The Report Committee for Caroline Meeden Bailey
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Pedestrian Counting Methods:
A Case Study for Austin's Pedestrian Program

APPROVED BY
SUPERVISING COMMITTEE:

Supervisor:

____
Sandra Rosenbloom

____
Joel Meyer

Pedestrian Counting Methods:
A Case Study for Austin's Pedestrian Program

by

Caroline Meeden Bailey, B.A.

Report

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Abstract

Pedestrian Counting Methods: A Case Study for Austin's Pedestrian Program

Caroline Meeden Bailey, M.S.C.R.P.

The University of Texas at Austin, 2017

Supervisor: Sandra Rosenbloom

The Pedestrian Program is the only program within the City of Austin that is devoted solely to pedestrian issues and planning within the City. Thus far, the program has been primarily concerned with pedestrian safety; with the release of the Pedestrian Safety Action plan this year, the program will soon be focusing on broader pedestrian issues. Namely, the Pedestrian Program would like to evaluate the walkability of Austin and collect data on pedestrian activity within the City that will help the City pass pedestrian-friendly policies and make improvements aimed at increasing the walkability of Austin. While there are many quantitative and qualitative measurements for evaluating walkability available, the Pedestrian Program would like to focus on counting pedestrians within Austin. The goal would be to implement a permanent pedestrian counting program within the Pedestrian Program, with specific goals the program would like to accomplish through the pedestrian counting program.

This professional report will outline a plan for how the Pedestrian Program can best achieve their pedestrian counting goals. This professional report reviews the importance of

planning for pedestrians as well as the current state of practice for pedestrian counting. Using case studies of pedestrian counting from around the United States, as well as an overview of readily available pedestrian counting techniques, I outline what the Pedestrian Program's goals are for their permanent pedestrian counting program, and I offer specific techniques aimed at achieving each goal. I found that, rather than a one-size-fits-all approach, the Pedestrian Program would be best served by a specific technique applied to each goal in order to obtain the best data that it can.

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Chapter One: Introduction

Austin, Texas, in the past few decades, has changed from a small and sleepy college-centered city to a rapidly growing with many industries that are attracting new residents from all over the United States. Austin has, historically, been a city that is dependent on automobile travel. This history of automobile travel is now at odds with how fast the city has been growing, leading to traffic congestion and ever-expanding and sprawling suburban development. In recent years, there has been interest in increasing the amount of people utilizing other modes of transportation in order to solve Austin's traffic woes, which has led to the creation of several active-transportation promoting policies and City departments. One such department within the City is the Active Transportation and Street Design Division within the Austin Transportation Department, which is home to Austin's Pedestrian Program, established in 2016.

The Pedestrian Program is the only program within the City of Austin that is devoted solely to pedestrian issues and planning within the City. Thus far, the program has been primarily concerned with pedestrian safety; with the release of the Pedestrian Safety Action plan this year, the program will soon be focusing on broader pedestrian issues. Namely, the Pedestrian Program would like to evaluate the walkability of Austin and collect data on pedestrian activity within the City that will help the City pass pedestrian-friendly policies and make improvements aimed at increasing the walkability of Austin. While there are many quantitative and qualitative measurements for evaluating walkability available, the Pedestrian Program would like to focus on counting pedestrians within Austin. Pedestrian activity levels throughout the City would be tracked over time in order to determine if walkability is, in fact, increasing within the City. The goal would be to implement a permanent pedestrian counting program within the Pedestrian Program.

This report will explore the current state of pedestrian counting methods and present options to the Pedestrian Program for planning and implementing a pedestrian counting program. Chapter Two will provide a brief overview of why pedestrian planning is important, and how pedestrian counting can be beneficial for pedestrian planning. Following that, Chapter Three will discuss policies and programs at the City of Austin that would benefit from the data collected from a permanent pedestrian counting program before discussing the goals of the Pedestrian Program in implementing a permanent pedestrian counting program.

Chapter Four will present and examine the best and most common methods and technologies available for counting pedestrians, including the benefits, drawbacks, associated costs, and tradeoffs for each one. I will also discuss emerging new technologies that may be useful for pedestrian counting in the future. Then, this report will take each of the goals of the pedestrian counting program and determine which method is best suited for each goal.

Finally, Chapter Five will discuss next steps and things for the Pedestrian Program to think about, including analyzing the data, sharing the data, and evaluating the pedestrian counting program. Following that, there will be a brief summary of the overall report with key takeaways. Then, the report will conclude.

Chapter Two: Planning for Pedestrians

WHY IS IT IMPORTANT TO PLAN FOR PEDESTRIANS?

For a majority of the last century, development within the United States has revolved around the automobile, to the detriment of people who would like to either bike or walk to their destinations. Reliance on the private car has led to sprawling cities and negative consequences for people and the environment. The Center for Disease Control and Prevention reports that 36.5% of adults in the United States were obese in 2011-2014 due to lack of physical activity (Ogden, 2016). Trapped greenhouse gas emissions increasingly make the planet warmer and potentially too warm to comfortably support human life in the future. Emissions from automobiles make up about 16% of the total greenhouse gas emissions in the United States (EPA, 2016). One way to reduce the number of auto trips that contribute to global greenhouse gas emissions is to promote active transportation alternatives, such as walking for all trips, not just walking for recreation. Komanoff et al (1993) find that between 1.2 and 5.0 percent of passenger vehicle emissions of CO, NOx, VOCs, and CO2 were annually offset by bicycling and walking (although this is a high estimate). Encouraging people to replace their automobile trips with active transportation modes is one way that cities can combat climate change.

Careful planning to encourage pedestrianism and to create walkable communities must consider a wide range of physical, environmental, social, and human factors. A city needs more than sidewalks to call itself walkable; the overall design of the streets and the surrounding environment must making walking a feasible and appealing alternative to driving for many people. The appropriate pedestrian infrastructure and improvements, as well as proper maintenance of those facilities, would increase walking which can decrease vehicle miles traveled and provide positive benefits for cities and for people.

What kind of positive benefits could walkable cities provide? Walkable cities could contribute to increased traffic safety by increasing the number of pedestrians on the streets and changing the behavior of drivers so they respect pedestrians (Jacobsen, 2003). Encouraging people to walk more would lead to healthier lives; walking is an easy and free activity for most people (U.S. Department of Health and Human Services, 2015). Frank et al (2004) show that “increased levels of mixed use and corresponding moderate physical activity (i.e., walking) are associated with reduced odds of obesity” (p. 94). Walkable neighborhoods also enable people to reduce automobile use for commuting to jobs or running errands; when residents live closer to their jobs they can spend less of their income on transportation (Quednau, 2016; Leinberger & Alfonzo, 2012). Transportation costs are usually the second highest household expenditure; in Austin, Texas, for example, the average annual transportation cost per household is $12,264 (H+T Affordability Index, 2017). Walkable neighborhoods can contribute to positive mental and emotional health by encouraging social interactions between people on city streets (Watts et al., 2015; Finlay et al., 2015). Walkable places typically have higher housing values, reflecting the popularity of accessible neighborhoods. Other benefits of walking in lieu of driving include decreased traffic congestion and street noise (Rabl & de Nazelle, 2012; Giles-Corti et al., 2014).

Increasing walkability may have some negative consequences. Increased home prices resulting from increased pedestrian infrastructure could lead to gentrification and community displacement when current residents cannot pay increasing taxes and other rising homeowner costs. Careful planning, however, can help cities mitigate those negative impacts and ensure that pedestrian improvements benefit everyone in the city. Pedestrian planning can be done with every community in mind, with a focus on equity.

There are a variety of tools that cities can use to measure walkability that will aid cities in their pedestrian planning efforts. The Austin Pedestrian Program would like to implement a permanent pedestrian counting program as their first step in planning for a walkable city. This report focuses on the Program's original goal: counting pedestrians and learning how pedestrian counting can be useful for the Pedestrian Program and the City of Austin as a whole.

WHAT IS PEDESTRIAN COUNTING AND WHY IS IT USEFUL FOR PLANNING?

Pedestrian counting refers to the practice of collecting pedestrian volume data: selecting a location or multiple locations, and counting each pedestrian that walks by. Counting can either be done manually or using automated devices. Cities have long used a variety of systems for collecting, summarizing, and disseminating motor vehicle traffic volumes, but those systems do not typically include pedestrian or bicycle volume data (Ryus et al., 2014). Cities typically collect pedestrian volume data for specific projects, rather than across a city as a whole. Transportation agencies that lack system-wide pedestrian volume data, however, do not know where pedestrian facilities are needed the most or which facilities are most in the need of improvement. Collecting pedestrian volume data at random locations is not sufficient for calculating pedestrian levels throughout a city nor do the data allow cities to estimate what pedestrian volume levels may look like in the future.

It is important to differentiate between motorized (motor vehicle) and non-motorized (pedestrian) volume data for several reasons. First, non-motorized volumes fluctuate more from day to day than motor vehicle volumes, particularly due to the weather or other environmental variables. Day to day variability is also related to lower hourly pedestrian volumes compared to automobile volumes. Adjacent land uses tend to impact pedestrian volumes more than vehicular traffic because pedestrian trips are also usually shorter than trips made by automobile and typically have different purposes than automobile trips (Kuzmyak, Walters, Bradley & Kockelman, 2014). The peak periods for pedestrian trips and automobile trips may also not coincide. It is difficult to detect bicyclists and pedestrians in motorized counts because they are smaller than automobiles; do not always stay in sidewalks or bike lanes; sometimes move in unpredictable ways such as crossing streets where there are no marked crosswalks; may linger in front of sensors; and usually will travel closely together, which will make it difficult for the sensor to distinguish individual members of a group, and may lead to undercounting of pedestrians or bicyclists (FHWA, 2011; Ryus et al., 2014). Automatic vehicle counters are not likely to record pedestrians accurately for these reasons. Finally, it is also important to understand that the methods used to count non-motorized vehicles differ from those used for counting automobiles; so traffic engineers may not have as much experience using these methods.

CASE STUDIES OF PEDESTRIAN COUNTS THAT HAVE VALUE FOR PLANNERS.

This section highlights case studies showing how cities or governmental organizations have used pedestrian counts for a variety of planning purposes. These case studies illustrate how pedestrian count data can be useful for different projects and programs, such as Safe Routes to School programs, yearly data analysis, or even the process of creating a Pedestrian Master Plan. Some of the case studies also involve bicycle counts, because many organizations combine pedestrian and bicycle counts in their programs; the case studies still offer insight that will help the Pedestrian Program plan and implement a pedestrian-only counting program. Additionally, some of the case studies do not necessarily show that walking increased when the city focused on pedestrian counts, but how the pedestrian counts were useful for planning purposes and evaluation of programs and policies. Altogether, the case studies will provide valuable lessons to Austin's Pedestrian Program that will help them plan their own counting program and ensure they capture valuable pedestrian data.

California's Safe Routes to School Program

Many communities, states, and even the federal government have official Safe Routes to School programs that are aimed at increasing the number of children walking to and from school. The state of California has one such program, which funds six type of infrastructure improvements: sidewalk improvements; traffic calming and speed reduction projects; pedestrian and bicycle crossing projects; bicycle facilities; traffic control devices; and traffic diversion projects for schools statewide. In a study of 10 California elementary schools that received Safe Routes to School improvements, Boarnet, Day, Anderson, McMillan, and Alfonzo (2005) determined the expected outcomes of each improvement type funded by the Safe Routes to School Program, and measured the actual outcomes of each improvement type against the expected outcomes. The authors surveyed parents and counted pedestrians before and after each improvement was installed in order to gauge whether the projects had shown evidence of success. Most of the sidewalk gap closure projects resulted in an increased numbers of children walking to and from school as well as decreased numbers of children walking in the street or on the shoulder once the missing sidewalk was constructed (Boarnet et al., 2005). However, the other types of Safe Routes to School projects did not show as large an impact.

