TECHBRIEF

HSIS

HIGHWAY SAFETY INFORMATION SYSTEM

This document is a technical summary of the Federal Highway Administration report PBCAT Version 3.0 User Guide (Thomas et al. 2021).

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PBCAT–PEDESTRIAN AND BICYCLE CRASH ANALYSIS TOOL VERSION 3.0

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OBJECTIVE

Pedestrians, bicyclists, and other nonmotorist road users account for a growing share of all U.S. traffic fatalities in recent decades (National Highway Traffic Safety Administration 2019). An even larger number of nonmotorists are seriously injured each year in collisions involving motor vehicles. Addressing these issues requires a national, collaborative, and comprehensive approach to nonmotorized road user safety.

The Federal Highway Administration (FHWA) supports a systemic safety approach and proven safety countermeasures to develop cost-effective projects and programs that address safety risk (FHWA 2021a; FHWA 2021b). Foundational to this approach is a better understanding of nonmotorized road user safety risks, which requires high-quality, objective data. Crash data are a primary data source for analyzing and understanding these crash risks. However, crash data are often not as complete or descriptive for crashes involving nonmotorists as for crashes that involve only motorists. The Pedestrian and Bicycle Crash Analysis Tool (PBCAT) Version 3.0 is the latest iteration of a tool that helps road safety professionals improve crash data about nonmotorist crashes to better understand and address nonmotorist road user safety risks (FHWA n.d.a).

WHAT IS PBCAT?

PBCAT assists agencies in categorizing or crash typing nonmotorist road user crashes and is now in its third version (PBCAT 3). PBCAT allows users to apply an analysis technique known as "crash typing" to derive consistent and objective data from crash report inputs and narratives (Harkey et al. 2006).

PBCAT version 1 (FHWA 1999) and PBCAT version 2 (FHWA 2006), which was released in 2006, served for many years as a national resource for pedestrian and bicyclist crash typing and data enhancement. However, previous versions of the software, which were desktop applications, are no longer compatible with a large proportion of current computer operating systems, and an update was needed. In addition to the functionality issue, there were other reasons to consider an overhaul of the crash-typing logic. A well-defined crash type variable has historically been missing in crash databases for crashes involving nonmotorists. PBCAT 3 is designed to meet the needs of new operating systems and provide a better crash-typing logic.

PBCAT 3 incorporates extensive stakeholder input on the needs and uses for the data. PBCAT 3 builds on previous versions by creating a more accessible, browser-based application available to all users via FHWA's Highway Safety Information System (HSIS) website (FHWA n.d.b). The crash typing workflow also builds on recent research that provides an enhanced understanding of common crash types (Schneider et al. 2016; Kumfer et al. 2019; Sanders et al. 2020; Shah et al. 2021). PBCAT 3 enables users to develop a database of details associated with crashes between motor vehicles and pedestrians, pedalcyclists, and other personal conveyances (such as electric scooters or personal mobility devices).

PBCAT 3's crash typing captures information on the precrash location and maneuver of each participant, as well as crash-level details that produce a final crash type code. These enhanced data allow analysts to compare common crash types in their jurisdiction to diagnose risk and develop countermeasures. This TechBrief provides a summary of the PBCAT 3 application and its suitability for nonmotorized user crash analysis.

NEED FOR CRASH TYPING

Crash types describe immediate precrash events or conflict types associated with crashes involving different road users. The information provided by crash typing can help safety professionals determine:

- Appropriate and effective road safety measures.
- Improvements to policies, community, and roadway design guidance.
- Other strategies, such as enhanced crash-prevention technologies.

Crash types are frequently missing or not well-defined in existing crash databases when bicyclists, pedestrians, and other nonmotorized road users are involved in collisions with motorists. These details may be documented in qualitative crash narratives and not readily captured in more consistent crash codes. Furthermore, the variables captured for crashes involving nonmotorized road users are more reflective of conditions relevant for motor vehicle-only collisions. Crash typing serves as a tool to assist State and local practitioners, researchers, and other stakeholders to develop supplemental data elements to improve the usefulness of crash data for crash and injury prevention.

BENEFITS OF CRASH TYPING WITH PBCAT 3

PBCAT 3 is a web-based application developed to help agencies generate unique crash types from a nonmotorized road user safety perspective. PBCAT 3 helps agencies generate objective descriptors of nonmotorist crash types, which in turn can be used to inform prevention strategies and solutions to improve nonmotorist safety and access. PBCAT 3 turns information derived from crash reports on the precrash maneuvers of the motorist and nonmotorist involved in a crash into variables that better describe the events and conflict types in a consistent manner. The PBCAT 3 application also helps users generate other variables about crash events and the location context from a nonmotorist safety lens. The variables developed using PBCAT 3 can complement existing crash data to help inform efforts to improve nonmotorist safety.

