if a training course will have an effect on perceptions of safety. It will be interesting to see if upon completion of training, users feel safer and more comfortable while using public buses. This pilot group of participants can be contrasted to the HT focus group participants.

Recommendations

The researchers determined that both studies were necessary to test whether an environmental analysis of bus routes and stops in reported areas of interest would support the findings of the focus groups and student surveys. In summary, students reported that public transit did not meet their needs due to infrequent service, overcrowded buses, unbearable travel time, and negative perceptions of safety at bus stops. To varying degrees, the researchers dealt with all negative responses, except for overcrowded buses. There is a disconnect between how students perceive public transit and our analysis of the system. We found that the students' perceptions were not always consistent with the environmental analysis. The clock travel time was not found to be unreasonable; however, measuring time tolerance is difficult to quantify person to person. The cluster analysis revealed spatial differences when identifying negative attributes. Downtown bus stops had several negative attributes due to the surrounding land use and people. Bus stops in the HT area often lacked seating. It was observed in the East Riverside area, near IH-35, suspicious individuals loitering near bus stops. However, none of the bus stop structures in the three areas were in very poor condition.

The researchers suggest that a transit training program for HT students could be beneficial in improving ridership, including a discount card. This program would compare the City of Austin's system to other city's transit agencies of similar sizes. In addition, specialized sessions would be provided where students are taught how to use the transit system to access their personal destinations, including training in self-defense when facing violence at bus stops. Lastly, students should explore sustainable energy use, including how their travel choices affect their health as well as that of future generations.

APPENDIX A: ACTIVITY TYPE AND POPULAR DESTINATIONS FROM FOCUS GROUP SURVEY

Activity Type	**DESTINATION**
Church	Greater Mount Zion St. James Baptist Church
Exercise	24 Hour Fitness (E 41st St. & IH-35)
Entertainment	Alamo Draft House-Lamar
Event Center	Auditorium Shores Palmer Event Center (SXSW) Austin Convention Center
Grocery Shopping	HEB - Pleasant Valley Walmart Parmer
School	HT
Shopping Center	Barton Creek Mall Highland Mall
Social Anchor	East Riverside area Chicon/12th Street
Work	Actual Work Locations