Santa Monica's Pedestrian Demand Index Model

In Santa Monica, California, the city used the data collected from biannual pedestrian counts, along with other data, to create a Pedestrian Demand Index map that shows which areas of Santa Monica are likely to see the highest rates of pedestrian numbers and demand for pedestrian improvements (City of Santa Monica, 2016). Santa Monica's Pedestrian Suitability Index Demand Analysis included demographic information, social equity data, land use data, special district information, pedestrian counts, and physical geography data. The city was able to combine the demand index with an analysis of existing pedestrian infrastructure in order to see which areas would benefit the most from improvements, especially if they were crucial connections to elsewhere. Santa Monica was then able to use these data to create their Pedestrian Action Plan for future pedestrian planning.

Jacksonville, Florida's Pedestrian Safety Analysis

In 2016, the Robert Wood Johnson Foundation sponsored a program called "Technology for Healthy Communities," which provided support for communities to implement technological solutions that would target their most dire heath issues. One of the beneficiaries of this program was Jacksonville, Florida, who partnered with Numina, the Health Planning Council of Northeast Florida, and the Clinton Health Matters Initiative to install Numina sensors in order to collect bicycle and pedestrian counts and other data. Jacksonville wanted to collect these data because the city is the third most dangerous in the United States for pedestrian safety; by collecting these data, they could pinpoint opportunities for investment that would improve pedestrian safety while also encouraging residents to be more physically active (Camesas, 2016). Jacksonville also sought to improve health outcomes and reduce the number of residents suffering from chronic diseases as a result of this initiative. Jacksonville installed 22 Numina sensors around the city at 11 different sites that had been identified as high-risk with significant pedestrian safety issues in underserved neighborhoods. These data showed Jacksonville that the intersections believed to be high risk actually were not very dangerous when crashes were compared to the pedestrian volumes identified at those locations.

The National Bicycle & Pedestrian Documentation Project

Established in 2003 by Alta Planning + Design and the Institute of Transportation (ITE) Engineers Pedestrian and Bicycle Council, the National Bicycle and Pedestrian Documentation Project (NBPDP) is a bicycle and pedestrian count and survey project that occurs every year. The main objectives of the NBPDP are to create a standardized methodology for conducting bicycle and pedestrian counts and surveys that could be easily replicated in any community; create a freely available national database for the count data collected as a result of the standardized methodology; and use the data collected to analyze potential relationships between various elements and bicycle and pedestrian activity (NBPDP Project Description, 2009). The NBPDP was started because there was a need for more guidance and documentation pertaining to bicyclist and pedestrian data. Without data on pedestrian behaviors, it is hard to justify or quantify the effects of investing in pedestrian facilities and improvements in addition to investing in automobile infrastructure.

The NBPDP created free standardized and consistent bicycle and pedestrian count and survey forms for agencies and organizations to use if they choose to participate in the NBPDP's National Documentation Days, which occurs in early September each year. September was chosen for the national count date because higher volumes of bicyclists and pedestrians tend to occur during that month (NBPDP Instructions, 2010). There is also an option to do additional surveys and counts during the months of January, May, and July in order to collect seasonal data.

After participating agencies and organizations conduct their pedestrian and bicycle travel surveys and counts, they can send their collected data to the NBPDP, where it will be added to a national database. This national database is freely accessible for any organization that participates in the NBPDP. The NBPDP will also provide summary reports to everyone who participated. Additionally, for agencies that use one of Eco-Counter's automatic counting devices, the NBPDP will "provide a free summary report of the data in exchange for submission of the annual automatic count data to the project" ("National Bicycle and Pedestrian Documentation Project," 2016). Once all of the data have been collected from all of the participating organizations, Alta Planning + Design will create an annual Summary Report of Trends for public viewing, which will include information such as volumes by user group; comparison of volumes to location attributes; understanding of trip purpose; and understanding of trip origin, among other data.

As of January 2009, the NBPDP had collected data on approximately 310 counts in about 93 different communities nationwide ("Fact Sheet and Status Report," 2009). By participating in the annual count dates for the NBPDP each year, the City of Austin would be contributing a national database on pedestrian count data, which would benefit all the communities that participate. The more data that is collected on pedestrian behavior and activity levels nationwide, the easier it will be to quantify the positive benefits of increasing the walking mode share for transportation and to justify investments in pedestrian improvements and facilities.

San Diego County, CA

In 2006, Caltrans, the Traffic Safety Center at the University of California Berkeley, and Alta Planning + Design all collaborated on developing a bicycle and pedestrian demand model for San Diego County, known as the Seamless Travel Project. For the Seamless Travel Project, bicycle and pedestrian counts and intercept surveys were conducted over two years; the purpose of the project was to gauge the effects of variables such as socio-demographic factors or land use mix on bicycling and walking levels throughout the county (Jones et al., 2010). San Diego County was selected to be the focus of this project because the county had data available from previous bicycle counts that could be used to test and validate the counts conducted for this project. Additionally, San Diego County also had a public GIS database that is updated frequently, which was useful for the Seamless Travel Project.

The variety of data collected is useful for comparing trends and location attributes from year to year. The project involved two manual counts at 80 locations around San Diego County during peak periods in 2007 and 2008; a year of automated 24-hour counts at five locations from August 2007 to July 2008; and intercept surveys. The 80 count locations (a mixture of historic bicycle count locations and new locations) were chosen based on the "presence and type of bicycle facilities, high pedestrian crash areas, areas identified for future smart growth, locations near transit stops, locations near planned or recently completed bicycle and pedestrian projects, and variety of land uses and demographics" (Jones et al., 2010, p. 38). The counts all took place during peak periods for bicyclists and pedestrians during the day.

In addition to the manual and automated counts, intercept surveys were conducted, and 367 surveys of pedestrians were collected from 25 count locations (Jones et al., 2010). The pedestrians surveyed were chosen randomly. The results of the intercept surveys showed that 63% of the trips were transportation-related. Major factors involved in pedestrians choosing to not walking more often included traffic, crime, poor driver behavior, lack of facilities, and poor lighting. A majority of the pedestrians most likely walked for economic reasons. Finally, Hispanic and Latino people were more represented in these surveys than the entire county (Jones et al., 2010).

As a result of the pedestrian counts and surveys taken for the Seamless Travel Project, Jones et al. learned several important lessons for pedestrian counting. First, the reasons why people chose to walk were similar to the percentages found for household travel and private vehicle trips in general; i.e., people who walk were walking for a variety of reasons, not just recreation. Additionally, the location of the automatic counters would influence the data collected, since "pedestrian activity is affected by facility type (pathways, sidewalks), surrounding land use, weather, time of year, and many other factors" (Jones et al., 2010, p. 84).

FHWA Bicycle-Pedestrian Count Technology Pilot Project

In 2015, the Federal Highway Administration (FHWA) started a Bicycle-Pedestrian Count Technology Pilot Project that lasted for one year. The pilot project was intended to assist Metropolitan Planning Organizations (MPOs) in quickly planning and implementing effective automated counting programs for pedestrians and bicyclists with limited funding as a model for other agencies and entities as they planned and implemented their own counting programs (Baas, Galton, & Biton, 2016). Ten MPOs were chosen for the pilot project, based on their population size (at least one million people) and their lack of a formal bicycle-pedestrian counting program or experience in conducting such counts. Through the study, each MPO received $20,000 "to purchase and install bicycle and pedestrian counting equipment, to gather baseline count data, and to consider how these data may be used to support multimodal planning and project development" (Baas, Galton, & Biton, 2016, p. 1).

This pilot project offers insightful lessons for the Pedestrian Program, since there were a variety of MPOs involved in the project, and they all took different approaches to planning and implementing their bicycle and pedestrian counting programs. For example, two MPOs rotated their counters from location to location within their regions in order to capture the differences in land use types, densities and building types. A different MPO, by contrast, decided to use only regional trails and pathways for all of their counts. Some MPOs chose to conduct counts on recently installed or future infrastructure projects in order to quantify the impacts of those improvements on alternative transportation in their regions. Other MPOs chose locations where manual counts had been done previously in order to receive more data about those locations and so the automatic counter data could be validated against the previous manual counts. Overall, there were more than 170 locations used during the pilot project among the ten MPOs, with most of the MPOs choosing locations where the volumes of bicyclists and pedestrians were highest. Several of the MPOs also coordinated with local agencies and organizations when choosing the count locations.

The MPOs that participated in this study learned a lot about planning and implementing counting programs and collected useful data that aided them in their analysis. Among all of the MPOs, the data were used to create a baseline at the selected count locations; pinpoint various patterns based on the time of day or week; determine where there were safety issues for pedestrians; evaluate the impact of improved infrastructure; and compare pedestrian to automobile counts in order to ascertain modal share. One MPO created summary reports that looked at count volumes in relation to the weather, seasons, and land use conditions; this same MPO also took counts before and after paving a trail in order to gauge the impact of the trail improvement. Two MPOs reported that the count data they collected were useful when applying for federal funding, such as the Transportation Alternatives Program (TAP) or Congestion Mitigation and Air Quality (CMAQ) funds; one of these MPOs also noted that the data were helpful in the creation of an Alternative Transportation Plan (Baas, Galton & Biton, 2016). Overall, the MPOs, especially the ones that had conducted manual counts in the past, benefitted from significant time and labor savings as well as increased amounts of data because they were able to track pedestrians and bicyclist volumes over a longer period of time. The pilot project allowed the MPOs to track these data more efficiently.

SUMMARY

Around the country, many entities and agencies are using pedestrian count data to aid in their planning processes for improving pedestrian facilities within cities. Since Austin does not have a comprehensive and permanent pedestrian counting program yet, it is beneficial to learn from other cities and organizations about what they have done and what lessons they have learned from implementing their own pedestrian counting programs, as the case studies showed. Collecting baseline pedestrian counts and tracking the changes in pedestrian activity levels over time will enable the Austin Pedestrian Program to assess what impact, if any, their pedestrian policies and projects have and adjust their pedestrian planning processes if the desired impact is not being achieved. Additionally, the Pedestrian Program can determine which projects have the greatest impact and prioritize those kinds of projects in order to achieve a greater impact with the same budget. For example, it would be useful to track changes in the number of people walking in the event of major road projects or closures, to see if walking is a viable alternative transportation option in those events. Pedestrian count data will also allow the Pedestrian Program to determine which areas are actually in need of pedestrian improvements in order to increase pedestrian safety, rather than spending money on locations that are already comparatively safe. One of the more interesting uses for the pedestrian count data is in applying for federal funding; the Austin Transportation Department will usually apply for federal funding from the Capital Area Metropolitan Planning Organization (CAMPO), and these data could make their projects even stronger when they apply. While these are not all of the ways that the Pedestrian Program could use pedestrian count data, these would likely be the biggest uses of any collected data. Before collecting any data, however, the Pedestrian Program should have very clear goals and objectives in mind for their pedestrian counting program, an issue I cover in the next chapter.

Chapter Three: The City of Austin's Pedestrian Goals

This chapter provides a brief overview of the factors that led to the City of Austin's Pedestrian Program's desire to create a Pedestrian Counting Program. The city wants to improve infrastructure conditions for pedestrians in Austin, and this objective is reflected in various plans, policies, and actions that the city has adopted over the last few years. I describe the various programs and their data needs and I end by pulling all the themes together.

AUSTIN, TEXAS

Imagine Austin, Austin's comprehensive plan, was adopted in 2012; expanding transportation mode choices is a high priority of the plan. The plan's vision statement states that Austin is a livable city, and that future development should occur in "connected and pedestrian-friendly patterns supporting transit and urban lifestyles" while also reducing sprawl (Imagine Austin, 2012, p. 84). Another component of the vision statement asserts that Austin is a mobile and interconnected city that "promotes safe bicycle and pedestrian access with well-designed routes that provide connectivity throughout the greater Austin area;" the plan sees the cycling and pedestrian routes as a critical element of the overall regional transportation network (Imagine Austin, 2012, p. 86). *Imagine Austin* states that it is important to ensure that any new development or redevelopment within Austin will be pedestrian-friendly and connected to the rest of the city because pedestrian-friendly development will help address "many of the challenges facing Austin, including motor vehicle congestion, commute times, air quality, transportation costs, lack of connectivity, bicycle safety, and recreational access" (Imagine Austin, 2012, p. 98). Overall, the comprehensive plan provides a broad guideline for increasing pedestrianism within the city, and influences all other programs and policies related to pedestrianism and walkability in Austin.

