

Identifying Barriers to Understanding Pedestrian and Bicycle Safety Laws: Crash Analysis

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Introduction

The overall purpose of the Identifying Barriers to Understanding Pedestrian and Bicycle Safety Laws project is to better understand the existing barriers to the public’s understanding of pedestrian and bicyclist safety laws, research solutions, and best practices, and to develop educational materials to increase awareness of these laws for bicyclists, pedestrians, and motorists on Texas roadways.

Crash analyses provide traffic safety stakeholders with information on the factors involved in crashes. This information can guide resource allocation and interventions including engineering, educational, and enforcement strategies. The crash analysis discussed herein attempted to identify crashes involving a pedestrian or bicyclist resulting from a traffic safety law being violated. The Texas Transportation Code provides many regulations for all forms of transportation, including for pedestrians and bicyclists.

Background: Texas Transportation Code

The Texas Transportation Code provides regulations on all forms of transportation, including for pedestrians and bicyclists (Texas Constitution and Statutes, 2020). These laws regulate behavior, signage, traffic control, and right-of-way and also provide definitions, all of which form the basis for how traffic safety for all road users is enforced. Table 1 summarizes the pedestrian and bicyclist safety statutes found in the Texas Transportation Code. These codes include regulations that pedestrians, bicyclists, and motor vehicle drivers must follow that are related to pedestrian and bicyclist safety.

Table 1. Summary of Texas Pedestrian Safety Laws (Texas Constitution and Statutes, 2020).

Heading	Section(s)	Ped/Bike Law	Summary
Emerging from an Alley, a Driveway, or a Building	§545.256	Ped/ Bike	Vehicles should yield right-of-way to a pedestrian on a sidewalk when emerging from an alley, driveway, or building.
Crossing a Sidewalk or a Hike-and-Bike Trail	§545.422	Ped	Motorists cannot drive a vehicle on a sidewalk or a hike-and-bike trail unless authorized.

Heading	Section(s)	Ped/Bike Law	Summary
Traffic-Control Signals	§552.001	Ped	Pedestrians must follow traffic-control signals unless there is a pedestrian-control signal. If facing a green signal (unless the sole green signal is a turn arrow), a pedestrian may proceed across a road.
Pedestrian Right-of-Way	§552.002 and §552.003	Ped	<p>Pedestrians facing a “Walk” signal possess right-of-way and can begin crossing. If a “Don’t Walk” or “Wait” signal displays, a pedestrian already crossing can continue crossing.</p> <p>Drivers must yield right-of-way to a pedestrian in a crosswalk if there is no traffic-control signal and a pedestrian is crossing on the same half of the roadway as the vehicle or approaching from the opposite side as to be in danger. A pedestrian should not leave a sidewalk (or another place of safety) to enter a crosswalk if it is not possible for the vehicle to yield right-of-way. If a vehicle approaches another vehicle yielding right-of-way to a pedestrian, it may not pass. Section 552.003 also specifies punishment for the death or serious injury of a visually impaired or disabled pedestrian.</p>
Pedestrian to Keep to the Right	§552.004	Ped	Pedestrians should walk on the right half of a crosswalk if possible.
Cross at a Point Other Than a Crosswalk	§552.005	Ped	<p>Pedestrians crossing must yield right-of-way to a vehicle on the highway if at a place other than a crosswalk at an intersection or there is a pedestrian tunnel or overhead crossing. When between adjacent signalized intersections, a pedestrian may only cross in marked crosswalks.</p> <p>Pedestrians may not cross an intersection diagonally unless authorized.</p>
Use of a Sidewalk	§552.006	Ped	Pedestrians cannot walk along and/or on a roadway if there is an adjacent sidewalk. If no sidewalk is available, the pedestrian should try to walk on the left side of the roadway or shoulder facing oncoming traffic. If a driver is emerging from an alley, building, private road, or driveway, he or she should yield right-of-way to pedestrians.
Solicitation by Pedestrians	§552.007	Ped	A pedestrian may not stand in the roadway for any solicitation purposes unless for a charitable contribution as authorized by a local authority per §552.0071.
Local Authorization for Solicitation by a Pedestrian	§552.0071	Ped	A local authority is granted the power to authorize a person to stand in a roadway with a written application and proof of insurance to solicit a charitable contribution.

