Center for Advanced Multimodal Mobility Solutions and Education

Project ID: 2022 Project 06

Choosing Locations for Installation of Pedestrian Crossing Signs and Safety Measures at Non-signalized Intersections (Phase II)

Final Report

by

Isabelle Reynolds (ORCID ID: https://orcid.org/0009-0000-1431-9299
Graduate Research Assistant, Center for Transportation Research
Phone: 1-512-471-4541; Email: izzi@utexas.edu

and

Randy Machemehl, Ph.D., P.E. (ORCID ID: https://orcid.org/0000-0002-6314-2626)
The University of Texas at Austin
301 E. Dean Keeton Street, Stop C1761, Austin, TX 78712
Phone: 1-512-471-4541; Email: rbm@mail.utexas.edu

for

Center for Advanced Multimodal Mobility Solutions and Education
(CAMMSE @ UNC Charlotte)
The University of North Carolina at Charlotte
9201 University City Blvd
Charlotte, NC 28223

September 2024

ACKNOWLEDGEMENTS

This project was funded by the Center for Advanced Multimodal Mobility Solutions and Education (CAMMSE @ UNC Charlotte), one of the Tier I University Transportation Centers that were selected in this nationwide competition, by the Office of the Assistant Secretary for Research and Technology (OST-R), U.S. Department of Transportation (US DOT), under the FAST Act. The authors are also very grateful for all the time and effort spent by DOT and industry professionals to provide project information that was critical for the successful completion of this study.

Table of Contents

Abstract....4
Introduction....5
Literature Review....6
Methodology....7
Results....12
Discussion....16
Conclusions....16
Acknowledgments....16
Author Contributions....16
References....17

List of Figures

Figure 1. All Pedestrian Crashes on TxDOT Austin District Roads (10).... 10
Figure 2. Locations With A Rating of 6 or 7 (10).... 11
Figure 3. Imagery of Each Potential Location (10).... 14

List of Tables

Table 1. MUTCD Approved Pedestrian Control Devices.... 5
Table 2. Criteria Missed by Crashes With a Score of 6 or 7.... 12
Table 3. Additional Data About Crash Locations.... 13

Abstract

The National Highway Traffic Safety Administration (NHTSA) reports most pedestrian traffic deaths occur in urban areas (85%), at non-intersection locations (75%), and in the dark (78%) (*1*). This paper demonstrates a methodology for selecting locations to implement pedestrian safety countermeasures in urban, non-intersection, unlighted locations. The location selection process uses a ranking system with seven criteria to evaluate potential sites. The methodology is applicable to a variety of countermeasures if the criteria are changed to reflect the desired attributes of a location for installation of that countermeasure. This project demonstrates the methodology through a case study in the Texas Department of Transportation (TxDOT) Austin District with the goal of sequentially implementing a high-visibility painted crosswalk, lighting, and other countermeasures in phases to study safety improvement impacts on driver and pedestrian behavior.

Keywords: Pedestrian Safety, Pedestrian Crashes, Crosswalk

Introduction

In 2022, vehicles struck and killed 7,522 pedestrians on United States roadways (*1*, *2*). Pedestrian fatalities are consistently increasing, with 68 percent more than in 2011 (*2*). From 2017 to 2021, the TxDOT Austin District had 2,335 pedestrian crashes (*3*). This report is presented as a case study of pedestrian safety using the TxDOT Austin District.

One way of encouraging safe pedestrian travel is through the implementation of control devices. The Manual of Uniform Traffic Control Devices (MUTCD) for Streets and Highways specifies national standards for all traffic control devices, including road markings, highway signs, and traffic signals (Federal Highway Administration 2009). In the context of pedestrian facilities, control devices can include signs, beacons, signals, pavement, markings, and raised islands. Table 1 shows the corresponding section in the MUTCD for each type of approved pedestrian control device.