Following the adoption of *Imagine Austin*, a Complete Streets policy was adopted by the City in June 2014. Complete Streets refers to streets that are "inviting and accessible places to walk, bike, or ride for people of all ages and abilities" ("Complete Streets," n.d.). The Complete Streets ordinance is intended to complement *Imagine Austin* and advocates for better mobility options and compact and walkable development patterns as tools for increasing the overall quality of life for all of Austin's residents. The policy seeks improvements in livability, affordability, equity, as well as the quality of the environment. Adopting the Complete Streets policy for the city means that any new roadway construction or roadway reconstruction must include pedestrian and bicycle improvements, green infrastructure, increased connectivity to the overall street grid, public transportation facilities, and other such improvements.

The Urban Trails program released their Master Plan in 2014, which "envisions a system of Urban Trails that connects all of Austin by allowing residents to go from one end of the City to the other in a safe and healthy way" (Urban Trails Master Plan, 2014, p. ii). These Urban Trails would complement the existing on-street pedestrian network, "giving residents the opportunity to use active transportation to travel greater distances across all parts of Austin and creating a true '8 to 80' network, where an 8 year old child can walk or ride with an 80 year old" (Urban Trails Master Plan, 2014, p. ii). Increasing the walkability of Austin and the number of pedestrians on the streets means that City staff needs to consider all motives for walking trips, including recreation.

The City of Austin has a Great Streets Development Program within the Planning and Zoning Department, similar to the Complete Streets policy, which "provides a mechanism to improve the quality of downtown streets and sidewalks, aiming ultimately to transform the public right-of-ways into great public spaces" ("Great Streets Program," n.d.). The program allows the city to work together with private developers to share the costs of needed streetscape improvements that transform public streets into high quality urban streets. The program, however, is limited to only downtown streets ("Great Streets Program," n.d.). Austin's Great Streets include design elements such as "sidewalks 18 or 32 feet in width; street furnishings that include benches, bike racks and trash receptacles; and street trees that are spaced so that there is a contiguous canopy at maturity to provide shade" ("Great Streets Program," n.d.). The program is funded by the Great Streets Parking Meter Fund, which sets aside 30% of the parking revenues collected in downtown within the program's boundaries to provide assistance to the development community to implement the Great Streets standards; approximately $400,000 is generated each year from this fund ("Great Streets Program," n.d.).

In 2016, Austin passed an update of their Sidewalk Master Plan and ADA Transition Plan, which describes asset management policies for sidewalks within City of Austin right-of-way (Sidewalk Master Plan, 2016). Currently, the sidewalk network has roughly 2,400 miles of existing sidewalk but lacks approximately 2,580 miles of sidewalk. The Sidewalk Master Plan is implemented by the Austin Public Works Department's Sidewalk Program; one of the goals of the plan is to encourage walking as an alternative mode of transportation. The plan has a ten-year target to install all very high and high priority sidewalks within ¼ mile of all identified schools, bus stops, and parks, including both sides of arterial and collector streets and one side of residential streets. This would equate to approximately 390 miles of new sidewalks, or 39 miles of sidewalk installed each year of the ten year period (Sidewalk Master Plan, 2016). The Sidewalk Program and the Special Projects Division, also located within the Public Works Department, would benefit from pedestrian count data as a way to benchmark the success of the Sidewalk Master Plan in building needed sidewalks within Austin, and to show how new or improved sidewalks are actively contributing to increased pedestrian levels within Austin.

Austin voters approved a Mobility Bond in 2016, which earmarked $720 million for improvements to transportation and mobility throughout Austin, with $482 million specifically for corridor improvements ("Corridor Program Implementation Office," n.d.). The mobility bond has three major components: Local, Corridor, and Regional improvements for transportation within the city. The corridor program seeks to improve major corridors within Austin. The local mobility improvements include sidewalks, Safe Routes to School, Urban Trails, as well as Vision Zero Fatality Reduction Strategies ("2016 Bond Programs and Projects," n.d.). Pedestrian improvements for all portions of the mobility bond may include installation or rehabilitation/replacement of curb ramps, sidewalks, curbs, driveway aprons; improvements to non-motorized, multi-use pathways; improvements to dangerous intersections; and other pedestrian improvements.

The Safe Routes to School program, housed within the City of Austin's Public Works Department, educates students on pedestrian and bicycle safety and provides crossing guards at crucial intersections ("Public Works Department Programs," n.d.). The aim of the program is to eliminate barriers that preclude children from walking to school. This is important, since "the percentage of children walking or bicycling to school nationwide has dropped precipitously, from approximately 50% in 1969 to just 13% in 2009 ("Quick Facts and Stats," n.d.).

The City of Austin also adopted the Vision Zero Action Plan in 2016. Vision Zero is based on the principle that there should be no fatalities or serious injuries on roadways and streets resulting from crashes. The Vision Zero Action Plan has set a goal of eliminating all deaths and serious injuries from crashes by 2025. This goal necessitates a multi-pronged effort among various City departments and other agencies to redesign the transportation system so that when people make mistakes on the road, those mistakes are not fatal. This Vision Zero Action Plan adopts citywide policies related to education, engineering, enforcement, transportation planning, land-use planning, and street design (Vision Zero Action Plan, 2016). While Vision Zero focuses on safety improvements, those safety improvements could lead to increases in pedestrians if people perceive streets to be safe and comfortable for walking. Pedestrian count data would benefit the Vision Zero

Program by providing context for pedestrian crashes within Austin; if the program knows where people are walking within the city, planners can account for pedestrian exposure.

City of Austin Pedestrian Program

Austin Transportation Department's (ATD) Active Transportation and Street Design Division, established in July 2016, oversees the City's Bicycle Program, Vision Zero Program, Bike Share, Street Design and emerging Pedestrian Program. Existing pedestrian efforts were fragmented and there was no comprehensive program for coordinating them. Additionally, while ATD had a strong Bicycle Program in place, ATD leadership felt that the need for a separate program specifically focused on providing solutions that could address the nuanced challenges faced by people walking in Austin. Other factors that led to the establishment of the Pedestrian Program were, 1) the trends observed in Austin's peer cities to have dedicated pedestrian programs; 2) the strong community voice for pedestrians that was present in the city in the form of an emerging advocacy community, including the Pedestrian Advisory Council (PAC); and 3) the desire to support the Vision Zero Action Plan and Program (L. Dierenfield and J. Meyer, personal communication, July 6, 2017).

The Pedestrian Program is still a new program, with one dedicated Pedestrian Coordinator. The primary focus for the program thus far has been the creation of the Pedestrian Safety Action Plan (PSAP), which will serve as a holistic strategy for addressing pedestrian safety in Austin in support of the Vision Zero Program. The program is concerned with pedestrian safety, but the program's purview covers many other aspects of pedestrianism.

According to ATD staff interviewed for this report, the main objectives of the Pedestrian Program are to:

Goal 1: Encourage walking within Austin;

Goal 2: Create pedestrian friendly places through placemaking;

Goal 3: Advocate for pedestrian issues in interactions with other city departments; and

Goal 4: Influence both policy and programmatic activities within the city (L. Dierenfield and J. Meyer, personal communication, July 6, 2017).

For example, the Pedestrian Program has been recently creating a Pedestrian Crossing Improvement Program, which aims to create safer pedestrian crossings, using low cost treatments at large numbers of locations across the city. The Pedestrian Program has also been involved in the effort to overhaul Austin's Land Development Code, known as CodeNEXT, to ensure that the new land development code will promote walkability. In the future, the Pedestrian Program would like to create a Pedestrian Master Plan for Austin and establish a dedicated Placemaking Program.

The Pedestrian Program does have a number of challenges including the lack of resources, both in terms of staffing and funding. There is little awareness and understanding of the program and its purpose within the city and a lack of available data. Austin's auto-oriented land use patterns and driving culture also makes creating a walking culture very challenging in all areas of the city. It is also difficult to articulate the needs of the program and turn conceptual support from other stakeholders into actual support for the program (L. Dierenfield and J. Meyer, personal communication, July 6, 2017). While the city does have access to pedestrian crash data, there are few data on overall levels of pedestrian activity or pedestrian travel patterns within the city. Some of these challenges stem from the infancy of the program and are expected to be overcome as time, attention, understanding and resources come online.

The Pedestrian Program staff would like to implement an ongoing and sustainable pedestrian counting program as a way to gather more information and data to support their policies. Having a counting program in place will provide concrete data to measure the successes of the program's recent efforts to promote walking in Austin and increase pedestrian safety on roadways. The collected data could be used to validate and calibrate a pedestrian demand model; measure the impact of specific pedestrian improvement projects; predict where crashes might happen; and also be used to solicit more support from other city departments and outside organizations. While the Austin Transportation Department has conducted pedestrian counts in the past, those counts were usually conducted for a specific project, or as part of a traffic study, and not specifically for evaluating walkability or gathering baseline pedestrian volume data (E. Bollich, personal communication, July 11).

The Austin Transportation Department does currently have several automatic counting devices installed throughout the city that count both bicyclists and pedestrians.

There are two different kinds of counting devices currently installed, one of which is the Eco-Counter "Multi-Nature" device. Typically a permanent installation, the "Multi-Nature" device combines the PYRO passive infrared sensor (the sensor is housed in a post) with Eco-Counter's ZELT inductive loop. The Urban MULTI device is able to differentiate between pedestrians and bicyclists through a subsystem of the device called the Smart Connect, which "analyses the signal from both sensors in order to count and classify each user" ("MULTI Urban," n.d.). This device is best suited for multi-use pathways with high volumes of pedestrians and bicyclists. There are currently six "Multi-Nature" devices installed within the central core of Austin, all located on urban trails. The other Eco-Counter device currently in use within Austin is the "Urban Zelt" device, which only counts bicyclists. The Austin Transportation Department has a website hosted by Eco-Counter that shows the number of people walking and biking at these locations, broken down by mode. The volumes can be further broken down by month, week, or day as well.

Besides the installation of permanent automated counters in Austin, there have been one-time bicycle counting projects where the Austin Transportation Department was able to expand the scope of the project so that pedestrians could also be counted. For example, Austin was one of the ten cities chosen for the PeopleForBikes Big Jump Project, which is assisting those ten cities in quickly and radically transforming their bicycling infrastructure and expanding their outreach efforts at the same time, in order to double or triple the number of people bicycling in specific areas of those cities over a three-year period ("Big Jump Project," n.d.). As a part of the Big Jump Project, the Austin Transportation

Department was able to receive funding to conduct 24 hour video counts at 50 locations throughout the central core of Austin through a contractor. While the video recording counts were initially focused on counting bicyclists, the Austin Transportation Department was able to expand the scope so that pedestrians could be counted as well. The video counts were done using regular video cameras installed at the chosen locations; the pedestrians shown on the videos will be manually counted by outside staff.

The Capitol Area Metropolitan Planning Organization (CAMPO), the region's Metropolitan Planning Organization (MPO) has also conducted pedestrian counts within Austin in the past. CAMPO currently operates a bicycle and pedestrian monitoring program in partnership with the Texas Transportation Institute and the City of Austin ("Active Transportation," n.d.). In 2010, CAMPO conducted manual pedestrian counts at several locations within Austin. CAMPO and the City of Austin also jointly operate an Eco-Counter PYRO-Box in Austin, located on the Lance Armstrong Bikeway at Waller Creek. The PYRO-Box has been in place since December 18, 2012, recording over 1.6 million individuals through July 2017. The count data are available to the public through a web viewer accessible from the CAMPO website.