Heading	Section(s)	Ped/Bike Law	Summary
Drivers to Exercise Due Care	§552.008	Ped	In addition to the right-of-way of pedestrians stipulated under §552.02 and §552.03, a vehicle driver must exercise due caution to avoid a collision with a pedestrian, including a child, a confused person, or an incapacitated person. A vehicle driver may sound the horn when necessary.
Ordinances Relating to Pedestrians	§552.009	Ped	A local authority may pass ordinances to require pedestrians to comply more strictly with official traffic-control signals and prohibit pedestrians from crossing roadways in business districts and designated highways unless in a crosswalk.
Blind Pedestrians	§552.10	Ped	Pedestrians cannot “carry a white cane on a public street or highway unless the person is totally or partially blind.” A vehicle driver approaching a pedestrian guided by an assistance animal or carrying a white cane must take precaution to avoid a collision, bringing “the vehicle to a full stop if injury or danger can be avoided only by that action.” Section 552.10 also specifies punishment for the death or serious injury of a blind person.
Passing to the Left; Return; Being Passed	§545.053	Bike	Bicyclists must pass a vehicle to the left at a safe distance. After passing, the bicyclist needs to move to the right side when it is safe. When being passed, a bicyclist should move or remain to the right and should not accelerate until passed (unless passing to the right is permitted).
Driving on an Improved Shoulder	§545.058	Bike	Limitations on driving on an improved shoulder in this section do not apply to bicycles, authorized emergency vehicles responding to calls, and police patrols. A vehicle may operate on improved shoulders to the right of the roadway, if safe and necessary, and only to stop, stand, or park; accelerate before entering the roadway; turn right; pass another vehicle that is slowing or stopped on the roadway or turning left; allow another vehicle to pass; follow an official traffic-control device; or avoid a collision. A vehicle may operate on an improved shoulder to the left of a divided, limited-access, or controlled-access highway if safe movement to the right shoulder is not feasible, to avoid a collision, or to follow official traffic-control devices.
Method of Giving Hand-and-Arm Signals	§545.107	Bike	If applicable, a vehicle driver or bicyclist must give hand signals from the left side of the vehicle or bicycle as follows: “to make a left-turn signal, extend the hand and arm horizontally; to make a right-turn signal, extend the hand and arm upward (a bicyclist may signal from the right side of the vehicle with the hand and arm extended horizontally); and to stop or decrease speed, extend the hand and arm downward.”

Heading	Section(s)	Ped/Bike Law	Summary
Stopping, Standing, or Parking Prohibited in Certain Places	§545.302	Bike	<p>Vehicles (including bicycles) cannot stop, stand, or park on the roadway side of a stopped or parked vehicle; on a sidewalk; in an intersection; on a crosswalk; in front of an official sign that prohibits stopping; etc.</p> <p>Unless picking up or dropping off a passenger, a vehicle cannot stand or park an occupied or unoccupied vehicle in front of a driveway; close to a fire hydrant; close to a crosswalk at an intersection; near a flashing signal, stop sign, yield sign, or traffic-control signal; or at the driveway entrance to a fire station. A vehicle may not be parked in front of a public or private driveway or an official sign that prohibits standing.</p> <p>Bicyclists may stop, stand, or park a bicycle on a sidewalk if it does not stop the movement of other traffic on the sidewalk.</p> <p>In addition, parking rules do not apply if the avoidance of conflict is necessary or the operator is complying with traffic-control devices or law enforcement.</p> <p>Last, a local agency may adopt its own ordinance to regulate stopping, standing, or parking.</p>
Opening Vehicle Doors	§545.418	Bike	<p>Vehicle doors should not be opened on the side available to moving traffic unless the door opening does not interfere with traffic movement. The door should not be open longer than is necessary to load or unload a passenger.</p>
Rights and Duties	§551.101	Bike	<p>A bicyclist has the same rights and duties as a vehicle driver unless an exception is provided or the said right or duty cannot be practically applied to a bicyclist.</p>
General Operation	§551.102	Bike	<p>A bicyclist must have a permanent and regular seat attached to the bicycle and may not carry more persons than the bicycle is equipped to carry. Bicyclists may not carry any object that prevents the safe operation of the bicycle with at least one hand on the handlebars. In addition, bicyclists may not attach either themselves or the bicycle to a streetcar or vehicle on a roadway.</p>
Safety Equipment	§551.104	Bike	<p>A bicycle is required to be equipped with a brake and cannot be operated at nighttime unless the bicycle is equipped with a white light on the front and a red reflector or light on the back.</p>

