Report No. UT-26.10

PEDAT: A PEDESTRIAN DATA PLATFORM

Prepared For:

Utah Department of Transportation
Research & Innovation Division

Final Report
June 2026

RESEARCH

UDOT Keeping Utah Moving

Utah Department of Transportation - Research Division
4501 South 2700 West - P.O. Box 148410 - SLC,UT 84114-8410

DISCLAIMER

ACKNOWLEDGMENTS

The authors acknowledge:

- The Utah Department of Transportation (UDOT) for funding this research.
- The Technical Advisory Committee for helping to guide the research, including the following individuals from UDOT: Christian Baker, Glenn Blackwelder, Mike Brooks, Jared Bowling, Travis Evans, Heidi Goedhart, Paul Jencks, W. Scott Jones, Neda Kiani, Brad Loveless, Matt Luker, Jamie Mackey, Kevin Nichol, Angelo Papastamos, Nathan Peterson, Adam Radel, Jesse Sweeten, Mark Taylor, Corey Unger, Keaton Walker, Rudy Zamora.
- Staff at Avenue Consultants who helped translate a research product into an implemented tool: Emma Abel, Nuzhat Azra, David Bassett, Daniel Kimball, Shawn Larson, Derek Lowe, Jackson Porter.
- The dozens of people from UDOT and other agencies and organizations who participated in stakeholder meetings, and whose reviews and suggestions significantly improved the pedestrian data platform.

TECHNICAL REPORT ABSTRACT

1. Report No. UT-26.10	2. Government Accession No. N/A	3. Recipient's Catalog No. N/A
4. Title and Subtitle PEDAT: A Pedestrian Data Platform		5. Report Date June 2026 6. Performing Organization Code
7. Author(s) Patrick A. Singleton, Amir Rafe		8. Performing Organization Report No.
9. Performing Organization Name and Address Utah State University Department of Civil and Environmental Engineering 4110 Old Main Hill Logan, UT 84322-4110		10. Work Unit No. 5H089 22H 11. Contract or Grant No. 22-8892
12. Sponsoring Agency Name and Address Utah Department of Transportation 4501 South 2700 West P.O. Box 148410 Salt Lake City, UT 84114-8410		13. Type of Report & Period Covered Final Mar 2022 to Jun 2026 14. Sponsoring Agency Code AM22.05

15. Supplementary Notes

Prepared in cooperation with the Utah Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration

16. Abstract

The objective of this work was to develop a robust pedestrian data (PEDAT) platform—built upon high-resolution traffic signal data and research relating push-button data to pedestrian volumes—that can be used to monitor pedestrian activity and provide pedestrian data for a variety of tasks in planning, design, operations, and management. Following a series of three stakeholder meetings and an iterative design process, the research team started with an existing prototype and created an entirely new and more functional PEDAT Version 1. The online dashboard allows users to select multiple signal locations, filtered by date, and view figures, maps, and tables that summarize and visualize the estimated pedestrian volumes in various ways. The data, charts, and a PDF report can be downloaded. One limitation is that the data for PEDAT Version 1 had to be manually processed by the research team. Therefore, to implement this research, the Utah Department of Transportation (UDOT) and its contractors integrated PEDAT into their Automated Traffic Signal Performance Measures (ATSPM) system, relying on automatically aggregated and archived signal data housed in a cloud computing database. The latest version of PEDAT is the "Pedestrian Activity" feature in UDOT's ATSPM Version 5.2, and it has been operating online with data since January 2026. As a result of this project, anyone can extract estimated pedestrian volumes at nearly 2,000 signals throughout Utah, thus aiding important efforts in pedestrian transportation planning, design, and operations.

17. Key Words Pedestrians, Walking, Traffic surveillance, Traffic signals, Pedestrian detection, Visualization, Data science		18. Distribution Statement Not restricted. Available through: UDOT Research Division 4501 South 2700 West P.O. Box 148410 Salt Lake City, UT 84114-8410 www.udot.utah.gov/go/research		23. Registrant's Seal N/A
19. Security Classification (of this report) Unclassified	20. Security Classification (of this page) Unclassified	21. No. of Pages 62	22. Price N/A	

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UNIT CONVERSION FACTORS

SI* (MODERN METRIC) CONVERSION FACTORS				
APPROXIMATE CONVERSIONS TO SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa
APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. (Adapted from FHWA report template, Revised March 2003)