The pedestrian count data collected by the City and through CAMPO are useful to the City, but are not sufficient for the Pedestrian Program's needs. It is essential to collect sustained pedestrian data over a long period of time from several locations around the entire city in order to acquire an accurate picture of what pedestrian activity levels are really like within Austin. Thus far, there has not been a comprehensive effort by the City of Austin to conduct pedestrian counts throughout the city in order to draw any conclusions about pedestrian activity throughout the city. By implementing a permanent pedestrian counting program, the Pedestrian Program hopes to collect long term pedestrian activity data that will benefit multiple city departments and support current and future pedestrian-oriented policies or programs.

According to Pedestrian Program staff, the main objectives for a pedestrian counting program are to:

Goal 1: Track changes in walking levels over time citywide;

Goal 2: Use the counts to help develop a citywide model of pedestrian activity;

Goal 3: Track walking levels and behavior changes at specific locations (e.g. corridors or commercial districts);

Goal 4: Conduct before/after studies when installing new pedestrian facilities in order to assess the impact of the improvements; and,

Goal 5: Put pedestrian crash data into context (i.e. normalize crash rates by pedestrian activity to better understand where the highest risk areas are for pedestrians. (J. Meyer, personal communication, July 10, 2017).

Staff indicated a desire for a pedestrian counting program that would ideally cover a wide geographic area. They recognize that, due to resource constraints, there may be limitations on how expansive the initial counting program can be, especially early on in the program's existence. One priority for planning the pedestrian counting program is to set it up in a way that would allow for long-term counts across the city in order to track changes in pedestrian levels, but also be flexible enough to be able to move counters to other locations for short counts for specific projects (J. Meyer, personal communication, July 10, 2017).

SUMMARY

The City of Austin has a variety of plans, departments and programs that all promote pedestrianism in some way. This report outlined several of the plans and policies that the City of Austin has published and established that relate to pedestrianism already. Behind those plans and policies, there are City departments, programs, and offices carrying out the plans and policies. These departments and programs include the Sidewalks, Urban Trails, and Safe Routes to School Programs within the Public Works Department; the Planning and Zoning Department, especially the Great Streets Program; the Economic Development Department; and the Street Banner, Arterial Management Division, and Vision Zero programs within Austin Transportation Department. Each department, program, division, or office all have a different purpose, but each has a mission that in some way promotes pedestrianism. Based on conversations with City staff, Table 1 below identifies how a permanent pedestrian counting program would benefit each of these programs.

Program/Vision (Department)	How would they benefit?
Sidewalks and Special Projects Program (Public Works Department (PWD))	Pedestrian counts can be used to prioritize where new sidewalks should be built or where existing sidewalks need to be improved or replaced.
Urban Trails Program (PWD)	Pedestrian counts would be analyzed to see which Austin trails have the most traffic, which helps the program plan future trails. The data would also be used to gauge the success of projects and track changes in usage over time.
Safe Routes to School Program (PWD)	Pedestrian counts can be used to track how many children are walking to and from school and that data can justify safety improvements for children who are walking to and from school.
Planning and Zoning Department (P&Z)	Pedestrian counts would help them understand latent demand for walking, if the built environment serves all people (or only the "Strong and Fearless/"Enthused and Confident" walkers), and help them come up with better designs, standards and code, and plans (corridor, district, neighborhood).
Redevelopment Division (Economic Development Department (EDD))	Pedestrian count information would help the department determine how foot traffic impacts the economics of businesses within a business district, and provide information on if people walk to their destination or park and overall sales as it relates to number of customers and foot traffic within a district.
Street Banner Program (ATD)	Pedestrian counts could assist with promoting the program, opening new banner districts, and developing a new sub-program of pedestrian-level banners in areas with pedestrian counts that are higher than vehicle counts.
Arterial Management Division (ATD)	Pedestrian count data would allow the Division's PHB program to justify the installation of PHBs where there is a high volume of pedestrians but a lack of safe pedestrian street crossings.
Vision Zero Program (ATD)	Pedestrian counts would give the program a denominator for calculating injury and fatality rates for pedestrians. Calculating these rates would help the program prioritize engineering, enforcement, and education activities.

Table 1: Benefits of Pedestrian Counts to various City departments.

The pedestrian counting program is intended to help the Pedestrian Program first and foremost. The pedestrian data collected from this pedestrian counting program, however, can benefit other departments as well. The Pedestrian Program is not a silo onto itself; the Program will seek to collaborate with other departments so that the Pedestrian Program is not duplicating data collection underway in other city programs while providing those agencies and programs with valuable pedestrian data they may not be collecting. The Pedestrian Program must take a multi-pronged approach to developing their pedestrian counting program to meet their needs and those of other city departments. The program will need to collect different types of pedestrian data for different reasons over different time periods; they cannot create therefore, a one-size-fits-all pedestrian counting program. Capturing relevant data for estimating pedestrian activity levels citywide, for example will not necessarily provide appropriate data for examining dangerous intersections within the city – the data needs are very different. The Pedestrian Program should choose specific counting methods that match specific city goals, keeping in mind that counting methods may overlap for some of the goals. In the next chapter, I present an overview of some of the common pedestrian counting methods that would be best suited to the Pedestrian Program's goals and needs, as well as utilizing emerging technologies that may be useful.

Chapter Four: Methods of Determining Pedestrian Volumes

This chapter briefly examines various methods available for counting pedestrians and evaluates the benefits, drawbacks, and associated costs of each one. Different types of counting methodologies suit different goals, and it is important to determine which counting method suits each particular goal for the pedestrian counting program. There are both manual and automated counting methods available to count pedestrians. To manually count pedestrians, cities conduct in person counts either in the field or evaluate pedestrian activity recorded on video. Automated count technologies include video image processing; pressure/acoustic pads (also known as Piezometric pads); laser scanning devices, passive infrared sensors; active infrared sensors; radio beam devices; or a combination of any of the above technologies.

There is no perfect technology available for counting only pedestrians. Many of the available technologies described in this chapter cannot distinguish between pedestrians and bicyclists, so their usefulness in counting pedestrians is limited to pedestrian-only areas, such as sidewalks or trails. However, it is possible to use one technology that counts both pedestrians and bicyclists in tandem with a bicycle-only counting technology in an area with both bicyclists and pedestrians in order to capture the volume of pedestrians and bicyclists, by removing out the number of bicyclists from the overall number of pedestrians and bicyclists. This means that the Pedestrian Program would have to coordinate with the rest of the Active Transportation department on capturing the bicyclist data and then manually capture the pedestrian data by subtracting the bicyclist data from the pedestrian data. Using two technologies requires more resources than using just one technology, as well.

Some of the technologies mentioned are also primarily used indoors or work best indoors, which is not useful to the Pedestrian Program now. These technologies, however, could theoretically be used outdoors and could be useful in the future. Each technology described below does have drawbacks that limits how, where, and how often these technologies can be used.

The next section explores the best methods and technologies for capturing pedestrian data. Some technologies, such as pressure pads, laser scanning devices, and radio beam devices, will not be discussed here because they do not fit the Pedestrian Program's current needs; because there is limited information on their successful use for outdoors pedestrian counting; they are typically used to count pedestrians indoors (for example, in shopping malls); and they are sensitive to environmental conditions. First, I describe manual counting methods, the only way to truly count just pedestrians without any location limitations or technology constraints. I then look at combination technologies which count both pedestrians and cyclists at the same time and then require an additional effort to separate pedestrian from cycling data. There are technologies which can be used to just count pedestrians but they face location constraints (they can only be used where no cyclists are present) so that a combined approach is often needed. I conclude by looking at emerging and innovative resources that may be useful for pedestrian counting in the future.

MANUAL COUNTS

The first kind of manual pedestrian counting involves trained observers counting the number of pedestrians passing by a given location using paper sheets, traffic count boards, ‘clicker’ counters, or smartphone apps to record the numbers (NASEM, 2014). These counts generally take place over one to four hours with intervals of roughly 15 minutes each; they can take place at screenline, intersection, or midblock locations. Screenline refers to an imaginary line across the intersection or roadway; when pedestrians cross this imaginary line, they are counted. In-field manual counts tend to be the most widely used method for collecting pedestrian volume information since no equipment is needed, and the counts can be very accurate as long as the field observers are well-trained (FHWA, 2011). There are, however, drawbacks to in-field manual counting, including the high labor costs, the logistics of conducting long-term or permanent counts, and an inability to authenticate or double-check data, especially if volunteer staff are used.

The second form of manual pedestrian counting involves the use of video recordings, in which the selected location is recorded with video cameras, and then, observers watch the videos and count the pedestrians that appear on the screen. Recording the number of pedestrians can be done using paper, a handheld counter, or a computer with an additional specialized keyboard made specifically for traffic counts. Manual counting through video recordings offers more flexibility than in-field counts because it is possible to re-watch footage, which increases the accuracy of the counts and allows observers to verify the data; it is also more flexible in that it allows observers to watch the footage when it fits their schedule, rather than having to stand outside for several hours. Labor costs can be lower than on-site manual counts because observers can quickly skim through inactive periods on the recordings (FHWA, 2011). There are some problems with this form of manual pedestrian counting; purchasing, installing, and maintaining the video cameras used can be cost-prohibitive. Costs may be reduced by using regular video cameras as long as they are installed in secure boxes; for more detailed video recordings, higher quality cameras are needed (Ryus et al., 2014). Other equipment needed for video counting includes a computer that is able to play videos as well as computer software that is suitable for recording counts. Cities have to consider the tradeoffs between labor and capital costs in using video manual techniques.

The two forms of manual counting are similar, in that they are best suited for short duration counts; both can be used to gather other information about pedestrians, such as gender, direction of travel, usage of a stroller or walker, or pedestrian behavior such as walking against a pedestrian signal. Labor costs are higher, however, than for automated counting technology. There are some key differences that may make one form a better choice than the other one, depending on the situation. Labor costs (staff time needed to train counters and for counters to do the counts) are high for both forms, but in different ways. City staff conducting counts outside take time away from other priorities and lose time spent traveling to count locations and setting up. Using video recordings to count pedestrians does not require staff to leave the office so they can fit the counts into their schedule. It still takes more time, however, to analyze the video recordings than it would to stand outside and count pedestrians for several hours.

One way to reduce staff labor would be to use volunteers to conduct the manual counts in the field or through videotape recordings. Volunteers could be useful if the Pedestrian Program would like to conduct many manual counts all at one time, and the volunteers could come from local school programs or from organizations related to walkability and pedestrianism. Of course, the Pedestrian Program would have to factor in the time and cost of training the volunteers as well as managing the data the volunteers collect. Additionally, it is important to make sure that volunteer observers understand exactly how to conduct a count in order to avoid the effects of unconscious or intentional bias with both forms of manual counts (human and video) for both forms of manual counting. Experts counsel that there should be more than one volunteer at locations with high pedestrian volumes in order to increase the accuracy of the counts (NASEM, 2014). Several studies that compared field counts to video counts found that, while field counts tended to undercount pedestrians compared to video counts, having the proper equipment and training could reduce that undercounting. Focusing specifically on the number of pedestrians in a location (rather than also capturing person attributes for example) and using ‘clicker’ devices increased the accuracy of the field counts. Overall, for new pedestrian counting efforts, manual counts tend to be the best method to start off with, because the associated costs are low and the manual count locations can form the basis for automated count locations in the future (Ryus et al., 2014).