Heading	Section(s)	Ped/Bike Law	Summary
Operation on a Roadway	§551.103	Bike	Bicyclists moving slower than other traffic should ride as close as possible to the right curb or edge of the roadway, unless they are passing other vehicles; they are preparing to turn left; there is a condition, hazard, or object on the roadway that prevents them from doing so; or they are riding in a lane that is too narrow to safely travel side by side with a motor vehicle. A bicyclist “on a one-way roadway with two or more marked traffic lanes may ride as near as possible to the left curb or edge of the roadway.” Bicyclists may ride two abreast. Additionally, bicyclists riding two abreast on a laned roadway must ride in a single lane. Bicyclists may not ride more than two abreast unless in a roadway set aside for exclusive bicycle operation.

Methods

Data Sources

The crash analysis was conducted using the Texas Department of Transportation’s (TxDOT’s) Crash Records Information System (CRIS) data from 2015 to 2019 (Texas A&M Transportation Institute, 2020). The data were extracted on January 20, 2021.

Identifying Law-Related Crashes

Contributing Factors

The team first reviewed reported contributing factors that are associated with the Texas Transportation Code, including intersection status, failure to yield right-of-way, failure to pass safely, and dark lighting condition.

Intersections are of particular concern because they are where pedestrians and bicyclists are most likely to interact with motorists (National Highway Traffic Safety Administration, 2014).

Intersection status was defined as crashes with intersection-related ID assigned as intersection or intersection related. The Texas Transportation Code includes statutes that address yielding right-of-way specific to intersections including pedestrians and traffic-control signals (§552.001), pedestrians’ right-of-way (§552.002/§552.003), and crossing at a point other than a crosswalk (§552.005). As part of intersection status, driveway involvement was examined for crashes with intersection status defined as driveway access, which is addressed in §545.256 (Emerging from an Alley, Driveway, or Building) of the Texas Transportation Code.

Traffic-control devices were then examined for intersection and intersection-related crashes, providing a better understanding of the scenarios in which crashes are occurring. All traffic-control devices were examined for the purposes of this analysis. Specifically, §552.001 covers pedestrians and crossing-signal devices.

To help guide interactions between pedestrians, bicyclists, and motorists, the Texas Transportation Code includes many statutes regarding yielding right-of-way (see §552.002, §552.003, §552.005, §552.006, and §545.256). Failure to yield right-of-way was defined as individuals with the following contributing factors: failed to yield right-of-way to an emergency vehicle, failed to yield right-of-way at an open intersection, failed to yield right-of-way for a private drive, failed to yield right-of-way at a stop sign, failed to yield right-of-way to a pedestrian, failed to yield right-of-way for turning left, failed to yield right-of-way for turning on red, failed to yield right-of-way at a yield sign, or a pedestrian failed to yield right-of-way to a vehicle. Through examining the magnitude of failing to yield right-of-way, the team can understand the degree to which these laws are being violated.

Passing is also included in existing pedestrian and bicyclist safety laws, including §552.002, §552.003, and §545.053. Failure to pass safely was defined as individuals who were reported to have failed to pass to the left safely.

The team explored lighting condition for bicyclist-involved crashes since §551.104 states that bicyclists need to have reflectors and/or lights to ride at night. Dark lighting condition was defined as crashes with lighting condition dark—not lighted, dark lighted, or dark unknown lighting. While lighting condition does not determine if the bicyclist had proper safety equipment, it does provide information on the number of riders riding at times that would require this equipment. The dark lighting condition was only explored for bicyclists who under §551.104 are required to have lights and/or reflectors to operate at night.

Table 2 summarizes the Texas Transportation Code associated with each contributing factor.

Table 2. Contributing Factors and the Associated Texas Transportation Code.