LIST OF ACRONYMS

ATSPM	Automated Traffic Signal Performance Measures
CSV	Comma-Separated Values (file type)
FHWA	Federal Highway Administration
ID	Identification
JSON	JavaScript Object Notation (file type)
LiDAR	Light Detection and Ranging
PDF	Portable Document Format (file type)
PEDAT	Pedestrian Data
PNG	Portable Network Graphics (file type)
RDS	R Data Serialization (file type)
STL	Singleton Transportation Lab
SQL	Structured Query Language
TAC	Technical Advisory Committee
QA/QC	Quality Assurance/Quality Control
UDOT	Utah Department of Transportation
USU	Utah State University

EXECUTIVE SUMMARY

This research documents the development and implementation of a pedestrian data (PEDAT) platform. PEDAT is built upon high-resolution traffic signal data from push-buttons, and it estimates pedestrian crossing volumes at intersections using findings from previous research. The tool and its dashboard provide valuable data on pedestrian activity that can be used for important transportation tasks including pedestrian planning, design, operations, and management.

The research team started with a prototype online dashboard that had been created during a previous Utah Department of Transportation (UDOT) research project. That research developed equations that estimated pedestrian volumes from signal-based push-button data with good accuracy. In this project, following a series of three stakeholder meetings and an iterative design process, the research team created and worked with UDOT to deploy PEDAT Version 1. The online dashboard allows users to select one or more locations, filter for a specific date range, and look at hourly or daily data. The interface then presents a series of figures, maps, and tables showing average pedestrian volumes (by hour of day, day of week, and month of year), an interactive time-series plot showing volumes over time, an interactive map comparing volumes across locations, and downloadable figures and data tables. Finally, the dashboard allows the generation of a PDF report to save the results.

On the back end, the PEDAT pedestrian data dashboard relies upon a pre-processed database containing estimated pedestrian volumes for each hour and each pedestrian phase at most signalized intersections in Utah. This database was constructed by first processing and aggregating raw traffic-signal controller log data, and then applying pedestrian volume estimation models. A big limitation is that this processing was accomplished manually by the research team, hindering the long-term maintenance and sustainability of the tool.

To implement the research and overcome this limitation, the research team provided technical support to UDOT and other contractors, who integrated the PEDAT dashboard into Version 5.2 of UDOT's Automated Traffic Signal Performance Measures (ATSPM) system. The most critical enhancement was to create new workflows that utilized existing automated ATSPM

data aggregation processes to generate the push-button and other pedestrian-related signal data inputs needed for the pedestrian volume estimation models. Additionally, almost all of the functionality of PEDAT Version 1 was ported over to a new user interface within ATSPM that allows users to select locations, dates, and time aggregations, and to visualize the results in averages, figures, plots, maps, tables, and a report. The interface pulls from UDOT's cloud database of ATSPM aggregation data (updated frequently) and automatically queries and processes the outputs. This new PEDAT version is operating on UDOT's ATSPM website as a "Pedestrian Activity" report, with data from January 1, 2026, allowing users to get pedestrian data on demand from nearly 2,000 locations throughout Utah. This meets the original goals of the project, to enhance the monitoring of pedestrian activity for multiple uses.

The report concludes with additional recommendations. These include: improving the data cleaning and quality assurance processes (to flag missing and potentially erroneous data); enhancing the PEDAT back end (improving signal configuration information about pedestrians, to provide more details about specific crossings and anticipate flexibility for estimating directional pedestrian volumes) and front end (to integrate with other pedestrian and related datasets); and conducting future research (to verify the volume estimation methods, and prepare for LiDAR and other passive methods of pedestrian detection).

1.0 INTRODUCTION

1.1 Problem Statement

1.1.1 Purpose and Need

Detailed knowledge about pedestrian behavior and the sensitivity of walking to temporal conditions and locational characteristics is limited by a lack of pedestrian volume data. Existing manual and automated pedestrian counting methods are insufficient for capturing continuous data on walking both over time and across many locations.

One promising emerging big data source on walking is from high-resolution traffic signal controller logs. Using data management systems like the Automated Traffic Signal Performance Measures (ATSPM) system, transportation agencies can archive every time a person presses a pedestrian push-button to request to cross the street at a signalized intersection. Through a large-scale effort involving counts of pedestrian crossing events from over 10,000 hours of video at 90 signalized intersections in Utah, research has demonstrated that pedestrian signal data can accurately estimate pedestrian crossing volumes, with correlations around 0.85 (Singleton & Runa, 2021; Singleton, Runa, & Humagain, 2020). In other research, these volumes have been used to develop direct-demand models that predict pedestrian volumes using built environment and land use characteristics (Singleton, Park, & Lee, 2021).