With the expanding use of diverse types of personal conveyances for travel and recreation, such as shared mobility and electric bikes, there is also a need to capture crash events involving more types of nonmotor vehicle road users for safety analysis. PBCAT 3 expanded to address different types of nonmotorists in addition to crashes involving cyclists and pedestrians—all in one streamlined and easy-to-use system. PBCAT 3 can be used to type crashes involving persons using power-enhanced pedalcycles and various types of personal conveyances and those involving more traditional pedestrians and pedalcyclists. PBCAT 3 also offers the ability to capture a single crash type for nonmotorist falls or crashes that do not involve a motor vehicle.

MAIN FEATURES OF PBCAT 3

PBCAT 3 is a browser-based, easy-to-use application for developing new variables useful for nonmotorized safety analysis. Users comparing prior versions with PBCAT 3 will notice major differences in platform, crash typing logic, and output data in the third version. PBCAT 3 has significant improvements in the functionality and features that make it easier to generate data. PBCAT includes the following features:

- Online open-access format: PBCAT 3 operates as an online, browser-based tool. It is available to anyone coding crash reports or specific variables related to a crash.
- Improved adaptability: PBCAT 3 complements States' crash data systems, and PBCAT 3's variable outputs can be linked with other datasets using the jurisdictions' unique crash identifiers.
- Updated road user options: PBCAT 3 allows users to choose from a wide array of nonmotorist road users, including pedestrians, bicyclists, and nonmotorists, using varied types of personal conveyances, with or without supplemental power.
- Simplified crash types: In PBCAT 3, crash type is derived from a combination of motorist and nonmotorist maneuvers. The crash type that results is distinct from other variables or location context of the crash, which improves the objectivity of crash types. Additionally, the logic framework results in only one crash type possibility per crash.
- Streamlined logic: The crash typing process has a set number of questions and category options, and users have the ability to skip certain questions. The same system is applied to all nonmotorist modes, which enhances the ability of analysts to identify common and distinct crash risk patterns across the nonmotorized modes.

- New illustrations: Graphic illustrations help users confirm location context variables and depict the resulting crash types based on selected motorist and nonmotorist maneuvers. The illustrations are available for users to download on the PBCAT 3 application support images web page (Thomas et al. 2021).

- User-friendly data output: Data are output in a user-friendly, comma-separated value (csv) format that enables importing into various data analysis and management platforms, linking multiple files, and compiling data from other sources.

One major difference in PBCAT 3 compared to earlier versions is that the new crash types are defined using a similar, consistent framework as those described in recent research and build on existing crash data practices. Crash types in the updated PBCAT are a starting point for analysis, using data for crash type and other variables that can be objectively and consistently determined from crash reports. FHWA's PBCAT Version 3.0 User Guide documents the compatibility and interoperability between the PBCAT 3 application and previous PBCAT software versions (Thomas et al. 2021).

One Module Allows Crash Typing for Most Nonmotorist Modes

A notable feature of the streamlined crash typing system is the ability to type crashes involving pedestrians, cyclists, and other nonmotorized modes within the same crash typing system.

The following transport types are covered by PBCAT 3:

- Bicyclists and other pedalcyclists and power-assisted pedalcycles (typically assistance is capped at speeds of 30 mph (SAE International 2019)).

- Pedestrians, wheelchair/mobility chair users, and persons moving under their own power using devices that are not pedalcycles (skates, kick-scooters, etc.).

- Persons using personal conveyance devices that are powered but designed for low-speed use (also typically capped at 28–30 mph) on trafficways and paved surfaces (SAE International 2019).

- The following road users involved in crashes with motorists are not readily covered by PBCAT 3 crash typing:

- Conveyances involving animals or riders of animals.

- People in railway cars, trams, or trolleys.

- Mopeds and motorized scooters or motorcycles.

Because personal transportation is evolving rapidly, practitioners need better information about the characteristics, operations, and safety of these new types of transport. While categorizing these types of road users is challenging, the definitions and inclusion of these modes in PBCAT 3 will contribute new data and insights to the discussion about crash data collection on these road user types.

Users Can Easily Merge Data with Other Crash Variables

Because PBCAT 3 is designed to provide new variables to link to existing data, once crash type and other data elements are coded, users can compile the downloaded PBCAT data with other data related to the crash. Variables such as injury severity, the demographic characteristics of those involved, the environment, contributing factors, and some roadway characteristics are already commonly available in crash databases. If spatial coordinates are linked to the source crash data, users also have the option of linking many other data types as well. The csv data format provides flexibility for importing and linking the data to other data types.

With the database compiled, analysts can identify prevalent crash types and associated factors that may be targeted with engineering countermeasures, changes in policies or design guidance, and other safety measures.

AUDIENCE AND USES FOR PBCAT 3 DATA

Crash type and the other PBCAT 3-coded variables can be used to enhance crash data to help:

- Detect emerging safety issues or changing trends about new types of road users.

- Identify crash conflict patterns to target with potential roadway improvements.

- Define crash scenarios and circumstances that may be useful for crash avoidance technologies research.