Contributing Factor	Texas Transportation Code
Intersection Status	§552.001, §552.002, §552.003, §552.005
Driveway Access	§545.256

Contributing Factor	Texas Transportation Code
Traffic-Control Device	§552.001
Failure to Yield Right-of-Way	§552.002, §552.003, §552.005, §552.006, §545.256
Failure to Pass Safely	§552.002, §552.003, §545.053
Dark Lighting Condition	§551.104

Note: The dark lighting condition was only explored for bicyclists who under §551.104 are required to have lights and/or reflectors to operate at night.

Charges

The team then reviewed reported charges associated with crashes to understand citations given to bicyclists, pedestrians, and motorists in the reported pedestrian- and bicyclist-involved crashes. The TxDOT CRIS charge file does not specify which law was violated; instead, charges are reported as an open-text field. To determine which law was potentially violated, all charges were manually reviewed and classified based on the person type (e.g., driver, pedestrian, or bicyclist) and the reported charge. There were instances in which a charge could potentially fall into more than one statute being violated. Table 3 provides a brief definition of the charges included for each pedestrian and bicyclist safety law.

Table 3. Classification of Charges into Pedestrian and Bicyclist Safety Laws.

Heading	Section(s)	Ped/Bike Law	Charge Definition
Emerging from an Alley, a Driveway, or a Building	§545.256	Ped/Bike	Charges involving either a driver or bicyclist who failed to yield right-of-way at an alley, a driveway, or a building.
Crossing a Sidewalk or a Hike-and-Bike Trail	§545.422	Ped	Charges involving a driver driving on a sidewalk.
Traffic-Control Signals	§552.001	Ped	Charges involving a pedestrian who disregarded a signal or walked against a traffic-control device.
Pedestrian Right-of-Way	§552.002 and §552.003	Ped	<ol style="list-style-type: none"> 1. Charges involving a pedestrian who failed to yield right-of-way at a crosswalk or disregarded a stop sign. 2. Charges involving a driver or bicyclist who failed to yield right-of-way or disregarded a stop sign.
Pedestrian to Keep to Right	§552.004	Ped	A pedestrian who failed to keep right.

Heading	Section(s)	Ped/Bike Law	Charge Definition
Cross at a Point Other Than a Crosswalk	§552.005	Ped	A pedestrian who crossed at a point other than a crosswalk. Note: Pedestrians who were described as crossing where prohibited were flagged as violating Sections 552.005 and 552.009. Pedestrians who were found to be entering the path of the vehicle were flagged as violating Sections 552.005, 552.006, and 552.007 since it was not feasible to determine which law had been violated.
Use of a Sidewalk	§552.006	Ped	A pedestrian who was found to be walking on a street, walking on a roadway, or entering the path of a vehicle. Note: Pedestrians who were found to be entering the path of the vehicle were flagged as violating Sections 552.005, 552.006, and 552.007 since it was not feasible to determine which law had been violated.
Solicitation by Pedestrians	§552.007	Ped	A pedestrian who was reported to be soliciting. Note: Pedestrians who were found to be entering the path of the vehicle were flagged as violating Sections 552.005, 552.006, and 552.007 since it was not feasible to determine which law had been violated.
Local Authorization for Solicitation by Pedestrian	§552.0071	Ped	A pedestrian who was reported to be soliciting with local authorization.
Drivers to Exercise Due Care	§552.008	Ped	A driver or bicyclist who failed to exercise due care.
Ordinances Relating to Pedestrians	§552.009	Ped	A pedestrian who was reported violating a local ordinance. Note: Pedestrians who were described as crossing where prohibited were flagged as violating Sections 552.005 and 552.009.
Blind Pedestrians	§552.10	Ped	<ol style="list-style-type: none"> 1. A pedestrian found to be carrying a white cane but who is not blind. 2. A driver not taking precaution near a pedestrian using a white cane.
Passing to the Left; Return; Being Passed	§545.053	Bike	A bicyclist with a charge indicating that he or she passed to the right or when it was unsafe.
Driving on an Improved Shoulder	§545.058	Ped/Bike	A driver who was charged for driving on an improved shoulder or in the shoulder lane.
Method of Giving Hand-and-Arm Signals	§545.107	Bike	A bicyclist who was charged for failing to signal.
Stopping, Standing, or Parking Prohibited in Certain Places	§545.302	Bike	A driver or bicyclist who was charged for stopping, standing, or parking on the main traveled way.
Opening Vehicle Doors	§545.418	Bike	A driver who was charged with opening doors that interfered with traffic.

