Traffic Conflict Technique Toolkit

Making the Journey to and from School Safer for Students

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Traffic Conflict Technique Toolkit

Making the Journey to and from School Safer for Students

An evidence-based approach to designing and executing traffic conflict data collection with a focus on school zones in low- and middle-income countries

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Introduction

Overview

The Traffic Conflict Technique (TCT) is a means of proactively collecting observational data to evaluate the safety of intersections or stretches of roadways with the intention of preventing crashes and injuries before they occur. Particularly in locations where data are scarce, TCTs can help determine if road safety interventions are effective in reducing traffic conflicts, and thus, reducing crashes and injuries. This toolkit is intended to serve as a comprehensive guide for applying TCTs and presents a variety of different methods to conduct this evaluation based on time, resources, and need.

Global Burden

Every year, road traffic crashes are responsible for more than 1.35 million deaths (World Health Organization, 2018a). More than half (54%) of the deaths are among vulnerable road users (e.g., pedestrians, cyclists, and motorcyclists) (World Health Organization, 2018a). Beyond the deaths, an additional 20-50 million people are nonfatally injured in crashes each year, many of whom experience disabilities because of their injuries (World Health Organization, 2018b).

Low- and middle-income countries (LMICs) are disproportionately affected. In 2016, 93% of road traffic deaths occurred in LMICs, despite these countries having only 60% of the world's vehicle fleet (World Health Organization, 2018a). Furthermore, in LMICs, the injuries and deaths are estimated to cause economic losses of up to 5% of an individual country's gross domestic product (World Health Organization, 2015).

Global Burden among Children and Young Adults

Globally, road traffic injuries have now become the leading cause of death among people aged 5 to 29 years (World Health Organization, 2018a). In fact, each day over 500 children aged 5 to 19 years die as a result of injuries sustained from a road traffic crash (Safe Kids Worldwide, 2019). Additionally, it is estimated that each year, ten million children are injured or disabled as a result of road traffic crashes (Peden et al., 2008).

Taking Action for Prevention

Road traffic crashes and their resulting injuries are preventable and more can be done for prevention. In fact, the prevention of road traffic crashes has gained the attention of many leaders around the world. In 2010 the United Nations General Assembly proposed the Global Plan for the Decade of Action for Road Safety 2011-2020 (United Nations, 2010). The Decade was developed to stabilize and reduce road traffic deaths globally by 2020 through improving road infrastructure, vehicle design, road user behavior, post-crash response, and road safety management capacity (United Nations, 2010).

The Sustainable Development Goals (SDGs) represent the next big benchmark in road safety. Representatives from the United Nations have established 15 SDGs to achieve a healthier and more sustainable future by 2030 (United Nations, 2015). The SDGs address a vast number of important global challenges related to inequality, poverty, climate, prosperity, environmental decline, and peace and justice (United Nations, 2015). Two of the goals focus on road safety. The first goal, SDG 3.6, aims to reduce the number of global deaths and injuries from road traffic crashes by 50% by 2020 (United Nations, 2015). The second goal, SDG 11.2, aims to provide access to safe, affordable, accessible, and sustainable transport systems for all by 2030 (United Nations, 2015). The United Nations asserts that improving the world's transport systems is key to improving road safety and preventing road traffic crashes (United Nations, 2015).

The concept of Vision Zero—that no loss of life on the road is acceptable—has helped communities around the world take action for road safety. Vision Zero began in Sweden in 1997 and "is a concept that embraces a transformative mindset and approach to making all roads safe" (Vision

Zero, 1997b). Vision Zero refuses to accept that fatalities and serious injuries are inevitable consequences of mobility on the world's roads (Vision Zero, 1997b). One of the pillars of Vision Zero is to improve road safety through a safe systems approach. The Safe Systems approach is a broad, systemic technique based on the principle that road traffic deaths are unacceptable and avoidable if effective injury prevention strategies are implemented worldwide (Vision Zero, 1997a). Human error and vulnerability on the road are inevitable, but Vison Zero asserts that the road system should be designed so that when a crash does occur, the crash does not have a fatal outcome (Vision Zero, 1997a). Therefore, World Resources Institute has argued that governments, the private sector, and every community around the world are responsible for identifying evidence-based measures that will reduce the possibility of crashes and a devastating outcome if a crash does occur (World Resources Institute, 2018). The Save LIVES road safety technical package provides interventions and core components to be implemented following a safe systems approach to achieve the SDGs (World Health Organization, 2017). Examples of the core components include speed management, leadership on road safety, infrastructure improvement and design, vehicle safety standards, enforcement of traffic laws, and post-crash survival (World Health Organization, 2017). As part of the Safe Systems approach, policies and programs that result in safer vehicles, safer road users, safer roads, and therefore a safer system, will save lives and prevent injuries and avert related societal and economic costs.

Data for Injury Prevention

Typically, when there is interest in learning if a particular intersection or stretch of roadway is unsafe or if changes/interventions improved safety, police records and/or other crash surveillance systems are used. However, evaluation using these data sources typically requires several years of crash data and several sources of data. What happens when such data are not available? What happens when road safety interventions are introduced without a way of evaluating the intervention's effectiveness? Stakeholders might have to wait several years to evaluate an intervention or might not be able to evaluate the changes at all.

Although it also has limitations, collecting traffic conflict data and applying TCTs allows for a relatively quick and timely evaluation to determine whether or not interventions improve safety by reducing conflicts at an intersection or on a stretch of roadway. Deciding which proven strategies might make the biggest injury prevention impact in a specific location, community, or school zone can be challenging. This toolkit presents the concept of TCTs, which can help road safety stakeholders decide which strategies might be the most effective for injury prevention and evaluate the impact of the intervention(s) after implementation by counting and studying traffic conflicts.

The Traffic Conflict Technique

What is a Traffic Conflict?

A traffic conflict occurs when two or more road users are on a collision course and risk colliding/crashing with each other if one of the road users does not change their movement or trajectory (Laureshyn & Várhelyi, 2018). As an example of a traffic conflict, visualize a pedestrian stepping out into the road in order to cross the road. When stepping into the road the pedestrian stepped into the path of an oncoming vehicle (i.e., the vehicle is headed straight toward the pedestrian). To avoid hitting the pedestrian, the approaching vehicle must slam on the brakes. The vehicle changed its movement/trajectory to prevent the collision/crash. If the vehicle did not slam on the breaks (i.e., the vehicle's movement/trajectory remained unchanged), the vehicle would have hit the pedestrian, causing a collision/crash. In other words, a traffic conflict is a traffic event involving the interaction of two or more road users, when one or both must take evasive action (e.g., swerve, stop) to avoid a collision/crash (Parker & Zegeer, 1989).

What are Traffic Conflict Techniques?

TCTs are relatively low-cost and simple techniques that do not require the availability of existing data. TCTs evaluate the "near misses" as an indication of overall road safety. They can provide objective evidence about the need for a road safety intervention and create a baseline by which to evaluate the effect of the intervention. The main advantage of TCTs is that they are easy to understand and provide a way of conducting real-world observations. Even in their simplest form, they provide a way of basing road safety improvement decisions on real-world data and assessing the impact.

Purpose

This toolkit describes how to collect and analyze traffic conflict data both before and after the implementation of a road safety intervention to determine if the intervention is effective in reducing traffic conflicts. The toolkit aims to provide technical assistance to LMICs on how to apply TCTs in areas of concern and to determine the effectiveness of road safety interventions.

Primary Audience

The toolkit is designed to be used by anyone interested in improving road safety. A background in road safety is not necessary to use this toolkit.

Objectives

1. Use traffic conflict data to identify if an existing intersection/stretch of roadway is unsafe.
2. Provide technical assistance, guidance, and procedures on how to:
   - conduct a road safety assessment.
   - decide which data collection method to use during traffic conflict data collection.
   - conduct data collector training and prepare for data collection.
   - collect non-motorized and motorized road user counts.
   - collect traffic conflict data before the implementation of a road safety intervention (pre-intervention data).
   - analyze and interpret the pre-intervention traffic conflict data to identify what type of road safety intervention might be needed.
   - collect traffic conflict data after the implementation of a road safety intervention (post-intervention data).
   - analyze and interpret the post-intervention traffic conflict data.
   - compare pre- and post-intervention traffic conflict data to evaluate the effectiveness of the road safety intervention.

School Zone Safety Improvement

To help the reader understand how to apply the traffic conflict methods to a specific road safety issue of interest, the toolkit examples focus on creating safer school zones for children. Therefore, the toolkit specifically focuses on traffic conflicts between non-motorized student road users (e.g., pedestrians or cyclists) and motorized road users (e.g., cars, trucks, buses, motorized 2- and 3-wheelers) occurring in and around primary and secondary school zones in LMICs. These types of traffic conflicts are referred to as pedestrian-vehicle conflicts. Examples of pedestrian-vehicle conflicts are detailed in Appendix A. However, the toolkit methods can be applied to other types of traffic conflicts. For example, a TCT method to evaluate vehicle-vehicle conflicts is available here from the U.S. Department of Transportation.

The TCT Methods

This toolkit includes five pedestrian-vehicle traffic conflict data collection methods, each of which can be tailored to different settings:

- **Method 1:** Zegeer Pedestrian-Vehicle Conflict Technique
- **Method 2:** Cynecki Pedestrian-Vehicle Conflict Technique
- **Method 3:** Version 1: Institute of Highways and Transportation Conflicts Technique (IHTCT) Pedestrian-Vehicle Conflict Technique
- **Method 4:** Version 2: Institute of Highways and Transportation Conflicts Technique (IHTCT) Pedestrian-Vehicle Conflict Technique
- **Method 5:** Swedish Traffic Conflict Technique

While each method has been used in different countries and contexts, considering whether the methods provided would need to be adapted to capture the realities of each setting can help ensure their successful implementation. The methods are generally simple enough to be used by any individual willing to invest some time in learning the methods and following the protocols. However, there might be advantages to coordinating with others who have done similar assessments in order to build confidence in applying the TCT methods.

Rather than incorporating a detailed description of each of the five methods into the main text of the toolkit, each method is described in detail in Appendices B-F. Each method is unique and offers different options to consider. Regardless of which method is chosen, it is ideal to use a video camera, cell phone video camera, tablet video camera, etc. to complement data collection when applying the TCT. **Using a video camera is not necessary, but video footage provides the opportunity to review the identified traffic conflicts, helping to ensure data quality.** Moreover, video footage of local traffic conflicts can be useful to share with local decision makers. Information about how to incorporate a video camera into data collection is presented in Appendix G.

To demonstrate how TCTs can be applied in the field, four of the five TCT methods in this toolkit were pilot tested in Mexico City, Mexico in December 2018 (Methods 2 and 5) and Dar es Salaam, Tanzania in May 2019 (Methods 1 and 3). Details and lessons learned from these four real-world applications of the methods can be found in Appendices B-F. At the time the toolkit was completed, pilot testing of Method 4 had occurred in Ho Chi Minh City, Vietnam, but the results had not been finalized; therefore, only testimonials from this pilot test are included in the toolkit. Box 1 provides testimonials supporting the successes of pilot testing the TCT methods in the field.

To note, the traffic conflict situations described in this toolkit refer to both right-hand traffic flow (i.e., driving on the right-hand side of the road) and left-hand traffic flow (i.e., driving on the left-hand side of the road). Some of the methods might need to be adjusted depending on the direction of traffic flow. Examples of potential traffic conflict scenarios specific to the direction of traffic flow are presented in Appendix H.

Box 1

Testimonials from pilot testing the Traffic Conflict Technique (TCT) methods in the field, Dar es Salaam, Tanzania, May 2019

"It was a wonderful experience to pilot the TCT methods in Dar es Salaam. The two methods are useful for our School Area Road Safety and Improvements Program, both in assessing the risks that road users (especially children around schools) face and during the evaluation period when finding out whether our road safety improvements have reduced or ended the risks."

– George Malekela, Amend

"Piloting the TCT methods for the first time around schools in Dar es Salaam was an excellent opportunity for us to learn other ways of assessing the risks that vulnerable road users face every day. With similar road dynamics as those in many other sub-Saharan countries, it is our hope that this experience will help to improve the design of the TCT methods."

– Simon Kalolo, Amend

Testimonials from pilot testing the Traffic Conflict Technique (TCT) methods in the field, Ho Chi Minh City, Vietnam, October 2019

"It was a great opportunity to pilot the TCT methods in Ho Chi Minh City. The toolkit has helped us identify various risks posed to pedestrians and other road users in our effort to improve school zones."

– Hong Thi Diem Bui, AIP Foundation

"We hope to incorporate TCT methods into our future school zone safety programs to identify and evaluate the impact of our interventions. This will help us tremendously in improving the quality of school zones and other high-risk road areas in Vietnam."

– Linh Thi Dieu Pham, AIP Foundation

Limitations to Consider

1. **Conflicts might not equal crashes**: The methods presented in this toolkit have been developed and implemented by researchers from across the globe; however, not all the methods have been validated to show a direct relationship between traffic conflicts and crashes. Nonetheless, analyzing traffic conflicts can enhance understanding of the crash risk between pedestrians and vehicles. Additionally, it is a means of evaluating road safety interventions quickly and requires minimal resources.
2. **Validation of methods**: Traffic conflict studies can occur in a variety of cultures and locations, and although a method might have been validated, it might not have been validated for a specific location.
3. **Consistency among data collectors**: Another concern is ensuring the reliability or consistency of results between the data collectors. It can be difficult to achieve objectivity when estimating the severity of a traffic conflict, because of differences in personal perceptions of a conflict. This limitation can be addressed through in-depth data collector training, practicing the chosen method with previously recorded video footage, and capturing video recordings during data collection to provide the opportunity to review and confirm conflicts.
4. **Limited consensus to determine conflict severity**: Many traffic conflict measures and definitions are associated with conflict severity and no consensus has been reached on what measures and definitions should be used. This could be due to the inherent differences in local cultures, where one definition might be understood in one context or culture but might not be understood in another.
5. **Limitation of human data collection**: Human data collectors have their limitations. Avoiding assigning the data collectors too many tasks or too large of a data collection site, which might place unrealistic demands on human data collectors, can help promote data quality. This limitation can also be addressed by incorporating a video camera into data collection, which allows the opportunity to review and confirm manually recorded conflicts.


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Definitions

Below are several definitions to refer to when using this toolkit and when discussing road safety.

Controlled intersection: Intersections that are controlled using traffic controls such as stop signs or markings (World Health Organization, 2013).

Junction or intersection: The point at which two or more roads meet or cross (World Health Organization, 2013).

Pedestrian crossing: A designated point on the road where a pedestrian crosses the road. Also referred to as crosswalks or zebra crossings, they are sometimes found at intersections and along road sections. Most commonly, marked crossings are designated as pedestrian crossings with painted stripes in white or yellow on the roadway (World Health Organization, 2013).

Road infrastructure: Road facilities or equipment such as a road network, parking spaces, stopping places, bridges, sidewalks, and speedbumps (World Health Organization, 2013).

Road user: A person using any part of the road system as a non-motorized (pedestrian, cyclist, etc.) or motorized (vehicle, motorized 2- or 3- wheeler, bus, lorry, etc.) transport user (World Health Organization, 2015).

School zone: An area on the street and sidewalk near a school where school children are likely to be present in high numbers as they enter and exit the school (iRAP, 2010).

Signalized intersection: Intersections controlled by automatic traffic signals (World Health Organization, 2013).

Traffic calming: A road design strategy aimed at reducing vehicle speeds (World Health Organization, 2015). Examples include speed bumps, narrowing traffic lanes, stop signs and roundabouts.

Traffic conflict: A traffic event involving the interaction of two or more road users where one or both road users take evasive action such as braking or weaving to avoid a collision (Parker & Zegeer, 1989).

Uncontrolled intersection: Intersections not controlled by traffic signs, markings, authorized personnel, or automatic traffic signals (World Health Organization, 2013).

Vulnerable road user: Road users most at risk in traffic, including pedestrians, cyclists, children, elderly, people with disabilities and motorcyclists (World Health Organization, 2015).

The Traffic Conflict Technique Procedure

The TCT procedure begins with assessing existing road user risk then progresses to collecting and analyzing traffic conflict data to inform the selection and implementation of the road safety intervention(s). Collecting traffic conflict data can begin once a school zone has been identified as a location of interest/concern for student pedestrians/cyclists, or where the implementation of a road safety intervention is planned to occur. The TCT procedure contains several steps; each step is described in further detail below. Figure 1 illustrates the entire recommended TCT timeline.