Before this project, the major barrier to utilizing pedestrian signal data for research, analysis, and practice was the difficulty accessing such data from the ATSPM system and translating that data into quantified (and visualized) information on levels of walking—such as pedestrian volumes for days, times, and locations, or average pedestrian volumes over various time periods—that is relevant for different specific tasks. Having access to richer pedestrian data paves the way for increased behavioral understanding and improved practice in the areas of travel monitoring (Humagain & Singleton, 2021), traffic operations, travel behavior, traffic safety analysis (Singleton, Mekker, & Islam, 2021), pedestrian planning, and sustainable and smart cities.

1.1.2 Vision

The project envisioned a robust, online platform for pedestrian data (PEDAT) analytics—the initial vision is shown in Figure 1.1—that processes pedestrian signal data from traffic signal controller logs (or other sources), applies volume estimation models, and makes the results available to researchers and practitioners for various uses. The PEDAT system has three primary components: the user interfaces, the scripts and pedestrian databases, and the existing infrastructure.

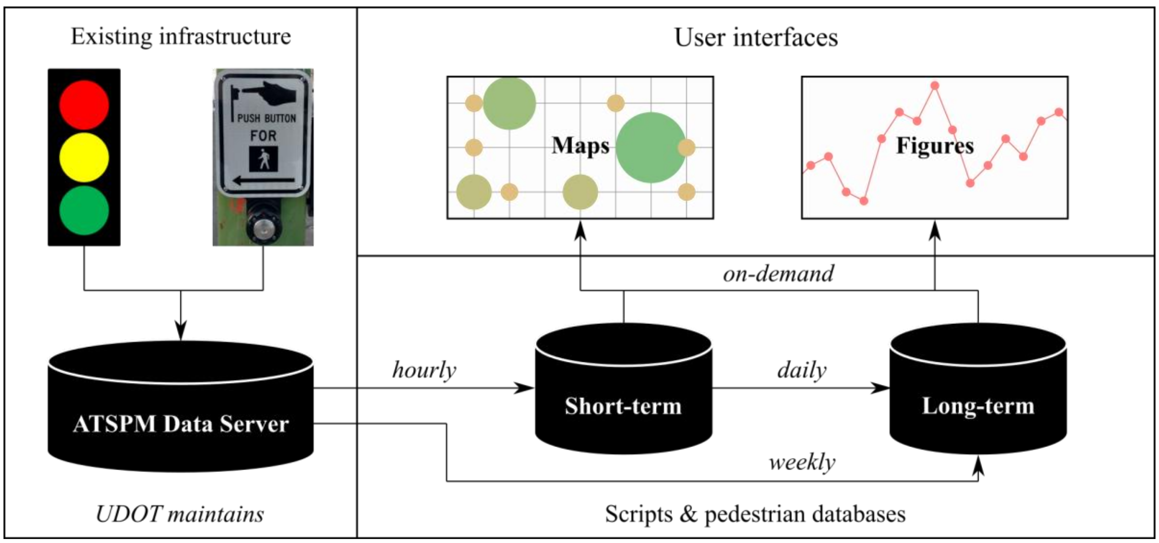


Figure 1.1: Initial Vision for the PEDAT Pedestrian Data Platform

The underlying infrastructure to support the PEDAT system already exists and is managed by UDOT. Traffic signal controllers in the field record events in traffic signal controller logs, which are transmitted to UDOT's Traffic Operations Center, where the data are archived in the ATSPM data server.

The online, interactive user interfaces are designed to visualize pedestrian data in different formats, including maps (for cross-sectional data), figures (for time-series data), and tables; users can also download data and reports. Users can specify whether data are expressed in totals, averages, or ratios; different time intervals and time units; and select locations. The initial vision for PEDAT was to have multiple user interfaces, each for a different application or flavor of PEDAT, potentially including:

- PEDAT Live: Near real-time fine-grained data, up to 48 hours in the past. For pedestrian monitoring, event management, incident response.
- PEDAT History: Like Live, but longer-term fine-grained data (days to years). For crash reconstruction, post-hoc evaluation of system performance.
- PEDAT Planning: Historical data but averaged and aggregated over time periods. For pedestrian planning, safety, health analyses, infrastructure prioritization.
- PEDAT Local: Extends Planning to non-signalized intersections and non-intersection planning geographies (e.g., block groups, transportation analysis zones), utilizing spatial interpolation and associations with land use / built environment characteristics.
- PEDAT Forecast: Extends Planning/Local to allow user-specified future changes to land use / built environment. For long-range land use / transport planning.

In the end, the PEDAT pedestrian data platform developed through this project realized PEDAT Live, PEDAT History, and most of PEDAT Planning within a single interface, for simplicity and ease of application. As detailed later, PEDAT Local is recommended as future work, while there was not sufficient demonstrated need for the functionality of PEDAT Forecast at this time.