Heading	Section(s)	Ped/Bike Law	Charge Definition
Rights and Duties	§551.101	Bike	A bicyclist who was found to be violating a law specific for vehicles.
General Operation	§551.102	Bike	A bicyclist who was found to not have a seat, carrying too many people or an object that obstructed safe operation of the bicycle, or riding with no hands on the handlebars.
Safety Equipment	§551.104	Bike	A bicyclist riding a bike with no brake or no light or reflector at night.
Operation on a Roadway	§551.103	Bike	A bicyclist who was found to have failed to keep on the right side of roadway or riding too far into the lane.

Data Analysis

Descriptive statistics were computed using a multitude of software, including SAS 9.4, Stata 15, and Microsoft Excel.

Limitations

Because the charges are an open-text field, the information obtained for the charges is dependent on what the officer put in this field. The data do not specify which statute was violated. These data also assume that the officer is familiar with the details of pedestrian and bicyclist laws covered in the Texas Transportation Code. Another limitation is that the team had to manually classify this information, which introduces potential human error. To overcome this, classifications were checked three or more times to minimize the impact of the task being human dependent. In addition, due to the fact the data do not indicate the specific code that was violated, there were instances in which a charge could potentially fall under more than one statute violation. For example, a charge that stated “pedestrian entering path of vehicle” could have fallen under §552.005, §552.006, and §552.007. In addition, pedestrians who were found to be crossing where prohibited may have been in violation of parts of §552.005 and §552.009. In these instances, individuals were found to be in violation of all potential statutes. Under §552.005, the violation could be for failure to yield right-of-way under subsection a or crossing illegally under subsections b or c. It was not feasible to specify which subsection of a statute had been violated with the charge file. A final limitation is that the current project is focused on state pedestrian and bicyclist safety laws; thus, the team did not explore or identify violations at the local ordinance level or other violations to the Texas Transportation Code.

Results

A total of 41,785 crashes were included in the analysis. Of these, 12,771 (31 percent) were found to be bicyclist involved and 29,030 (70 percent) were found to be pedestrian involved. These percentages sum to greater than 100 percent because 16 crashes involved both a pedestrian and bicyclist. Figure 1 displays the number of pedestrian- and bicyclist-involved crashes by year. The number of crashes remained relatively stable during the time period. The next sections discuss the contributing factors reviewed and charges identified.

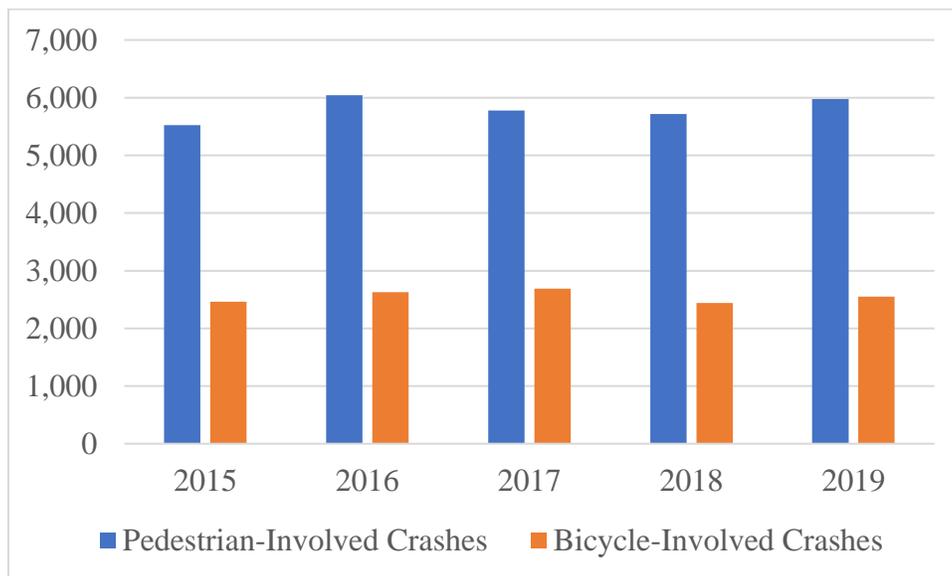


Figure 1. Pedestrian- and Bicyclist-Involved Crashes by Year.