The Traffic Conflict Technique Procedure

Step 1:

Determine road user risk by conducting a road safety assessment

Step 2:

Decide which Traffic Conflict Technique method to use

Step 3:

Conduct data collector training

Step 4:

Prepare for data collection

Step 5:

Collect road user counts

Step 6:

Collect traffic conflict data (pre-intervention)

Step 7:

Analyze and interpret data

Step 8:

Select and implement road safety intervention(s) informed by the analyzed data (or previously selected interventions)

Step 9:

Collect traffic conflict data (post-intervention)

Step 10:

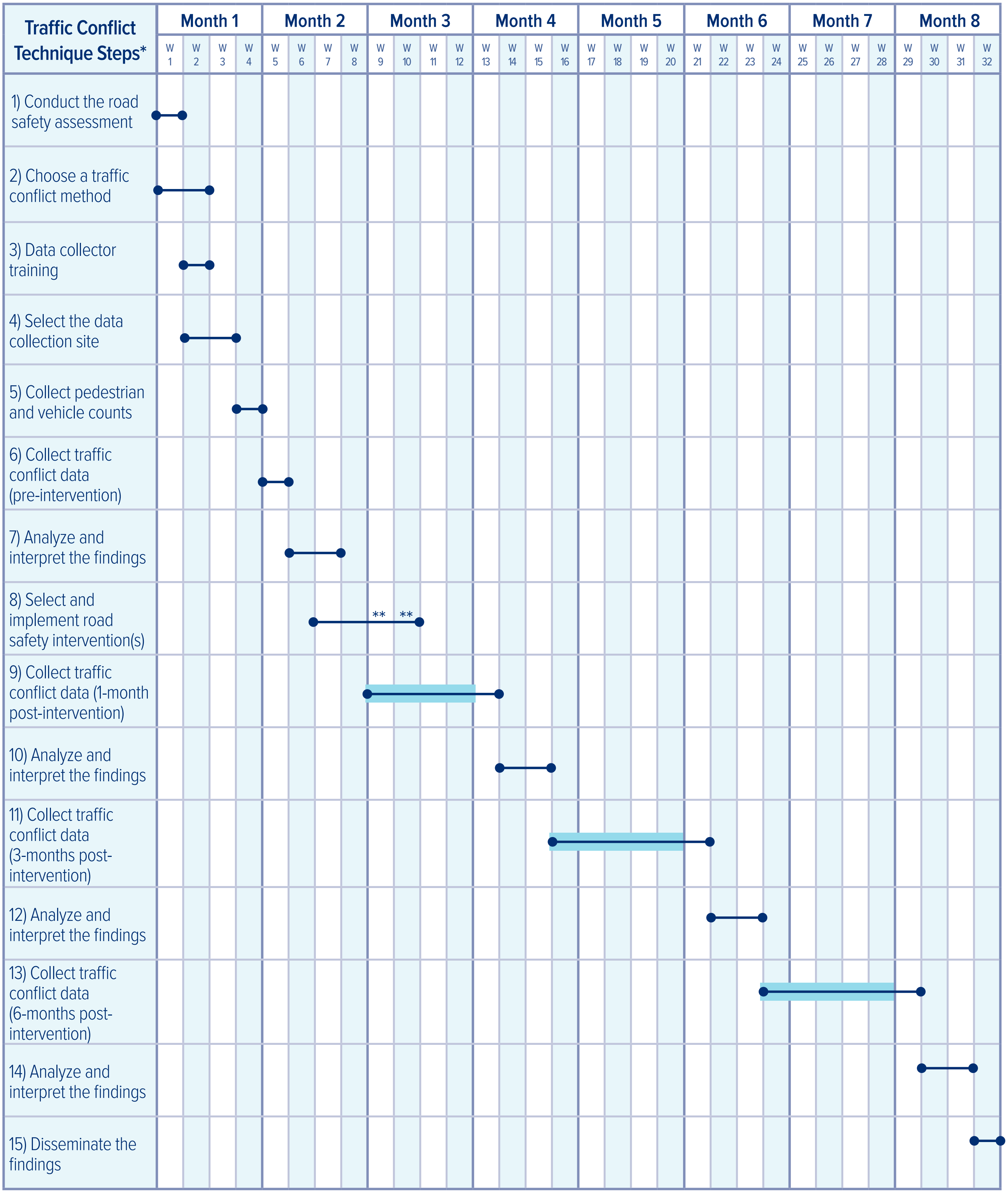
Analyze and interpret data

Step 11:

Disseminate findings

Figure 1

Recommended Traffic Conflict Technique (TCT) timeline



* If completion of any of the steps is delayed, the TCT procedure will be prolonged.

** If implementation of the road safety intervention takes longer than planned, the subsequent steps will be prolonged.

W Week

Possible waiting period during intervention implementation.

Step 1: Determine road user risk by conducting a road safety assessment

Conducting a road safety assessment is not a required component of the TCT procedure. However, it is beneficial because it provides a broad, comprehensive picture of the infrastructure, road user behavior, and cultural context of the area of concern.

A road safety assessment is a formal and systematic approach to determine the safety of an existing intersection or stretch of roadway (World Health Organization, 2013). Road safety assessments are community-specific and should address the local situation (World Health Organization, 2013). For example, assessing a stretch of roadway in an urban area might reveal an obvious absence of non-motorized road user facilities (e.g., no footpaths, lack of streetlights, limited crosswalks/zebra crossings) in the road design. For the purposes of this toolkit, the road safety assessment identifies and examines safety issues for student road users and helps determine which types of road safety interventions would improve pedestrian/cyclist safety. Box 2 highlights the International Road Assessment Programme's (iRAP) Star Rating for Schools (SR4S) tool (iRAP, 2017). This is one example of an evidence-based road safety assessment tool that can be used to measure pedestrian road safety in a school zone. If a road safety assessment cannot be conducted, the iRAP SR4S tool can be used to assess the school zone to get a sense of the current safety status.

Most of the aspects of a road safety assessment can be captured through the observation of pedestrians and vehicles at the data collection site (see Step 4 for details on selecting the data collection site); however, not all aspects below need to be addressed. For an example of a pedestrian-specific safety assessment, see the Safe Routes to School's Walkability Assessment. For more information on road safety assessments, see Chapter 3 (pages 43-58) of the 2013 WHO Pedestrian Safety Manual.

Box 2

International Road Assessment Programme (iRAP) Star Rating for Schools (SR4S)

Star Rating for Schools (SR4S) is an evidence-based tool used to measure, manage, and communicate the level of pedestrian risk on roads. The tool uses a web-based reporting system supported by a mobile application to assess the safety of spot locations in school zones. The internationally recognized measure rates the least safe locations with 1 star and the safest locations with 5 stars. Using the iRAP SR4S application allows for a relatively quick and efficient assessment and gives valuable information that can be used to help select road safety improvements.

The iRAP SR4S assessment can be used as a stand-alone tool or combined with a TCT method. If used together with a TCT, SR4S can give a baseline star rating before the implementation of a road safety intervention and a comparison star rating after the implementation of a road safety intervention. This information can help with the evaluation of the intervention(s).

If a road safety assessment can be conducted, the assessment should occur before the pre-intervention traffic conflict data collection period (Step 6). **However, results are most valid when both the road safety assessment and the pre-intervention traffic conflict data collection period occur during similar times of the week and under the same weather conditions.** For example, if traffic conflict data are scheduled to be collected on Monday between 8am–9am, completing the road safety assessment the Monday before the traffic conflict data collection period between 8am–9am would give the best results. If the weather is unusual during one of the scheduled data collection periods (e.g., random rain shower [i.e., not during rainy season where rain is expected/usual]) and is affecting the way the road users are interacting, rescheduling the data collection period to occur the following week promotes consistency.

While there is no standard approach for conducting a road safety assessment, there are certain aspects to consider:

- The number of individuals conducting the assessment depends on local capacity and availability.
- Confining the radius/area of the assessment to where conflicts are most likely to occur (e.g., near school exits/entrances, intersections) and where the paths of the students and vehicles are most likely to cross can improve efficiency.
- Conducting the assessment during school arrival and departure times at all entrances/exits of the school will give the most helpful results.
- It can be useful to consider if student traffic differs between the days of the school week. The days of the week the assessment is conducted might be more important than the number of days the assessment is conducted. For example, are there changes in traffic flow between a Monday and a Tuesday (e.g., due to extended vacations/weekends)? Are there religious customs to consider when students might be arriving/departing school at different times throughout the day?

Below are individual steps, examples of questions for the data collectors to consider, and evidence-based methods for obtaining the answers (World Health Organization, 2013). Descriptions of each can be documented in a variety of ways through drawings, explanations, or using a checklist of the existing road user facilities.

Infrastructure assessment

1) Roadway assessment
   a) Describe the pedestrian crossing (e.g., pedestrian-directed signs and signals, quality/presence of painted stripes, width of crosswalk).
      i) Are there obstacles near the beginning or end of the pedestrian crossing that could obstruct a road user's view of when a pedestrian enters the roadway or of an approaching vehicle?
      ii) Are there markings on the roadway in front of the pedestrian crossing to indicate where vehicles should stop?
   b) Describe the roadway (e.g., quality of the road, potholes/debris, slickness).
      i) Are traffic control devices, traffic signals, posted speed signs, and/or other signs present?
      ii) Describe the number of lanes, barriers between lanes, presence of a bicycle lane, and presence of a left turn lane and/or right turn lane for vehicles.
      iii) Are there vehicles or other objects in the street next to the pedestrian crossing (e.g., parked cars, construction equipment, street vendors)?
      iv) Describe all potential points where vehicles could access the roadway (e.g., side streets, parking lots).

2) Sidewalk assessment
   a) Describe the quality of the sidewalk prior to the pedestrian crossing (e.g., surface condition, material, width).
      i) Are there obstacles that could potentially obstruct a road user from using the sidewalk?
      ii) Are there physical barriers or separations between the sidewalk and other road users?

Potential data sources for the infrastructure assessment include:

- Observation
- Analysis of aerial photographs of the streets, sidewalks, and school zones
- Public feedback on the conditions of the road and sidewalk

Note: consent and other approvals are required for any data collection that involves interviews with/survey of people.

Behavioral assessment

1) Road users
   a) Describe the types, speed, and volume of road users (over a defined period of time, first traveling in one direction, then the other).
   b) How are vehicles interacting with pedestrians? For example, do vehicles generally follow the rules of pedestrian crossings and allow pedestrians the right-of-way?

2) Pedestrians
   a) Describe the volume of pedestrians crossing the street (over a defined period of time at a specific location).
   b) Is a crossing guard present?
   c) Provide an age range estimate of pedestrians. In a school zone, are any students walking with adults? If so, what are the approximate ages of the students being escorted? If not, are the students mostly walking alone or in groups with other students?
   d) Describe locations where pedestrians are crossing the street. Pedestrians can access a roadway at almost any point in the school zone, not just at a crosswalk or intersection.
   e) Describe the most likely traffic conflicts based on the roadway design and the manner in which pedestrians are crossing the street.

Potential data sources for the behavioral assessment include:

- Observation
- Pedestrian and vehicle counts
- Surveys on risk factors, knowledge, attitudes, perceptions, etc.

Note: consent and other approvals are required for any data collection that involves interviews with/ survey of people.

Cultural assessment

1) What are pedestrians' understanding of and compliance with traffic control devices?
2) What are the local traffic laws or policies related to school zones?
3) Are the traffic laws or policies enforced?
4) Do the road users know what the consequences are for violating the traffic laws or policies?

The cultural assessment is one instance when observational data might not be enough. Potential data sources for the cultural assessment include:

- Reviews of police statistics on pedestrian safety regulation violations
- Reviews of reports to identify types of traffic law enforcement strategies in use
- Continuous video recording at intersections
- Interviews with road users

Note: consent and other approvals are required for any data collection that involves interviews with/ survey of people.

Depending on the local situation and available personnel and resources, perhaps not all the recommended information listed above will be gathered during the road safety assessment. **However, the information that is collected during the road safety assessment can help determine which of the five TCT methods will be best to use.**

Step 2: Decide which Traffic Conflict Technique method to use

Table 1 provides a list of criteria to consider when deciding which TCT method to choose. Brief descriptions of the five TCT methods provided in this toolkit are included below Table 1 and detailed information on each method can be found in Appendices B-F. Each method has been appropriately adapted to account for pedestrian-vehicle conflicts for the school zone safety improvement example used throughout this toolkit. Once the method most useful to the local situation is chosen, the user can read the more detailed information on the method of choice, which can be found in Appendices B-F. If the user is unsure about which method to choose, they can also review the more detailed methods to further inform their selection.

Table 1

List of criteria for each Traffic Conflict Technique (TCT) method

Criteria	Method 1: Zegeer Pedestrian-Vehicle Conflict Technique	Method 2: Cynecki Pedestrian-Vehicle Conflict Technique	Method 3: Version 1: IHTCT[1] Pedestrian-Vehicle Conflict Technique	Method 4: Version 2: IHTCT[1] Pedestrian-Vehicle Conflict Technique	Method 5: Swedish Traffic Conflict Technique
Ease of use	Simple → Complex				
Required road safety experience	• Low	• Low	• Medium	• Medium	• High
Human and financial resources	• Low	• Low	• Medium	• Medium	• High
Good when there are:	• Limited amount of time and/or personnel available	• Limited amount of time and/or personnel available	• Adequate time and/or personnel available	• Adequate time and/or personnel available	• Adequate time and/or personnel available
Not ideal when there are:	• Only a few conflict types (e.g., conflicts specifically involving left-turning vehicles)	• Only a few conflict types (e.g., conflicts specifically involving left-turning vehicles)	• Many different conflict types (e.g., vehicle slows or stops for pedestrian, diagonal pedestrian crossing)	• Many different conflict types (e.g., vehicle slows or stops for pedestrian, diagonal pedestrian crossing)	• Many different conflict types (e.g., vehicle slows or stops for pedestrian, diagonal pedestrian crossing)
Unique benefit	• Quick snapshot of the traffic conflict situation • Minimal data collector training required	• Quick snapshot of the traffic conflict situation • Minimal data collector training required	• More comprehensive picture of traffic conflicts • Potential for higher data quality due to more data collector training • More objective conflict severity score[2]	• More comprehensive picture of traffic conflicts • Potential for higher data quality due to more data collector training • More objective conflict severity score[2]	• More comprehensive picture of traffic conflicts • Potential for higher data quality due to more data collector training • More objective conflict severity score[2] • Can quantify the conflict severity score
Unique limitation	• Potential for lower data quality due to possible data collector subjectivity • Cannot quantify the conflict severity score	• Potential for lower data quality due to possible data collector subjectivity • Cannot quantify the conflict severity score	• More time devoted to data collector training	• More time devoted to data collector training	• More time devoted to data collector training
Video recording	• Not necessary • Useful to improve data quality	• Not necessary • Useful to improve data quality	• Very useful due to method complexity	• Very useful due to method complexity	• Highly recommended

1 IHTCT = Institute of Highways and Transportation Conflicts Technique

2 During data collection, a conflict severity score will be assigned to an observed conflict based on the actions and movements of the pedestrian or vehicle or both. The conflict severity score provides an overall indication of existing road user safety in the school zone.

Method 1: Zegeer Pedestrian-Vehicle Conflict Technique

(Zegeer, Randolph, Flak, & Bhatacharya, 1980)
Detailed in Appendix B

To identify traffic conflicts, this simple method uses the definitions of the 13 most common types of pedestrian-vehicle conflicts that could occur in school zones (example provided in Table 2). However, the list of the different types of conflicts can be expanded or narrowed to take into account the types of issues known to occur in the local situation. For example, if there is a specific type of conflict that is not on the list (e.g., pedestrian moves out of the path of the vehicle), data collectors can add this conflict type to the list. Using this method, the data collector assigns every pedestrian crossing one of the three subjective levels of traffic conflict severity by placing a tally in the corresponding box:

- Routine: A conflict that is determined not to be very close to a collision.
- Moderate: A conflict that involves a quick maneuver by a pedestrian or vehicle (e.g., an abrupt deceleration or swerve).
- Severe: A conflict where a collision is barely avoided due to a last-second reaction by the pedestrian or vehicle.

Table 2

Example of the data collection form for one component of the method:

Type of conflict	Routine	Moderate	Severe	Total
1. Vehicle slows or stops for pedestrian	| |	|		3
2. Vehicle slows or stops for previous pedestrian conflict		| | | |		4
3. Vehicle weaves around a crossing pedestrian	|		|	2

Method 2: Cynecki Pedestrian-Vehicle Conflict Technique

(Cynecki, 1980)
Detailed in Appendix C

This simple method includes a description of 16 possible pedestrian and vehicle conflict classifications (e.g., right turn on red conflict, diagonal pedestrian crossing) (example provided in Table 3). The data collectors will identify the different road users (e.g., pedestrian, cyclist, vehicle) and then assign a corresponding conflict severity to each road user involved in the conflict. The conflict severity is determined by the road user's movements (e.g., hesitation, complete stop).

Table 3

Example of the data collection form for one component of the method:

Conflict Number	Time	Conflict Classification (see appendix)	Road User 1	Severity: Road User 1	Road User 2	Severity: Road User 2	Location of Conflict	Notes
Conflict 1	14:02	#1, #7, #10	Pedestrian	2 (backup movement)	Car	2 (complete stop)	5 meters east of crosswalk	Parked car on side of road
Conflict 2								
Conflict 3								

Method 3: Version 1: Institute of Highways and Transportation Conflicts Technique (IHTCT) Pedestrian-Vehicle Conflict Technique

(Kaparias et al., 2010)

Detailed in Appendix D

This more complex method categorizes the traffic conflict based on various classifications within each of these four factors:

1) Factor A – Time to Collision
   - Long (#1), Moderate (#2), Short (#3)
2) Factor B – Severity of Evasive Action
   - Light (#1), Medium (#2), Heavy (#3), Emergency (#4)
3) Factor C – Complexity of Evasive Action
   - Simple (#1), Complex (#3)
4) Factor D – Distance to Collision
   - Far (#1), Medium (#2), Short (#3)

Once a classification (1-4) has been assigned for each factor (A-D), these classification numbers are vertically ordered in the Final Classification Sequence table (example provided in Table 4). This provides a final classification sequence of four vertical numbers. This sequence is then used to determine the severity of the conflict by using the Conflict Severity Scoring Table (example provided in Table 5). The conflict severity can fall anywhere between Grade 1 (slight) to Grade 4 (serious) on the severity scale. Generally, the higher the classification numbers (e.g., 3 and 4), the more severe the conflict.