APPENDIX B: CUMULATIVE DISTRIBUTION FUNCTION

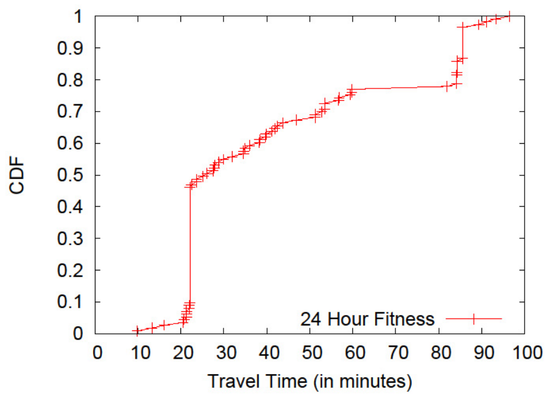


Figure A- 1. CDF of Bus Travel Time to 24 Hour Fitness

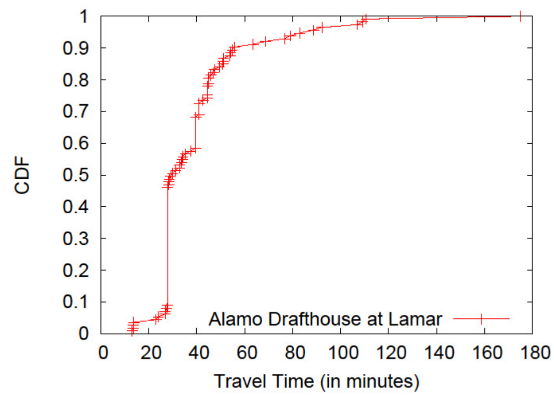


Figure A- 2. CDF of Bus Travel Time to Alamo Drafthouse

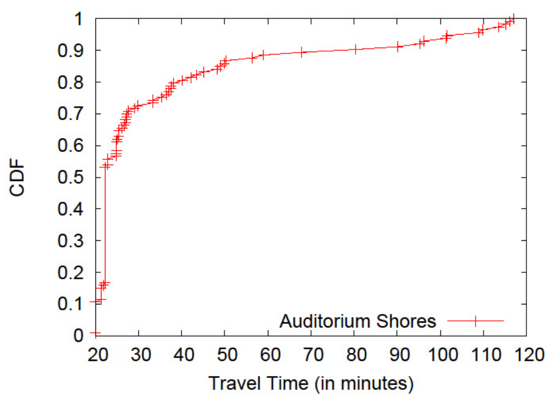


Figure A- 3. CDF of Bus Travel Time to Auditorium Shores

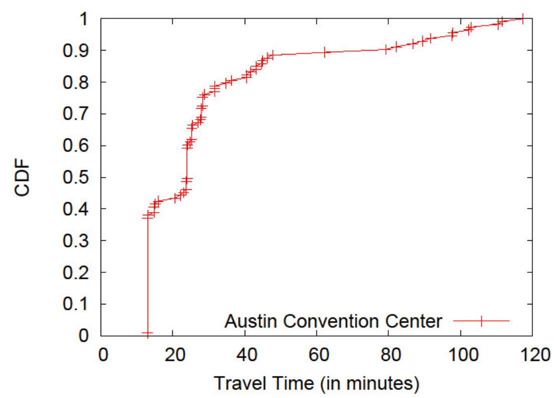


Figure A- 4. CDF of Bus Travel Time to Austin Convention Center

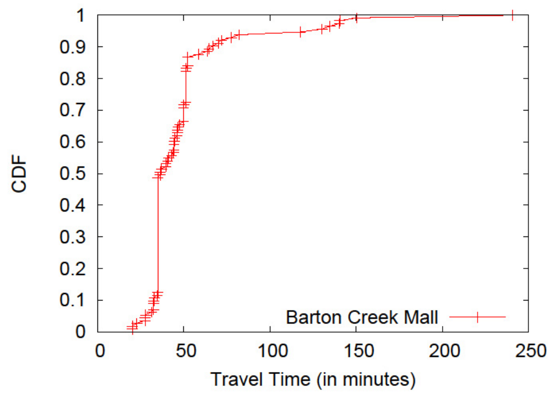


Figure A- 5. CDF of Bus Travel Time to Barton Creek Mall

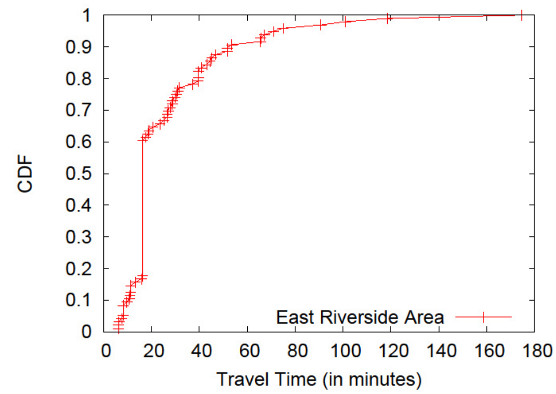


Figure A- 6. CDF of Bus Travel Time to East Riverside Area

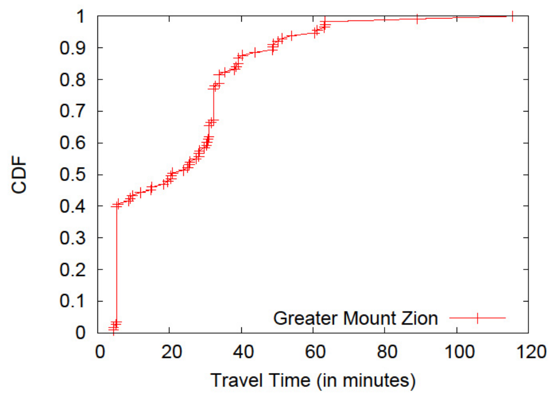


Figure A- 7. CDF of Bus Travel Time to Greater Mount Zion

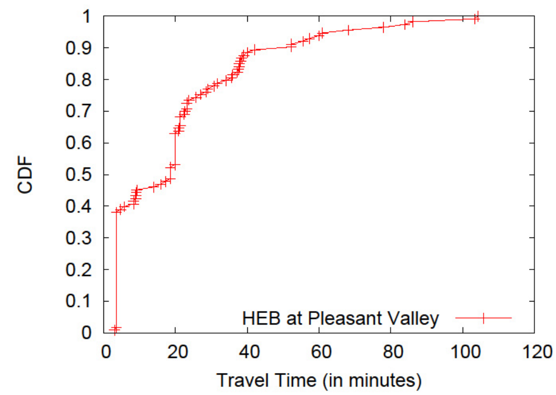


Figure A- 8. CDF of Bus Travel Time to HEB at Pleasant Valley

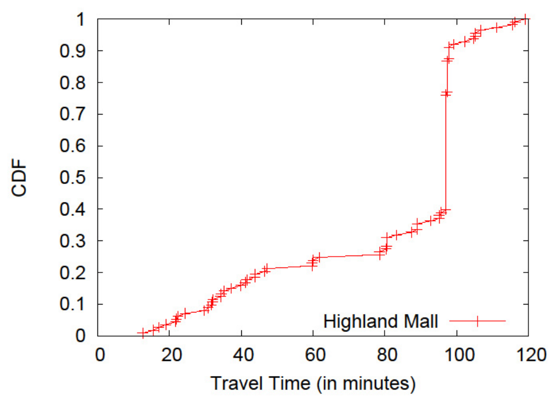


Figure A- 9. CDF of Bus Travel Time to Highland Mall

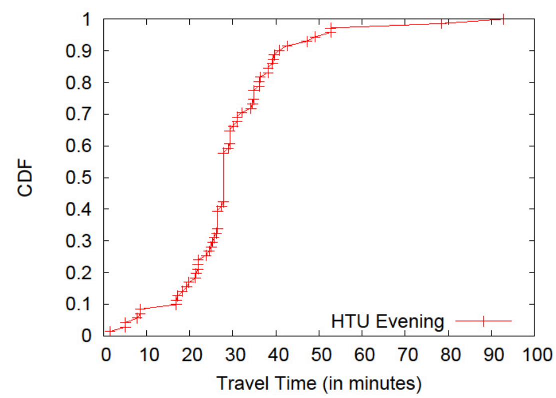


Figure A- 10. CDF of Bus Travel Time to HTU Evening

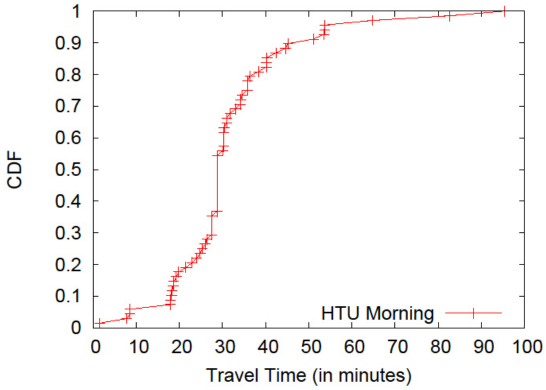


Figure A- 11. CDF of Bus Travel Time to HTU Morning

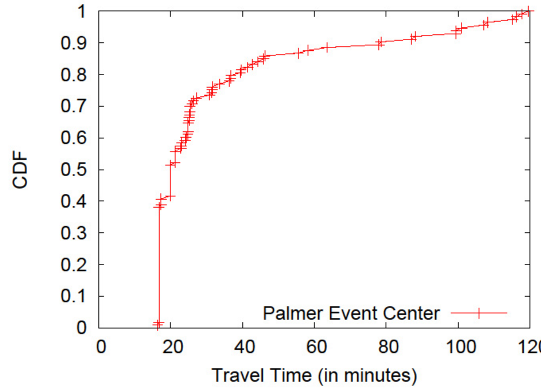


Figure A- 12. CDF of Bus Travel Time to Palmer Event Center

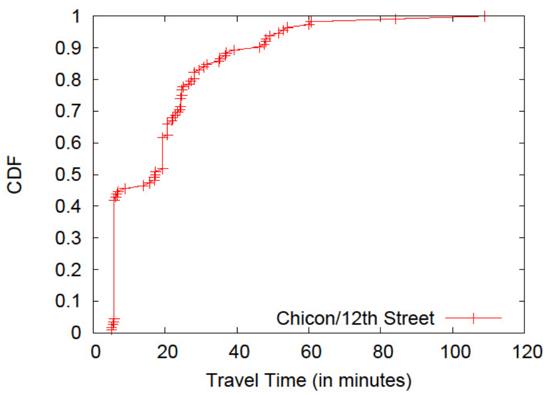