Table 1. MUTCD Approved Pedestrian Control Devices

Control Device	Section	Title
Signs	2B.52	Pedestrian Crossing Signs
	2B.11	Yield/Stop Here for Ped Signs
	2B.52	Pedestrian Signs
Signals	4E.01	Pedestrian Signal Heads
Beacons	4F.01	Application of Pedestrian Hybrid Beacons
Pavement Markings	3B.15	Transverse Markings
	2B.18	Crosswalk Markings
Islands	3I.06	Pedestrian Islands and Medians

This project provides a procedure for identifying and prioritizing pedestrian crash locations for installation of appropriate pedestrian safety features. The goal of the project is to install the crosswalk in parts, first installing a high-visibility painted crosswalk, then crosswalk lighting, and finally other beneficial safety measures. The installation in parts allows for individual assessments of the marginal safety benefits of the different crosswalk components. This paper discusses the first step in enhancement of pedestrian safety, which is the location selection.

Literature Review

The traditional process for identifying locations in need of safety improvements usually begins with a search of recorded crash data for hotspots where numbers of crashes are unusually large. The procedure proceeds with analysis of crashes in each hotspot, linking crashes to causative factors. Much research has produced a well understood set of methods for performing hotspot identification. The Highway Safety Manual outlines a six-step process for selecting locations to implement safety initiatives (*4*): (1) Network screening, (2) Diagnosis, (3) Countermeasure selection, (4) Economic appraisal, (5) Project prioritization, and (6) Safety effectiveness evaluation. This six-step process for identifying high-risk areas largely is applied to vehicular crashes.

When this approach is used to identify pedestrian crash hotspots, it does not work as well due to the low numbers of pedestrian crashes composing most crash hotspots. With infrequent crash rates, there are often few areas with more than one crash, and instead, mostly scattered data. Therefore, traditional methods that work to identify vehicular crash hotspots often do not work, and new approaches need to be developed specifically to analyze pedestrian crashes.

The Federal Highway Administration (FHWA) 2018 Guidebook on Identification of High Pedestrian Crash Locations identified the most common practice among State DOTs was to use fatal and serious crash injury numbers and crash rates (*5*). This guidebook also identifies a couple of potential practices in determining crash hotspots. One large-scale approach is to use a grid to count the number of crashes in each grid cell and identify areas of a city or region with high counts of pedestrian crashes. Another approach is the sliding window approach, where a corridor is analyzed by selecting a length for analysis, and then moving that segment a given offset along the entire corridor, recording the number of crashes within the region. A length of the corridor with a higher number of crashes is likely to be a hotspot.

There are numerous ways to prioritize pedestrian improvements once they are determined to be needed. National Highway Cooperative Research Program (NCHRP) Report 803 provides a methodology from which a list can be produced, ranking pedestrian and/or bicycle improvement projects based on weighted priorities of input factors (*6*).

According to the National Highway Transportation Safety Association (NHTSA), in 2022 most pedestrian traffic deaths occurred in urban areas (85%), at non-intersection locations (75%), and in the dark (78%) (*1*). These facts highlight urban, non-intersection locations and night-time conditions as most problematic for pedestrian crashes.

Several pedestrian safety improvement countermeasures for urban, non-intersection, not lighted locations include painting crosswalks, in street crossing signs (R1-6), overhead lighting, flashing beacons, and pedestrian hybrid beacons. Installing crosswalks and adding lighting is part of the Complete Streets initiative designed to produce streets that provide safe use and mobility to all users regardless of age or ability (FHWA).

It is increasingly important to select locations with specific attributes and high crash risks to install countermeasures. This paper looks at an approach to pedestrian crash countermeasure selection and implementation that relies on a ranking system, incorporating both crash risk and type of location, selecting specifically a location with inadequate lighting in an urban, non-intersection area.

Methodology

This effort is presented as a case study that focuses on facilities maintained by the TxDOT Austin District. To select a location for pedestrian safety project implementation, this study analyzed all pedestrian crashes in the TxDOT Crash Records Information System (CRIS) in the TxDOT Austin District region (*8*). CRIS shows 3,026 pedestrian crashes between July 1, 2019, and July 1, 2024. Of these crashes, 660 had no location reported or inadequate location data, leaving a starting data set of 2,366 crashes.

Crashes were chosen as the method of selecting potential locations for pedestrian safety feature installation as they represent a surrogate for pedestrian demand for a crossing facility, useful in showing at least at some time a pedestrian had a desire to cross the roadway.