Table 4

Example of the final classification sequence for one component of the method:

Final Classification Sequence	
Factor A	2
Factor B	4
Factor C	3
Factor D	3

Table 5

Example of determining the conflict severity for one component of the method:

Conflict Severity Scoring Table						
Factor	Grade 4 conflict - serious					
A	2	2	3	3	3	3
B	4	4	3	3	4	4
C	1	3	1	3	1	3
D	3	3	3	3	3	3

Method 4: Version 2: Institute of Highways and Transportation Conflicts Technique (IHTCT) Pedestrian-Vehicle Conflict Technique

(Kaparias et al., 2015)
Detailed in Appendix E

This complex method consists of three distinct steps (example provided in Table 6):

1) Recording each pedestrian-vehicle conflict using two types of interactions pertaining to the speed of the vehicle:
   a. Steady Care-Pedestrian Interactions: The vehicle is traveling at a steady speed at the time of interaction with the pedestrian.
   b. Effective Shared Space Interactions: The vehicle is stopped or traveling at very slow speeds.
2) Identifying a severity grading for both the pedestrian and vehicle using three criteria:
   a. Change in speed
   b. Change in direction
   c. Vehicle acceleration
3) Collecting pre- and post-intervention traffic conflict data.

Table 6

Example of the data collection form for one component of the method:

			Steady Care-Pedestrian Interactions		Effective Shared Space Interactions	
	Criteria	Grade	Before Intervention	After Intervention	Before Intervention	After Intervention
Vehicle	I (change in speed)	1 – full speed				
		2 – slowed down				
		3 – stop				

Method 5: Swedish Traffic Conflict Technique

(Hydén, 1987)
Detailed in Appendix F

This complex method requires two measurements—speed and distance—to determine the severity of a pedestrian-vehicle conflict. The best way to measure pedestrian and vehicle speed and distance is through in-field practice or video recording. The speed of the road user is estimated at the moment the first road user takes evasive action (RU1), and at that same moment, the distance is estimated from the exact location where RU1 takes the evasive action to where the collision would have occurred if the evasive action had not been taken. For example, a vehicle is headed straight toward a pedestrian and the vehicle brakes to avoid a collision. The evasive action is the vehicle braking; thus, the vehicle is RU1. The speed is estimated at the exact moment the vehicle brakes to avoid colliding with the pedestrian (i.e., the data collector estimates the speed of the vehicle). At the same moment, the distance from where RU1 braked to where the collision would have occurred is also estimated (i.e., the data collector estimates the distance from the vehicle to the point where a collision would have occurred if evasive action was not taken). The speed and distance measurements are used to identify a Time-to-Accident (TA) indicator. The TA indicator is the time remaining for the road user to successfully perform an evasive action to avoid a collision. The TA indicator, along with the speed, is then graphed on the severity curve (shown in Appendix F) to determine if the conflict is a serious or non-serious conflict.

Step 3: Conduct data collector training

The data collector training steps below apply regardless of which TCT method is chosen. Data collectors play a critical role in traffic conflict studies; therefore, assembling and training a skilled data collection team to be reliable, objective, and consistent supports the quality of results. The length of data collector training depends on the TCT method chosen and can range from 2-5 days, with more time necessary for the data collectors to be trained on the more complex methods. During training, it is important for each data collector to attend each day for the entire day to guarantee that no material is missed. Data collector training can include TCT information, practical instructions, training on previously video-recorded conflicts, real-world pilot data collection, and standardization of the processes the data collectors should follow (Laureshyn & Várhelyi, 2018). Laureshyn & Várhelyi (2018) state it is important that the same data collectors record conflicts consistently over time. A refresher training can help ensure data quality if a significant amount of time passes between data collection periods.

Results are of the highest quality when at least two data collectors are present at the site. Generally, the number of data collectors at one site depends on the complexity of the data collection site, with one data collector responsible for a 4-lane intersection or stretch of roadway (Laureshyn & Várhelyi, 2018). If more data collectors are available, more traffic conflict data can be recorded at different areas within the site, with two clearly identified boundaries:

- **Data collection site:** The entire school zone within which data collection will occur.
- **Observation area:** An individual section inside the data collection site for which one data collector is responsible.

For example, one data collector will collect data within his/her own observation area within the larger data collection site, while another data collector will collect data within another observation area within the same data collection site. Therefore, there will most likely be more than one observation area within each data collection site. Positioning each data collector at different observation areas (intersections/stretches of roadways) within the data collection site and assuring they are able to capture everything in their designated observation area can avoid duplication.

During training, using multiple data collectors to observe a specific observation area and, if possible, a video camera, can support training quality. Video camera footage can be used as a training tool for the data collectors to verify the conflicts and discuss conflicts observed to help ensure standardized data collection. An example training schedule used during the TCT method piloting in May 2019 in Dar es Salaam, Tanzania is described in Box 3 (data collectors were trained on two TCT methods and the data collection team conducted three pilot tests). A more generic sample data collector training schedule is located in Appendix I.

To note, trainers might want to consider instructing data collectors on what to do/who to call for help if they witness a crash at any point during the TCT procedure.

Box 3

Example five-day training schedule used in Dar es Salaam, Tanzania, May 2019

Day 1
- Overview of TCTs
- Step-by-step introduction of Method #1

Day 2
- Continued introduction of Method #1 (practiced understanding using previously recorded video footage)
- Afternoon pilot test in the field
- Debrief (watch videos, lessons learned, etc.)

Day 3
- Step-by-step introduction of Method #2 (practiced understanding using previously recorded video footage)
- Afternoon pilot test in the field
- Debrief (watch videos, lessons learned, etc.)

Day 4
- Morning pilot test in the field
- Debrief (watch videos, lessons learned, etc.)

Day 5
- Comprehensive debrief of the pilot tests
- Next steps

Step 4: Prepare for data collection

Obtaining permission

Before applying the TCTs, local procedures and permissions might be required. This could include the government, the community, the school, etc. When focusing on students (such as the example in the toolkit), involving the school as soon as possible can help avoid unexpected challenges. Depending on school procedures, the school might also need to contact the parents. Ethical standards dictate consideration of whether an ethical review (such as Institutional Review Board [IRB]) is necessary to collect traffic conflict data (Emanuel, Abdoler, & Stunkel, 2010).

Selecting the data collection site

Depending on the local situation, selecting the data collection site might need to occur before or at the same time as the procedures for gathering necessary approvals to apply the TCTs. Once necessary entities are aware and in agreement with the traffic conflict study, the data collection site can be selected/finalized. Factors one might consider while selecting the data collection site/sites include:

1) Where is a safe place for the data collector to stand/sit that is sufficiently away from the road and in a place that will not distract road users?
2) What arrangements can be made for the data collector to be protected from the elements (e.g., sun, rain)?
3) How can it be assured that the data collector is able to collect data from the same location several months in the future during the post-intervention data collection period? Would future construction projects and/or the intended intervention(s) at the site hinder data collection from the same location?
4) How can it be assured that the data collector has a safe and unobstructed view of the site, keeping in mind parking spots on the street that might obstruct the view if a vehicle were to park there?
5) Where should the data collector stand in order to be close enough to an intersection or stretch of roadway within the school zone to clearly see road user behavior in their observation area? For example, since most of the student pedestrian-vehicle conflicts will most likely occur close to the school, perhaps the data collection area should not span more than 100 meters (330 feet). If the data collector is observing an intersection, positioning of the data collector could be approximately 45-90 meters (150-300 feet) from the intersection, on the right side of the road from the direction the vehicles approach the crossing. If vehicles in the country drive on the left-hand side of the road, positioning the data collector on the left-hand side of the road from the direction the vehicles approach the crossing could give more useful results.
6) How do the size of the street and the presence of a median influence the data collectors' specific observation area? If the data collector does not have a clear view of his/her entire observation area, focusing only on the unobstructed area is essential for ensuring high data quality.
7) If students cross the street at more than one area in the school zone, data collectors should be positioned at as many of those areas as possible.

After selecting the data collection site, if information about the site (e.g., crash data, volume of traffic) is available from observations, police records, traffic safety reports, etc., this information can be used to provide a baseline understanding of traffic flow at the site and to supplement the data collected during the traffic conflict study.

Prior to arriving at the data collection site, data collectors can review the Data Collection Materials Checklist (Box 4) to ensure the required materials are in possession. Depending on the method being used, all the data collection materials might not be necessary.

Box 4

Data collection materials checklist

- ☐ Detailed site data collection form (Appendix J)
- ☐ Data collection forms (specific to the TCT method)
- ☐ Copy of letter of support from school & local police department (other required approvals)
- ☐ Supervisor contact information
- ☐ Personal identification
- ☐ Cell phone
- ☐ Cell phone charger
- ☐ Camera
- ☐ Camera charger
- ☐ Video camera
- ☐ Video camera charger
- ☐ Memory card (for cameras)
- ☐ Tripod
- ☐ Watch with alarm
- ☐ Safety vest
- ☐ Tape measure
- ☐ Compass or other device to show direction
- ☐ Writing utensils
- ☐ Clipboard
- ☐ Water
- ☐ Hat
- ☐ Sunglasses
- ☐ Sunblock lotion
- ☐ Rain poncho

Data collection: Best practices

Arriving at the data collection site at least 20 minutes before the data collection period begins to observe traffic for at least five minutes helps the data collectors become familiar with the traffic flow and common maneuvers. Taking photos (if acceptable/approved by those who approved the project) of the data collection site (e.g., intersection, pedestrian crossing, posted signs, potential road hazards) helps to track the physical inventory of the data collection site.

Additional items to consider include the following:

1) Filling out the detailed site data collection form (see Appendix J) before each data collection period provides a standardized space for the data collectors to note the time, weather, road conditions, location of data collection within the site, and any unique circumstances about the site.
2) As each data collector takes responsibility for documenting traffic conflicts that occur in his/her defined observation area, they do not need to include conflicts that occur within sight of the data collector but outside of his/her defined observation area. This will prevent duplications in the collected data.
3) Setting an alarm on a phone or watch can ensure an exact data collection period and alert the data collector of the exact data collection start and end time.
4) Setting up video equipment (if it is being used) in an adequate space/area in clear view of the intersection/stretch of roadway within the observation area can help ensure the recordings are most useful.
5) Given the likelihood that pedestrians (especially students) might cross the roadway in groups, if a conflict occurs with a vehicle, most accurate data will be achieved if the number of conflicts recorded represents the number of pedestrians involved and the data collector makes a note on the detailed site data collection form about the specific circumstances of the scenario (i.e., it was a group of X number of pedestrians and one car).

Timing of data collection

Following this framework, there are three separate data collection periods throughout the study:

1) **Road user counts**
   (refer to Step 5)
   This step occurs one week before the data collectors are scheduled to collect traffic conflict data. Data collectors travel to the data collection site during the same time and day of the planned traffic conflict data collection and count the number of pedestrians and vehicles that pass through the data collection site.

2) **Traffic conflict data (pre-intervention)**
   (refer to Step 6)
   This step occurs one week after collecting road user counts (Step 5), when data collectors bring the relevant data collection forms (specific forms for each method located in Appendices B-F) to record the number and types of traffic conflicts. They may also bring a video camera, if available.

3) **Traffic conflict data (post-intervention)**
   (refer to Step 9)
   Post-intervention data collection occurs at multiple points in time, ideally at least one month after intervention implementation, as well as three months and six months post-intervention.

Collecting traffic conflict data pre- and post-implementation of a road safety intervention captures data that reflect true and regular traffic behavior. When planning data collection periods, avoiding instances when students are not in school (e.g., holidays and regular breaks) is essential for proper interpretation of the data. Ensuring all data collection periods occur when students are traveling to and from school, and in locations where students are most likely to interact with vehicles, will provide an accurate picture of the highest risk periods for the students. Depending on the school, this may include when students are going to school, leaving school, and possibly around lunchtime. Ensuring similar weather conditions, time of day, and traffic flow during all data collection periods allows for data to be compared without concerns about external factors (e.g., rain) that could affect data collection and the comparison of data from one data collection date/time to another.

Step 5: Collect road user counts

Before beginning traffic conflict data collection, collecting pedestrian and vehicle counts at the selected data collection site provides a baseline road user count. The baseline counts will serve as a reference when analyzing and interpreting the data for that specific data collection site. The type of pedestrian and vehicle does not need to be specified. For example, a pedestrian can be a person, cyclist, etc. and is counted as a “pedestrian” and a vehicle can be a car, truck, bus, motorized 2- and 3-wheeler, etc. and is counted as a “vehicle”. When collecting road user counts, it might be helpful to track the specific behaviors of each road user based on the local situation. Examples for pedestrian behaviors include: how many pedestrians cross the street at a crosswalk (if present), the manner in which pedestrians cross the street at the crosswalk (e.g., are the pedestrians looking for vehicles or crossing without looking), etc. Examples for vehicle behaviors include: how many vehicles turn left and right, how many vehicles turn at an intersection or a cross street, etc.

Step 6: Collect traffic conflict data (pre-intervention)

Traffic conflict data collected before the implementation of a road safety intervention provides baseline data that can be used to compare with traffic conflict data collected after the intervention is implemented. This will help to assess and evaluate if there was an improvement in road safety for the students (or the population of interest). The data collectors will use the chosen method and associated data collection tools from Appendices B-F to document the observed pedestrian-vehicle conflicts. Throughout this process, staying standardized and objective (i.e., opinions and emotions are separate from data collection) in the way potential conflicts are identified and documented supports data quality.

As detailed in Step 7 (analysis and interpretation), collecting traffic conflict data for 1-2 hours per day (one hour in the morning before school and/or one hour in the afternoon after school) over the course of five days is a common practice. One advantage is that this will capture any irregularities or fluctuations in traffic flow from otherwise normal day-to-day traffic. If necessary, a minimum of two days could be considered adequate, but this might not capture the natural increases or decreases of traffic flow and traffic conflicts in the school zone. Also, consider if the timing of data collection (e.g., morning vs. afternoon) matters regardless of the number of days data are collected. If resources allow, it would be beneficial to collect data in both the morning and afternoon to compare the differences observed.

Data quality

Following the pre-intervention traffic conflict data collection period (Step 6), the data collectors can compare findings and review the traffic conflict data collection forms to ensure the forms are free of errors (e.g., missing forms, missing data, unclear writing, data points recorded in the wrong columns/rows). Video recording their specific observation area allows footage to be cross-checked with the manually recorded conflicts.

In addition, reviewing any unusual experiences with team members at the end of each data collection period can help determine how to handle possible data inconsistencies. A few examples of unusual experiences might be if an animal walks into the road, if a police car has its lights on in the school zone (assuming that is unusual), or if a vehicle has stalled in the middle of the road. These experiences might make data collection more challenging and will make it difficult to compare data collected across the data collection periods.

Even after data collector training, it is possible that the data collector(s) might feel uncertain about whether to classify each traffic issue as a traffic conflict. For the purposes of this toolkit, it is preferable to be cautious and include all possible traffic conflicts, even when uncertain. After data collection, discussions with team members or reviews of video footage could help clear up any indecision or uncertainty. However, considering the intent of the road users before characterizing an event as a conflict can help. For example, vehicles stopping intentionally to let pedestrians cross are simple acts of politeness and do not need to be recorded as a conflict. The same can be said for natural events or instances not related to an approaching vehicle, where student pedestrians might change their speed or direction, irrespective of the presence of other road users.

Step 7: Analyze and interpret data

Data analysis and interpretation will inform which road safety intervention(s) is/are selected and implemented (Step 8). Choosing the same analysis approach for both the pre-intervention and post-intervention data analysis periods will ensure consistency throughout the TCT study. Two approaches to analyze traffic conflict data are presented below and can be applied to any method in the toolkit. The approaches do not differ greatly and can be tailored based on the local situation and what is observed in the school zone (e.g., volume of conflicts, types of conflicts).

7.1 Traffic conflict rate

- Results in the number of conflicts per 1,000 vehicles (or any multiplier the data collectors choose).

7.2 Percentage of traffic conflicts

- Results in the percentage of specific conflict types (e.g., cyclist-vehicle conflict, pedestrian stops suddenly) among all conflicts.

Depending on which type of TCT is being used (e.g., non-motorized-motorized, pedestrian-vehicle, vehicle-vehicle) the below count types can be interchanged for the applicable road users. For example, if analyzing pedestrian-vehicle conflicts, when using the analysis options below, mention of "vehicle count" is interchangeable for "pedestrian count," which refers to the number of vehicles or pedestrians that cross the road in the observation area.