Figure A- 13. CDF of Bus Travel Time to Chicon/12th Street

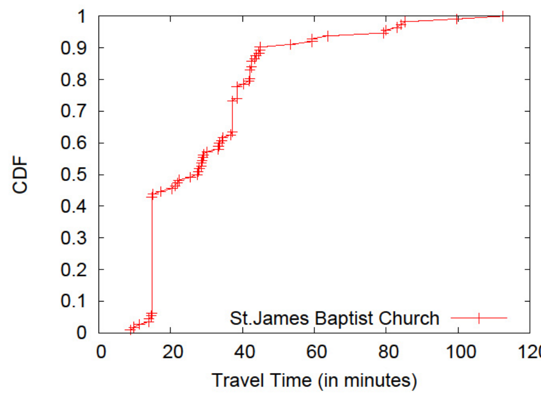


Figure A- 14. CDF of Bus Travel Time to St. James Church

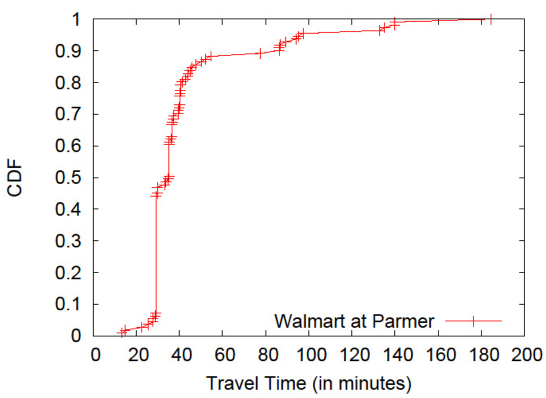


Figure A- 15. CDF of Bus Travel Time to Walmart at Parmer

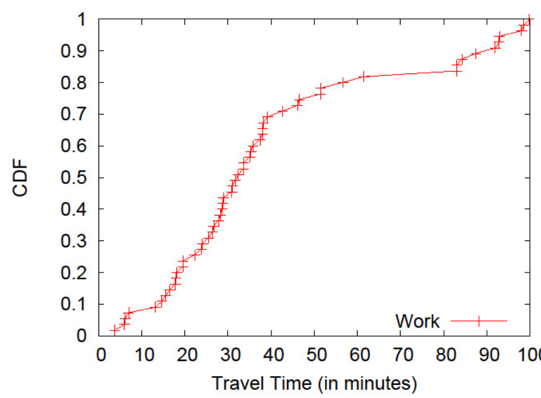


Figure A- 16. CDF of Bus Travel Time to Work

Appendix C: Focus Group Comments and Record Data

	Total Participants	Males	Females	Physically Attacked	Friend Attacked
	37		37	5	16
	17	17		6	11
TOTAL	54			11	27

Built Environment/Perception of Security									
Participants	Police Presence	Familiar with Surroundings & Faces	Walking with Company	Good Lighting	Crowding Areas	Well-maintained & Friendly Built Environment	Others	Total Comments	Average # of Comments by Participant
Total	29	8	11	30	14	31	14	137	6.9
Percentage	21%	6%	8%	22%	10%	23%	10%	100%	
Percentage of Average	54%	15%	20%	56%	26%	57%	26%		

Built Environment/Perception of Insecurity									
Participants	Isolated Dark Areas	Suspicious People	Walking Alone	Hot Spots	Crowding Areas	Lack of Police Presence	Poor Built Environment	Others	Total Comments	Average # of Comments by Participant
Total	36	33	6	15	10	4	14	15	133	6.0
Percentage	27%	25%	5%	11%	8%	3%	11%	11%	100%	
Percentage of Average	67%	61%	11%	28%	19%	7%	26%	28%		