AUTOMATED COUNTING METHODS

This section discusses different technologies that cities can use to capture pedestrian data. All of these methods can capture pedestrian data, but it is important to note that none of the methods can be used for counting only pedestrians in any kind of location at any time. One method uses only one technology to record multiple modes, including pedestrians, of travel through an intersection. The other methods, while they do capture pedestrian volume data, can only do so under certain conditions, and may need the use of a second technology for counting and then removing bicyclists from the data set in areas where there is a mix of pedestrians and bicyclists. Using two technologies is useful for situations where there is a mix of traffic modes because no current automated technology can separately detect bicycles and pedestrians and provide individual counts for each (NASEM, 2014). Using a tandem technology can also be useful for agencies that would like to count both pedestrians and bicyclists but obtain mode-specific data; doing so would allow for more efficient use of resources.

Automated counting technologies also raise the issue of undercounting or overcounting. It may be possible to offset or overcome the counting errors through adjustment functions, that is, equations used to adjust raw automated count data to reduce the amount of errors present in the data, as well as project what future pedestrian volumes may look like. Cities can use two types of adjustment factors: correction and expansion factors. The first kind of factor is used to correct for any systematic inaccuracies in the counting technology and are created using validation counts; expansion factors are used to extrapolate long-term pedestrian volumes from short duration counts (Ryus et al., 2014). Factors are generally simple multiplicative functions, i.e. multiplying the counts by specific numbers. Ryus et al. (2014) suggest that any adjustment factor used be created specifically for each site location, because each site will have different characteristics that will affect the count data. The National Bicycle and Pedestrian Documentation Project that can help agencies select the necessary adjustment factor for their count data, or even provide adjustment factors that have already been created, which can then be modified to fit the Pedestrian Program's data.

Video Image Processing

Video image processing encompasses any video-based data collection that counts and classifies users through a computer model or algorithm rather than through a manual counting process (FHWA, 2011). This technology has become more popular in recent years due to its benefits; the data are more accurate, labor costs are lower, and it performs better than other methods in crowded settings. The algorithms used in these computer models can be programmed to count every pedestrian walking by and track their directions and rate of walking; some programs can even create a map of pedestrian movements. There is no standard approach for this technology however; rather, the algorithms employed are programmed by the manufacturers of the video image processing devices specifically for the equipment used and the location where the equipment will be deployed (FHWA, 2011). The software, in short, is not plug-in ready out of the box, but is being programmed for each organization's purposes. The video camera used for this type of technology also needs to be installed overhead in the location(s) chosen. For example, Numina, a company that offers video image processing devices for sale, will provide at least one staff employee to assist a city employee or engineer in installing the sensor; this labor cost is included in the price of the sensor. However, the sensors are only available to lease from the company, but there are unlimited non-commercial licenses available with the sensor. The data collected can be viewed either through the Numina web dashboard, which was built specifically for urban planners, or through an application programming interface (API) (P. de Konkoly Thege, personal communication. June 27, 2017). Numina also offers a dedicated customer support service to help with the process of installing and maintaining the sensor and data.

There are drawbacks to using video image processing. One problem is costs for automated video processing counting are high, because the vendor does all of the processing, rather than the client. This does means that staff do not have to be as involved in actually counting the pedestrians on the screen and can devote their time to other priorities. Another potential issue is occlusion: that is, trouble detecting individual pedestrians who are traveling in groups, when one pedestrian may be blocked by another pedestrian and therefore not counted (NASEM, 2014). Finally, environmental factors such as lighting differences may affect the accuracy of the processors; glare from the sun or from windows, for example, may affect the video recordings.

Figure 1 below shows an example of what video image processing produces. Each colored line represents a different mode of travel and direction of travel through an intersection. The algorithm behind the video image processing device is able to separate out the different modes of travel and count the number of travelers for each mode.

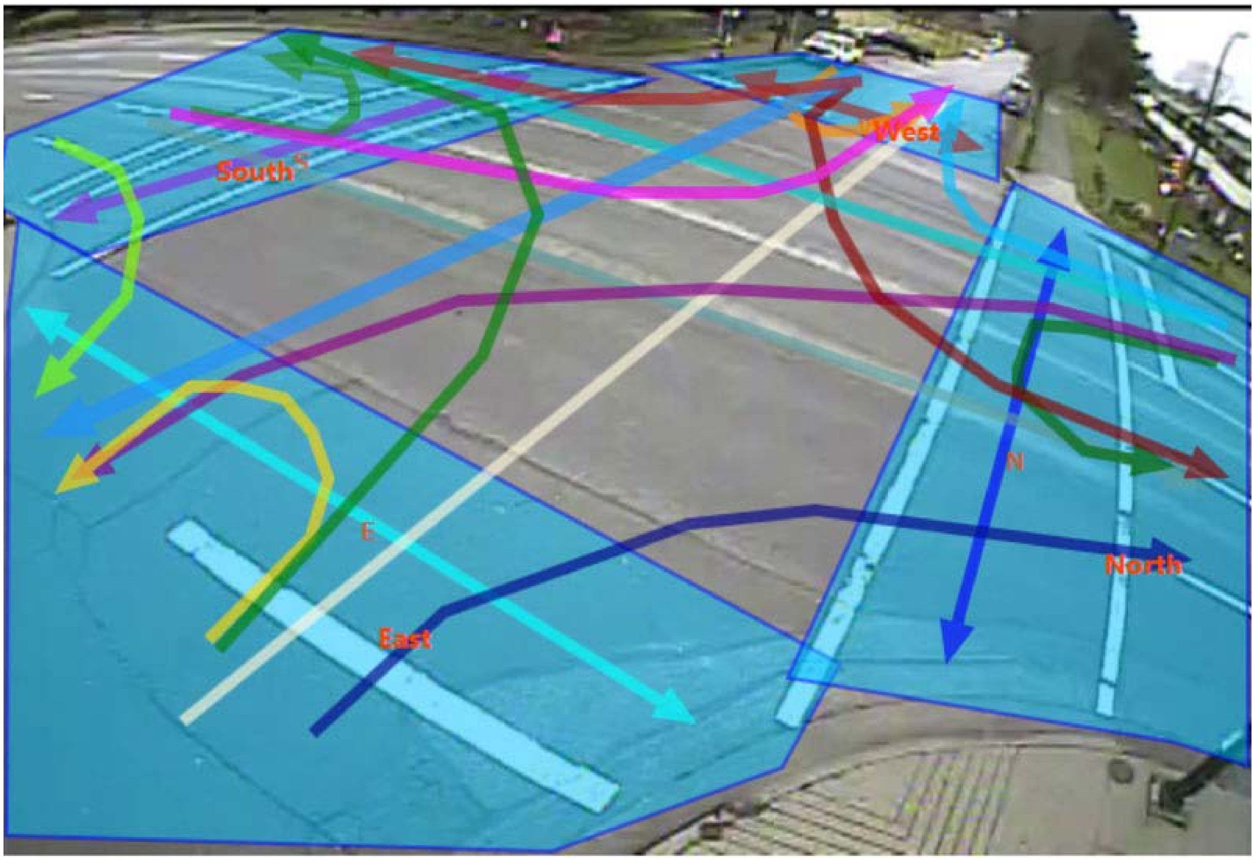

Figure 1: An output of what a video image processing device does. Source: Miovision, n.d.

Passive Infrared Technology

Passive Infrared technology uses passive infrared sensors (also known as piezoelectric or pyroelectric sensors) to sense pedestrians and bicyclists by detecting the infrared radiation emanate as they walk past the sensors (NASEM, 2014). As with the other technologies discussed in this report, passive infrared sensors cannot solely detect pedestrians unless the sensors are installed in pedestrian-only areas or is used in tandem with a bicycle-only counting sensor. Passive infrared sensors offer several benefits; they are small and portable, so they are easy to install; only one device needs to be installed on one side of the location of the count. The sensors can also be moved from location to location easily because they are small. These sensors work well for counting pedestrians over an extended period of time, such as years. Training time is also short, typically less than 30 minutes. These sensors have moderate costs compared to other counting technologies; a typical unit costs between $1,000 and $3,000 on average. There is a higher upfront cost in purchasing the equipment, but sensors used for long term counting lower equipment costs over time (Ryus et al., 2014). If a bicycle counting technology is used in tandem with a passive infrared sensor, the overall equipment cost will be higher, but it should not cost more to separate the pedestrian data from the bicycle data, because many sensors upload their data to online servers, where the data can be separated out in software made for the sensors. As one example, the company Eco-Counter provides a free software with their sensors that can do separate the collected data for Pedestrian Program staff.

Passive infrared sensors do have some drawbacks; they have to be placed in a way that will prevent errors due to light reflecting off water or windows. The most common error that occurs with these devices is undercounting combined cyclists and pedestrians because the sensors are unable to accurately identify the correct number of individuals walking or bicycling in groups. Several studies focused on these devices found consistent undercounting as pedestrian volume increased, especially compared to manual counts involving videotapes (Ryus et al., 2014). Passive infrared sensors work best when they are not facing towards a wall, or something other than the street; also, for best results, they should be placed in locations where pedestrians are not likely to hang around for long periods of time.

Passive infrared sensors seem to be the most commonly used device for automated pedestrian counting; there are many examples of cities and other entities using passive infrared sensors for counting pedestrians outdoors. MetroPlan Orlando, for example, a regional transportation planning agency for Orange, Osceola, and Seminole counties in Florida, uses Eco-Counter's PYRO-Boxes for their automated pedestrian and bicycle program, established in 2015. The agency chose Eco-Counter PYRO Boxes because they were small, easy to install and remove, and could be moved from location to location, plus the devices can also automatically collect the count data and transmit the information to an online database and they are relatively low maintenance (MetroPlan Orlando, 2016). MetroPlan Orlando chose 17 different locations to conduct pedestrian counts, based on corridors and intersections that either had high pedestrian volumes or experienced a high number of crashes. MetroPlan coordinated with the Florida Department of Transportation and local communities to conduct these counts. MetroPlan also conducts manual counts, but they specifically wanted to purchase automated counters in order to "gather a continuous record of our bicycling and walking activity throughout particular corridors and to understand how volumes can change with weather, season, land use changes, and transportation projects" (MetroPlan Orlando, 2016, p. 4). MetroPlan rotated the counters through each of the 17 locations chosen. Their 2016 report on Bicyclist and Pedestrian Counts does not indicate that MetroPlan had yet purchased pneumatic tubes for counting bicyclists, so the count numbers recorded at each of the 17 locations include both pedestrians and bicyclists.

Figure 2: Example of a Passive Infrared Sensor installed within the large black pole next to the building wall. Source: Eco-Counter, n.d.

Active Infrared Technology

Active infrared technology uses devices that transmit an infrared light beam from a transmitter to a receiver; the devices then count the number of pedestrians or bicyclists that cross through the beam (NASEM, 2014). As with the other technologies discussed in this report, active infrared sensors cannot solely detect pedestrians unless the sensors are installed in pedestrian-only areas or is used in tandem with a bicycle-only counting sensor. Active infrared sensors can be used for short-term or permanent installations (Ryus et al., 2014). Active infrared sensors are highly portable, which makes conducting counts at multiple locations easier; these sensors are also generally less cost-prohibitive than other automated counting devices (FHWA, 2011). However, while they can and have been used outdoors, they operate best when used indoors, because animals, rain, leaves, or other non-pedestrian objects can interfere with the devices (FHWA, 2011). Finally, active infrared devices cannot differentiate between objects interrupting the beam, which can lead to false positives (NASEM, 2014).

Active infrared sensors, while not as common as passive infrared sensors, have been used for pedestrian counting programs. The Seamless Travel Project in Southern California (mentioned earlier) used both passive and infrared sensors. The project installed active infrared sensors from TrailMaster at three locations; two in the city of San Diego and one in the city of Coronado. The two San Diego locations counted both pedestrians and bicyclists, while the Coronado location only counted bicyclists. Jones et al (2010) noted that one of the benefits of using the TrailMaster sensors was that “two TrailMasters can be installed in the field at one location, and then each set differently, one to record all events and the other to record only pedestrians" (p. 40-41). The researchers also found that the TrailMaster sensors tended to undercount all travelers by roughly 12% to 18%, and undercount pedestrians by 25% to as much as 48%. The TrailMaster sensors seem more accurate than the passive infrared sensors in counting all travelers, but require careful thought in selecting locations for installation, because the sensors have to be installed opposite each other. Overall, the active infrared sensors seemed to be best suited for locations along trails or similar pathways rather than urban environments because this will reduce the potential for undercounting due to crowds.