7.1: Traffic conflict rate

Step 7.1a: Count/Tally the total number of vehicles that pass through the data collection site (Step 5) during the data collection period (e.g., 8am–9am) on each day that data are collected (e.g., 5 days).

Step 7.1b: Sum/Total the number of vehicles that passed through the data collection site across all of the data collection periods (Table 7).

Step 7.1c: Divide the total number of vehicles by the number of data collection periods. The result of this step is the average traffic flow per data collection period.

Average number of vehicles: 2047 vehicles / 5 days = 409.4 vehicles per data collection period (1-hour time period)

Step 7.1d: Count/Tally the total number of conflicts that occur in the data collection site (Step 6) during the data collection period (e.g., 8am–9am) on each day that data are collected (e.g., 5 days).

Step 7.1e: Sum/Total the number of conflicts that occur in the data collection site across all of the data collection periods (Table 8).

Table 7

Example: Collect vehicle counts (8am–9am)

	Monday	Tuesday	Wednesday	Thursday	Friday	Total
Total number of vehicles observed	375	425	408	399	440	2047
	Step 7.1a	Step 7.1a	Step 7.1a	Step 7.1a	Step 7.1a	Step 7.1b

Table 8

Example: Collect traffic conflict data (pre-intervention) (8am–9am)

	Monday	Tuesday	Wednesday	Thursday	Friday	Total
Total number of conflicts observed	12	14	8	10	13	57
	Step 7.1d	Step 7.1d	Step 7.1d	Step 7.1d	Step 7.1d	Step 7.1e

Step 7.1f: Divide the total number of conflicts by the number of data collection periods. The result of this step is the average number of conflicts per data collection period.

> **Average number of conflicts:** 57 conflicts / 5 days = 11.4 conflicts per data collection period

Step 7.1g: Divide the average number of conflicts by the average number of vehicles then multiply by 1,000 to get the number of conflicts per 1,000 vehicles (traffic conflict rate).

> **Calculate the traffic conflict rate:** 11.4 conflicts (Step 7.1f) / 409.4 vehicles (Step 7.1c) = 0.028 conflicts per vehicle x 1,000 vehicles = 28 conflicts per 1,000 vehicles

7.2: Percentage of traffic conflicts

Step 7.2a: Count/Tally the total number of conflict types (Step 6) that occur in the data collection site during the data collection period (e.g., 8am–9am) on each day that data are collected (e.g., 5 days).

Step 7.2b: Sum/Total the number of conflict types that occur in the data collection site across all of the data collection periods (Table 9).

Step 7.2c: Divide the total number of a specific conflict type (e.g., pedestrian stops suddenly) by the total number of conflicts then multiply by 100 to get the percentage of that specific conflict type among all conflicts per data collection period.

> **Percentage of specific conflict type (pedestrians stopping suddenly):** 23 pedestrian stops suddenly / 57 total conflicts = 0.404 x 100 = 40.4% of all conflicts involved pedestrians stopping suddenly

Table 9

Example: Collect traffic conflict data (pre-intervention) (8am–9am)

Conflict Types	Monday	Tuesday	Wednesday	Thursday	Friday	Total number of conflict types
Cyclist-vehicle conflict	2	1	0	1	1	5
Pedestrian stops suddenly	6	4	0	4	9	23
Right-turning conflicts	0	3	0	0	0	3
Left-turning conflicts	4	6	8	5	3	26
Total number of conflicts	12	14	8	10	13	57
	Step 7.2a	Step 7.2a	Step 7.2a	Step 7.2a	Step 7.2a	Step 7.2b

Step 8: Select and implement road safety intervention(s) informed by the analyzed data (or previously selected interventions)

Before the selection and implementation of an intervention, stakeholders engaging with the community can ensure adequate acceptance. Generally, when initiating change within a community, the change is more likely to be successful and sustainable if the community is engaged as early as possible in the process (Howat et al., 2001). The establishment of a community road safety committee is an effective strategy to ensure community engagement (Howat et al., 2001). Since schools are central to many communities and offer an opportunity for additional community involvement, schools can play an important role on the community road safety committee, which can provide support to the schools to strengthen road safety (Howat et al., 2001). If establishing a committee is not feasible, additional strategies for engaging the community could include placing informational flyers at schools and local businesses in the community with information about the TCT study and its objectives, as well as holding workshops with local council members, the media, school employees, etc. to discuss ideas about the proposed study.

When discussing the implementation of a road safety intervention, planners might want to consider how widely publicized the interventions should/will be and when the interventions will be announced. By announcing road safety intervention implementation plans, road users might hear about the potential changes and unknowingly adjust their behaviors in the observation area before the implementation of a road safety intervention. These changes might affect the evaluation of the intervention; therefore, the team might not get a true picture of road user behavior before an intervention is implemented. To avoid this, planners might consider not announcing interventions until after pre-intervention baseline and traffic conflict data are collected. For more details on developing an implementation strategy, implementing evidence-based interventions, as well as additional implementation and design information, please refer to the Child Health Initiative Global Toolkit.

The interventions presented in this toolkit are just a few options that have been proven effective. They focus on infrastructure improvements, speed reduction, school-based education programs, and improving pedestrian visibility. Researchers or stakeholders (e.g., road safety and public health professionals, school leadership, local community groups) might select interventions based on the most common types of observed traffic conflicts. For example, if the most common type of conflict between a pedestrian and a vehicle involves drivers who are turning but have an obstructed view of pedestrians (due to items such as billboards, garbage cans, bushes, etc.), then the intervention could involve removing objects that restrict the driver's view of potential pedestrians and/or installing a traffic signal. If vehicles are ignoring traffic signs in pedestrian crossing zones, then improved enforcement and/or public education could be implemented.

Below are some common and effective traffic calming techniques and pedestrian-focused road safety interventions. This list is not exhaustive and further consideration is useful when choosing the best road safety intervention(s) based on the local situation.

1) Infrastructure design and improvement are important traffic calming techniques. Helping prevent or restrict pedestrians from interacting with vehicles can eliminate conflicts (World Health Organization, 2013). Pedestrianization, which prevents pedestrians from accessing motorways and prevents vehicles from entering pedestrian zones, is one effective option to consider (World Health Organization, 2013).
2) Reducing vehicle speed decreases pedestrian injury severity if a crash occurs. According to the WHO, when motorized traffic mixes with pedestrians and cyclists, the speed limit should be less than 30 km/h (~18 mph) (World Health Organization, 2015). Reducing the speed of the vehicle decreases the risk of injury and death if the vehicle strikes a pedestrian. In fact, the risk of pedestrian fatality is five times higher at a speed of 50km/h when compared with a speed of 30km/h (Rosén & Sander, 2009).
3) School-based road safety education programs have been shown to increase road safety knowledge among students. During the programs, students are taught about the importance of being safe pedestrians, to use caution when walking to and from school, and how to think critically while walking among different types of road users (World Resources Institute, 2018).
4) Improving the sight and visibility of pedestrians can be achieved by wearing highly reflective clothing, implementing lights and/or crossing illumination measures for pedestrians, installing signals to alert motorists of crossing pedestrians, and reducing or eliminating physical objects (e.g., parked cars, trees, dumpsters) that cause visual obstruction near the crossings. Studies have found that marked pedestrian crossings might give a false sense of safety to the pedestrian, while the road users might be less likely to yield to pedestrians relative to a pedestrian crossing at a signalized intersection (World Health Organization, 2013). Therefore, additional safety measures (e.g., signage, raised median refuge island, rumble strips) should accompany all marked pedestrian crossings.

Step 9: Collect traffic conflict data (post-intervention)

Post-intervention data collection occurs at multiple points in time, ideally at least one month after the implementation of a road safety intervention, as well as at the three month and six month mark. Data collection at least one month post-intervention helps capture data after road users are more likely to have re-established their normal driving and walking tendencies. If post-intervention data are collected immediately after intervention implementation, the road users are likely to be overly cautious, and thus the data might be skewed. Data collection at the three month and six month mark post-intervention allows comparisons to be made over time to ensure a continued effect and a decrease in conflicts. It also offers information on whether the intervention is working and the sustainability of the effectiveness of the intervention.

As a reminder, the post-intervention data collection period(s) gives the most accurate comparison if it occurs at the same time(s) of day and same day(s) of the week as the pre-intervention data collection period, with all other conditions (except those changed due to the intervention) during the post-intervention data collection period being as similar as possible to the pre-intervention data collection period. For example, if the pre-intervention data collection period occurred between 8am–9am on a Wednesday that was a typical school day (e.g., not during a holiday), then the post-intervention data collection period would also occur between 8am–9am on a Wednesday that is a typical school day.

Step 10: Analyze and interpret data

Return to Step 7 for post-intervention data analysis and interpretation options.

Step 11: Disseminate findings

TCT findings can be used to identify the most effective location(s) for road safety intervention implementation, advocate for a certain intervention, and secure funding for infrastructure improvements to increase the safety of the school zone. TCT findings can be shared with local road safety and school stakeholders, so they are aware of the issues surrounding road safety in their community. Various avenues to disseminate the findings include:

- Solicit press and media coverage about the road safety changes taking place.
- Present findings to public officials at town hall meetings, community groups, and/or community and school events.
- Sponsor community events or educational/communications campaigns to highlight the benefits of road safety improvements.
- Highlight stories from local students about how their sense of safety has changed as a result of the intervention(s).
- Target local leaders, parents, and non-profit organizations who might be most likely to give support due to their own experiences with traffic safety or their concern for student safety.

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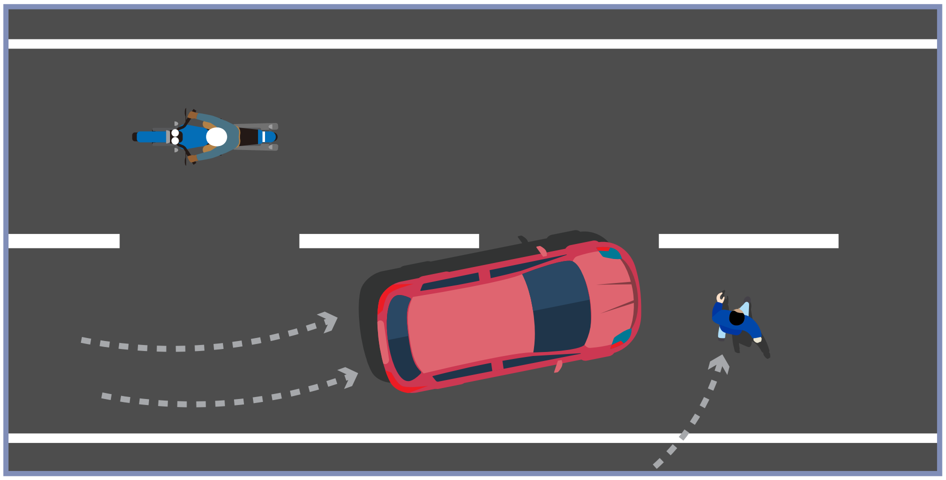
Appendix A

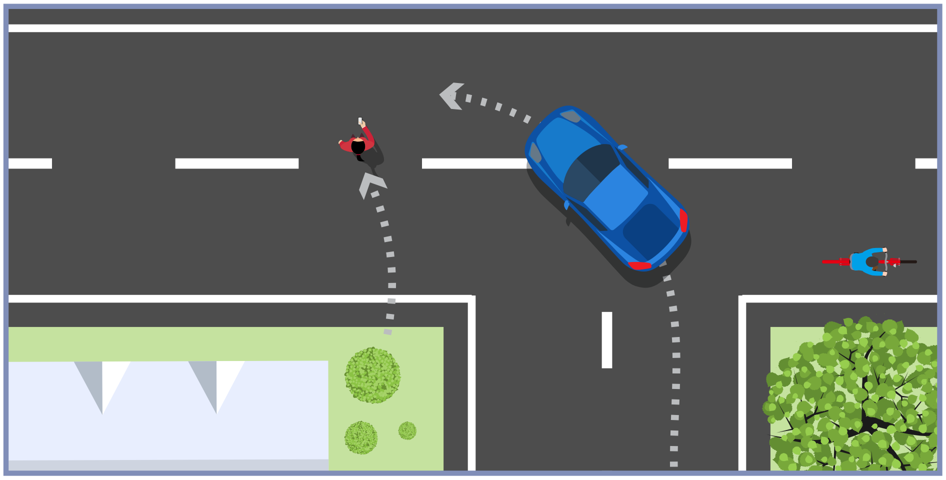
Examples of pedestrian-vehicle conflicts

Below are examples of possible conflicts that occur when a pedestrian/cyclist and a vehicle (e.g., car, truck, bus, motorized 2- and 3-wheeler) are on a collision course and will collide/crash unless either the pedestrian or the vehicle does not take evasive action. These examples are not all-encompassing, nor will they all be applicable to every local situation. Similar sketches can be made with http://draw.accidentsketch.com/.

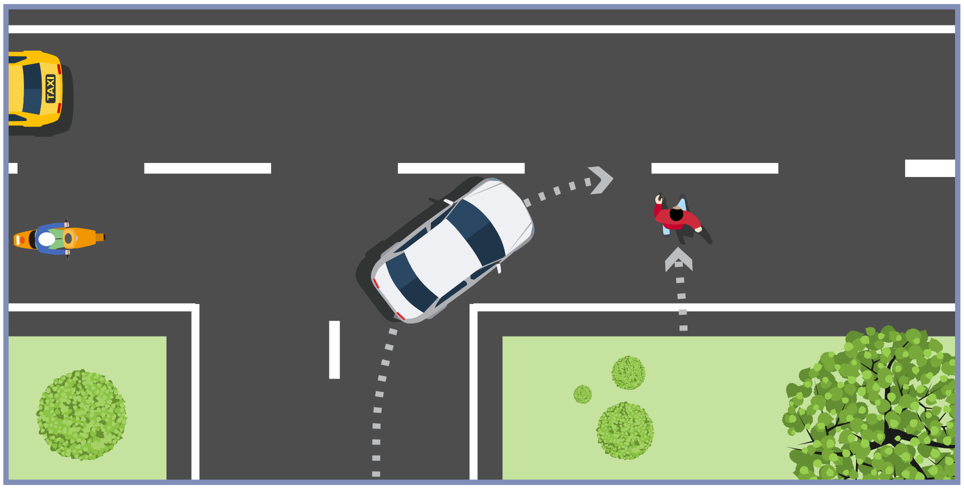
1. A pedestrian is attempting to cross the street not at an intersection or crosswalk. A vehicle is traveling straight and is now on a collision course for the pedestrian. The vehicle must either brake or swerve to avoid a collision with the pedestrian. *Note: this same example could also occur at an intersection and/or a crosswalk.*



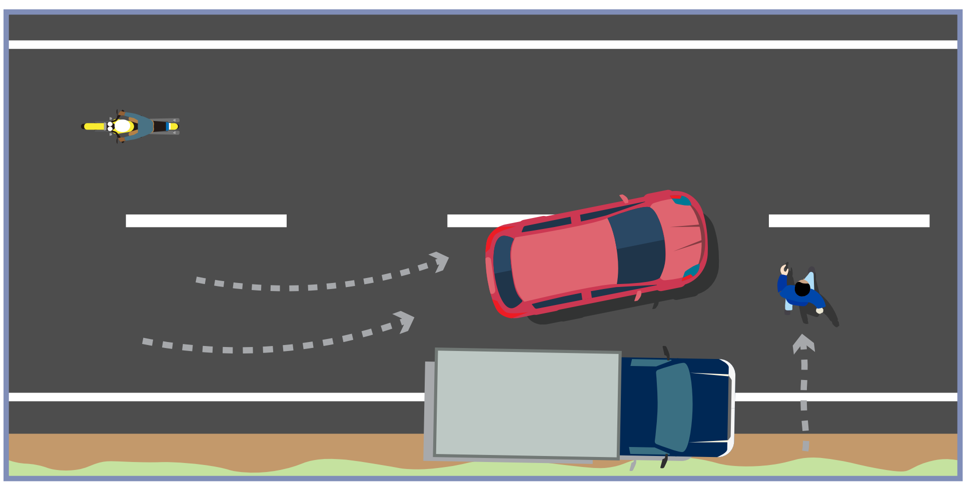
2. A pedestrian is attempting to cross the street at an intersection. A vehicle is turning left from a cross street and is now on a collision course with the pedestrian. The vehicle must either brake or swerve to avoid a collision with the pedestrian. *Note: this same example could also occur at a crosswalk.*



3. A pedestrian is attempting to cross the street at an intersection. A vehicle is turning right from a cross street and is now on a collision course with the pedestrian. The vehicle must either brake or swerve to avoid a collision with the pedestrian. *Note: this same example could also occur at a crosswalk.*



4. A pedestrian is attempting to cross the street not at an intersection or a crosswalk. A parked car on the side of the road blocks the driver of the vehicle from seeing the pedestrian. The vehicle must either brake or swerve to avoid a collision with the pedestrian. *Note: this same example could also occur at an intersection and/or a crosswalk.*



Appendix B

Method 1: Zegeer Pedestrian-Vehicle Conflict Technique

To identify traffic conflicts, this method uses the definitions of the 13 most common types of pedestrian-vehicle conflicts that could occur in school zones (Table 10). However, the list of the different types of conflicts can be expanded or narrowed in consideration of what types of issues are known to occur in the local situation. For example, if there is a specific type of conflict that is not on the list (e.g., pedestrian jumps out of vehicle's path), data collectors can add this conflict type to the list.