APPENDIX D: ATLAS-TI FREQUENCY OUTPUT AND RESULTS

CODES-PRIMARY-DOCUMENTS-TABLE
Report created by ANA - 02/06/2010 08:41:35 PM
HU: [C:\Users\Ana\Desktop\RESULTS.hpr6]

Code-Filter: All [6]
PD-Filter: All [71]
Quotation-Filter: All [262]

	Isolated Areas	Lighting	Police	Poor Environment	Suspicious People	WellEnvironm ent	TOTALS
P 1: 2-001.doc	0	3	0	0	1	0	4
P 2: 2-002.doc	0	2	0	0	1	1	4
P 3: 2-003.doc	0	3	0	0	1	1	5
P 4: 2-004.doc	1	2	0	0	2	0	5
P 5: 2-005.doc	1	1	1	2	1	1	7
P 6: 2-006.doc	0	3	2	0	2	0	7
P 7: 2-007.doc	0	1	1	0	0	1	3
P 8: 2-008.doc	0	2	0	2	4	0	8
P 9: 2-009.doc	0	1	0	0	1	1	3
P10: 2-010.doc	1	0	1	0	0	0	2
P11: 2-011.doc	0	2	0	0	2	1	5
P12: 2-012.doc	1	2	0	1	0	1	5
P13: 3-001.doc	2	2	0	0	0	0	4
P14: 3-002.doc	0	0	5	0	1	0	6
P15: 3-003.doc	0	1	2	0	0	0	3
P16: 3-004.doc	1	1	0	0	0	0	2
P17: 3-005.doc	0	2	3	0	1	0	6
P18: 3-006.doc	0	0	3	0	1	0	4
P19: 3-007.doc	0	0	2	0	2	1	5
P20: 3-008.doc	0	1	2	0	0	0	3
P21: 3-009.doc	0	2	2	0	0	0	4
P22: 3-010.doc	1	1	2	0	0	0	4
P23: 3-011.doc	0	2	2	0	1	0	5
P24: 3-012.doc	0	0	3	0	0	1	4
P25: 3-013.doc	1	0	0	0	0	0	1
P26: 3-014.doc	0	0	2	0	1	1	4
P27: 3-015.doc	0	1	1	0	1	0	3
P28: 3-016.doc	0	0	2	0	1	0	3
P29: 3-017.doc	0	0	1	0	1	0	2
P30: 3-018.doc	0	0	0	0	1	1	2
P31: 3-019.doc	0	0	1	0	2	2	5
P32: 3-020.doc	0	2	1	0	2	0	5
P33: 3-021.doc	0	3	2	0	1	0	6
P34: 3-022.doc	0	1	0	1	2	0	4
P35: 4-001.doc	0	0	0	0	0	0	0
P36: 4-002.doc	0	0	3	0	0	0	3
P37: 4-003.doc	0	0	1	0	0	0	1

P38: 4-004.doc	0	0	0	0	0	0	0
P39: 4-005.doc	1	3	2	0	0	0	6
P40: 4-006.doc	3	2	1	0	0	0	6
P41: 4-007.doc	0	1	1	0	0	0	2
P42: 4-008.doc	1	2	0	0	0	0	3
P43: 4-009.doc	0	0	1	0	0	0	1
P44: 4-010.doc	0	3	3	1	0	1	8
P45: 4-011.doc	1	1	1	0	0	0	3
P46: 4-012.doc	1	2	0	0	0	1	4
P47: 4-013.doc	2	2	0	1	0	1	6
P48: 4-014.doc	1	3	0	0	0	0	4
P49: 4-015.doc	0	2	0	0	0	0	2
P50: 4-016.doc	1	1	0	0	3	0	5
P51: 4-017.doc	0	0	2	0	0	0	2
P52: 4-018.doc	1	1	0	0	0	0	2
P53: 4-019.doc	0	1	0	0	0	0	1
P54: 4-020.doc	0	2	0	0	0	0	2
P55: NFG1NoteTa	0	1	1	0	2	0	4
P56: NFG1NoteTa	0	0	0	0	0	0	0
P57: NFG2NoteTa	1	1	0	0	1	1	4
P58: NFG2NoteTa	0	0	0	0	2	1	3
P59: NFG2NoteTa	0	3	0	3	5	0	11
P60: NFG3NoteTa	1	0	1	0	2	1	5
P61: NFG4NoteTa	0	1	2	0	3	2	8
P62: NFG4NoteTa	0	1	3	2	2	3	11
P63: PNFocus 1 Q	0	0	0	0	0	0	0
P64: PNFocus 1 Q	0	0	0	0	0	0	0
P65: PNFocus 1 Q	0	0	0	0	0	0	0
P66: PNFocus 2 Q	0	0	0	2	4	0	6
P67: PNFocus 2 Q	0	0	0	0	0	0	0
P68: PNFocus 3 Q	0	0	0	0	4	1	5
P69: PNFocus 3 Q	0	0	0	0	0	0	0
P70: PNFocus 4 Q	0	0	0	0	0	0	0
P71: PNFocus 4 Q	0	1	0	0	0	0	1
TOTALS:	23	75	63	15	61	25	262