Initially, crashes were removed if they did not fit the following criteria based on the information reported for each crash in the CRIS database:

1. Crash was located on a TxDOT owned roadway.
2. Crash was located on a roadway that is not an Interstate or US/State Route.
3. Crash was located at least 300 feet from the nearest signalized intersection or Pedestrian Hybrid Beacon.

Since this project case study is focused on the TxDOT Austin District, it was a requirement that the proposed roadway for crosswalk installation be in their jurisdiction. Additionally, the goal of this project was to implement crosswalk lighting at a location without signalization, so only crashes were included that occurred more than 300 feet from the nearest crosswalk or, if no crosswalk was present, edge of the nearest signalized intersection. This distance was chosen because, in the MUTCD, Section 4D.01, midblock crosswalks may not be signalized unless they are located at least 300 feet from the nearest intersection (*9*). Although the installed crosswalk was not initially signalized, there is no minimum distance for location of unsignalized crosswalks in the MUTCD. Information pertaining to the distance of a point from nearby intersections was ascertained from Google Maps satellite images (*10*).

After removing crashes that did not entail a viable location according to these criteria, 131 crashes were analyzed. Of the crashes removed from the analysis, 1,508 crashes were not on a TxDOT facility, and 508 crashes were on an Interstate or US/State highway. After applying this criteria, 350 crashes remained; 219 crashes were at or within 300 feet of an intersection or Pedestrian Hybrid Beacon.

A ranking system was developed, and the 131 existing viable crash locations were scored 0 or 1 on seven different criteria that would assess locations as strong candidates for crosswalk with lighting installation. These seven criteria are as follows:

1. The crash included a fatality.
2. The crash involved at least a minor injury or worse.
3. Sidewalks are located on both sides of the roadway.
4. There are no frontage roads or over/underpasses on the roadway.
5. Another crash occurred within 1000 ft.
6. The crash occurred during nighttime, including dawn and dusk.
7. The crash occurred on a facility without overhead lighting.

These criteria were selected based on both their importance to indicate a countermeasure is needed and the type of countermeasure that is needed. For instance, existing sidewalks enable a pedestrian to safely reach the crossing location, whereas a roadway without existing crosswalks faces a twofold problem of increased crash potential while the pedestrian is crossing the road and while the pedestrian is walking along it.

Whether the crash involved a fatality or injury and whether the crash occurred during the nighttime were determined based on crash data coded in the CRIS database (*8*). Sidewalk, frontage road, and overhead lighting information was determined using Google Maps satellite images and Google Street View (*10*).

All criteria were summed for each crash. One crash had a score of 7, and 14 crashes had a score of 6. Maps showing pedestrian crashes for the TxDOT Austin District and a zoomed-in section containing downtown Austin can be seen in Figure 1 and Figure 2. These crashes are color coded according to the rating they received.