Table 10

Zegeer Pedestrian-Vehicle Conflict Technique list of conflict types

Vehicle-related conflicts	
CONFLICT TYPE	**DESCRIPTION**
1) Vehicle slows or stops for pedestrian	A pedestrian is crossing the street in front of an approaching vehicle, causing the vehicle to slow or stop
2) Vehicle slows or stops for previous pedestrian conflict	A following vehicle is forced to slow or stop for a lead vehicle that has slowed or stopped for a pedestrian
3) Vehicle weaves around a crossing pedestrian	A pedestrian is crossing the street causing an approaching vehicle to weave around them
4) Vehicle brakes or weaves around a standing pedestrian	A vehicle brakes or weaves around a pedestrian who is standing in the roadway or on the side of the roadway waiting to cross the street
5) Vehicle brakes or weaves around a pedestrian walking on shoulder	A pedestrian walking on the shoulder, either with or against traffic, causes a vehicle to brake or weave
6) Vehicle disregards crossing guards	A vehicle passing through a school zone disregards a stop indication by the crossing guard by either swerving around students or the crossing guard
7) Vehicle turn conflict	A vehicle turns into a driveway or side street and must slow or stop for a crossing pedestrian
Pedestrian-related conflicts	
CONFLICT TYPE	**DESCRIPTION**
8) Pedestrian runs across the street	A pedestrian runs across the street as a vehicle approaches but the vehicle does not brake or weave
9) Pedestrian stops in street	A pedestrian is crossing the street and must stop on the median or between lanes before completing the crossing
10) Pedestrian traffic signal violation	A pedestrian crosses against the traffic signal at a signalized intersection and returns to the side of the road to prevent a conflict
11) Pedestrian false start across street	A pedestrian starts crossing the street and realizing an error in judgment, retreats to the starting point to prevent a conflict

Other Road User Behaviors	
CONFLICT TYPE	**DESCRIPTION**
12) Jaywalking	A pedestrian is crossing the street in violation of appropriate crosswalk locations
13) Total pedestrian volume crossing street	The number of pedestrians crossing the street within the school zone where they might be exposed to approaching vehicles is counted

Using this method, every vehicle-related and pedestrian-related conflict is recorded and assigned one of the three subjective levels of severity by the data collector:

Routine: A conflict that is determined not to be very close to a collision

Moderate: A conflict that involves a quick maneuver by a pedestrian or vehicle (e.g., an abrupt deceleration or swerve)

Severe: A conflict where a collision is barely avoided due to a last-second reaction by the pedestrian or vehicle

Ideally, the data collectors would like to see a decrease in the number and rate of severe traffic conflicts, which would create a shift and a potential increase in routine conflicts from the pre- and post-intervention data collection periods.

A data collection form was developed to assist the data collectors during the data collection period (Figure 2). This form has been adapted based on comments during debriefing sessions after the pilot testing in Dar es Salaam, Tanzania.

The original Zeeger Pedestrian-Vehicle Conflict Method and corresponding data collection forms can be found here.

To fill out the form, simply place a tally in the correct column (routine, moderate, severe) of the type of observed conflict. After the data collection period is completed, add up each row to get the total number of types of conflicts for that data collection site, and then add up the columns to get the total number of each conflict severity.

Figure 2

Updated Zegeer Pedestrian-Vehicle Conflict Technique data collection form based on comments from the pilot test in Dar es Salaam, Tanzania, May 2019

Data Collection Form for Zegeer Pedestrian-Vehicle Conflict Technique

Date:________________________(DD/MM/YYYY)   Weather:__________________________________

(Weather options: no rain, light rain, heavy rain)

School:____

Location:____(insert GPS coordinates if available)

Name of data collectors:____

Start time:_____:_____   End time:_____:_____   Day of week:________________________________

Instructions: Place a tally in the severity column (routine, moderate, severe). Do not record the severity of #12 or #13; simply tally the total count. Add up each row for a count of the total number of types of conflicts and each column for a count of the total number of each conflict severity.

Routine: A conflict that is determined not to be very close to a collision

Moderate: A conflict that involves a quick maneuver by a pedestrian or vehicle (e.g., an abrupt deceleration or swerve)

Severe: A conflict where a collision is barely avoided due to a last-second reaction by the pedestrian or vehicle

Type of Conflict	Routine	Moderate	Severe	Total
1) Vehicle slows or stops for pedestrian				
2) Vehicle slows or stops for previous pedestrian conflict				
3) Vehicle weaves around a crossing pedestrian				
4) Vehicle brakes or weaves around a standing pedestrian				
5) Vehicle brakes or weaves around a pedestrian walking on shoulder				
6) Vehicle disregards crossing guards				
7) Vehicle turn conflict				
8) Pedestrian runs across the street				
9) Pedestrian stops in street				
10) Pedestrian traffic signal violation				
11) Pedestrian false start across street				
Other:				
Other				
Total				
12) Jaywalking				
13) Total pedestrian volume crossing street				

Photo taken during the Method 1 pilot test in Dar es Salaam, Tanzania, May 2019 *Credit: Simon Kalolo*

Case Study of the Zegeer Pedestrian-Vehicle Conflict Technique, Dar es Salaam, Tanzania

In May 2019, data collectors were trained on the Zegeer Pedestrian-Vehicle Conflict Technique. Since this method is relatively simple, training took ½ day, after which the data collectors felt confident about assessing the conflicts and their severity. After the training, the Zegeer Pedestrian-Vehicle Conflict Technique was pilot tested in Dar es Salaam, Tanzania at two separate primary schools. The first pilot took place in the afternoon as the students were leaving school. The first school had two entrances/exits, which were located on opposite sides of the school and were both located on busy two-lane roads. This school had recently implemented safety measures and added a zebra crossing at the entrance/exit, speed humps on either side of the entrance/exit, speed limit signs, and school zone signs. There were four data collectors total, split into two teams of two. One person per team was capturing video footage while the other team member was manually recording traffic conflicts. The two teams were located on opposite sides of the road about 200 meters (~650 feet) apart. Each team focused on observing an intersection just down the road from the primary entrance/exit. The data collection period lasted approximately 30 minutes, from the time when the school released students, to the time when most students had left the school zone.

The second pilot took place at a different school, which was also in a busy location. This pilot occurred in the morning as the students were entering school. The second school had one primary entrance/exit, located at the juncture of a sharp curve in the road with newly implemented road safety interventions. There was one speed hump located on one side of the sharp curve, but no speed limit signs or school zone signs were present. There were four data collectors, with one team of two standing just ahead of the curve in the road, a third data collector standing just after the curve in the road, and a fourth data collector standing further down the road (close to another sharp curve). The team of two was capturing video footage and recording traffic conflicts just before the first curve, the third data collector was at a different location capturing traffic conflicts just after the first curve, while the fourth data collector was video recording the second curve. The data collection period lasted approximately 40 minutes, from the time when a majority of the students were on their way to school until the time school began.

The pilot team in Tanzania identified these lessons learned:

Additional data collector training required
This method has one main difference compared with the other methods: every pedestrian crossing the street is recorded. Specifically, there was uncertainty during the pilot about whether or not to record the pedestrian crossing the street (#13) if the pedestrian was also involved in a conflict. After discussions and debriefing, the team decided only to record the pedestrian as a tally in #13 if the pedestrian was NOT involved in a conflict, to avoid double counting. Therefore, tallies placed in the conflict categories were not also included in the total pedestrian count.

Ensure data collector consensus
Pertaining to observed conflicts, there was uncertainty around how to categorize some of the conflicts based on conflict type. For example, during one conflict, the data collectors saw #1 (vehicle slows or stops for pedestrian), #8 (pedestrian runs across the street), and #13 (total pedestrian volume crossing street). During the pilot, the data collectors placed a tally in each of the rows, uncertain of which conflict type to focus on. After discussions and debriefing, the team decided that (to keep in line with the toolkit) the best way to capture a conflict as a single conflict would be to categorize the conflict based on the road user who took the initial evasive action. Therefore, for the above example, the conflict was only categorized as a #1 (vehicle slows or stops for pedestrian), since this was the first evasive action taken, which allowed the pedestrian to cross the street.

Spend additional time on conflict severity
There was uncertainty regarding the subjectivity of the severity scoring. During the pilot, each data collector subjectively recorded a severity score for each conflict (routine, moderate, or severe). However, while watching the video footage, the team discussed the conflicts in which a data collector was uncertain of how to code the severity and came to an objective consensus on the severity of the conflict(s) in question. This highlights the utility of using video footage to complement manual recording, especially when it is necessary to determine the severity of a conflict. To note: severity scoring is subjective and contextual. For example, a routine traffic conflict in one context might be categorized as severe in another context; this is important to keep in mind and discuss with the team before piloting.

Universal definitions
Pertaining to the severity scoring presented in this method, the team decided that, in general, a universal definition of the routine, moderate, and severe conflicts was necessary to lessen the subjectivity of severity scoring. It would have been more beneficial to spend additional time during training to practice how to determine the severity score with video footage to help the team reach a consensus on the severity definitions.

Expanding the conflict types
On the data collection form, a row for “Other Conflict” was included to allow for the capturing of additional conflicts that were not on the original list. For example, the team in Dar es Salaam decided to add a conflict labeled “pedestrian forces vehicle to stop,” because many times a pedestrian will put their hand up to force the vehicle to stop before they cross. Additionally, “pedestrian stops because of previous pedestrian-vehicle conflict” and “pedestrian stops because of previous vehicle-vehicle conflict” were added.

Define unknown terminology
The term “jaywalking” (#12) should be properly defined for those who are not familiar with the term.

Update data collection form
There were numerous suggestions about altering the data collection form created to use during the pilot. These changes have been made to the form in Figure 2 above. Additional suggestions that could be made based on the local situation include segmenting the form into different sections for pedestrians and vehicles and deleting rows that might not apply to the situation in the school zone (e.g., #6 “vehicle disregards crossing guards” or #10 “pedestrian traffic signal violation”).

Appendix C

Method 2: Cynecki Pedestrian-Vehicle Conflict Technique

This method includes a description of conflict classifications, a data collection procedure, and a data collection form. The first task of Method 2 is to identify the possible types of traffic conflicts that could occur in the specific school zone (or area of interest). The conflict descriptions are based on vehicle turning movements, the manner in which pedestrians access the roadway, and road user violations of traffic signals. The Cynecki Pedestrian-Vehicle Conflict Technique highlights the classifications of traffic conflicts listed in Table 11.

Table 11

Cynecki Pedestrian-Vehicle Conflict Technique list of conflict classifications

CONFLICT TYPE	DESCRIPTION
1) Vehicle slows or weaves for walking pedestrians	Occurs when a pedestrian accesses a roadway at a normal walking speed and a vehicle weaves or brakes to avoid a collision with the pedestrian. An occurrence of this conflict might indicate a visibility restriction for the pedestrian or vehicle. This conflict does not include vehicles turning into the path of a pedestrian at intersections or violations of a traffic signal by a pedestrian or vehicle. These types of conflicts are detailed below.
2) Vehicle slows or weaves for running pedestrians	Occurs when a pedestrian accesses a roadway at a running speed and a vehicle weaves or brakes to avoid a collision with the pedestrian.
3) Pedestrian walking or running in the roadway with the flow of traffic	Occurs as the result of a vehicle weaving or braking due to a pedestrian walking or running in the roadway or on the shoulder in the direction of vehicle traffic. These types of conflicts could also occur in areas of on-street parking due to pedestrians accessing parked vehicles.
4) Pedestrian walking or running in the roadway against the flow of traffic	Occurs as the result of a vehicle weaving or braking due to a pedestrian walking or running in the roadway or on the shoulder in the opposite direction of vehicle traffic.
5) Diagonal pedestrian crossing	Occurs when a pedestrian crosses a road at an angle other than 90° to the flow of traffic. These conflicts are particularly dangerous as the pedestrian will have their back to traffic at some point in their crossing, and because these crossings will typically take longer than a crossing at 90°. These crossings could occur due to offset sidewalks accessing a roadway.
6) Pedestrian in center lane	Occurs when the presence of a pedestrian in the center turn lane, or between lanes, causes a conflict with a vehicle.

7) Outside zebra crossing/crosswalk	When locations have crosswalks marked on the roadway, it might be beneficial to indicate the number of conflicts that occur outside of the marked crosswalk. These data could be useful for evaluating the effectiveness of marked crosswalks in reducing the number of pedestrian access points to a roadway and in identifying the effectiveness of the crosswalk as a safety countermeasure for pedestrians.
8) Right-turning conflicts	Occurs as the result of a vehicle turning right at an intersection or making a right turn into or out of a driveway. For more involved right-turn analysis, it can be subcategorized: a) vehicles turning right from the roadway, b) vehicles turning right onto the roadway.
9) Left-turning conflicts	Occurs as the result of a vehicle turning left at an intersection or making a left turn into or out of a driveway. For more involved left-turn analysis, it can be subcategorized: a) vehicles turning left from the roadway, b) vehicles turning left onto the roadway.
10) Right-turn-on-red conflicts	Occurs when a vehicle initiates a right turn during a red traffic signal that results in a conflict with a pedestrian crossing the roadway.
11) Pedestrian violation of traffic signal	Occurs as the result of a pedestrian violation of a traffic signal or signalized pedestrian crossing (e.g., pedestrian walk light). For example, the conflict occurs when the pedestrian attempts to cross the roadway against a traffic signal or a pedestrian starts to cross when the signal is flashing "DON'T WALK." Before the pedestrian completes the crossing, the signalized pedestrian crossing changes to red and a vehicle brakes, weaves, or hesitates to avoid a collision.
12) Vehicle violation of traffic signal	Occurs as the result of a vehicle violation of a traffic signal or signalized pedestrian crossing (e.g., pedestrian walk light). Examples include vehicle failure to stop, failure to yield, running a red light/pedestrian crossing light, or an illegal right-turn-on-red/left-turn-on-red.
13) Vehicle U-turn	Occurs as the result of a vehicle making a U-turn on a road, which creates a conflict with a pedestrian.
14) Pedestrian-bicycle conflict	Occurs as the result of a traffic conflict between a pedestrian and a bicycle.
15) Pedestrian-motorcycle conflict	Occurs as the result of a traffic conflict between a pedestrian and a motorcycle.
16) Other	Captures a traffic conflict not defined above.

Once there is an understanding of the types of conflict classifications, the severity of both the pedestrian and the vehicle is determined using a list of possible actions that could occur during a conflict. The actions in Table 12 are listed by increasing severity.

Table 12

Cynecki Pedestrian-Vehicle Conflict Technique conflict severity actions of the pedestrian and vehicle

Actions of the Pedestrian
1) **Hesitation:** Pedestrian hesitates briefly while crossing the roadway in response to vehicle traffic.
2) **Backup movement:** Pedestrian briefly reverses direction of travel while in the roadway in response to vehicle traffic.
3) **Running movement:** Pedestrian increases speed to avoid a collision with a vehicle while in the roadway.
4) **Near-miss crash:** A collision is imminent but is avoided just before impact.
Actions of the Vehicle
1) **Routine conflict:** Vehicle brakes or weaves routinely to avoid a collision with a pedestrian.
2) **Complete stop or erratic maneuver:** Vehicle comes to a complete stop or suddenly swerves to avoid a collision.
3) **Near-miss crash:** A collision is imminent but is avoided just before impact.

Data collection procedures

Fill out the data collection form shown in Table 13 below using the list of conflict classifications and conflict severity listed above. The original Cynecki Pedestrian-Vehicle Conflict Technique and corresponding data collection forms can be found here.

The severity of a conflict is defined at the exact moment one of the road users begins to take evasive action; the road user who first took evasive action is called "Road User 1." For example, if the pedestrian stops suddenly to avoid colliding with an oncoming vehicle before the vehicle reacts, Road User 1 is the pedestrian.

It is possible, perhaps likely, that a conflict could be categorized into several different classifications. For example, a vehicle was forced to slow for a pedestrian who was crossing the street outside of the crosswalk as the vehicle was turning into the crosswalk while the light was red. Using the definitions above, this traffic conflict example would be coded using the following types of conflict: 1 (vehicle slows or weaves for walking pedestrians), 7 (outside zebra crossing/crosswalk), 10 (right-turn-on-red conflict). If the pedestrian had reacted by backing up onto the sidewalk, then the pedestrian conflict severity code would be 2. If the vehicle had suddenly stopped, but did not need to slam on the brakes, then the vehicle conflict severity would be 2.