Figure 3: Example of an Active Infrared Sensor. Source: TrailMaster, n.d.

EMERGING TECHNOLOGIES

The world of pedestrian counting technologies is changing all the time; new and innovative technologies are appearing on the market every day. There are now multiple mobile applications geared to pedestrian counting that may make manual counting easier, more accurate, and less labor-intensive. There are other sources of data that produce pedestrian counts in a non-traditional way. In this section I explore some emerging, intriguing, and innovative sources of pedestrian data.

One such mobile application is the Counterpoint smartphone application. The application is free to use, and it is essentially crowdsourced pedestrian counting. Anyone using the application can conduct their own count at a site of their own choosing, or add to an already existing site (Alta Planning, 2016). The application functions by having the user setting an imaginary line, and then pressing buttons in the application to record anyone or anything that crosses the imaginary line. The novel thing about the Counterpoint application is that there are more than the standard automobile, bicycle, and pedestrian categories; the application can count visually impaired people, physically impaired people, and people using wheelchairs, motorcycles, buses, and more. This would allow for more detailed data on different types of pedestrians that some automated counting technology may not provide. The application is free to download and easy to use, but at the moment it is not a sufficient replacement for traditional manual counting and should be used as a supplemental tool that would require more coordination; for example, the application could be used in tandem with multiple volunteers to count pedestrians for a period of hours at one location – sort of a flash count.

GPS-enabled route trackers such as Strava Metro or MapMyWalk may also prove useful for pedestrian counting in the future. These applications today are primarily used by recreational walkers to track the distance walked, walking speed, and route taken, but the data generated by these applications may give general indications of where people are walking, when, and under which kinds of environmental and weather conditions (Alta Planning, 2016). Several cities, including Portland, have purchased data sets from Strava, Inc., to understand trip patterns in their cities (Alta Planning, 2016). The downside of using these data sets is that they may not reflect every type of person walking, since the users of these applications are primarily recreational pedestrians; the application may not capture those who walk for utility, such as commuters. The state of Texas has recently purchased two years of Strava Metro's bicycle and pedestrian data, which are separate and not combined, and will be sharing it with local government entities, including Austin. These data would supplement pedestrian count data and could also be an important data source for a Pedestrian Demand Index model.

One company, Placemeter, offers video image processing; the company uses existing cameras within the city, such as traffic cameras, instead of installing cameras or sensors at intersections and on streets,. Placemeter's goal is to work with various entities to create video feeds that will cover approximately 90% of New York City's sidewalks or public spaces (Leber, 2014) through a partnership with New York City allowing the company to access the city's publicly available traffic camera feeds and live webcam websites such as Earthcam (Leber, 2014). The company needs about 2,000 to 3,000 well-placed cameras but so has access to only about a fifth of that number, Placemeter wants to essentially 'crowdsource' video feeds and traffic data in the future by creating "a small network of contributors who will mount their unused smartphones to their windows and videotape their streets" (Leber, 2014).

Cellular networks and GPS navigation data are other emerging technologies that could provide valuable information about pedestrian movements. Telecommunications companies (e.g. Verizon or AT&T) would sell their data about subscriber movements to other companies or governmental organizations. The information collected from the subscriber data has the potential to "help cities plan smarter road networks, businesses reach more potential customers, and health officials track diseases" (Leber, 2013). One company, AirSage, in Atlanta (GA), has been able to secure exclusive rights to install hardware that will collect real-time cellular tower signaling data within the firewalls of two major wireless carriers in the United States. Their software will anonymize and encrypt the data collected as it is being collected, and then they can sell that data to third-party companies who then sell it to government agencies and other organizations (Grabar, 2015). AirSage's algorithms function by searching for patterns in location data as users' mobile devices ping cellular towers in different locations. The company established their second partnership with a U.S. carrier, and claims that "…it has been processing 15 billion locations a day and can account for movement of about a third of the U.S. population in some places to within less than 100 meters" (Leber, 2013). The technology so far is not able to distinguish between drivers and pedestrians, except in locations such as trails where the primary mode of transportation is likely to be on foot. In the future, the technology could become more advanced to the point where it would be able to distinguish between different modes of traveling.

It is important to note that there are some serious privacy concerns with this new and emerging technology. Lisa Schweitzer and Nader Afzalan (2017) discuss the implications and impending ethics crisis for planners regarding the use of cell phone data. They argue that the purchase of data derived from mobile applications and privately owned sensors may not be ethical due to "ubiquitous data sensing, new consumer tracking capabilities, obscure and readily skipped terms of use agreements, and rapidly changing technologies" (Schweitzer & Afzalan, 2017, p. 166). Therefore, privacy concerns should be of paramount importance for planners who are considering purchasing this data. While the data could be anonymized, it is also worth thinking about how secure the raw data is, especially in light of several security breaches that have been made public within the last year, such as Uber or Equifax. Planners should take care to ensure that any data they collect is secure and does not reveal personal information about the people they are supposed to plan for.

SUMMARY

Table 2 summarizes the information presented in this chapter on different well-accepted counting methods available, their benefits and drawbacks, and associated costs. The table does not include emerging technologies because there is not yet enough information on how they could be included in a pedestrian counting program.

Table 2: Summary of Different Pedestrian Counting Methods.

Method	Duration	Description	Benefits/Drawbacks	Cost Range
Manual Counts (In-Field)	Short	Pedestrian volume data is collected by humans who use paper sheets, traffic count boards, 'clicker' counters, or smartphone apps to record the number of pedestrians passing by a given location.	Benefits: • Can collect pedestrian characteristics and behavior • No installation costs Drawbacks: • Short counts only • Potential for counting errors • Labor costs could be high • Counts have to be done at a specific time	$
Manual Counts (Video)	Short	The selected location is recorded with video cameras, and observers watch the videos to count the pedestrians.	Benefits: • Can collect pedestrian characteristics and behavior • Offer flexibility in choosing when to count pedestrians from the office Drawbacks: • Higher installation costs unless video cameras are already available	$-$$
Video Image Processing	Short or Continuous	Locations are recorded with video cameras and algorithms or computer models are used to count and classify pedestrians.	Benefits: • Portable • Minimal time investment • Can capture pedestrian characteristics, behavior and movement Drawbacks: • Expensive	$1,500 - $5,000 +
Passive Infrared Sensors	Short or continuous	These sensors count pedestrians by detecting infrared radiation emanating from the pedestrians as they walk past the sensors.	Benefits: • Portable • Easy to install • Widely used Drawbacks: • Need a separate sensor for bicycles to distinguish between users • Can only be used for screenline counts	$1,000 - $3,000 +

Table 2, cont.

Method	Duration	Description	Benefits/Drawbacks	Cost Range
Active Infrared Sensors	Short or continuous	These devices transmit an infrared light beam from a transmitter to a receiver and count the number of pedestrians that cross through the beam.	Benefits: • Portable • Easy to install Drawbacks: • Cannot distinguish between bicyclists and pedestrians • May have false positives due to interference	$200 - $500
Using two technologies	Short or continuous	This situation uses one type of technology to count pedestrians and a different type of technology to count bicyclists.	Benefits: • Can count pedestrians and bicyclists simultaneously Drawbacks: • Higher cost due to using two technologies	$4,000 - $6,000 +

There is no one technology or method that will help the Austin Pedestrian Program meet all of its goals. Most of the technologies available are only useful for counting pedestrians in certain situations and would have to be restricted to sidewalks or other pedestrian-only spaces unless a second technology specifically for counting bicycles is also purchased. All of the automated technologies do offer portability, which is convenient for changing locations and adding flexibility to the program, but selecting the locations do require careful thought to capture the right data and avoid substantial errors.

It would probably make the most sense for the Pedestrian Program in its early days to focus on collecting pedestrian data using manual counts (either in the field or through video recordings) or video image processing devices. Automated sensors might make more sense on highly-trafficked sidewalks where it would be difficult to count large numbers of pedestrians, such as in the downtown Austin area or in the Domain. The program can install more automated counters or install combination technologies for capturing pedestrian and bicyclist data in order to expand the scope of their pedestrian counting program once the overall program has matured and gained experience with counting pedestrians. The additional cost will be easier to justify once the Pedestrian Program can demonstrate the effectiveness and usefulness of the count data and has more buy-in from city officials and other stakeholders. The Program should tailor a specific strategy, however, to each of its goals. I discuss this issue in the next chapter.

Chapter Five: Applying Methods to Goals

I apply information about the different kinds of pedestrian counting methods to the Pedestrian Program's specific goals for pedestrian counting in this chapter. Each goal is best served by one counting method or a specific mixture of counting methods, rather than applying a 'one-size-fits-all' approach to all the city's pedestrian goals. It is important that the city pick the method that best fits the purpose of each goal in order to get the best and most accurate data possible for planning purposes.

The main objectives of Austin's pedestrian counting program are to:

Goal 1: Track changes in walking levels over time citywide;

Goal 2: Use the counts to help develop a citywide model of pedestrian activity;

Goal 3: Track walking levels and behavior changes at specific locations (e.g. corridors or commercial districts);

Goal 4: Conduct before/after studies when installing new pedestrian facilities in order to assess the impact of the improvements; and,

Goal 5: Put pedestrian crash data into context (i.e. normalize crash rates by pedestrian activity to better understand where the highest risk areas are for pedestrians. (J. Meyer, personal communication, July 10, 2017)

I examine each goal specifically and discuss the best pedestrian counting method or methods for that particular goal. The Pedestrian Program can evolve and become more robust and pursue additional goals as new resources are identified and the staff has gained experience with the initial data collection methods and logistics.

GOAL 1: TRACK CHANGES IN WALKING LEVELS OVER TIME CITYWIDE

The first goal, tracking changes in pedestrian activity or pedestrian volume over time, is the broadest goal for the Pedestrian Program's pedestrian counting program. The purpose of tracking these changes is to gauge whether the Pedestrian Program's policies and actions are actually increasing the number of people choosing to walk as their form of transportation within Austin. It is not possible or feasible to count pedestrians at every intersection or location in Austin, of course, but it is possible to count pedestrians at specific locations across the city once or twice a year, and then use adjustment factors to extrapolate these patterns across the city and estimate how many people are walking on the streets of Austin annually.

The Pedestrian Program should use manual counting of video recordings as the primary method for short-term pedestrian counts. Total equipment costs will be lower, even though counting pedestrians on video recordings requires more staff labor than onsite counts Once the Pedestrian Program has established a permanent counting program and conducted several counts over a year or two, staff can expand to automated counters. I recommend conducting manual counts through video recordings because existing video cameras are available and the ATD staff is familiar with this method of counting pedestrians.

The Pedestrian Program can rotate the existing video cameras among various locations until the Program has collected a 24 hour video recording of each location. It is important to consider several factors in choosing count locations. In order for the manual counts to be useful for tracking changes in walking levels over time and for developing a citywide model of pedestrian activity, representative locations within the city should be chosen. Representative locations are generally dispersed throughout the community; found in areas with diverse land use types; represent multiple types of pedestrian facilities; and represent the different socioeconomic characteristics that can be found within the community. The chosen locations should also have relatively high levels of existing pedestrian activity, as collecting pedestrian counts at locations with high pedestrian volumes already may prove helpful in garnering institutional support for a permanent pedestrian counting program. For example, once political support is in place, counts at locations with lower pedestrian volumes will be easier to justify (FHWA, 2016). Finally, additional resources would be helpful in selecting the right locations for pedestrian counts, such as crash data or United States Census information. I recommend choosing a mixture of locations where Big Jump and CAMPO counts have previously been conducted, which will allow for historical comparisons, as well as additional locations chosen to achieve the geographic coverage required to fully capture pedestrian activity across the city. The City also has CCTV cameras on traffic signals that could be used for manual counting of video recordings. Each location should be recorded for 24 hours with the video cameras which will allow the Pedestrian Program to see differences in pedestrian activity levels throughout the day. Figure 4 below shows what the potential locations could be.