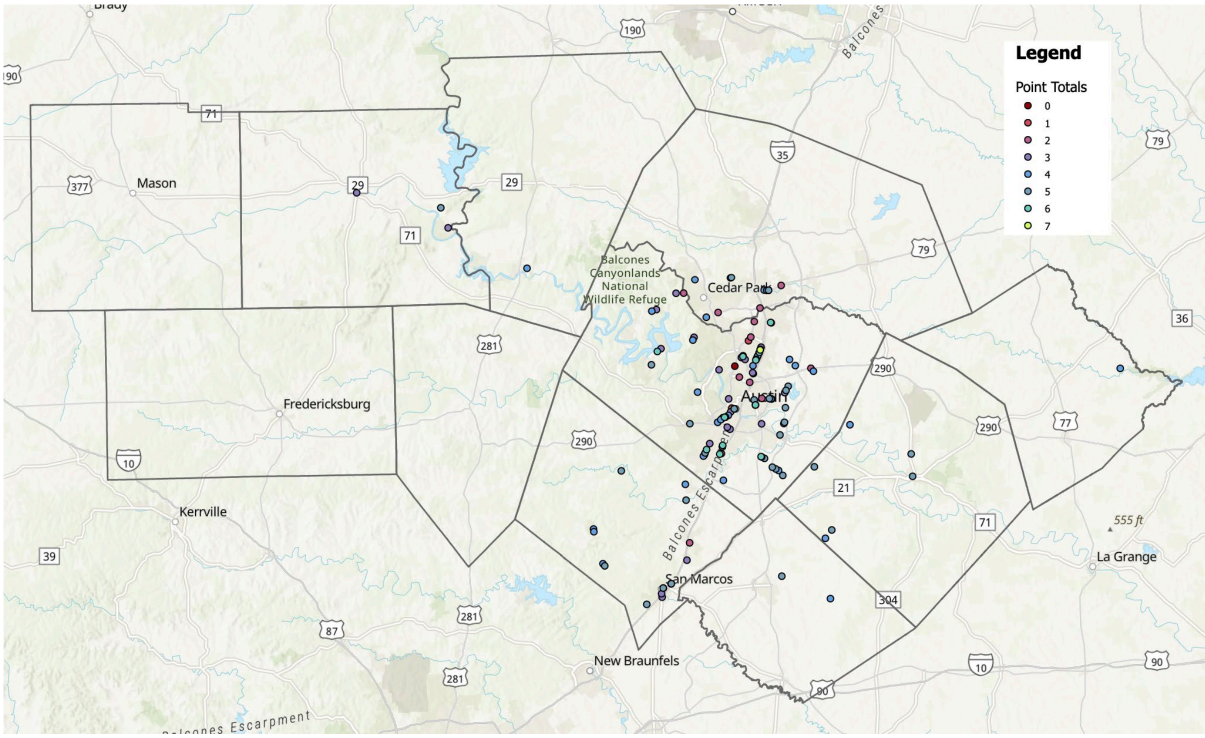

Figure 1. All Pedestrian Crashes on TxDOT Austin District Roads (10)
Non-Intersection Locations and
Non-Highway or Interstate Locations