For the reported crashes, 91,353 primary people were included in the crash data, with a total of 14,729 charges reported. Of the reported charges, 10,317 (70 percent) were associated with pedestrian-involved crashes, 4,402 (30 percent) were associated with bicyclist-involved crashes, and 10 (0.7 percent) were associated with a crash involving both a pedestrian and bicyclist.

The following subsections describe contributing factors and charges identified for pedestrian- and bicyclist-involved crashes.

Pedestrian Crashes

Contributing Factors

Intersection Status

First, intersection status was explored and revealed that 39 percent of pedestrian-involved crashes from 2015 to 2019 involved an intersection or were intersection related, 5 percent involved driveway access, and 56 percent were non-intersection related (see Table 4). Over time, the percentage of intersection-related crashes decreased slightly, from 35 percent in 2015 to 32 percent in 2019, whereas during the same time period, non-intersection crashes increased from 52 percent to 56 percent.

Table 4. Pedestrian-Involved Crashes by Intersection Status.

Year	Intersection	Intersection Related	Driveway Access	Non-intersection	Total
2015	369 (7%)	1,936 (35%)	318 (6%)	2,898 (52%)	5,521
2016	480 (8%)	1,995 (33%)	326 (5%)	3,240(54%)	6,041
2017	410 (7%)	1,717 (30%)	310 (5%)	3,339 (58%)	5,776
2018	399 (7%)	1,732 (30%)	282 (5%)	3,305 (58%)	5,718
2019	424 (7%)	1,918 (32%)	299 (5%)	3,333 (56%)	5,974
Total	2,082 (7%)	9,298 (32%)	1,535 (5%)	16,115 (56%)	29,033

Traffic-Control Device

The most common type of traffic-control device reported for intersection and intersection-related pedestrian-involved crashes was the signal light (41 percent; n = 4,616), compared to the stop sign (19 percent; n = 2,105) and marked lanes (14 percent; n = 1,590) (data not shown).

Failure to Yield Right-of-Way

The team then examined failure to yield right-of-way for pedestrians and motorists involved in the pedestrian-involved crashes. Overall, 36 percent of pedestrians (n = 11,124) and 16 percent of motorists (n = 4,972) were found to have failed to yield right-of-way (data not shown).

Failure to Pass Safely

The team examined failure to pass safely for pedestrians and motorists involved in the pedestrian-involved crashes. There was only one pedestrian who failed to pass safely in the

pedestrian-involved crashes (data not shown). Of the motorists, 116 (0.4 percent) failed to pass safely (data not shown).

Charges

Of the 29,030 reported pedestrian-involved crashes, 28 percent (n = 8,129) had a reported charge. There were 10,317 charges associated with a pedestrian-involved crash; of these, 3,025 (29 percent) were found to not be a violation of a pedestrian or bicyclist law (e.g., no license, no registration, or speeding).¹ The current project is focused on state pedestrian and bicyclist safety laws; thus, no other charges are included in the report. Table 5 displays the classified reported charges for pedestrian-involved crashes. Only statutes with identified charges in the charge file are reported in Table 5. The top three charges identified were §552.002/§552.003, §552.005, and §552.006.

Table 5. Reported Charges for Pedestrian-Involved Crashes.

Heading	Section(s)	Ped/Bike Law	Charges Identified
Emerging from an Alley, a Driveway, or a Building	§545.256	Ped/Bike	12 drivers
Crossing a Sidewalk or a Hike-and-Bike Trail	§545.422	Ped	1 driver
Traffic-Control Signals	§552.001	Ped	51 pedestrians
Pedestrian Right-of-Way	§552.002 and §552.003	Ped	<ul style="list-style-type: none"> • 1,832 drivers • 365 pedestrians
Pedestrian to Keep to Right	§552.004	Ped	1 pedestrian
Cross at a Point Other Than a Crosswalk	§552.005	Ped	377 pedestrians
Use of a Sidewalk	§552.006	Ped	<ul style="list-style-type: none"> • 1 driver • 271 pedestrians
Solicitation by Pedestrians	§552.007	Ped	61 pedestrians
Drivers to Exercise Due Care	§552.008	Ped	39 drivers
Ordinances Relating to Pedestrians	§552.009	Ped	18 pedestrians

Note: Pedestrians who were described as crossing where prohibited were flagged as violating Sections 552.005 and 552.009. Pedestrians who were found to be entering the path of the vehicle were flagged as violating Sections 552.005, 552.006, and 552.007 because it was not feasible to determine which law had been violated.