APPENDIX E: BUS STOP SURVEY

BUS STOP SURVEY

Surveyor	Date/Time
Street Name/ Landmark/Intersection	Bus Route/Bus Stop Number

A. Bus stop Location and Transit experience

1) Is there a bus shelter?	Yes ☐	No* ☐
*If NO, please go to question 6		
2) Is the shelter accessible by wheelchair? Can a person using a wheelchair fit in the shelter? (minimum space of a common mobility device is 30 inches by 48 inches 760mm X 1200mm)	Yes ☐	No ☐
3) Are there damages to the bus shelter? △	No problems ☐ Broken Panels ☐ Holes in the Roof ☐ Needs repainting ☐	Graffiti ☐ Missing Panel ☐ Uneven floor ☐ Other (Specify) _____________
4) Rank the condition of the Shelter	1 ☐ 2 ☐ 3 ☐ 4 ☐ ☐ 1=Hazardous-broken glass, unstable 2= In poor shape though not hazardous 3= Fair, needs repainting, glass panels, needs cleaning, not hazardous bolts 4=Good, not perfect; but, no immediate repair needed 5=cosmetically excellent, new	
5) Which way does the shelter face? (orientation in relation to the street)	Facing Towards the Street ☐ Facing away from the street ☐	Facing on-coming traffic ☐ Other (specify) _________
6) What type of seating is available at the bus stop?	No seating* ☐ Bench inside the shelter ☐ Freestanding bench ☐	Fold down bench ☐ Leaning bench ☐ Other (specify):____________

*If NO seating, please go to question 9.		
7) Are there problems with the seating? △	No problems ☐ Broken pieces ☐ Need painting ☐ Filthy /Rusty ☐ Bushes/roots obstructing seating ☐	Graffiti ☐ Not securely installed ☐ Cracks and Holes ☐ Other (Specify):___________
8) Rank the condition of the Seating	1☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐	
	1= Hazardous, broken, someone could get hurt from normal use 2=In poor shape. though not hazardous 3=Fair, needs repaiting, needs cosmetic attention, not hazardous bolts 4=Good, not perfect; but, no immediate repair needed 5=Cosmetically excellent, new	
9) Where is the bus stop positioning in relation to the nearest intersection?	Nearside (before the bus crosses the intersection) ☐ Not near an intersection ☐ Mid-block ☐	Far side (Afte the bus crosses the interesection) ☐ Freeway bus pad ☐ N/A ☐
10) Adjacent property address (or name of business if visible)		
11) Adjacent property description △	Apartment Building ☐ Day Care ☐ Government Building ☐ Hospital ☐ Human Services Agency ☐ Industrial Site/Building ☐ Library ☐ Mall/Shopping Center ☐ Nursing Home ☐ Office Building ☐ Bar/Pub ☐	Park ☐ Park and Ride ☐ Place of Workship ☐ Residence-Townhouse ☐ Single residence ☐ Retail Store ☐ School ☐ Supermarket ☐

		Transit Station/Hub ☐ Vacant Lot ☐ Other (Specify):___________
12) Distance from the previous bus stop in feet?		
13) Is there a <u>visible</u> companion bus stop across the street?	Yes ☐ No ☐	
14) Where is the landing area positioned in relation to the curb/street	No landing area * ☐ Below street level (low ground or shoulder) ☐ Sidewalk ☐ Shoulder ☐	Adjacent ☐ Bus Bulb ☐ Off-Road ☐ Other (Specify):___________
***If NO landing area, please go to question 17.**		
15) What's the material of the Landing Area?	Asphalt ☐ Concrete ☐ Gravel ☐ Other (Specify):_____________	Dirt ☐ Grass ☐ Pavers ☐ N/A ☐

16) Are there problems (accessibility related) with the landing area?		No Problem	Not Accessible	Minimally Accessible	Accesssible
	Bushes/Trees/Roots	☐	☐	☐	☐
	Wheelchair mobility (too narrow)	☐	☐	☐	☐
	Surface Uneven	☐	☐	☐	☐
	Slopes up from the street	☐	☐	☐	☐
	Slopes down from the street	☐	☐	☐	☐
	Requires stepping over drain inlet	☐	☐	☐	☐
	Other (Specify)________				

17) Is there a sidewalk?	Yes ☐ No* ☐	
***If NO sidewalk, please go to question 20**		
18) Are there any physical barriers that constrict the	No physical barriers ☐ Electric/Telephone Poles ☐	Tree/Roots/Bushes ☐ Traffic Signs (Stop/Yield/etc) ☐

△

width of the sidewalk? (within the bock on which the bus stop is located)	Trash Cans ☐ Benches ☐ Newspaper Stand ☐ Sewer/Drainage Inlet ☐	Police Call Box ☐ Public Phone ☐ Street Light ☐ Other (Specify):___
19) Rank the condition of the sidewalk	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 1= Hazardous, large breaks, cracks, root uplifting, someone could get hurt from normal use or use of a wheelchair would be difficult 2=In poor shape though not hazardous, very rough, some root upflifting, cracks, breaks 3=Fair, minor root uplifting, minor cracks or breaks 4=Good, not perfect, but no inmediate repair needed 5=comestically excellent, new	
20) What are the primary trip generators for passengers at this bus stop? (Check all that apply) △	Apartments-large complex ☐ Apartments small building ☐ Townhomes ☐ Detached homes ☐ Day-care/pre-school ☐ Gas Station ☐ Government building ☐ Hospital/major Clinic ☐ Hotel ☐ Human Service Agency ☐ Library ☐ Major Shopping/employment(*wal-mart, target, mall)* ☐ Entertainment (Bar/Clubs/Pubs/ Movies/Theaters/Restaruants) ☐	Office Building*/employment* ☐ Park and Ride ☐ Place of Workship ☐ Elementary/Middle School ☐ High School ☐ College/University ☐ Senior Center ☐ Transfer to other bus stop ☐ Transit Station (Hub) ☐ Nursing Home ☐ Neighrohood Shopping (*grosery store)* ☐ Other (Specify):_______
21) What pedestrian amenities are at the nearest intersection (or other crossing opportunity)? △	Curb cuts all corners/ both side ☐ Visible crosswalk ☐ Curb cuts at some corners/ one side ☐ Pedestrian crossing signals ☐ Audible crosswalk signal ☐	Accessible Pedestrian Signal ☐ Traffic Light ☐ Crossing guard assistance ☐ Tactile warning strip on curb cut ☐ Other (Specify):_____________
22) Are there any problems with the trash receptacles? △	No Trash receptacle* ☐ Trash can very full ☐ Trash can not Securely installed ☐	Dirty and Filthy ☐ No problems with trash receptacle ☐ Other (Specify):________
***If NO Trash Receptacle please go to question 24 (Section B)**		