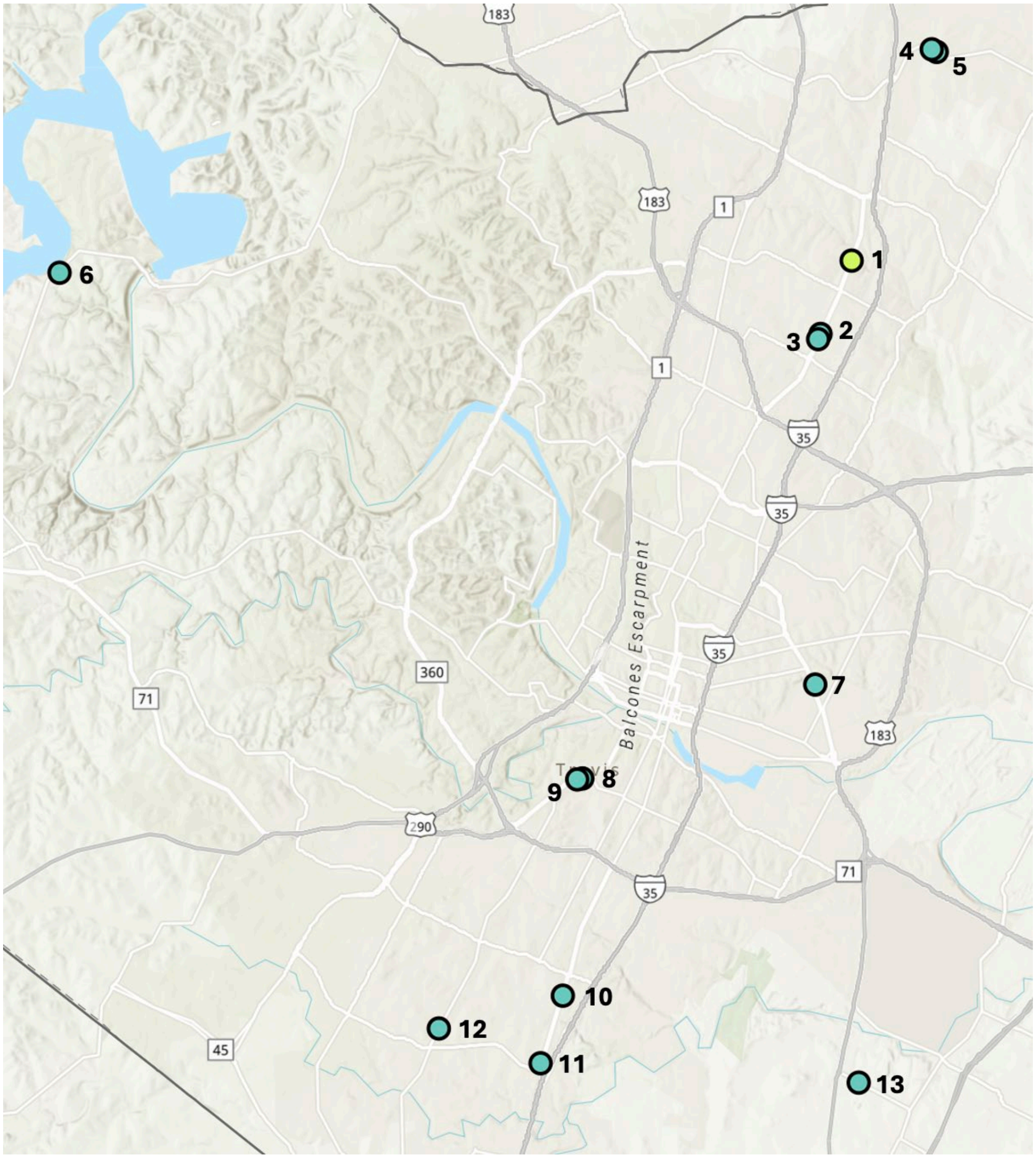

Figure 2. Locations With A Rating of 6 or 7 (10)

Results

After summing the points, the promising locations need to go through farther screening to determine the best locations for recommended crosswalk installation.

Table 2 outlines the point scores for each crash with a score of 6 or 7. For crashes scoring a 6, the criteria that was missing to reach a score of 7 is provided.

Table 2. Criteria Missed by Crashes With a Score of 6 or 7

	Street	Points	Criteria Missed
1	N Lamar Blvd between Little Oak Dr and Oakbrook Dr	7	None
2	N Lamar Blvd between W Longspur Blvd and Ken St	6	Overhead Lighting
3	N Lamar Blvd between W Longspur Blvd and Ken St	6	Overhead Lighting
4	W Pecan St between Foothill Farms Lp and Central Commerce Dr	6	Fatality
5	W Pecan St between Foothill Farms Lp and Central Commerce Dr	6	Sidewalks
6	FM 620 between Lariat Trl and General Williamson Dr	6	Sidewalks
7	Airport Blvd between Gunter St and Oak Springs Dr	6	Overhead Lighting
8	S Lamar Blvd between Goodrich Ave and Kinney Rd	6	Overhead Lighting
9	S Lamar Boulevard between Del Curto Rd and Goodrich Ave	6	Overhead Lighting
10	S Congress Avenue between Meadow Lea Dr and Cloudview Dr	6	Overhead Lighting
11	S Congress Ave between W Slaughter Ln and Ralph Ablanedo Dr	6	Nearby Crash
12	Menchaca Rd between Crownspoint Dr and Kimono Ridge Dr	6	Overhead Lighting
13	FM 812 between Foy Dr and Creedmoor Dr	6	Sidewalks

In Table 3 additional data pertaining to the attributes of the roadway and crash are provided, with the roadway alignment and date sourced from the CRIS database, nearby crashes determined using a 1000 foot circular buffer, and nearest marked crossing determined using Google Maps satellite imagery, Figure 3 (*8*, *10*).

Table 3. Additional Data About Crash Locations

	Speed Limit	Roadway Alignment	Date	Nearby Crashes	Nearest Marked Crossing (ft)
1	45	Straight, Level	4/1/22	1	1890
2	35	Straight, Level	8/27/23	1	465
3	35	Straight, Level	3/2/24	1	400
4	45	Straight, Grade	9/27/21	2	880
5	45	Straight, Level	9/28/22	2	311
6	55	Curve, Grade	3/18/22	1	> 2,000
7	40*	Straight, Level	9/17/22	2	470
8	40	Straight, Level	8/19/21	3	950
9	35*	Straight, Level	4/10/24	3	815
10	45*	Straight, Grade	12/30/20	1	> 2,000
11	45	Curve, Grade	9/23/19	0	475
12	45	Straight, Level	10/27/23	1	1170
13	60	Straight, Level	11/14/20	1	> 2,000

*Speed Limit data not available in CRIS database, determined from Google Streetview as nearby as possible to the crash site.