¹ Multiple people could be charged in a crash, or a person could be charged with more than one offense.

The team identified 19 drivers involved in a pedestrian-involved crash who had violated §545.058 by driving on the improved shoulder. While §545.058 is normally considered a bicycle safety law, this finding could be indicative of crashes involving unintended pedestrians.

Bicyclist Crashes

Contributing Factors

Intersection Status

Intersection status was then explored for bicyclist-involved crashes and showed that 60 percent of bicyclist-involved crashes from 2015 to 2019 involved an intersection or were intersection related, whereas 11 percent involved driveway access and 29 percent were non-intersection related (see Table 6). There were no significant changes throughout the time period.

Table 6. Bicyclist-Involved Crashes by Intersection Status.

Year	Intersection	Intersection Related	Driveway Access	Non- intersection	Total
2015	760 (31%)	777 (32%)	244 (10%)	681 (28%)	2,462
2016	812 (31%)	795 (30%)	258 (10%)	761 (29%)	2,626
2017	777 (29%)	839 (31%)	301 (11%)	774 (29%)	2,691
2018	673 (28%)	750 (31%)	292 (12%)	725 (30%)	2,440
2019	715 (28%)	814 (32%)	262 (10%)	761 (30%)	2,552
Total	3,737 (29%)	3,975 (31%)	1,357 (11%)	3,702 (29%)	12,771

Traffic-Control Device

The most common type of traffic-control devices reported for intersection and intersection-related bicyclist-involved crashes was the stop sign (39 percent; n = 3,003), compared to the signal light (31 percent; n = 2,381) and marked lanes (12 percent; n = 921) (data not shown).

Failure to Yield Right-of-Way

The team then examined failure to yield right-of-way for bicyclists and motorists involved in bicyclist-involved crashes. Overall, 18 percent of bicyclists (n = 2,325) and 8 percent of motorists (n = 1,079) were found to have failed to yield right-of-way (data not shown).

Failure to Pass Safely

The team then examined failure to pass safely for bicyclists and motorists involved in the bicyclist-involved crashes. Of the bicyclists involved in a crash, 44 (0.3 percent) failed to pass safely (data not shown). In comparison, of the motorists involved in a bicyclist-involved crash, 177 (1 percent) failed to pass safely (data not shown).

Lighting Condition

The team explored lighting condition for bicyclist-involved crashes because §551.104 states that bicyclists need to have reflectors and/or lights to ride at night. While lighting condition does not determine if the bicyclist had proper safety equipment, it does provide information on the number of riders riding at times that would require this equipment. Overall, 26 percent (n = 3,279) of the bicyclist-involved crashes were found to occur in dark lighted conditions (data not shown).

Charges

Of the 12,771 reported bicyclist-involved crashes, 28 percent (n = 3,526) had a reported charge. A total of 4,402 charges were associated with a bicyclist-involved crash; of these, 1,935 (44 percent) were found to not be a violation of a pedestrian or bicyclist law (e.g., no license, no registration, or speeding) (see footnote on page 12). The current project is focused on state pedestrian and bicyclist safety laws; thus, no other charges are included in the report. Table 7 displays the classified reported charges for bicyclist-involved crashes. Only statutes with identified charges in the charge file are reported in Table 7. The top three charges identified were §551.101, §551.104, and §551.103.

Table 7. Reported Charges for Bicyclist-Involved Crashes.