23) What is the type of installation for the trash receptacles? △	Attached to the Shelter ☐ Free Standing ☐	Garbage Bag ☐ Bolted to sidewalk ☐ Other (Specify) ______

B. Safety and Security

24) Where is the bus stop located?	In travel lane ☐ Bus lane/pull-off area ☐ Paved Shoulder ☐ No-parking portion of street ☐	In right turn only lane ☐ Unpaved shoulder ☐ Off Street ☐ Other (Specify):_________
25) Are cars parked in either side or between the landing area and the bus stopping area?	Yes ☐ No ☐	
26) Is there any speed limit sign near the bus stop?	Yes ☐ No ☐ Speed Limit in MPH: _________________	
27) What are the traffic controls at the nearest intersection? △	Traffic signals ☐ Flashing Lights ☐ Pedestrian Crossing Signal ☐	Crosswalk ☐ Stop/Yield sign ☐ No Traffic controls (None) ☐ Other (Specify):___________
28) Are there any potential traffic hazards? △	No potential traffic hazard ☐ The bus stop is just over the crest of a hill ☐ The bus stop is just after a curve in the road ☐ The bus stop is near an at-grade railroad crossing ☐ Waiting passengers are hidden from view of approaching bus ☐ A stopped bus straddles the crosswalk ☐ Bus stop just before crosswalk ☐	

	High speed traffic ☐ No crosswalk ☐ Other (Specify):______________________	
29) What type of lighting is available? (check at night only) △	No lighting ☐ Street light ☐ Shelter lighting ☐ Outside light on adjacent building ☐	Outside light on adjacent building ☐ Other (Specify)____________________
30) Are there any visible payphones?	Yes ☐	No ☐
31) Is the payphone within reach of a wheelchair?	Yes ☐	No ☐
32) Are there any visible police call box?	Yes ☐	No ☐
33) Is the police call box within reach of a wheelchair?	Yes ☐	No ☐
34) What countermeasures are you able to observe in the bus stop? (Security features)	No countermeasures (None) ☐ Security and security patrols Design actions ☐ (lighting, plataforms layouts, landing areas, recess wall, good visibily) ☐	Better information (poster, help-line instructions, ☐ anti-drug message) Use of Technology (cameras, emergeny phones ☐

35) Are there any negative environmental attributes or hazards?	Yes ☐ No* ☐	
***If NO negative environmental attributes, please go to question 38**		
36) What kind of negative attribute you can observe? △	Suspicious People (Homeless/Drunks/Dealers/Prostitutes) ☐ Broken windows ☐ Dark Alleys ☐ Poor Lighting ☐ Dirty Streets (Trash) ☐ Vacant Store/building ☐ Liquour Stores ☐ Pawn shops ☐ Bushes/Trees limiting visibility ☐	Dark Spots ☐ Motel ☐ Sex Shops ☐ XXX Theaters ☐ XXX Video Stores ☐ Strip Club ☐ Cantinas/Bar/Pub ☐ Billard/Pocker Rooms ☐ Other (Specify):_______________
37) Are there problems with the landscaping around the bus stop? △	No Landscaping ☐ No Problems with landscaping ☐ Trees/bushes encroaching on the landing area ☐ Trees and bushes encroaching on the sidewalk ☐ Tree branches that would hit the bus ☐ Poorly maintained/dry ☐ Filty/Dirty ☐ Other (Specify):________________________	
38) Is there a bus stop sign?	Yes ☐ No* ☐	

***If NO bus stop sign, please go to the general comments at the end of the questionnaire.**		
39) What information do the sign include? △	Bus Route ☐ Schedule ☐ Connetions ☐	Map ☐ Advertisment/Provider ☐ Other (Specify):______________
40) Are there problems with the signage? △	No problem with signage ☐ Not in eye level of wheelchair ☐ Letters too small/unreadable ☐ Sign in poor condition ☐ Pole in poor condition ☐	Blurry/unclear ☐ Sign not permanetly mounted ☐ Lighting on sign is poor ☐ Sign position hazardous to pedestrians ☐ Other (specify):_______________

***General Comments and Observations (attach photograph of the bus stop to the file):**

____

____

____

APPENDIX F: BUS STOP SURVEY AND FREQUENCY ANALYSIS

Evaluation of Bus Stops (N=38)