This project documents the user-informed development of the data visualization interfaces along with their underlying processes, including supporting databases and data processing scripts. Such processes can periodically query and process data from the ATSPM data server to the databases, as well as support rapid queries that return data to the user interfaces.

While traffic signal data may be one of the best sources of pedestrian data currently, that may change in the long run (20-30 years in the future), as new data sources come online (e.g., location-based services), pedestrian traffic operations methods adapt (e.g., passive detection), and technologies advance (e.g., LiDAR). Nevertheless, the PEDAT interfaces and many of the underlying procedures are robust to changes in the source data, so this effort will likely exhibit a good degree of longevity.

1.1.3 Principles

The pedestrian data need is so great that any information about walking activity, even if imperfect, is better than nothing. Therefore, this work employed a “build now, refine later” principle: Make the data available quickly, then spend time making it look and work better, making it more accurate, etc. This report documents several iterations of PEDAT.

Usability was another key guiding principle. These pedestrian data are useful for many different tasks, with multiple end users. Therefore, the interfaces and language used were designed to be clear and simple.

1.1.4 Management

Multiple groups beyond the research team were engaged to help manage this work. In addition to the Technical Advisory Committee (TAC) that provided oversight and feedback on project tasks and deliverables, more frequent meetings with the Project Champion ensured that key decisions were made strategically. Stakeholders from UDOT and other agencies and organizations were engaged at several points to ensure that the PEDAT platform would support user needs and key applications. UDOT partners from Avenue Consultants translated a working prototype of PEDAT into the ATSPM system, as described later.

1.2 Objective

The overall objective of this work was to develop a robust pedestrian data platform for UDOT—built upon traffic signal data, other pedestrian data, and related research—that can be used for a variety of tasks in planning, design, operations, and management.

1.3 Scope

This objective was accomplished through a series of interrelated tasks:

1. Develop pedestrian data platform
    a. Start with an existing pedestrian activity dashboard developed to monitor pedestrians during the COVID-19 pandemic (daily data, 2019 and 2020).
    b. Retrieve and process older and newer pedestrian traffic signal data.
    c. Create a prototype PEDAT pedestrian data platform to meet initial stakeholder needs. This includes user interfaces and back-end processes.

d. Refine the PEDAT pedestrian data platform based on stakeholder feedback. This includes developing a user guide.
e. Deploy the PEDAT pedestrian data platform online, hosted by UDOT.

2. Engage stakeholders
    a. Hold two focus groups with stakeholders and end users about pedestrian data needs and potential uses of pedestrian data.
    b. Hold one focus group with stakeholders and end users to demo the PEDAT pedestrian data platform and solicit feedback through user testing.
    c. Document findings from the stakeholder meetings.
3. Plan for ongoing maintenance and enhancement
    a. Meet with UDOT staff and consultants periodically to discuss integration with ATSPM data aggregations and other data management processes.
    b. Review ATSPM data aggregations to ensure compatibility with pedestrian volume estimation research.
    c. Recommend how to implement the PEDAT pedestrian data platform to pull directly from ATSPM data and automate.
    d. Recommend future enhancements to the PEDAT pedestrian data platform, with considerations such as improving quality control procedures, future-proofing the underlying database, making volume estimation methods more accurate, and providing ongoing support.

1.4 Outline of Report

This report summarizes the research process and the PEDAT pedestrian data platform. It contains the following:

- Chapter 1.0 introduces the research project's purpose and need, vision, principles, management, objective, and scope.
- Chapter 2.0 describes the development of the PEDAT data platform, from an existing prototype (PEDAT Version 0.5) through an initial user-informed development (PEDAT Version 0.9) to a user-enhanced final product (PEDAT Version 1.0).
- Chapter 3.0 presents PEDAT Version 1, including a description of the back end (data

processing) and a walk-through of the front end (user interfaces and visualization dashboard).

- Chapter 4.0 summarizes the implementation of the PEDAT pedestrian data platform into ATSPM (Version 5.2) as the Utah State University Pedestrian Activity report.
- Chapter 5.0 presents recommendations for future PEDAT enhancements, including improving data quality, enhancing volume estimation, and ensuring future functionality.
- Appendix A contains the PEDAT Version 1 User Guide.
- Appendix B contains reports from the stakeholder meetings.