Heading	Section(s)	Ped/Bike Law	Charges Identified
Emerging from an Alley, a Driveway, or a Building	§545.256	Ped/Bike	<ul style="list-style-type: none">• 31 drivers• 11 bicyclists
Passing to the Left; Return; Being Passed	§545.053	Bike	6 bicyclists
Driving on an Improved Shoulder	§545.058	Bike	7 drivers
Method of Giving Hand-and-Arm Signals	§545.107	Bike	5 bicyclists
Rights and Duties	§551.101	Bike	311 bicyclists
Operation on a Roadway	§551.103	Bike	55 bicyclists
Safety Equipment	§551.104	Bike	113 bicyclists

The manual review found that bicyclist-involved crashes had a significant number of drivers (n = 1,086) and bicyclists (n = 366) who were found to have failed to yield right-of-way, which is discussed under §545.153, §544.003, and §544.010.

Conclusions

Traditional crash analyses attempt to identify factors that contribute to crashes, which allows for targeted educational efforts. The team conducted a crash analysis to understand the association of crashes with existing pedestrian and bicyclist safety laws in Texas. These laws are designed to keep road users safe. Understanding crashes involving potential violations helps identify educational areas to increase awareness of the laws. The analysis specifically identified:

- Pedestrian-involved crashes:
 - 39 percent of crashes were intersection related.
 - 56 percent were not intersection related.
 - 5 percent involved driveway access.
 - 36 percent of pedestrians were found to have failed to yield right-of-way.
 - 16 percent of motorists were found to have failed to yield right-of-way.
 - The top three violations in the charge file were:
 - §552.002/§552.003—pedestrian right-of-way.
 - §552.005—crossing at a point other than a crosswalk.
 - §552.006—use of a sidewalk.
- Bicyclist-involved crashes:
 - 60 percent of crashes were intersection related.
 - 29 percent were not intersection related.
 - 11 percent involved driveway access.
 - 18 percent of bicyclists were found to have failed to yield right-of-way.
 - 8 percent of motorists were found to have failed to yield right-of-way.
 - The top three violations in the charge file were:
 - §551.101—rights and duties.
 - §551.104—safety equipment.
 - §551.103—operation on a roadway.

This information shows the importance of educational efforts on promoting pedestrian and bicyclist laws. The pedestrian crash analysis demonstrates that right-of-way for both pedestrians and motorists is an issue and, while 39 percent of crashes were related to an intersection, 56 percent occurred away from intersections. The charge file emphasizes that education on where and when pedestrians can and should cross a road and the use of sidewalks is also very important. In terms of bicyclists, the failure to yield right-of-way is a much lower percentage of the crashes, but it is evident that the majority of bicyclist-involved crashes occurred at or near an

intersection. The charge file highlights that education on the rights and duties of bicyclists, the use of proper safety equipment (specifically lights at night), and the general operation of bicycles on the roadway is needed to improve safety. The information ascertained from this analysis will be used to guide the development of educational materials during this grant year and can assist other traffic safety stakeholders with their efforts to increase awareness of state pedestrian and bicyclist safety laws.

This analysis builds upon traditional crash analyses that use crash, unit, and primary person tables to understand environmental, roadway, and behavioral factors associated with crashes. This analysis utilized the charge table, which is not traditionally utilized in crash analyses, to understand potential state pedestrian and bicyclist safety laws that are being violated. Through identifying laws that are being violated, the project team can address known problem areas.

While providing useful information, the charge file is limited to an open-text field that allows officers to freely enter the charge, which required the team to manually classify each charge to the associated Texas Transportation Code statute. This process may have resulted in potential biases since some charges did not fit clearly into just one statute. In addition, the charges are also dependent on the officers being aware of pedestrian and bicyclist safety laws as well as charging pedestrians, bicyclists, and motor vehicle drivers appropriately for violations. The charge file does not include warnings that road users may have been given. To build on this analysis, future work should explore supplementing crash, unit, primary person, and charge data through reviewing provided crash narratives, which provide a written paragraph describing the crash events.

References

- National Highway Traffic Safety Administration. (2014). *Pedestrian Safety Enforcement Operations: A How-To Guide*. Washington, DC: U.S. Department of Transportation. Available at <https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/812059-pedestriansafetyenforceoperahowtoguide.pdf>.
- Texas A&M Transportation Institute. (2020, January). Texas Department of Transportation Crash Records Information System MicroStrategy.
- Texas Constitution and Statutes. (2020). Transportation Code. Available at <https://statutes.capitol.texas.gov/?link=TN>.