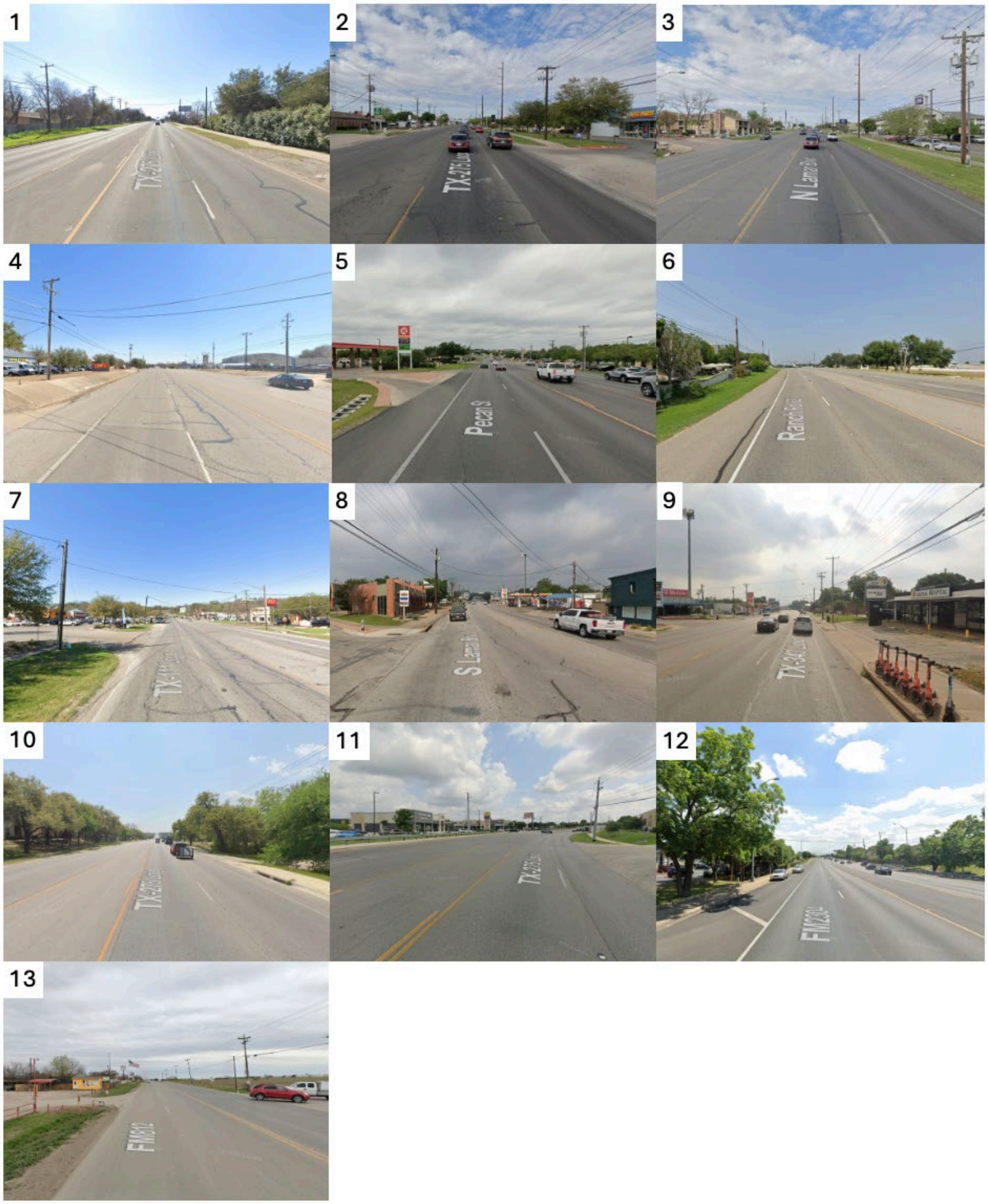

Figure 3. Imagery of Each Potential Location (10)

Evaluating the attributes of each location, it was determined crashes 5, 6, and 13 were at locations infeasible for crosswalk installation. This was due to a crossing 311 feet from location 5, determined to be too close to the 300 feet cutoff to justify the installation of a crosswalk. Locations 6 and 13 were infeasible for crosswalk installation due to high speed limits of 55 mph and 60 mph, respectively, at these locations.