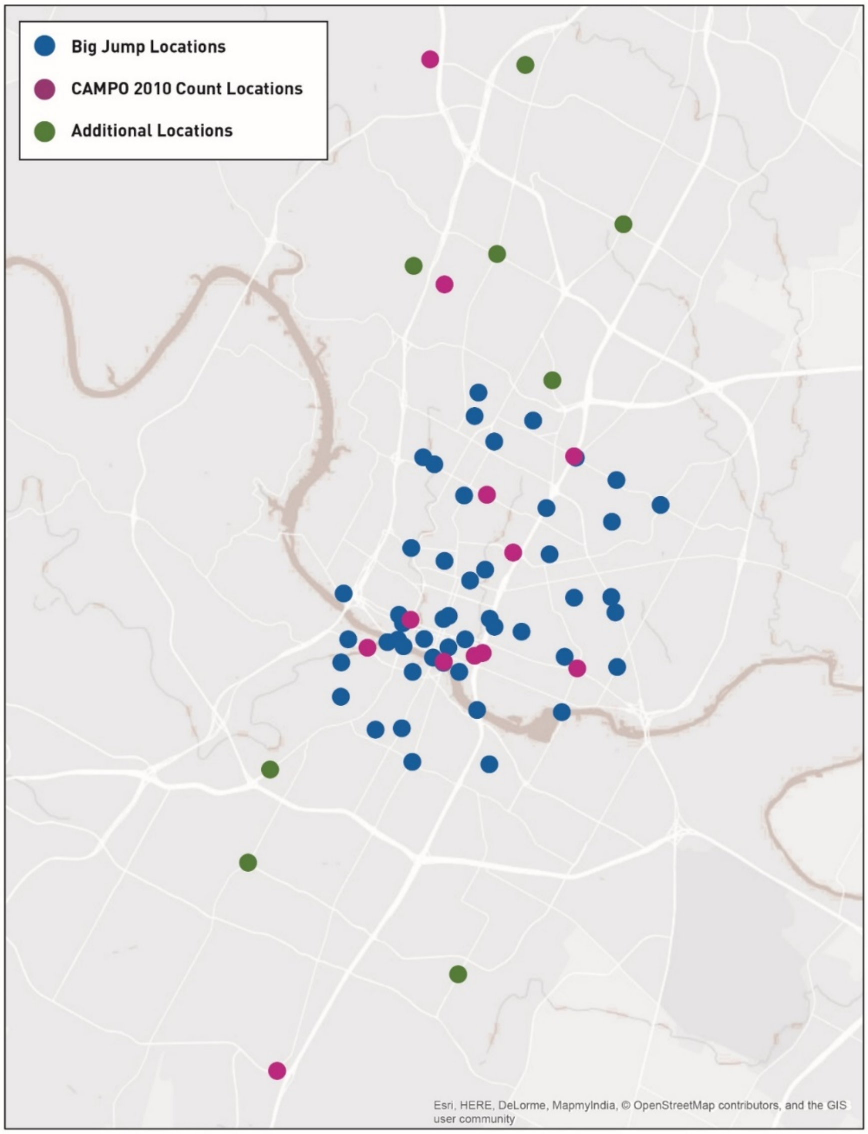

Figure 4: Manual Count Locations for Goal 1.

This process should be repeated twice a year for at least two years; many experts suggest doing pedestrian counts between May and October to reduce seasonal variability and lower estimation errors (FHWA, 2016). The National Bicycle and Pedestrian

Documentation Project (NBPDP) guidelines suggest conducting counts in May and September. The NBPDP chose September because it is typically a very active month for pedestrian activity; most people are back at school or work after vacations and most places experience good weather conditions in September. The NBPDP also suggests doing at least one weekday count and one weekend day count.

GOAL 2: USE THE COUNTS TO HELP DEVELOP A CITYWIDE MODEL OF PEDESTRIAN ACTIVITY

Some cities have created Pedestrian Demand Indexes, or Pedestrian Demand Models, in order to evaluate which areas of a city are more likely to see large volumes of pedestrians. These indexes and models are useful for pedestrian planning, because they allow cities to see where present demand for pedestrian improvements are located in the city, and where pedestrian improvements may be needed in the future.

If planners can estimate roughly how many pedestrians will be walking in the city in the present and future, then they can base their planning processes around those numbers, either by aiming to accommodate those future numbers or by implementing policies and infrastructure improvements in certain areas of the city in order to increase projected pedestrian volumes. Data collected from pedestrian counts have been used to validate these models, as Santa Monica, California did.

The Program does not need a specific counting method to support this goal. The pedestrian counts collected for the other goals can be used to validate any model that is created; it is more important to make sure that all collected data are accurate and reliable.

Program staff should calibrate and validate all equipment used and quality check all collected data. Doing so can be time and labor-intensive since it has to be done on a regular basis, and thus far there is no universally adopted standard method for doing so. Some companies, such as Eco-Counter, offer software with their automated pedestrian counting products that can do automated quality checks on the count data.

The Pedestrian Program can also decide to set up their own calibration and validation processes; if they choose to do so, there are several considerations to keep in mind. First, the Pedestrian Program should establish the level of data quality staff consider acceptable, which depends on what the data are being used for – so the data quality level could be different for each goal. Turner and Lasley (2013) argue that if the data are being used for high level analysis, such as evaluating pedestrian safety and crash risk, then the data quality should be high, having been corrected for errors and as accurate and precise as possible. However, data quality may not need to be as accurate or precise for many other planning purposes. Turner and Lasley (2013) provide examples where data of varying qualities are acceptable. To determine whether pedestrian volumes on a street warrant the installation of a traffic signal according to the *Manual on Uniform Traffic Control Devices* (MUTCD), pedestrian counts have to be collected hourly and the pedestrian volume has to be an accurate and fixed absolute value.

The Pedestrian Program can continue to set up the calibration and validation processes, by first validating the accuracy of the automated counters. Experts suggest that it is best to conduct a manual count at each location where there is an automated counter, in order to ensure that the automated and manual counts achieve similar results. The automated counters will need to be recalibrated in order to reduce errors if there is a large discrepancy between the automated and manual counts. The FHWA's *Traffic Monitoring Guide* (2013) recommends this process--using manual counts collected from video recordings for validating automated counting equipment—because it provides a basis for comparing the two counts and developing an adjustment factor that will correct for errors in the automated counting equipment.

The Program staff should clean the collected data once they have calibrated the equipment and confirmed the accuracy of the data has been verified, before doing any analysis. The staff should consider a few factors when cleaning the data for analysis. One common method for cleaning the data is to highlight (or flag) missing values or values that are at least three standard deviations above values from adjacent days, remove those outliers, and then recalculate the average, comparing the averages before and after to see if there is a dramatic change in the numbers (FHWA, 2016). Experts also recommend flagging the data if the total daily count is more than 50,000; if the total hourly count is more than 4,000; or if more than three identical non-zero values are next to each other. Staff should then recheck the fluffed data to verify its accuracy, and remove the data if necessary.

It is also important to consider additional information needed for a pedestrian demand model. The city of Santa Monica (CA), for example, used the data collected from biannual pedestrian counts, with other data, to create a Pedestrian Demand Index map that shows which areas of Santa Monica are likely to see the highest rates of pedestrian and demand for pedestrian improvements (City of Santa Monica, 2016). Santa Monica's Pedestrian Suitability Index Demand Analysis included demographic information, social equity data, land use data, special district information, pedestrian counts, and physical geography data.

The City of Austin's Sidewalks and Special Projects Division created a similar model for their 2009 Sidewalk Master Plan; the city used Geographic Information Systems (GIS) to recreate an automated analysis tool based on the criteria chosen in 2009 for the 2016 update of the Sidewalk Master Plan. The GIS Sidewalks model uses a Sidewalk Scoring Matrix that includes data such as proximity to different kinds of pedestrian attractors, including commuter rail stations, transit stops, grocery stores, and public places; the number of people living within a specific radius of the proposed sidewalk; median household income; core transit corridors, bicycle lanes, existing sidewalks; and citizen requests (Austin Sidewalk Master Plan, 2016). The model can be customized and run frequently in order to ensure that the data stay current. The Austin Pedestrian Program could create a similar model to the Sidewalk Scoring Matrix and even incorporate the prioritized sidewalks from the Sidewalks model into the Pedestrian Demand Model. This way, the Pedestrian Demand Model will also incorporate demand based on where sidewalks are most needed, which will ensure a commitment to equity in carrying out pedestrian improvements across the city.

GOAL 3: TRACK WALKING LEVELS AND BEHAVIOR CHANGES AT SPECIFIC LOCATIONS (E.G. CORRIDORS OR COMMERCIAL DISTRICTS)

There are actually three different sub-goals, or three different kinds of locations at which it would be relevant to track pedestrian activity levels: schools, corridors, and commercial districts. It is not appropriate to apply the same counting method to each of them. It is important to apply the counting method appropriate to each kind of location.

Conducting pedestrian counts at schools would allow the Pedestrian Program to evaluate which improvements and policies might be needed in order to get more children walking to and from school safely. Manual counts in the field would work best because staff would be able to get a first-hand look at conditions around schools and be able to talk to parents and children while also collecting pedestrian volume data. The pedestrian counts could be part of an overall walk audit for each school, that is, an evaluation of conditions around a school that may promote or discourage walking. Combining a walk audit with pedestrian counts will provide more useful data than pedestrian counts alone. The Safe Routes to School Program in the Public Works Department and the Active Transportation and Street Design Division in the Austin Transportation Department are currently collaborating with consultants to gather data for a Safe Routes to School Infrastructure Plan. As a part of the planning process for the SRTS Infrastructure Plan, staff will conduct a walk audit at each elementary and middle school in the City of Austin; they will assess current infrastructure conditions as well as conduct pedestrian and bicyclist counts. The Pedestrian Program can collaborate in the future with the Safe Routes to School Program to conduct pedestrian counts, linking the Safe Routes to School Program's pedestrian projects to the Pedestrian Program's overall goals.

Focusing on the other two locations, corridors and commercial districts, is important because Austin has been experiencing phenomenal growth in the last few decades. Austin is currently in the process of reforming the land development code, known as CodeNEXT, in order to manage the balance between the city's growth and maintaining Austin's quality of life. CodeNEXT emphasizes increased density along high-trafficked corridors such as Lamar Boulevard or Guadalupe Street because these corridors will lead more people to walk, cycle, or use public transit for their trips.

The city of Austin has also approved the creation of new, large mixed-use districts or designated certain areas for mixed-use development in the future, especially large parcels of land close to downtown. These mixed-use districts are intended to be pedestrian-friendly and in line with the vision of *Imagine Austin*. Tracking the pedestrian activity at these locations is important in order to assess whether the vision of *Imagine Austin* is actually being carried out in the city's policies, because mixed-use neighborhoods require walkability and pedestrian infrastructure in order to be successful. One such example is the Domain area, a large mixed-use area located in North Austin close to Mopac Expressway and US Highway 183, was established with the vision of the area becoming a second downtown for Austin. The South Central Waterfront District plan, lays out a mixed-use vision for the former Austin Statesman newspaper site located just south of downtown Austin on the shores of Towne Lake.

Austin's Pedestrian Program wants to track pedestrian activities in mixed use commercial districts and along major corridors. Installing passive infrared counters in these locations and along the major corridors seems to be the best way of tracking pedestrian volumes. The passive infrared sensors would save the Pedestrian Program staff labor time by reducing site visits and would allow the staff to conduct manual counts annually while passive infrared sensors would give them daily and seasonal data that would enhance their analysis. Passive infrared sensors can collect pedestrian volume data alone, but in these locations it may be best to purchase bicycle counting technology and partner with the rest of the Active Transportation and Street Design team to collect both pedestrian and bicyclist data. Purchasing the two technologies will incur higher upfront costs but the costs will be spread out over a long period of time. The Pedestrian Program staff will realize labor savings, using software to track pedestrian data over time.