Table 13

Example Cynecki Pedestrian-Vehicle Conflict Technique data collection form

Conflict Number	Time	Conflict Classification	Road User 1	Severity: Road User 1	Road User 2	Severity: Road User 2	Location of Conflict	Notes
Conflict 1	14:02	#1, #7, #10	Pedestrian	2	Car	2	5 meters east of crosswalk	Parked car on side of road
Conflict 2								
Conflict 3								
Conflict 4								
Conflict 5								
Conflict 6								
Conflict 7								
Conflict 8								
Conflict 9								
Conflict 10								

Photo taken during the Method 2 pilot test in Mexico City, Mexico, December 2018 *Credit: Douglas Roehler*

Case Study of the Cynecki Pedestrian-Vehicle Conflict Technique, Mexico City, Mexico

In December 2018, data collectors were trained on the Cynecki Pedestrian-Vehicle Conflict Technique. Since this is a relatively simple method, training was scheduled for ½ day, after which the data collectors felt confident they could easily classify the different types of conflicts and assess the severity. After the training, this method was pilot tested at a secondary school in Mexico City. The school had one primary entrance/exit located along a busy four-lane road (two lanes of traffic in each direction, with a median). Two data collectors were located on opposite sides of the four-lane road, and data collection occurred on an afternoon as students were leaving for the day. Video footage was captured outside the entrance/exit along with a manual data collector recording conflicts. The data collection period lasted approximately 35 minutes, from the time when the school released students, to the time when most students had left the school zone.

The pilot team in Mexico identified these lessons learned:

Record severity for all road users
Sometimes, the data collector might only record the severity for one road user—in this case, the pedestrian. Though, during the debriefing, which included watching the video footage, a realization was made that valuable information was lost by only collecting severity data on the pedestrian. For example, if the data collectors recorded only the pedestrian severity of the conflict, this conflict was determined not to be very severe. However, if conflict severity for both the pedestrian and vehicle were recorded, the conflict severity would have better aligned to reality. Therefore, it is recommended to record the severity for all road users involved in the conflict.

Additional data collector training required
After watching the video footage, the data collectors recorded many instances of normal crossings as conflicts when there actually was no conflict, which might indicate that more time should be spent on training (e.g., 1 full day) to fully understand how to classify the conflicts. For example, on the data collection form, the data collectors might have recorded every instance of a student crossing the street outside the crosswalk; however, Method 2 does not record each of these instances. Therefore, it is essential that data collectors are instructed to only record instances where two road users are on a collision course and will collide/crash if evasive action is not taken.

High data quality
Data quality was ensured through reviewing the video footage to identify additional conflicts that were previously missed during manual data collection and to review previously recorded conflicts that were not actually conflicts, based on this method.

Appendix D

Method 3: Version 1: Institute of Highways and Transportation Conflicts Technique (IHTCT) Pedestrian-Vehicle Conflict Technique

This method is more complex than Methods 1 and 2 because it requires more in-depth data collector training and involves several steps before determining the conflict severity grade. Using this method, not every pedestrian crossing the road should be recorded. The only events recorded are those where the vehicle or pedestrian perform evasive actions (e.g., speed up, slow down, swerve) to avoid what they think are potential collisions. Therefore, data collectors first determine whether the event is a conflict using Factors A (Time to Collision) and D (Distance to Collision), and then use Factors B (Severity of Evasive Action) and C (Complexity of Evasive Action) to grade its severity (Table 14).

Table 14

Version 1: Institute of Highways and Transportation Conflicts Technique Pedestrian-Vehicle Conflict Technique guide to classifying each element of the traffic conflict

Factor A: Time to Collision	
EXPLANATION	Classification
Long (class 1): The point when the evasive action for the vehicle or the pedestrian begins is much earlier than the point of potential collision, had the road user kept their initial speed and course.	1
Moderate (class 2): The point when the evasive action for the vehicle or the pedestrian begins is fairly close to the potential collision, which usually results in more severe braking.	2
Short (class 3): The point when the time of evasive action for the vehicle or the pedestrian is short, and the potential collision is near, which usually results in hard braking and a change of course.	3
Factor A Score:	

Factor B: Severity of Evasive Action ** Hierarchy of pedestrian severity: walk/stop – jog – run – sprint – emergency action **	
EXPLANATION	Classification
Light (class 1): Light, controlled acceleration or deceleration. For pedestrians, this corresponds to moving up or down one level on the severity hierarchy (see hierarchy above). For example, the pedestrian's movement increased from a walk/stop to a jog, or decreased from a jog to a walk/stop.	1
Medium (class 2): Moderate, but controlled acceleration or deceleration. For pedestrians, this corresponds to moving up or down by two levels on the severity hierarchy. For example, the pedestrian's movement increased from a walk/stop to a run, or decreased from a run to a walk/stop.	2
Heavy (class 3): Sharp, less controlled acceleration or deceleration. For pedestrians, this corresponds to moving up or down by three levels on the severity hierarchy. This is usually combined with a change in course following the acceleration or deceleration. For example, the pedestrian's movements increased from a walk/stop to a sprint, or decreased from a sprint to a walk/stop.	3
Emergency (class 4): Sudden, uncontrolled acceleration or deceleration. For pedestrians, this corresponds to moving up or down by four levels on the severity hierarchy. This is usually combined with a sudden change in course. For example, the pedestrian's movement increased from a walk/stop to emergency action, or decreased from emergency action to a walk/stop.	4
Factor B Score:	

Factor C: Complexity of Evasive Action	
EXPLANATION	Classification
Simple (class 1): The road user either accelerates or decelerates to avoid a collision (braking without change in course), or changes course to avoid collision (change in course without acceleration or deceleration).	1
Complex (class 3): The road user takes evasive action involving a distinct change to their course and accelerates or decelerates to at least medium severity.	3
Factor C Score:	

Factor D: Distance to Collision	
EXPLANATION	Classification
Far (class 1): Greater than two car lengths (9 meters or 29 feet) between the conflicting road users when they begin to take evasive action. For pedestrian crossings, this should be considered greater than one car length (4.5 meters or 14.5 feet).	1
Medium (class 2): Between one and two car lengths between the conflicting road users when they begin to take evasive action. For pedestrian crossings, this should be considered between half of a car length and one car length.	2
Short (class 3): Less than one car length between the conflicting road users when they begin to take evasive action. For pedestrian crossings, this should be considered as less than half of a car length.	3
Factor D Score:	

There are several steps to complete before getting an overall severity grade. To begin, arrange the scores from each factor vertically in Table 15 to get a final classification sequence.

Table 15

Version 1: Institute of Highways and Transportation Conflicts Technique Pedestrian-Vehicle Conflict Technique final classification sequence for Factors A-D

Final Classification Sequence	
Factor A	
Factor B	
Factor C	
Factor D	

Next, using Table 16 below, the conflicts are then categorized as Grade 1 (slight) to Grade 4 (serious) based on the vertical final classification sequence found in Table 15. Each vertical final classification sequence for Factors A-D corresponds to a specific conflict grade. An example is presented below.

Table 16

Version 1: Institute of Highways and Transportation Conflicts Technique Pedestrian-Vehicle Conflict Technique conflict severity scoring tables

Factor	Grade 1 conflict — slight												
A	1	1	1	1	1	1	2	2	2	2	2	3	3
B	1	1	2	2	1	1	1	1	1	2	2	2	2
C	1	3	1	3	1	3	1	3	1	1	3	1	3
D	1	1	1	1	2	2	1	1	2	1	1	1	1

Factor	Grade 2 conflict — serious																		
A	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	3
B	1	1	2	2	3	3	1	1	2	2	3	3	1	1	1	1	2	3	3
C	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	1	3
D	3	3	2	2	1	1	3	2	2	2	1	1	2	2	3	3	2	1	1

Factor	Grade 3 conflict — serious																			
A	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3
B	2	2	3	3	1	2	2	3	3	3	3	2	2	2	3	3	4	4	4	4
C	1	3	1	3	3	1	3	1	3	1	3	3	1	3	1	3	1	3	1	3
D	3	3	2	2	3	3	3	2	2	3	3	2	3	3	2	2	1	1	2	2

Factor	Grade 4 conflict — serious					
A	2	2	3	3	3	3
B	4	4	3	3	4	4
C	1	3	1	3	1	3
D	3	3	3	3	3	3

Hypothetical Example – Method 3: Version 1: Institute of Highways and Transportation Conflicts Technique Pedestrian-Vehicle Conflict Technique in a school zone

While watching previous video footage of a traffic conflict involving a pedestrian and vehicle, each factor is separately evaluated based on the various elements of the traffic conflict. In this example, Factor A is given a 2, Factor B is given a 3, Factor C is given a 1, and Factor D is given a 2. The following classifications are presented vertically for the four factors:

Final Classification Sequence	
Factor A	2
Factor B	3
Factor C	1
Factor D	2

Find the above vertical sequence of numbers (2, 3, 1, 2) in one of the conflict severity scoring tables. The final classification sequence is highlighted below.

Therefore, this example traffic conflict is considered a Grade 3 – serious traffic conflict.

Factor	Grade 3 conflict — serious																			
A	1	1	1	1	2	2	2	**2**	2	2	2	3	3	3	3	3	3	3	3	3
B	2	2	3	3	1	2	2	**3**	3	3	3	2	2	2	3	3	4	4	4	4
C	1	3	1	3	3	1	3	**1**	3	1	3	3	1	3	1	3	1	3	1	3
D	3	3	2	2	3	3	3	**2**	2	3	3	2	3	3	2	2	1	1	2	2

Photo taken during the Method 3 pilot test in Dar es Salaam, Tanzania, May 2019 *Credit: George Malekela*

Case Study of the Method 3: Version 1: Institute of Highways and Transportation Conflicts Technique Pedestrian-Vehicle Conflict Technique, Dar es Salaam, Tanzania

In May 2019, data collectors were trained on Method 3: Version 1: IHTCT Pedestrian-Vehicle Conflict Technique. Since this method is a more complex data collection method, training took one full day for the data collectors to learn the method, with the assistance of previously recorded video footage. After the training, this method was pilot tested in Dar es Salaam, Tanzania at a primary school. The pilot took place in the afternoon as the students were leaving school. The primary school had one main entrance/exit, which was located on a busy, traffic-clogged four-lane road (two-lanes of traffic in each direction, with a median). The street was also lined with street shops, which could have potentially hindered vehicles from seeing pedestrians and pedestrians from seeing vehicles. There were four data collectors across three locations—one team of two and two separate individual data collectors at different locations. Both of the individual data collectors were capturing video footage, while the team of two were manually recording traffic conflicts. One of the individual data collectors was located right outside the main entrance/exit while the other individual data collector was located on the opposite side of the four-lane road. As time passed and the students exited the school, this individual moved further down the road to capture video footage at another popular crossing. The team of two data collectors was positioned on the same side as the school entrance/exit. The data collection lasted approximately 45 minutes, from the time when the school released students, to the time when most students had left the school zone.

The pilot team in Tanzania identified these lessons learned:

Additional data collector training
Since there are various classification levels within each factor, more time spent on practicing would have been useful. One suggestion was to incorporate additional time during the training (2-3 additional hours) to practice the different explanations within Factors A-D and to watch more video footage, which was helpful in practicing the method before the pilot.

Video footage was very useful
Video footage that was captured during the pilot was very helpful in retroactively allowing the data collectors to replay the conflict and subsequently assess its severity.

Reschedule due to an unusual situation
Due to the rainy season in Dar es Salaam, many smaller roads surrounding the school were flooded and difficult to pass; therefore, traffic on the four-lane road was heavier than usual. This made it challenging to assess the traffic conflicts as the traffic was stop-and-go and very slow moving. While this situation might have given more possibility to potential conflicts between pedestrians and motorized 2- and 3-wheelers, because the motorized 2- and 3-wheelers began driving on the pedestrian walkway due to the heavy vehicle traffic, this is also considered an unusual situation. Therefore, in this instance, it is advisable to reschedule the data collection period to occur the following week.

Update data collection form
During the pilot there were numerous suggestions about altering the data collection form. Suggestions included increasing the row spacing and including the factor definitions directly on the conflict data collection form so the data collectors can see all the information on one page. Figure 3 below is an example of the updated form. The original Version 1: IHTCT Pedestrian-Vehicle Conflict Technique can be found here.

Figure 3

Updated Method 3: Version 1: Institute of Highways and Transportation Conflicts Technique Pedestrian-Vehicle Conflict Technique data collection form based on comments from the pilot in Dar es Salaam, Tanzania, May 2019

Version 1: IHTCT Pedestrian-Vehicle Conflict Technique - Traffic Conflict Data Collection Form									
	Time	Location of conflict	Factor A	Factor B	Factor C	Factor D	Final Classification (#, #, #, #)	Severity Grade	Notes
Conflict 1									
Conflict 2									
Conflict 3									
Conflict 4									
Conflict 5									
Conflict 6									
Conflict 7									
Conflict 8									
Conflict 9									
Conflict 10									

Factor A: Time to Collision	Factor B: Severity of Evasive Action	Factor C: Complexity of Evasive Action	Factor D: Distance to Collision
Long: 1 Evasive action begins much earlier than the point of potential collision. **Moderate:** 2 Evasive action begins fairly close to the potential collision. **Short:** 3 Evasive action is short and the potential collision is near.	**Light:** 1 Light, controlled acceleration or deceleration. Pedestrians (Peds): +1/-1 on hierarchy **Medium:** 2 Moderate, but controlled acceleration or deceleration. Peds: +2/-2 **Heavy:** 3 Sharp, less controlled acceleration or deceleration. Peds: +3/-3 **Emergency:** 4 Sudden, uncontrolled acceleration or deceleration. Peds: +4/-4	**Simple:** 1 Acceleration/deceleration or change in course to avoid collision (one or the other). **Complex:** 3 Acceleration/deceleration and a distinct change in course to avoid collision (both occur).	**Far:** 1 Greater than two car lengths (9 m or 29 ft) between the road users when evasive action is taken. Peds: greater than one car length (4.5 m or 14.5 ft). **Medium:** 2 Between one and two car lengths between the road users when evasive action is taken. Peds: half of a car length and one car length. **Short:** 3 Less than one car length between the road users when evasive action is taken. Peds: less than half of a car length.

Appendix E

Method 4: Version 2: Institute of Highways and Transportation Conflicts Technique (IHTCT) Pedestrian-Vehicle Conflict Technique

This method is more complex than Methods 1, 2, and 3 because it requires more in-depth data collector training to successfully complete the required steps to determine the severity of the conflicts. This method consists of three distinct steps:

1) Categorization of pedestrian-vehicle conflicts
2) Severity grading of the traffic conflict
3) Collecting pre- and post-intervention traffic conflict data

1) Categorization of pedestrian-vehicle conflicts

Each pedestrian-vehicle conflict is recorded using two types of interactions:

- **Steady Care-Pedestrian (SC-P) Interactions:** The vehicle is traveling at a steady speed at the time of interaction with the pedestrian. Therefore, the vehicle's movement is independent to that of the pedestrian.
- **Effective Shared Space (ESS) Interactions:** The vehicle is stopped or traveling at very slow speeds (slower than the speed of a walking student pedestrian) and pedestrians are also present in the road. Examples include a slow-moving line of cars with pedestrians choosing to walk between them to cross the road or pedestrians clearing a crossing immediately after a traffic signal has changed.

2) Severity grading of the traffic conflict

The criterion used to categorize the severity of the traffic conflict, changes in speed and direction, are provided in Table 17. Within each criterion is also a grade (1-4) by which to determine the severity. The criterion and grade are different for vehicles and pedestrians since their movements are naturally on different scales. Therefore, the conflicts between pedestrians and vehicles are graded based on several criterion and grades to determine severity.

- **Criterion I:** Focuses on the change in speed leading up to the interaction
- **Criterion II:** Focuses on the change in direction as a result of the interaction
- **Criterion III:** Focuses on the extent to which the vehicle returns to the desired speed following the pedestrian interaction

Criterion I and II involve both the vehicle and pedestrian, while Criterion III only involves the vehicle.

3) Collecting pre- and post-intervention traffic conflict data

Once the data collectors understand the SC-P and ESS Interactions along with the severity grading for each pedestrian-vehicle interaction, data collectors can begin to collect data. Results from each data collection period (pre- and post-intervention) are recorded in separate data collection forms (Tables 18 and 19, respectively). The data collector should place a tally in the corresponding box when a conflict is witnessed. To note, the severity grading for the vehicle is not assessed in ESS Interactions, because the short distances covered make it difficult to distinguish the drivers' behavioral response. Therefore, the ESS Interactions in the pre- and post-intervention columns for the vehicle will always be blank.