TABLE 1 *Bus Stop Shelters and Seating*		*Frequency and Percentage*	
Bus Stops with Shelter		**Yes =11 (29.0%)**	**No=27 (71.0%)**
	Shelter Accessible in Wheelchair	Yes=10 (90.9%)	No=1 (9.1%)
Shelter Damage		**Yes=5 (45.5%)**	**No=6 (54.5%)**
	Graffiti	Yes=5 (45.5%)	No=6 (54.5%)
	Broken Panels Roof with Holes Needs Repainting Missing Panels Uneven Floor Other	0 (0%)	
Shelter Condition		**Fair= 2 (18.2%)**	**Good=9 (81.8%)**
Shelter Orientation		**Facing Towards Street=11 (100%)**	
Seating at Bus Stops		**Yes=27 (71.0%)**	**No=11 (29.0%)**
Bus Stop Seating Type			
	Bench inside Shelter	10 (26.3%)	
	Freestanding Bench	17 (44.7%)	
Seating Problems		**Yes= 10 (37%)**	**No=17 (63%)**
	Needs Repainting	Yes=4 (14.8%)	No=23 (85.2%)
	Filthy and Rusty	Yes=8 (29.6%)	No=19 (70.4%)
	Graffiti	Yes=1 (3.7%)	No=26 (96.3%)

	Other	Yes=1 (3.7%)		No=26 (96.3%)
	Broken Pieces Bushes /Trees Obstructing Seating Seating not securely installed Seating with cracks and holes	0 (0%)		
Seating condition		Fair=9 (33.3%)	Good=11 (40.7%)	Excellent=7 (25.9%)

TABLE 2 ***Bus Stop Descriptions***		***Frequency and Percentage***	
Bus Stop Position			
1	Nearside	23 (60.5%)	
2	Mid-block	9 (23.7%)	
3	Farside	6 (15.8%)	
Distance from Previous Bus Stop in Miles			
	0.06	1 (2.6%)	
	0.08	1 (2.6%)	
	0.1	22 (57.9%)	
	0.2	9 (23.7%)	
	0.3	2 (5.3%)	
	0.4	2 (5.3%)	
	0.5	1 (2.6%)	
Has a Companion Bus Stop		Yes=33 (86.8%)	No=5 (13.2%)
Bus Stop Location			
1	In Travel Lane	36 (94.8%)	

2	Pull-off Area	1 (2.6%)	
3	Paved Shoulder	1 (2.6%)	
Posted Speed Limit near Bus Stops		**Yes=5 (13.2%)**	**No=33 (86.8%)**
Cars found parked in Bus Stop Area (incl. Landing Area)		**Yes=12 (31.6%)**	**No=26 (68.4%)**
Bus Stop Signage		Yes=38 (100%)	No=0%
	Bus Route #	38 (100%)	
	Schedule	7 (18.4%)	
	Connections	6 (15.8%)	
	Maps	7 (18.4%)	
	Advertisement	13 (34.2%)	
	Other	1 (2.6%)	
Bus Stop Signage Problems		Yes=10 (26.3%)	No=28 (73.7%)
	Not in Eye level of Wheelchair	1 (2.6%)	
	Letters too small and unreadable	2 (5.3%)	
	Pole in Poor condition	1 (2.6%)	
	Sign with poor lighting/ or poorly illuminated	5 (13.2%)	
	Other	3 (7.9%)	
	Sign in Poor condition Sign Blurry and Unclear Sign no Permanent Mounted Sign position hazard	0 (0%)	

TABLE 3 *Landing Area and Sidewalk*		*Frequency and Percentage*		
Landing Area		Yes=35 (92.1%)		No=3 (7.9%)
Landing Area Position				
3	Below Street	32 (91.4%)		
4	Sidewalk	3 (8.6%)		
Landing Area Material				
	Asphalt	1 (2.9%)		
	Concrete	30 (85.7%)		
	Pavers	2 (5.7%)		
	Other	2 (5.7%)		
	Gravel Dirt Grass	0 (0%)		
Landing Area with Problems		**Yes=28 (73.7%)**		**No=10 (26.3%)**
Landing Area Problems		**Not Accessible**	**Minimal Accessible**	**Accessible**
	Bushes and Trees	0 (0%)	5 (17.9%)	10 (35.7%)
	Wheelchair Mobility	3 (10.7%)	13 (46.4%)	11 (39.3%)
	Uneven Surface	1 (3.6%)	4 (14.3%)	10 (35.7%)
	Slopes Up	0 (0%)	3 (10.7%)	10 (35.7%)
	Slopes Down	0 (0%)	2 (7.1%)	9 (32.1%)
	Stepping over drain inlet	1 (3.6%)	0 (0%)	10 (35.7%)
	Other	1 (3.6%)	1 (3.6%)	2 (7.1%)
Bus Stops with Sidewalk		**Yes=37 (97.4%)**		**No=1 (2.6%)**
Sidewalk with Physical Barriers		**Yes=17 (45.9%)**		**No=20 (54.1%)**

	Electric or Telephone Poles	3 (8.1%)
	Benches	1 (2.7%)
	Sewer or Drainage	1 (2.7%)
	Trees/roots/bushes	7 (18.9%)
	Traffic Sign	5 (13.5%)
	Public Phone Box	1 (2.7%)
	Street Light	4 (10.8%)
	Other	7 (18.9%)
	Trash Cans Police Call Box News Stand	0 (0%)
Condition of Sidewalk		
2	In poor shape	1 (2.7%)
3	Fair	7 (18.9%)
4	Good	21 (56.8%)
5	Excellent / New	8 (21.6%)