2.0 PEDAT DEVELOPMENT PROCESS

2.1 Overview

This chapter describes the process of developing the PEDAT pedestrian data platform. Three PEDAT versions were updated or created as part of this research project, utilizing insights gained from three stakeholder focus group meetings. A prototype, PEDAT Version 0.5, was developed as part of earlier research; its data were updated through this work. Two initial stakeholder meetings were held with UDOT and other staff to gain an understanding of practitioner needs and wants regarding a pedestrian data platform. Following these two stakeholder meetings, the research team developed PEDAT Version 0.9 to be simple while containing most desired functionality. This version was shared and user-tested prior to a third stakeholder meeting, which solicited feedback and suggestions for improvement. Many of these comments were taken into consideration with the final enhancement process, yielding the key product of this research: PEDAT Version 1.0.

2.2 Prototype: PEDAT Version 0.5

A prototype pedestrian activity dashboard—Utah Pedestrian Activity (PEDAT Version 0.5)—was created by Patrick Singleton and the Singleton Transportation Lab at Utah State University (USU) in 2020. Originally developed to help monitor pedestrian activity and changes in walking during the COVID-19 pandemic, the dashboard evolved into a tool for monitoring pedestrian activity in Utah over time. This prototype had three basic functionalities.

First, the "Information" page served as a home page, providing information about the dashboard and how to use and interpret it. Additionally, there was information about changes in pedestrian activity in a recent week versus one year ago, as a way to track changes in pedestrian activity as disruptions related to the COVID-19 pandemic subsided. Figure 2.1 shows the layout of the "Information" page.

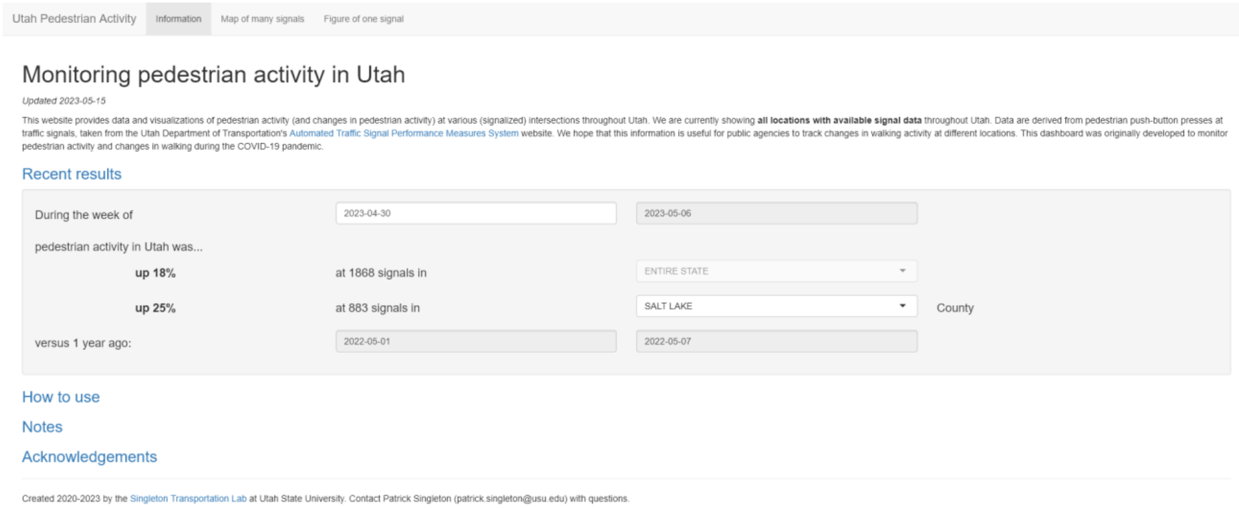


Figure 2.1: PEDAT Version 0.5: Information Page

Second, the "Map of many signals" page served as a useful dashboard for tracking patterns in pedestrian activity across locations and over time. As shown in Figure 2.2, the map showed daily estimated pedestrian volumes for all signals on a selected date, with circles sized by volume. The colors could be sized by volume as well (for no comparison), or the tool could select colors by comparing volumes versus one year ago (or other dates). The map was movable and zoomable, with a few pre-selected zoom-to locations. A date slider also allowed for easy date selection, or the option to press "play" and watch the map change over time.