Table 17

Version 2: Institute of Highways and Transportation Conflicts Technique Pedestrian-Vehicle Conflict Technique grades for the three criterion to determine severity

Grade	Vehicle reaction	Pedestrian reaction
Criterion I: Change in speed		
1	Continues at full speed	Continues at the same speed
2	Slows down in advance but does not come to a stop	Accelerates to complete the crossing before the vehicle's arrival
3	Slows down well in advance and stops before reaching the pedestrian	Stops temporarily to let the vehicle pass and then continues
4	–	Returns to the side of the road immediately
Criterion II: Change in direction		
1	Continues along intended path	Continues along intended path
2	Deviates to avoid pedestrian	Deviates to avoid vehicle
3	–	Returns to the side of the road
Criterion III: Vehicle acceleration		
1	Accelerates as soon as the pedestrian has crossed the path	–
2	Waits until the pedestrian is well clear before accelerating	–
3	No change in speed	–

Table 18

Version 2: Institute of Highways and Transportation Conflicts Technique Pedestrian-Vehicle Conflict Technique pre-intervention data collection form

			SC-P Interactions	ESS Interactions
	Criteria	Grade	Pre-Intervention	Pre-Intervention
Vehicle	I *(change in speed)*	1 – full speed		–
		2 – slowed down		–
		3 – stop		–
	II *(change in direction)*	1 – unchanged		–
		2 – deviated		–
	III *(vehicle acceleration)*	1 – accelerate immediately		–
		2 – wait to clear		–
		3 – no change		–
		VEHICLE TOTAL		
Pedestrian	I *(change in speed)*	1 – unchanged		
		2 – accelerate		
		3 – give way		
		4 – return		
	II *(change in direction)*	1 – unchanged		
		2 – deviated		
		3 – return		
		PEDESTRIAN TOTAL		

Photo taken during the Method 4 pilot test in Ho Chi Minh City, Vietnam, October 2019 *Credit: Agnieszka Krasnolucka*

Table 19

Version 2: Institute of Highways and Transportation Conflicts Technique Pedestrian-Vehicle Conflict Technique post-intervention data collection form

			SC-P Interactions	ESS Interactions
	Criteria	Grade	Post-Intervention	Post-Intervention
Vehicle	I *(change in speed)*	1 – full speed		–
		2 – slowed down		–
		3 – stop		–
	II *(change in direction)*	1 – unchanged		–
		2 – deviated		–
	III *(vehicle acceleration)*	1 – accelerate immediately		–
		2 – wait to clear		–
		3 – no change		–
		VEHICLE TOTAL		
Pedestrian	I *(change in speed)*	1 – unchanged		
		2 – accelerate		
		3 – give way		
		4 – return		
	II *(change in direction)*	1 – unchanged		
		2 – deviated		
		3 – return		
		PEDESTRIAN TOTAL		

Once each data collection period is complete and the conflicts are tallied in the two data collection forms, the cumulative results are placed into Table 20. The results are used to draw conclusions on the safety of the school zone and to generate possible ideas of how to improve the safety of students. The original Version 2: IHTCT Pedestrian-Vehicle Conflict Technique can be found here.

Table 20

Version 2: Institute of Highways and Transportation Conflicts Technique Pedestrian-Vehicle Conflict Technique cumulative results form

			SC-P Interactions		ESS Interactions	
	Criteria	**Grade**	**Pre-Intervention**	**Post-Intervention**	**Pre-Intervention**	**Post-Intervention**
Vehicle	I *(change in speed)*	1 – full speed				
		2 – slowed down				
		3 – stop				
	II *(change in direction)*	1 – unchanged				
		2 – deviated				
	III *(vehicle acceleration)*	1 – accelerate immediately				
		2 – wait to clear				
		3 – no change				
		VEHICLE TOTAL				
Pedestrian	I *(change in speed)*	1 – unchanged				
		2 – accelerate				
		3 – give way				
		4 – return				
	II *(change in direction)*	1 – unchanged				
		2 – deviated				
		3 – return				
		PEDESTRIAN TOTAL				

Hypothetical Example – Method 4: SC-P and ESS interactions for pedestrian-vehicle conflicts

Using Method 4: Version 2: IHTCT Pedestrian-Vehicle Conflict Technique, traffic conflict data was collected at one location within a school zone. Before an intervention is implemented, observations are conducted to get a sense of the number of vehicle and pedestrian interaction events (SC-P and ESS Interactions). During this pre-intervention data collection period, the following counts of SC-P and ESS Interactions were recorded and grouped by criterion and grade.

Pre-intervention Example: Method 4: Version 2: Institute of Highways and Transportation Conflicts Technique Pedestrian-Vehicle Conflict Technique data collection form (sample form)

			SC-P Interactions		ESS Interactions	
	Criteria	Grade	Pre-Intervention	Post-Intervention	Pre-Intervention	Post-Intervention
Vehicle	I *(change in speed)*	1 – full speed	200		–	
		2 – slowed down	7		–	
		3 – stop	–		–	
	II *(change in direction)*	1 – unchanged	207		–	
		2 – deviated	–		–	
	III *(vehicle acceleration)*	1 – accelerate immediately	2		–	
		2 – wait to clear	4		–	
		3 – no change	201		–	
		VEHICLE TOTAL	**621**		**0**	
Pedestrian	I *(change in speed)*	1 – unchanged	83		68	
		2 – accelerate	95		95	
		3 – give way	16		1	
		4 – return	13		10	
	II *(change in direction)*	1 – unchanged	193		157	
		2 – deviated	1		7	
		3 – return	13		10	
		PEDESTRIAN TOTAL	**414**		**348**	

After the road safety intervention was implemented, post-intervention data collection counts of SC-P and ESS Interactions were once again recorded and grouped by criterion and grade. The goal is to see a decrease in either the total number of traffic conflicts and/or in the severity of the recorded conflicts.

Post-intervention Example: Method 4: Version 2: Institute of Highways and Transportation Conflicts Technique Pedestrian-Vehicle Conflict Technique data collection form (sample form)

			SC-P Interactions		ESS Interactions	
	Criteria	Grade	Pre-Intervention	Post-Intervention	Pre-Intervention	Post-Intervention
Vehicle	I *(change in speed)*	1 – full speed	200	188	–	–
		2 – slowed down	7	4	–	–
		3 – stop	–	–	–	–
	II *(change in direction)*	1 – unchanged	207	192	–	–
		2 – deviated	–	–	–	–
	III *(vehicle acceleration)*	1 – accelerate immediately	2	1	–	–
		2 – wait to clear	4	3	–	–
		3 – no change	201	188	–	–
		VEHICLE TOTAL	**621**	**576**	**0**	**0**
Pedestrian	I *(change in speed)*	1 – unchanged	83	81	68	65
		2 – accelerate	95	85	95	67
		3 – give way	16	17	1	2
		4 – return	13	9	10	2
	II *(change in direction)*	1 – unchanged	193	183	157	122
		2 – deviated	1	–	7	2
		3 – return	13	9	10	–
		PEDESTRIAN TOTAL	**414**	**384**	**348**	**260**

In this example, the SC-P Interactions were more frequent compared with the ESS Interactions. With one exception ("pedestrian give way" increased by n=1), the number of all interactions decreased from the pre-intervention to post-intervention data collection periods. Pre-intervention, a vast majority of the pedestrians in SC-P Interactions attempted to avoid traffic and crossed as quickly as possible (n=95). Similar results were seen in the ESS Interactions, when even though the vehicles are stopped or moving slowly, the tendency of the pedestrians was to accelerate (n=95). Post-intervention results are similar to pre-intervention results. However, one noteworthy difference was a decrease in the number of pedestrians accelerating during ESS Interactions (n=67). This could be attributed to a post-intervention road design element that might have given pedestrians more confidence to cross the street.

Appendix F

Method 5: Swedish Traffic Conflict Technique

This is the most complex method in the toolkit because it requires the most time devoted to data collector training. Additionally, the use of a video camera is highly recommended due to the complexity of this method. However, the main benefit of Method 5 compared with Methods 1-4 is that this method results in a graphical depiction of the conflict severity score, which allows the data collectors to objectively quantify the conflict's severity.

This method requires two measurements—speed and distance—to determine the severity of a pedestrian-vehicle conflict. To reiterate, a collision course is necessary for measuring a traffic conflict. Unlike many of the other methods presented in this toolkit, Method 5, the Swedish Traffic Conflict Technique, requires a distinction between the two road users. Road User 1 (RU1) is always considered the road user who first took the evasive action. Road User 2 (RU2) is the road user who risks being collided with if RU1 does not take evasive action to avoid the collision.

Measuring Speed

Regardless of the manner in which data are captured (in-field data collection or video recording), measuring pedestrian and vehicle speed is improved through practice. Assuming access to a radar speed detector is unavailable, data collectors can be trained at estimating speed by having a colleague drive a vehicle at different speeds while the data collectors are standing on the side of the road estimating the vehicle speeds and recording the approximations to compare with the actual speeds the driver recorded. This can be practiced until the estimations align with the actual speed being driven. Experts of the Swedish Traffic Conflict Technique believe that judging vehicle speed is relatively reliable with practice.

Per Method 5, the speed of the road user who first takes the evasive action (RU1) should be estimated; the speed of RU2 is not estimated. The speed of RU1 (either the vehicle or the pedestrian) is estimated just before they take evasive action (e.g., vehicle slams on brakes, pedestrian jumps to the side of the road). For example, imagine a pedestrian is crossing the street in a crosswalk as a vehicle is headed toward the pedestrian. The pedestrian jumps out of the way of the oncoming vehicle, onto the side of the road. Therefore, the pedestrian is the first road user to take evasive action, so the speed of the pedestrian should be estimated.

Measuring Distance

The key to measuring distance is also through practice. It might be helpful to measure the actual distance between different points on the road and points near a crosswalk so the data collector can use the predetermined measures as a reference.

Similar to estimating the speed, just the distance of RU1 is estimated. The distance is estimated from the exact location where RU1 first takes the evasive action to where the collision would have occurred if the evasive action had not been taken. Let's continue to use the example above with the pedestrian and vehicle. Since the pedestrian was the road user who first took evasive action (RU1), estimate the distance between the location where the pedestrian initially began to jump out of the road to where the collision with the vehicle would have occurred.

Time-to-Accident Indicator

After the data collectors have estimated the speed and distance, these measures are used to find the Time-to-Accident (TA) indicator.

- **Time-to-Accident (TA):** The time remaining for the road user to successfully perform an evasive action to avoid a collision.

The TA indicator is an integral value in determining the conflict severity and is determined using the previously estimated speed and distance measures. A detailed example about how to find the TA indicator is provided below.

Conflict Severity Curve

The last step in Method 5 is to find the severity of the conflict. The conflict severity is determined by plotting the previously identified TA indicator onto the conflict severity curve. Plotting the TA indicator will visually illustrate if the conflict is considered a serious or non-serious conflict. A detailed example about how to plot the TA indicator is provided below.

Data Collection

During the data collection period for Method 5, data collectors will complete the Swedish Traffic Conflict Technique data collection form for each conflict (an example form is shown in Figure 4). This form can be adapted to the needs of the local situation. The original Swedish Traffic Conflict Technique and corresponding data collection forms can be found here.

After data collection, the data collectors review the video footage, if available, to confirm that the recorded conflicts were in fact conflicts, and to make sure the speed and distance estimates are as accurate as possible. To note, the data collectors collect all the information (speed and distance) for RU1 (the first to take evasive action). If it is unclear who first took the evasive action, collect speed and distance estimations for both RU1 and RU2. For this method it is best to use a video camera to review the footage and confirm the behaviors of the road users. If a video camera is not being used, the data collectors can focus on collecting all the information for just one of the road users. In this case, it is up to the data collectors which road user to focus on.

Hypothetical Example – Method 5: Applying the Swedish Traffic Conflict Technique

During data collection, a video camera was used to record the various traffic conflicts in one particularly busy school zone. After reviewing the video footage, the data collectors decided to discuss one of the conflicts. A vehicle was on a collision course headed for a pedestrian crossing the street on her way to school, but the vehicle swerved out of the way to avoid hitting the pedestrian. In this example, the vehicle first took the evasive action by changing its trajectory to avoid hitting the pedestrian, therefore, the vehicle is considered RU1. The speed of RU1 (vehicle) was estimated to be approximately 15 km/h (9 mph). At the exact moment of evasive action, the distance is estimated from the location where RU1 first took the evasive action to where the collision with the pedestrian would have occurred if the vehicle did not swerve. The distance from the vehicle to where the collision would have occurred was approximately one car length (4.5 meters or 14.5 feet). The completed example data collection form is illustrated in Figure 4.

Figure 4

Completed example Swedish Traffic Conflict Technique data collection form

Swedish Traffic Conflict Technique Data Collection Form

Date: 15/08/2019 (DD/MM/YYYY) Weather: no rain
(*Weather options: no rain, light rain, heavy rain*)

School: Secondary 1

Location: Intersection (insert GPS coordinates if available)

Name of data collectors: Jane Doe

Start time: 08:00 End time: 09:00 Day of week: Wednesday

	Road User 1 (first to take evasive action)	Road User 2
Choose one: Car	☑	☐
Pedestrian	☐	☑
Bicycle	☐	☐
Other	☐	☐
Evasive action:	☐ Brake ☑ Swerve ☐ Accelerate ☐ Stop ☐ Other	*If applicable* ☐ Brake ☐ Swerve ☐ Accelerate ☐ Stop ☐ Other
Speed of Road User 1: (first to take evasive action	15 ☑ kmph ☐ mph	____ ☐ kmph ☐ mph
Distance of Road User 1 to the potential collision point:	4.5 ☑ meters ☐ feet	____ ☐ meters ☐ feet

It is optional to collect these estimations on RU2

Description of the event:
Vehicle swerved to avoid striking student pedestrian.

Time-to-Accident (TA) Indicator

After the data collectors return from the data collection site with the completed form (or after the video footage is reviewed), the data collectors can find the Time-to-Accident (TA) indicator. Find the estimated speed and distance measures in the Time-to-Accident table (Table 21). To use the table, find the distance on the left side of the table (ROW). Next, find the speed of the vehicle located at the top of the table (COLUMN). Finally, find where the specific ROW and COLUMN intersect. The value in that box is the TA indicator.

In the example above, the speed estimation was 15 km/h (9 mph) and the distance estimation was 4.5 meters (14.5 feet). Therefore, finding where these two measurements intersect reveals a TA indicator of 1.1 (between 4 meters and 5 meters), as shown in the highlighted boxes in Table 21.

Table 21

Example Swedish Traffic Conflict Technique Time-to-Accident (TA) table

Distance		Speed																
		5	8	10	12	15	18	20	25	30	35	40	45	50	55	65	70	km/h
m	*feet*	*3*	*5*	*6*	*7*	*9*	*11*	*12*	*16*	*19*	*22*	*25*	*28*	*31*	*34*	*40*	*43*	*mph*
1	*3*	0.7	0.5	0.4	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
2	*7*	1.4	0.9	0.7	0.6	0.5	0.4	0.4	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	
3	*10*	2.2	1.4	1.1	0.9	0.7	0.6	0.5	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2	
4	*13*	2.9	1.8	1.4	1.2	1.0	0.8	0.7	0.6	0.5	0.4	0.4	0.3	0.3	0.3	0.2	0.2	
5	*16*	3.6	2.3	1.8	1.5	1.2	1.0	0.9	0.7	0.6	0.5	0.5	0.4	0.4	0.3	0.3	0.3	
6	*20*	4.3	2.7	2.2	1.8	1.4	1.2	1.1	0.9	0.7	0.6	0.5	0.5	0.4	0.4	0.3	0.3	
7	*23*		3.2	2.5	2.1	1.7	1.4	1.3	1.0	0.8	0.7	0.6	0.6	0.5	0.5	0.4	0.4	
8	*26*		3.6	2.9	2.4	1.9	1.6	1.4	1.2	1.0	0.8	0.7	0.6	0.6	0.5	0.4	0.4	
9	*30*		4.1	3.2	2.7	2.2	1.8	1.6	1.3	1.1	0.9	0.8	0.7	0.6	0.6	0.5	0.5	
10	*33*			3.6	3.0	2.4	2.0	1.8	1.4	1.2	1.0	0.9	0.8	0.7	0.7	0.6	0.5	
11	*36*			4.0	3.3	2.6	2.2	2.0	1.6	1.3	1.1	1.0	0.9	0.8	0.7	0.6	0.6	
12	*39*				3.6	2.9	2.4	2.2	1.7	1.4	1.2	1.1	1.0	0.9	0.8	0.7	0.6	
13	*43*				3.9	3.1	2.6	2.3	1.9	1.6	1.3	1.2	1.0	0.9	0.9	0.7	0.7	
14	*46*				4.2	3.4	2.8	2.5	2.0	1.7	1.4	1.3	1.1	1.0	0.9	0.8	0.7	
15	*49*					3.6	3.0	2.7	2.2	1.8	1.5	1.4	1.2	1.1	1.0	0.8	0.8	
16	*52*					3.8	3.2	2.9	2.3	1.9	1.6	1.4	1.3	1.2	1.0	0.9	0.8	
17	*56*					4.1	3.4	3.1	2.4	2.0	1.7	1.5	1.4	1.2	1.1	0.9	0.9	
18	*59*						3.6	3.2	2.6	2.2	1.9	1.6	1.4	1.3	1.2	1.0	0.9	
19	*62*						3.8	3.4	2.7	2.3	2.0	1.7	1.5	1.4	1.2	1.1	1.0	
20	*66*						4.0	3.6	2.9	2.4	2.1	1.8	1.6	1.4	1.3	1.1	1.0	
21	*69*							3.8	3.0	2.5	2.2	1.9	1.7	1.5	1.4	1.2	1.1	
22	*72*							4.0	3.2	2.6	2.3	2.0	1.8	1.6	1.4	1.2	1.1	
23	*75*								3.3	2.8	2.4	2.1	1.8	1.7	1.5	1.3	1.2	
24	*79*								3.5	2.9	2.5	2.2	1.9	1.7	1.6	1.3	1.2	
25	*82*								3.6	3.0	2.6	2.3	2.0	1.8	1.6	1.4	1.3	
26	*85*								3.7	3.1	2.7	2.3	2.1	1.9	1.7	1.4	1.3	
27	*89*								3.9	3.2	2.8	2.4	2.2	1.9	1.8	1.5	1.4	
28	*92*								4.0	3.4	2.9	2.5	2.2	2.0	1.8	1.6	1.4	

Conflict Severity Curve

Lastly, the conflict severity is determined by plotting the TA indicator (located on the x-axis) and the speed of the vehicle (located on the y-axis) onto the conflict severity curve in Figure 5. This figure has been adapted from focusing on vehicle-vehicle conflicts to more accurately represent pedestrian-vehicle conflicts. With the traditional vehicle-vehicle Swedish Traffic Conflict Technique, the threshold for serious versus non-serious conflicts is 26; however, for pedestrian-vehicle traffic conflicts, the threshold separating serious and non-serious conflicts was modified to the 24 mark (solid red line in Figure 5). This is because speeds are usually lower for conflicts involving pedestrians and/or cyclists, thus lowering the threshold from 26 to 24 will ultimately allow more pedestrian-vehicle conflicts to be included into the final analysis (Svensson, 1998). Therefore, if the TA indicator and speed intersect at or above the curve marked 24, it is considered a serious pedestrian-vehicle conflict. If the severity mark falls between two lines, the value should be considered the lower of the values. For example, if the severity mark is between lines 26 and 27, the severity score is considered a 26.