TABLE 4 ***Bus Stop and Pedestrian Amenities***		***Frequency and Percentage***	
Type of Pedestrian Amenities			
	Curb cuts all corners	23 (60.5%)	
	Visible crosswalk	28 (73.7%)	
	Curbs cuts at one side	15 (39.5%)	
	Pedestrian crossing signal	22 (57.9%)	
	Accessible Pedestrian Signal	8 (21.1%)	
	Traffic Light	21 (55.3%)	
	Tactile Warning	2 (5.3%)	
	Audible crosswalk Signal Crossing Guard Other	0 (0%)	
Trash Can		**Yes=28 (73.7%)**	**No=10 (26.3%)**
	Trash Can Full	3 (10.7%)	
	Trash can not secured	0 (0%)	
	Dirty and filthy	2 (7.1%)	
	Problems with trash can	Yes=6 (21.4%)	No=22 (78.6%)
	Other	2 (7.1%)	
Type of Trash Can		Free Standing= 28 (100%)	
Visible Payphones		Yes=5 (12.8%)	No=34 (87.2%)
Payphones Accessible in Wheelchair		Yes=2 (40%)	No=3 (60%)
Visible Police Call Box		Yes=1 (2.6%)	No=38 (97.4%)
Police Call Box accessible in wheelchair		0%	

TABLE 5 ***Bus Stop Areas and Adjacent Property Descriptions***	***Frequency and Percentage***
Bus Stops Adjacent Property Type	
Apartment complex	9 (23.7%)
Bar and Pub	8 (21.1%)
Government Bldg	4 (10.5%)
Human Service Agency	3 (7.9%)
Mall Shopping	6 (15.8%)
Office Building	15 (39.5%)
Other Parking Lot	4 (10.5%)
Other Restaurant	4 (10.5%)
Park	1 (2.6%)
Park and Ride	1 (2.6%)
Place of Worship	4 (10.5%)
Residence Townhouse	1 (2.6%)
Retail Store	9 (23.7%)
School	6 (15.8%)
Single Residence	6 (15.8%)
Supermarket	4 (10.5%)
Transit Station	3 (7.9%)
Vacant Lot	6 (15.8%)
Other	3 (7.9%)
Daycare Hospital Clinic	

	Industrial Site Library Nursing Home	0 (0%)	
Bus Stop landscape		Yes=23 (60.5%)	No=15 (39.5%)
Bus Stops with Landscape Problems		**Yes=7 (30.4%)**	**No=16 (69.6%)**
	Trees Bushes encroaching Landing Area	2 (8.7%)	
	Trees Bushes Encroaching Sidewalk	3 (13.0%)	
	Tree branches hit the bus	4 (17.4%)	
	Poorly maintained and Dry	2 (8.7%)	
	Filthy and Dirty	2 (8.7%)	
	Other	1 (4.3%)	
Bus Stop Primary Trip Generators			
	Apartment complex	9 (23.7%)	
	Apartment Small Bldg	7 (18.4%)	
	College	8 (21.1%)	
	Daycare	1 (2.6%)	
	Employment Center	5 (13.2%)	
	Entertainment	20 (52.6%)	
	Gas Station	4 (10.5%)	
	Government Bldg	3 (7.9%)	
	Homes	6 (15.8%)	
	Hotel	5 (13.2%)	
	Human Services	2 (5.3%)	
	Neighborhood Grocery	6 (15.8%)	
	Office Building	15 (39.5%)	

	Park and Ride	2 (5.3%)	
	Pharmacy	3 (7.9)	
	Place of Worship	5 (13.2%)	
	Senior Center	1 (2.6%)	
	Townhomes	3 (7.9%)	
	Transfer Bus	8 (21.1%)	
	Other	4 (10.5%)	
	Elementary/Middle School Library High School Hospital/Clinic Nursing Home Transit Hub	0 (0%)	
Bus Stop Area Traffic Controls		**Yes=35 (92.1%)**	**No=3 (7.9%)**
	Traffic Signal	31 (81.6%)	
	Pedestrian Crossing Light	21 (55.3%)	
	Crosswalk	28 (73.7%)	
	Stop/Yield sign	5 (13.2%)	
	Flashing Signal Other	0 (0%)	
Bus Stop Area Traffic Hazards		**Yes=36 (94.7%)**	**No=2 (5.3%)**
	Bus stop over hill	1 (2.8%)	
	Bus stop in curve	1 (2.8%)	
	Waiting Passenger hidden from view	5 (13.9%)	
	Bus Straddles crosswalk	7 (19.4%)	

	Bus Stop before crosswalk	17 (47.2%)	
	High speed traffic	17 (47.2%)	
	No Crosswalk	10 (27.8%)	
	Other	6 (16.7%)	
Bus Stops with lighting		**Yes=37 (97.4%)**	**No=1 (2.6%)**
	Street Light	37 (100%)	
	Shelter Light	0 (0%)	
	Outside Light	7 (18.9%)	
	Other	2 (5.4%)	
Bus Stop Area Countermeasures		**Yes=16 (42.1%)**	**No=22 (57.9%)**
	Design Actions	11 (68.8%)	
	Use of Technology	5 (31.3%)	
	Better Information Security Patrols	0 (0%)	
Bus Stops with negative environmental attributes		**Yes=32 (84.2%)**	**No=6 (15.8%)**
	Types of negative environmental attributes		
	Billiard and Poker Room	1 (3.1%)	
	Liquor Stores	2 (6.3%)	
	Pawn Shop	2 (6.3%)	
	Dirty Streets	4 (12.5%)	
	Other	4 (12.5%)	
	Broken Windows	5 (15.6%)	
	Parking Lot	6 (18.8%)	
	Cantinas Bar and Pub	8 (25.0%)	

	Vacant Stores/lot	10 (31.3%)
	Suspicious People	12 (37.5%)
	Poor Lighting	14 (43.8%)
	Bushes Trees limiting visibility	15 (46.9%)
	Dark Spots	18 (56.3%)
	Dark Alley Motel Sex Shops Strip Clubs XXX Theaters XXX Video Stores	0 (0%)

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