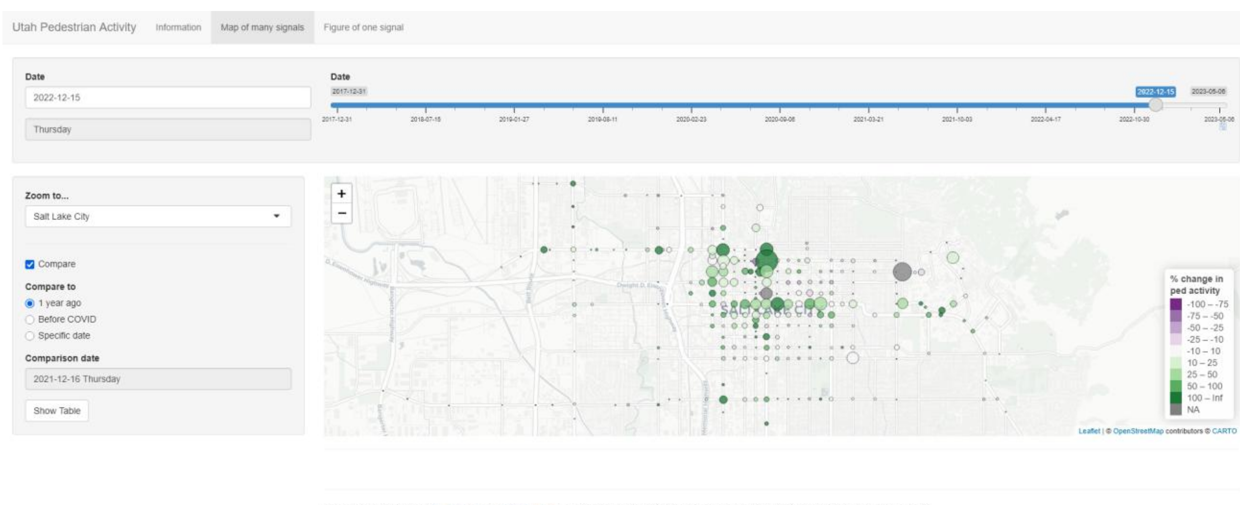


Figure 2.2: PEDAT Version 0.5: Map of Many Signals Page

Third, the “Figure of one signal” page showed pedestrian activity over time for one selected location. As shown in Figure 2.3, this portion of the dashboard allowed users to select a signal, provide a date range, and create both a figure and a data table showing the time series of daily estimated pedestrian volumes at that intersection. Options allowed for trends from one and two years ago to be plotted in the same figure, to see year-to-year changes.

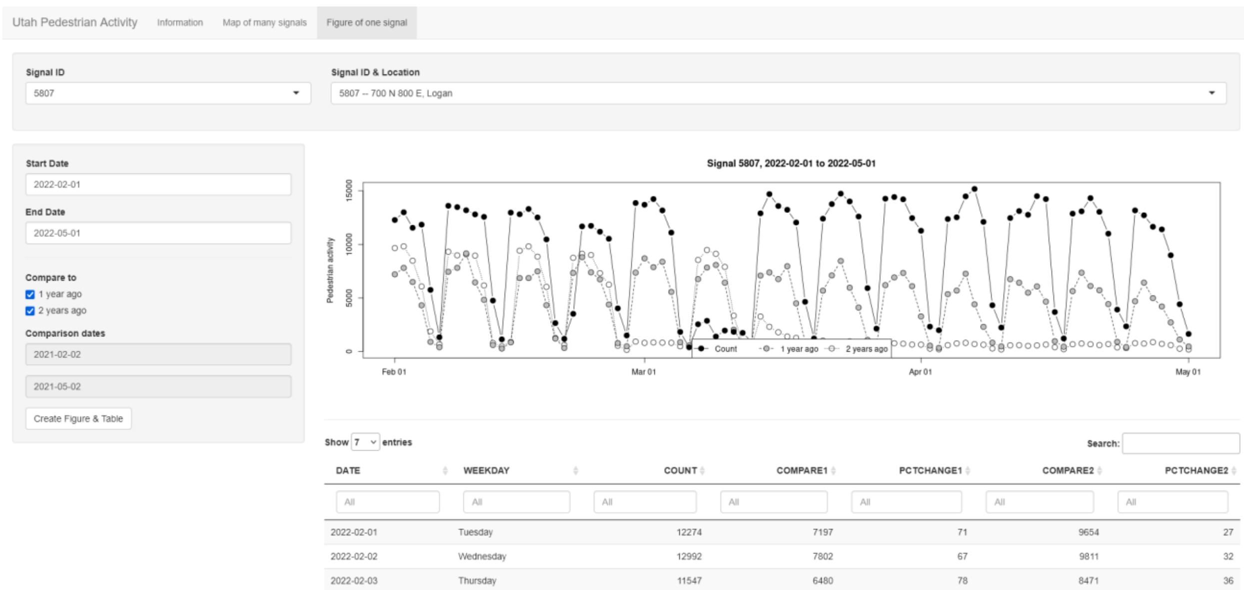


Figure 2.3: PEDAT Version 0.5: Figure of One Signal Page

The data underlying the prototype Utah pedestrian activity dashboard were downloaded from raw traffic signal controller logs accessed through UDOT’s ATSPM system. The data were then processed on USU computers using custom scripts. The dashboard’s interface was last updated in July 2021, and the underlying data were last updated in May 2023 for data through April 2023. The dashboard was designed in R and hosted as an online Shiny app (STL, 2023). There are no plans to provide further support for or to update this version.