Speed limit data was sometimes difficult to obtain for all locations; three of the 13 locations required that google maps be used to drive down the street and look for the speed limit signs. Therefore, a post-analysis screening of this data was used to eliminate locations that immediately seemed infeasible. This sort of "gut check" was an important step in the process to remove locations that, from a short summary, were determined to be poor locations.

After this initial screening, the potential locations for crosswalk installation were:

1. N Lamar Blvd between Little Oak Dr and Oakbrook Dr
2. N Lamar Blvd between W Longspur Blvd and Ken St
3. W Pecan St between Foothill Farms Lp and Central Commerce Dr
4. Airport Blvd between Gunter St and Oak Springs Dr
5. S Lamar Blvd between Goodrich Ave and Kinney Rd
6. S Lamar Boulevard between Del Curto Rd and Goodrich Ave
7. S Congress Avenue between Meadow Lea Dr and Cloudview Dr
8. S Congress Ave between W Slaughter Ln and Ralph Ablanedo Dr
9. Menchaca Rd between Crownspoint Dr and Kimono Ridge Dr
10. FM 812 between Foy Dr and Creedmoor Dr

North Lamar Blvd between West Longspur Blvd and Ken Street had two crashes on the same segment of road; the location was analyzed as one potential location. Ten promising potential locations for crosswalk installation remained.

Discussion

Occasional inaccuracies occur because of the nature of crash data. As an example, there are two crashes next to each other on South Congress Avenue that received a score of 6 and 5. The crash with a score of 5 had lighting coded as "DARK – LIGHTED", whereas the crash with a score of 6 had lighting coded as "DARK – UNLIGHTED". This is likely because on this stretch of road there appeared to be one overhead light, near where the pedestrian was hit.

Conclusions

This paper used a rating system based on selected criteria to evaluate and select potential pedestrian safety feature installation locations in the TxDOT Austin District. Following this review, 10 locations were selected for installations.

As a result of further review, incremental safety improvements may be installed. Following each incremental installation, driver behavior and pedestrian reactions could be monitored through video surveillance.

Acknowledgments

The authors acknowledge the guidance and support provided by the Texas Department of Transportation's Austin District, particularly Brenda Guerra, P.E.

Author Contributions

The authors confirm contribution to the paper as follows: study conception and design: Isabelle Reynolds and Randy Machemehl; data collection: Isabelle Reynolds; analysis and interpretation of results: Isabelle Reynolds and Randy Machemehl; draft manuscript preparation Isabelle Reynolds. All authors reviewed the results and approved the final version of the manuscript.

References

1. NHTSA. *Traffic Safety Facts 2022 Data*. Publication DOT HS 813 590. 2024.
2. Cova, E. Pedestrian Fatalities at Historic High. *Smart Growth America*. https://smartgrowthamerica.org/pedestrian-fatalities-at-historic-high/. Accessed Jul. 30, 2024.
3. TxDOT. *Pedestrian Safety Action Plan*.
4. AASHTO. Highway Safety Manual (HSM). American Association of State Highway Transportation Officials (AASHTO), 2010.
5. Fitzpatrick, K., R. Avelar, S. M. Turner, and Texas Transportation Institute. *Guidebook on Identification of High Pedestrian Crash Locations*. Publication FHWA-HRT-17-106. 2018.
6. NCHRP. *Pedestrian and Bicycle Transportation Along Existing Roads—ActiveTrans Priority Tool Guidebook*. Publication 803. 2015.
7. FHWA. Complete Streets. https://highways.dot.gov/complete-streets. Accessed Feb. 20, 2024.
8. TxDOT. CRIS Query. https://cris.dot.state.tx.us/public/Query/app/home. Accessed Jul. 31, 2024.
9. FHWA. Manual on Uniform Traffic Control Devices for Streets and Highways: 11th Edition. Dec, 2023.
10. Google Maps. *Google Maps*. https://www.google.com/maps. Accessed Jul. 31, 2024.