After plotting the estimated speed (15 km/h) and TA indicator (1.1) from the example above, the severity mark appears to fall near the bottom left of the graph (indicated by the circle in Figure 5). Therefore, this conflict is considered to be serious in severity.

Once the severity of the traffic conflict has been identified for each conflict, the results are entered into a summary table (Table 22). The information in the summary table can be used to form conclusions about the current safety of the school zone and to generate possible ideas of how to improve the safety of students.

Figure 5

Example Swedish Traffic Conflict Technique severity curve (modified specifically for pedestrian-vehicle conflicts)

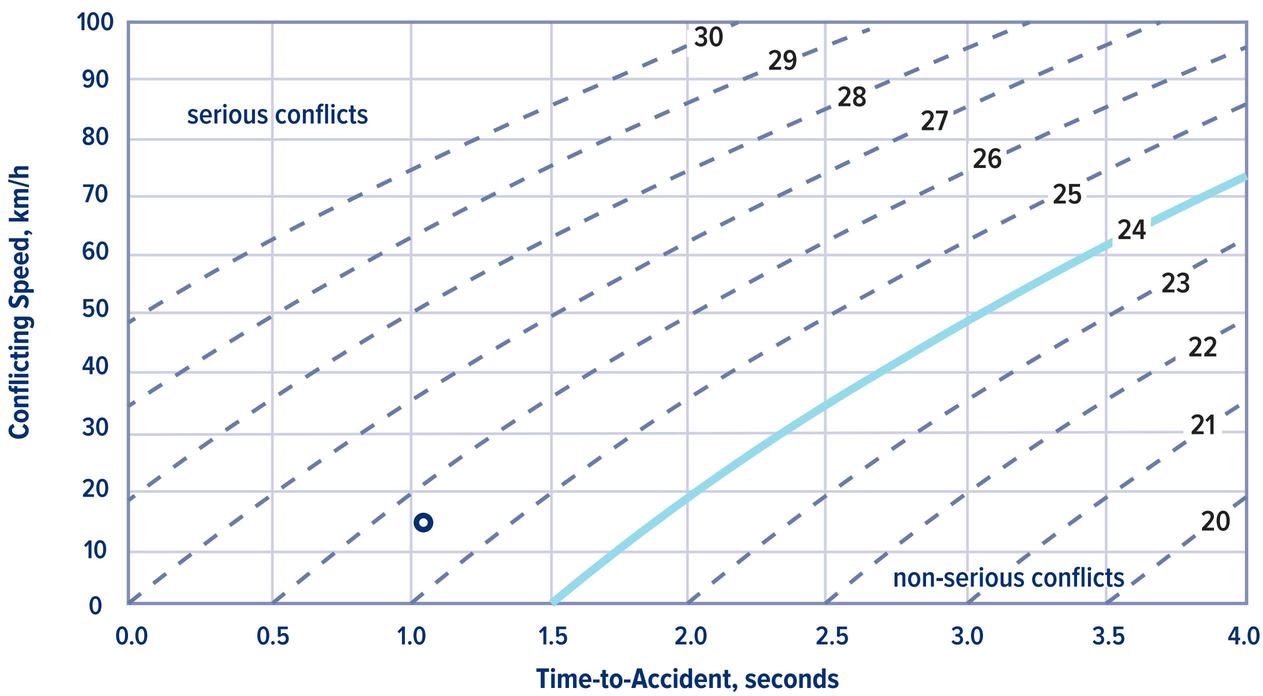


Table 22

Example Swedish Traffic Conflict Technique data collection summary table

Conflict	Date	Time	Conflict Type	Road User who took evasive action	Speed	Second Road User	Distance between two Road Users	Time-to-Accident (TA) Indicator	Severity
1	2019-02-21	07:09	Vehicle swerves	Vehicle	15 km/h	Pedestrian	4.5 meters	1.1	25
2									
3									
4									
5									

Photo taken during the Method 5 pilot test in Mexico City, Mexico, December 2018 *Credit: Douglas Roehler*

Case Study of the Swedish Traffic Conflict Technique, Mexico City, Mexico

In December 2018, the Swedish Traffic Conflict Technique was pilot tested in Mexico City at a primary school. The school had two primary entrances/exits. One entrance was located along a secondary street (one lane of traffic in each direction), while the other entrance was located along a busy four-lane road (two lanes of traffic in each direction, with a median). Two data collectors were located at each entrance/exit, on opposite sides of the road. Data collection occurred on an afternoon as students were leaving for the day. The entrance/exit along the secondary road was recorded with a video camera, along with a manual data collector. The data collection period lasted approximately 30 minutes, from the time when the school released students, to the time when most students had left the school zone.

The pilot team in Mexico identified these lessons learned:

Value of video recording
While many of the conflicts were captured by the manual data collector, several were missed and only identified after reviewing the video footage. Therefore, it is recommended to manually record all the possible conflicts during data collection and then review the video footage to confirm.

Observe a small area
Most of the students along the entrance/exit on the secondary road crossed the street within a 45 meter (150 foot) area. Therefore, it was important to keep a closer radius within the school zone to capture the area where the students were entering/exiting school.

More data collectors required for a large school zone
It was difficult for a data collector to capture conflicts occurring on both sides of the median along the four-lane road. Therefore, a data collector needs to be on both sides of the road when there are several lanes of traffic, and each should only be responsible for capturing conflicts that occur on their side of the road. Data collectors should be as close to the area where conflicts are likely to occur, without obstructing normal traffic flow.

Be aware of pedestrian crossing patterns
During the data collection period, the data collector noticed students were crossing at an area outside of the original observation area where they began collecting data. Therefore, the data collector shifted their observation area by about 1.5 meters (5 feet) during the data collection period for an unobstructed view of where most of the students were crossing. It is important for the data collectors to be aware of pedestrian crossing patterns and how these could potentially change during the data collection period. For example, as it gets closer to the time that school starts, students might begin to cross outside of the crosswalk to save time. In this case, the data collector should expand and broaden the observation area to capture all these possible instances.

Photo taken to illustrate incorporating a video camera into data collection during the Method 4 pilot test in Ho Chi Minh City, Vietnam, October 2019

Credit: Agnieszka Krasnolucka

Appendix G

Incorporating a video camera into data collection

Pilot testing of the TCT methods demonstrated the value of incorporating a video camera into data collection. Below are points to consider when deciding whether or not to use a video camera during data collection.

Benefits of using a video camera:

- Improves data quality through the confirmation of manually recorded conflicts
- Requires fewer data collectors
- Opportunity to review the video several times to more accurately confirm traffic conflicts
- Allows for continuous data collection throughout the data collection period

Potential issues with using a video camera:

- Might be difficult to acquire a camera due to the location of the study and available funds
- Battery power could limit data collection
- Could draw unwanted attention to the data collection team
- Viewing the video content likely requires a computer and/or a projector

Selecting the appropriate video camera:

- The video camera should be able to withstand the local weather elements and is, ideally, waterproof, could be placed in direct sunlight, and can withstand high or low temperatures
- Multiple battery packs might be needed to allow for continuous video recording
- More than one video camera memory card might also be needed
- Resolution: Video Graphics Array of 480 x 640 works well. This resolution setting enables conflicts to be easily identified, but the resolution is not high enough to see individual faces (which typically upholds research ethical standards).

Different ways of using the video camera:

The video camera can either be used as a stand-alone data collection tool or as an aid to manual data collection.

1) Stand-alone data collection tool
   - The video camera is placed at an elevated location overlooking the entire observation area. Testing this several times ensures the observation area is completely in view and is in focus.
   - The battery life is tested so the data collectors can plan to replace the battery during data collection without significant gaps in recording. A hard-wired power source is preferred but is not always possible.
   - The amount of memory storage is tested to ensure there are no gaps in recording.
   - Oftentimes, video camera settings can be adjusted to extend the life of the battery and memory card.

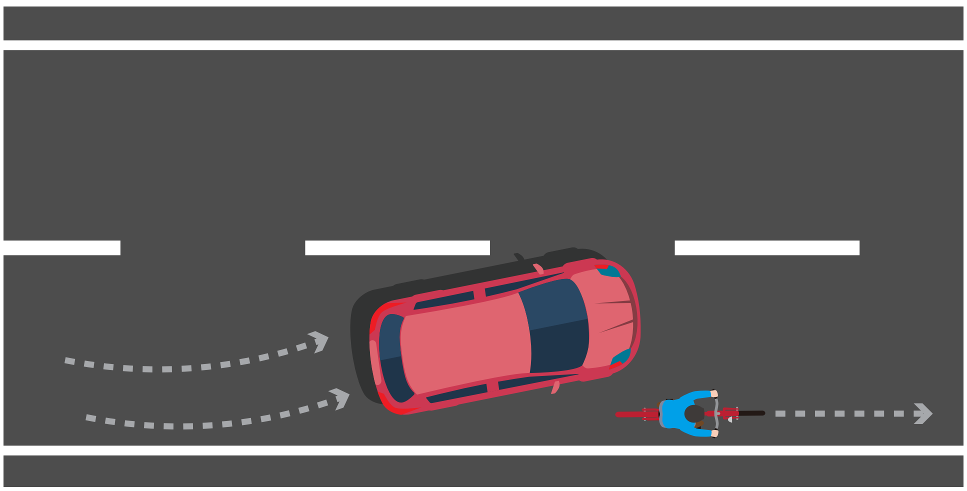
2) Aid to manual data collection
   - The video footage could also serve as a confirmatory source for traffic conflicts identified during manual data collection. During the pilot tests, video footage was critical in confirming manually recorded conflicts, therefore, if available, video recording is highly useful.
   - When the video camera is being used as an aid to manual data collection, the camera is mounted to overlook the observation area. The data collectors record the time of the potential conflict and after data collection a team member can replay the video to confirm whether a conflict occurred.
   - Using a video camera together with manual data collectors increases data quality and validity.

Appendix H

Examples of right-hand and left-hand traffic flow

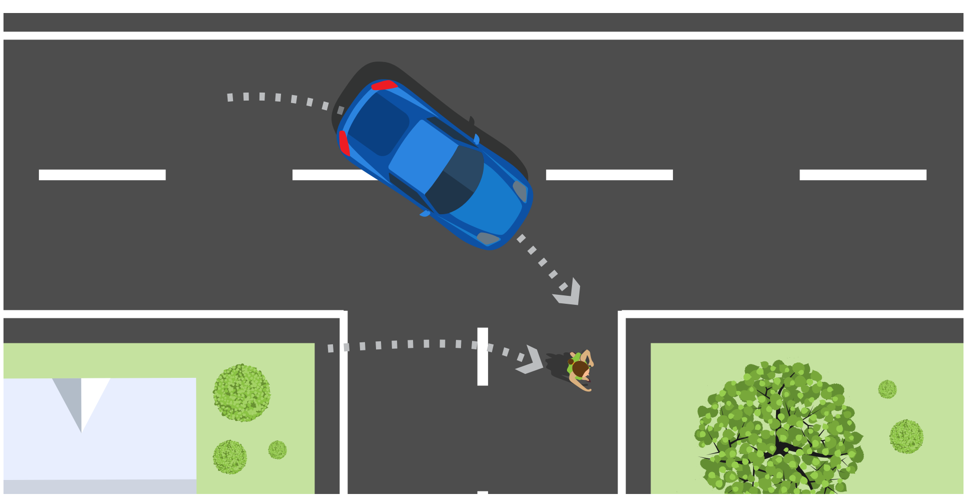
Example of right-hand traffic flow

1. A pedestrian/cyclist is walking/riding straight along the right side of the road (not on the sidewalk). The vehicle swerves to the left to avoid colliding with the pedestrian.



Example of left-hand traffic flow

2. A vehicle prepares to turn right across traffic, as a pedestrian is crossing the road. The pedestrian increases walking speed and swerves to the right to avoid colliding with the vehicle.



Appendix I

Sample data collector training schedule

Data collector training might span 2-5 days, depending on the type of method, available time, and resources. During the training, previously recorded video footage can help the data collectors identify traffic conflicts. After the training, traffic conflict data collection could begin immediately if the data collectors feel confident in identifying and recording traffic conflicts. However, before each distinct data collection period (i.e., pre-intervention and post-intervention) throughout the TCT procedure, a short data collector refresher training helps maintain quality. Table 23 outlines a sample training schedule which can be modified based on the local situation.

Table 23

Sample data collector training schedule

Day 1 (Morning)	Day 1 (Afternoon)
• Orientation to general local traffic activities, traffic conflict programs, and the importance of data collection.	• Orientation to local road safety laws, policies, and practices. Focus on: – School zones – Right-of-way laws – Laws and common violations on roadways where traffic conflicts might occur
Day 2 (Morning)	**Day 2 (Afternoon)**
• Review of same-direction/rear-end traffic conflict definitions and most common traffic conflict definitions. Knowledge of the most common traffic conflicts is required before pilot testing in the field. • Review pedestrian and vehicle scenarios and watch previously recorded video footage to discuss whether they are traffic conflicts or not.	• Complete an introduction pilot test of the information learned in the morning session to observe and practice manual recording in a simple, uncongested data collection area. • After the pilot test, time should be reserved for in-classroom debriefing.
Day 3 (Morning)	**Day 3 (Afternoon)**
• Review of cross-traffic conflict definitions and most common traffic conflicts. Knowledge of the most common traffic conflicts is required before pilot testing in the field. • Review pedestrian and vehicle scenarios and watch previously recorded video footage to discuss whether they are traffic conflicts or not.	• Complete a pilot test of the information learned so far to observe and practice manual recording in a more complex data collection area. • After the pilot test, time should be reserved for in-classroom debriefing.
Day 4 (Morning and Afternoon)	
• Small group practice in the field at different times of the day. Small groups of data collectors should independently observe a specified direction of traffic for a specified period of time. These individuals should not mention if/when they record a traffic conflict during this process. At the end of the data collection period, the individuals should compare findings. If the number of recorded traffic conflicts among the group align (i.e., each individual recorded the same five traffic conflicts), this indicates a high group reliability. If there are wide variations in the recorded traffic conflicts among the individuals, further training is necessary. • After the small group practice, time should be reserved for in-classroom debriefing. • In the field, data collectors should periodically conduct a similar reliability check at the start or end of each data collection period.	
Day 5 (Morning and Afternoon)	
• Summary and discussions of: information taught throughout the week and different traffic conflict definitions, as well as lessons learned from the pilot tests, debriefing sessions, and small group reliability practice.	

Appendix J

Sample detailed site data collection form

Form 1

Sample detailed site data collection form

1. Data Collector:	2. Date:
3. Location City: Street name: Name of nearest intersecting street:	
4. Weather conditions a) clear/cloudy b) rain c) snow/sleet d) fog/mist e) other:	5. Temperature: ☐ C ☐ F
6. Lighting conditions: a) daylight b) dawn/dusk c) other:	
7. Roadway conditions: a) dry b) snow/ice/mud c) wet d) other:	8. Posted speed limit: ☐ km/h ☐ mph
9. Type of school: a) primary b) secondary c) university/college d) other:	
[Please turn to the next page to complete the diagram]	

In the box below, draw a diagram of the study area and indicate the following items:

1. Number of lanes and width of roadway
2. Distance to nearest intersection(s)
3. Medians
4. Driveways or other access points
5. Locations of on-street parking zones
6. Sight obstructions
7. Indicate northerly direction
8. Established crosswalks
9. Predominate pedestrian crossing points
10. Locations and types of traffic control devices (signs, signals)
11. Other necessary details (e.g., sidewalk locations, hazards)
12. School entrances

Notes:

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