2.3 Stakeholder Meetings 1 & 2

Before designing a new and improved PEDAT pedestrian data platform, it was important to understand the needs and wants of potential users. Therefore, the research team held two online stakeholder meetings with potential users, to discuss use cases, preferences, and desired features.

- **Stakeholder meeting 1** was held on November 23, 2022, and was attended by 17 UDOT employees from various divisions.
- **Stakeholder meeting 2** was held on February 15, 2023, and was attended by 11 external-to-UDOT stakeholders from the public and private sectors, as well as four UDOT employees.

Both stakeholder meetings started with a short background presentation, describing the motivation for the project, as well as previous work done to estimate pedestrian volumes from traffic signal push-button data and to develop the prototype dashboard (PEDAT Version 0.5).

The majority of each meeting was spent soliciting feedback from attendees about what users would want to see from a pedestrian data platform. Given the relatively large number of attendees, this was facilitated through a series of online polls, followed by open discussion about each poll. Questions were asked about the following topics.

- **Uses for pedestrian data**: most important piece of information, activities where data would be useful, use cases, needs.
- **Spatial and temporal dimensions**: different spatial scales, different temporal scales or aggregations, totals versus averages, uses for each scale, historical data, future predictions.
- **Features of a platform**: downloads, reports, other datasets, features, frequency of use.

In terms of *uses for pedestrian data*, stakeholders consistently prioritized planning, followed by safety, and then design and operations. Examples of *planning* activities and use cases included monitoring pedestrian traffic, understanding pedestrian demand, prioritizing and selecting projects, calibrating demand models, supporting first-mile/last-mile access to transit, supporting safe routes to schools, providing context for pedestrian audits, and making the case for walkable economic development opportunities. For *safety*, most respondents discussed the need for pedestrian volumes as a measure of exposure, for various safety applications including calculating crash rates, identifying high-risk hot spots, and performing systemic safety analyses. Discussions around *design* centered on how pedestrian volumes could inform the placement, sizing, and design of pedestrian ramps, curb extensions, sidewalks, etc. Applications in *operations* included traffic signal timing and phasing changes.

In terms of *spatial and temporal dimensions*, participants generally wanted access to pedestrian data at more fine-grained spatial units, such as crossings, intersections, segments, and corridors. Hourly data was of greatest interest, with some also wanting to see data aggregated to days or disaggregated to 15-minute periods. Recent, up-to-date data was very important to nearly all attendees. UDOT attendees preferred future predictions to historical data, while external stakeholders thought both were somewhat to very important. Different uses required pedestrian data to be organized for different spatial and temporal units.

In terms of *features of a platform*, stakeholders needed the ability to download raw data (e.g., CSV) for use in customized analyses or for joining with other data sources. A downloadable summary report (e.g., PDF) was also very or somewhat useful, while a separate mobile app did not seem important to most. When asked how often a pedestrian data platform might be used, UDOT employees tended to report weekly use, while external stakeholders tended to report monthly use.

The notes and findings from the stakeholder meetings were compiled (see Appendix B) and shared with the project TAC. This feedback was essential for the research team, helping to inform the design of the PEDAT dashboard and the prioritization of features to include.

2.4 Initial Development: PEDAT Version 0.9

Following the two stakeholder meetings, the research team focused its efforts on creating an online dashboard developing both the front-end user interface and the back-end data process. After exploring a variety of platforms for the web app's development, its deployment, and its hosting online, the research team settled on the following: (1) coding the app in Python; (2) deploying it on Streamlit, an open-source data app development tool; (3) hosting it on Streamlit's cloud platform; and (4) sharing open source code on GitHub.

The data schema was simple by design. Based on the way data were formatted in PEDAT Version 0.5, pedestrian data estimates were processed offline by the research team from raw traffic signal controller log data using separate data processing scripts. The underlying database contained few columns (signal ID, phase number, timestamp, and estimated pedestrian volume) and many rows, one for each signal ID, phase number, and hour. To this was added location information for each signal, including spatial coordinates for mapping and location text (intersection, city, etc.) for searching and reporting results. For testing, the research team worked with a small dataset (few locations over a shorter time period). Once the app was ready for user testing, the full dataset was swapped in (hosted in Google Cloud BigQuery).