GOAL 4: CONDUCT BEFORE/AFTER STUDIES WHEN INSTALLING NEW PEDESTRIAN FACILITIES IN ORDER TO ASSESS THE IMPACT OF THE IMPROVEMENTS

The purpose of this City goal is to better understand which pedestrian facility improvements are the most cost-effective. Collecting pedestrian counts before and after each installing various pedestrian improvements would provide the Pedestrian Program with data to assess which improvements are more effective than others, particularly with programs that the Pedestrian Program is in the process of planning and implementing, such as the Creative Crosswalks program. The Pedestrian Program could choose to implement low-cost options such as painting crosswalks or high-cost options such as installing

Pedestrian-Hybrid Beacons (PHBs), pedestrian-activated stoplight signals installed at crosswalks. In an ideal world, PHBs could be installed all over Austin but it is not a feasible option for both practical and financial reasons. Low-cost options might deliver the same or better results as higher-cost options, giving the Pedestrian Program more value for their spending—and the City needs data to evaluate the outcomes.

Using video recordings to manually count pedestrians at the locations where the City has installed pedestrian improvements seems like the best measurement option. The Pedestrian Program already has access to a supply of video cameras for this purpose, as well as access to CCTV cameras around the city. There would be no direct monetary cost into conducting these counts; the staff would have to spend time setting up the cameras, viewing the video recordings, and recording observed pedestrian data. The Program recorded pedestrian behavior before and after the pedestrian improvements are implemented. The city should capture data over a 24 hour period, once during the week and once on a weekend to provide a reasonable picture of pedestrian activity in the area. Another benefit of using the video recordings is that the staff can evaluate other factors as well: for example, lighting at night or other environmental factors that may encourage people to walk at that particular location, questioning whether proposed pedestrian improvements will address those factors.

GOAL 5: PUT PEDESTRIAN CRASH DATA INTO CONTEXT (I.E. NORMALIZE CRASH RATES BY PEDESTRIAN ACTIVITY TO BETTER UNDERSTAND WHERE THE HIGHEST RISK AREAS ARE FOR PEDESTRIANS)

The City seeks to better understand the areas in the city that pose risks for Austin's pedestrians, in order to better target safety improvements. Some areas of Austin may seem to be incredibly dangerous for pedestrians based on crash rates, but, if the city knows how those rates relate to actual pedestrian volumes in those areas – then, areas thought to more dangerous areas may not be disproportionately dangerous at all. Collecting pedestrian volume data in order to normalize pedestrian crash rates by exposure will help the city deliver safety improvements to the areas that experience a high number of crashes as well as high volumes of pedestrians. Austin's Vision Zero Policy means that any death is one death too many, so the goal here is not to ignore areas that have relatively few numbers of pedestrian deaths or injuries. The goal is to make sure that all areas with pedestrian crashes occurring are being targeted, but that the areas with the highest numbers of pedestrians and a high number of crashes are especially being effectively targeted. Preventing further pedestrian deaths is important, and this data should be useful towards that end.

For this goal, the Pedestrian Program can use either manual counts via video recordings or video image processing to count pedestrian activity. Using video recordings for manual counts is a lower -cost option than using video image processing devices, but the labor costs would be higher for manual counts. The Pedestrian Program staff can evaluate the overall conditions of the intersections being studied in addition to collecting pedestrian volume data using these methods. The more data the Pedestrian Program can collect, the better their analyses will be.

SUMMARY

It is important for the Pedestrian Program to track its goals using the most appropriate methods and approaches, based on the kind of data they need. It is important that the Pedestrian Program carefully considers how best to track each goal and apply the right method to each goal. In an ideal world, the Pedestrian Program would not have any labor, resource, financial, or equipment constraints and could install an automated counter at every important location and intersection within Austin. The program has limited resources and must decide how it can best balance its data needs against the resources needed to capture that data. The next chapter describes what steps the Pedestrian Program once it has the appropriate data to measure its movement toward its goals.

Chapter Six: Future Considerations and Conclusion

How can the Pedestrian Program best use the pedestrian data they collect? How should the Program evaluate the data as well as the effectiveness of pedestrian counting program to ensure that the program is effective achieving their overall goals? What is the best way to share the data with other city departments, other governmental agencies, and other stakeholders?

First, the Pedestrian Program has to determine how to analyze the collected data. The FHWA (2016) recommends that agencies create several metrics for summarizing and evaluating collected data, including annual average daily pedestrians (AADP) for continuous counters and average daily pedestrians (ADP) for non-continuous counters, as well as the differences in AADP between weekday and the weekend. Agencies can also calculate the average number of pedestrians per month; and yearly changes in number of pedestrians counted. It is also helpful to calculate the trends in the data from year to year. The Regional Planning Commission for the New Orleans Metropolitan Region, for example, began publishing a yearly Pedestrian and Bicycle Count Report in 2010; the annual report takes a comprehensive look at the state of bicycling and pedestrianism in the New Orleans region and also evaluates the validity of the data collected from the Commission’s counters. The Regional Planning Commission analyzes and compares the data it collects, highlighting changes and trends in the data. This would be a good model for Austin’s Pedestrian Program to emulate.

The Pedestrian Program can evaluate the best way to share the pedestrian data collected a vast array of stakeholders, including other City departments, other agencies and organizations, and the public. Some data can be restricted for internal use while other data are made freely accessible to the public and other interested parties. There are several methods for sharing the count data with the public online, including publishing the data in a map through the use of an application program interface (API); in datasets that can be downloaded; and using maps show both the data and any relevant analyses of the data. Additional analysis of the data can also be published online (FHWA, 2016).

The FHWA (2016) suggests that when publishing data online for the public, it is important to list essential information associated with the data, such as the data source and quality, so that users know the data are accurate and reliable. To ensure that the data remains reliable, the FHWA (2016) also recommends that any data uploaded online is backed up on a regular basis to avoid any loss of data. The FHWA also suggests that agencies allow other users to download the data from a website so the users can use the data for their own analysis. The Austin Pedestrian Program could also upload the collected data to national online databases such as the National Bicycle and Pedestrian Documentation Project's database or the FHWA's Travel Monitoring Analysis System. There are local benefits to sharing pedestrian data with other local jurisdictions, such as CAMPO or TxDOT. Being included in a national dataset may improve the Pedestrian Program's chances of acquiring funding, such as TIGER grants, for future projects (FHWA, 2016).

Once the City Pedestrian Program has analyzed and shared the data, it is important for staff to evaluate the overall pedestrian counting program. The Pedestrian Program should ensure that their approach is responsive to changes over time in the objectives of the program, available resources, the need to add or remove count locations, and new counting methods (Ryus et al., 2014). It is essential that the City assess and evaluate the program from time to time although we lack information on how best to evaluate a pedestrian counting program. The FHWA (2016) report asked attendees at a webinar on Pedestrian Counting Methods what they would recommend for communities that were just beginning to plan and implement a pedestrian counting program. The eight recommendations were:

1. Ensure that the pedestrian counting program is connected to performance measures;
2. Identify the health and economic benefits associated with trails (as well as pedestrian infrastructure and walkability);
3. Communicate with stakeholders;
4. Document the entire process (planning and implementation of the counting program) from start to end;
5. Identify all available technology to count pedestrians;
6. Be flexible;
7. Select the right data collection method for a project's specific purpose;
8. Research count locations carefully;

9. Set up a long-term strategic plan to ensure that the pedestrian counting program is being maintained effectively and is producing deliverables that are helping the agency achieve its goals;

10. Create a quality assurance/quality control method for the data collected;

11. And lastly, be patient.

(FHWA, 2016)

With the above recommendations in mind, Austin's Pedestrian Program should set up an evaluation cycle that will produce yearly reports as well as comprehensive analytical reports every five years. A yearly report will review the data the program has collected so far, analyze the difference in the data from the year before, and establish what additional data is needed. A yearly report will also ensure that the Pedestrian Program is staying accountable to its goals. Many cities generally update their plans every five years, so reviewing and analyzing the data collected every five years would show any actual changes in pedestrian activity levels over time.

The Pedestrian Program should consider what planning processes or projects they would like to implement next. The Program has recently released a draft version of its Pedestrian Safety Action Plan; pedestrian count data can be valuable for evaluating the outcomes of the Plan's goals. The Pedestrian Program is concerned with the entire state of the pedestrian environment within Austin, not just the pedestrian safety aspect. It would be extremely useful to ensure that the pedestrian count data should tie back to broader Pedestrian Program goals and actions.

The Program can use pedestrian volume data to further their overall program goals. The data can help Program staff create a Pedestrian Demand Model, which will give them a reasonable estimate of pedestrian activity levels within the city and allow the Program to determine where to target resources most effectively. The Program can then create a Pedestrian Master Plan in order to provide a framework for implementing programs and policies that will encourage walking within the city as a whole. The Pedestrian Program can determine which factors seem linked to high levels of safe pedestrian activity and plan to apply those factors to other locations in order to promote walking. Finally, collecting accurate and relevant data will allow the Pedestrian Program to advocate for pedestrian issues and influence both policy and programmatic activities within the city as a whole, using long term and accurate data to back up their efforts.

The Pedestrian Program has program and pedestrian counting goals they would like to achieve. The Pedestrian Program needs detailed and accurate pedestrian data to achieve these goals; they can capture those data in ways that allows them to track the progress and success of their goals. The Pedestrian Program should take a multi-pronged approach to their pedestrian counting program, based on programmatic needs and the needs of other city departments and local stakeholders. The program needs to collect different types of pedestrian data for different reasons over different time periods. It makes the most sense for the Pedestrian Program to choose a specific counting method for each goal, keeping in mind that counting methods may overlap for some of the goals.

This report has identified he best and most common types of available pedestrian counting methods and technologies and described the benefits, drawbacks, and tradeoffs associated with each method. There is no one technology or method that will help the Pedestrian Program meet all of its goals. Most of the technologies available are only useful for counting pedestrians in certain situations-- sidewalks or other pedestrian-only spaces-- unless the Program also purchases and use a second technology specifically for counting bicycles. The program can install more automated counters or install combination technologies for capturing pedestrian and bicyclist data in order to expand the scope of their pedestrian counting program once the pedestrian counting program has matured and the Pedestrian Program has gained experience with counting pedestrians. The additional cost will be easier to justify once the Pedestrian Program has proof of the effectiveness and usefulness of the count data and has more buy-in from city officials and other stakeholders.

It is important that the Pedestrian Program carefully consider how best to track the implementation of each of its goal, identify the kind of data need to measure how well those goals are being achieved, and apply the right data collection method to each specific goal. None of the methods covered in this report are perfect, but the field of pedestrian counting is still relatively new. Counting methods and technologies will likely improve over time as more cities and organizations begin to implement long term pedestrian counting programs. Austin's Pedestrian Program can collect valuable data to support and justify their planning processes by implementing a permanent pedestrian counting program. The City's data can contribute research data and lessons learned to the field of pedestrian counting for other cities.

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Vita

Caroline Meeden Bailey was born in Houston, Texas and grew up there. After graduating from Memorial High School, Houston, Texas, in 2008, she attended Texas Tech University and The University of St. Thomas in Houston, graduating from St. Thomas in December 2012 with a Bachelor of Arts in Environmental Studies and a minor in International Studies. Caroline also received a GIS Technician Certificate from Houston Community College in December 2013. Before entering the Community and Regional Planning graduate program at the University of Texas at Austin in September 2015, she was employed as a GIS Mapping Specialist in Houston. She is currently employed with the City of Austin in the Public Works Department.

Permanent email: carolinembailey@utexas.edu

This report was typed by the author.