Given the range of data elements generated through PBCAT 3, the application is suitable for a diverse audience of State, local, Tribal, and national transportation safety practitioners and researchers. Some potential applications of PBCAT 3 data include the following:

- Identifying common and distinct crash types and related factors across nonmotorized modes. PBCAT 3 applies the same system for typing crashes for all types of nonmotorist users. This allows analysts to identify conflict patterns that are shared or different across these different types of road users, which could aid the prioritization of safety improvements. A study by Shah et al. (2021) used a pilot version of the PBCAT 3 crash-typing logic to type and compare crashes involving powered scooter users and bicyclists. The Shah study found both similarities and differences in the patterns observed in a relatively small sample of crashes. At the same time, the system provides flexibility to code additional factors that may be more prevalent among crashes involving some nonmotorist types (e.g., bicyclists, joggers, or powered scooters) than others (e.g., people walking).

- Using hotspot, systemic, and policy approaches to improve road safety. State and local road and transit safety planners, engineers, and their partners in land use planning can use PBCAT 3 data to better understand crash patterns, including risks and relationships of these patterns or crash types with other factors. The data can help users identify and diagnose safety problems in crash hotspots and risk-based, systemic treatment approaches and may help to influence policies and system-level changes that can influence common collision patterns (Thomas et al. 2018).

- Establishing vehicle and other technologies research. Given the PBCAT 3's focus on road user maneuvers and paths (with secondary variables available for location types and facility types), data related to real crash scenarios also have the potential to inform vehicle detection and crash avoidance technologies research.

- Comparing and validating conflict studies. Because of the relative infrequency of pedestrian, cyclist, and other nonmotorist crashes at any one location (although fatality rates can be high), it can be difficult to perform pedestrian and bicycle safety studies or evaluate the safety effects of specific treatments based on crash data alone. For these reasons, studies are increasingly using video-collected data to analyze near-crash conflicts to better understand safety risks and the potential safety effects of treatments. The new PBCAT 3 crash types may better correspond with types of conflicts identified in such studies and, therefore, may improve the ability to compare results of conflict studies with actual crash data.

- Engaging in the Safe System Approach. Nonmotorist crashes result from diverse types of road users and vehicles interacting within a complex transportation and land use system. In the Safe System Approach, efforts are applied at many leverage points in the transportation system. These efforts include providing safer road networks for all types of road users (appropriate to location contexts), and working toward safer vehicles, safer speeds, safer road users, and better post-crash care to prevent crashes and minimize serious injuries (FHWA 2021c). While crash types in PBCAT 3 capture only the most immediate events and conflict type that led to a crash, identification of these patterns may be useful to help identify and alter upstream policies and design practices. This could also improve safety in other components of the transportation system, such as safer speeds and improved infrastructure (Bailey and Woolley 2017).

- Obtaining data improvement. The results of crash typing studies using PBCAT 3 may help inform those involved in defining and developing procedures and forms for collecting crash data. PBCAT 3 provides detailed descriptions of each variable and maps those that relate to current national practice-suggested crash data elements such as the Model Minimum Uniform Crash Criteria (National Highway Traffic Safety Administration 2017).

CONSIDERATIONS FOR USING PBCAT

Although there are advantages in typing crashes using PBCAT 3, there are also additional considerations when applying crash typing, using the application, and analyzing the resulting data.

PBCAT 3 developers considered the diverse roles (and constraints) of those involved in the process of generating and using crash data. These roles include the complexity of accurately gathering data at a crash scene and the varied needs of analysts for accurate, objective, and timely data:

- Users are not required to re-enter data that are captured in other datasets. Instead, the intent is that PBCAT data should be linked to other crash variables (if these are needed for safety analysis purposes).

- PBCAT 3 crash-typing logic offers the ability to easily code specific elements related to nonmotorist crashes and provides flexibility on many of the elements that may be coded.

- Data elements are clearly named, and text descriptors are used for variable values in the csv data output. As a result, these data elements are more easily interpreted by end-users of the data.

Data elements in PBCAT 3 are not exhaustive, however. They are dependent on the quality of crash reports. There are many factors that contribute to a crash event, and many of these factors are not typically well reported in crash data. For example, crash data are unlikely to document important nearby attractors, distance to the nearest controlled crossing, or traffic conditions at the time of the crash. In some instances, linking other datasets such as indepth crash reviews, roadway inventory, land use, and census data with PBCAT 3 data may help to provide more insight. Collecting information and experiences directly from nonmotorists and motorists may also add important insights that cannot be gleaned using existing data. Users should therefore consider the following limitations when using PBCAT 3 data:

- Are intended to supplement existing crash and other data (not recreate variables that already exist).
- Cannot compensate for insufficiently described crashes (including lack of detail in narratives and diagrams) or data that crash reports are not structured to collect (traffic conditions, distance to nearest controlled crossing, signal phasing, lighting adequacy, built environment and population characteristics, and attractors).
- Describe only the most immediate events leading up to a collision as reported in traffic crash reports.

Crash types must be complemented with other sources of knowledge—including from users of the system—to improve safety managers' and other safety stakeholders' understanding of what may be needed to reduce nonmotorist crashes and injuries.

ACCESSING PBCAT

FHWA hosts PBCAT through the HSIS at the Turner-Fairbank Highway Research Center. PBCAT can be accessed directly at https://pbcat3.org/ or the at the HSIS laboratory website at https://www.hsisinfo.org/index.cfm.

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