The user interface and its functionality underwent several iterations. The development process started by trying to replicate PEDAT Version 0.5 in the new Streamlit platform. Then, new functionality was added based on feedback and prioritized needs from the first two stakeholder meetings. Additionally, prototype versions were shown through a series of meetings to TAC members (and staff from UDOT's data analytics group), to gauge their feedback, help prioritize functionality, and overcome back-end challenges. Through this process, it was decided to integrate the anticipated multiple PEDAT versions (see Section 1.1.2) into a single dashboard that could address needs for data from the recent past up to several years ago.

The basic functionality of this PEDAT Version 0.9 is briefly described here. To the extent that features are similar to PEDAT Version 1.0, more details can be found in Chapter 3.0. In Step 1, users selected one or more locations, using a drop-down selection (to filter for a specific city), a map to click one or more signals, or a search bar. In Step 2, users selected a type of data: hourly data from the last year, or daily data from the past five years. In Step 3, users selected other parameters, including start and end dates, spatial aggregation (entire intersection or specific phase), and temporal aggregation (hour, day, week, month, year). Then, the platform produced several types of outputs: (a) averages by location, day of week, and time of day; (b) other figures showing distributions and time series; (c) a map allowing the user to compare locations at any given time; (d) raw data and summary statistics; and (e) a summary report that could be downloaded in PDF format. Additionally, the raw data for most figures and tables could be downloaded.

2.5 Stakeholder Meeting 3

After developing the initial PEDAT platform (Version 0.9), the research team held another online stakeholder meeting, with many of the same invitees and attendees as the first two stakeholder meetings. A few days prior to the meeting, a link to the PEDAT dashboard (along with a user guide) was distributed to meeting invitees. The objective of the meeting was to solicit feedback on the dashboard, its user interfaces, and its overall functionality.

- **Stakeholder meeting 3** was held on February 29, 2024, and was attended by 29 UDOT employees and non-UDOT external stakeholders.

The meeting began with a quick recap of the project's objectives, followed by a live demo of the PEDAT platform. Afterwards, feedback was solicited in a structured way, using a Jamboard (for online interactive comments), as well as chat and open discussion. The discussion was split into the following topics: the three initial steps to run the tool (select locations, select data type, and select parameters), the various outputs that were generated (averages, figures, map, data, report), and other desired functionality.

There were several comments about the initial steps to run the tool. Several participants had difficulties loading the tool or had the webpage automatically re-load before they could finish using it. There were also some comments asking for easier ways to interact with the map when selecting locations. Regarding outputs, attendees really appreciated the various outputs generated by the dashboard, including plots of averages, temporal distributions, maps, and data tables. Most comments were suggestions for minor changes to text, colors, layout, or descriptions for clarity. In terms of other desired functionality, a few participants requested the integration of other active transportation datasets such as trail counts and Strava Metro data.

2.6 Final Enhancements: PEDAT Version 1

Following the final stakeholder meeting, the research team reviewed the comments received, organized and prioritized the feedback, and implemented changes to the draft PEDAT pedestrian data platform. Key changes are summarized below:

- Step 1: Simplified and improved methods to select locations.
    - Removed filtering to specific cities for simplicity and ease of updating. Map still allows searching by location.
    - Changed map marker type from unique traffic signal symbol to standard pin symbols, to reduce loading time.

    - Changed map marker zoom functionality from no grouping to clustering by number, changing as the user zooms in and out of the map, to avoid overlapping symbols and improve readability.
    - Map basemap changed to show highways and streets more clearly.
    - Selected locations now appear as a list with checkboxes, for easier review and revision.
- Step 2: Minor improvements.
    - Made options within “Step 2: Select parameters” conditional upon locations and data type selected in Step 1.
- Outputs: Minor edits to enhance outputs for users.
    - Added summary “Metrics” for the selected data and parameters.
    - Made minor wording changes to improve clarity of the output averages, figures, and data tables.
- Map output: Significant modifications.
    - Map basemap changed to show highways and streets more clearly.
    - Made selection of date range and hour range simpler and easier to use.
    - Allowed different aggregation methods (total, daily, hourly).
    - Removed three-dimensional bars for legibility. Replaced with two-dimensional circles. Circles indicate pedestrian activity through both area and color, for visual redundancy.
- Entire tool: Improved overall functionality.
    - Combined Steps 1 and 2 into “Step 1: Select data type and location(s).”
    - Added “Submit” button after each step, to eliminate page loading issues and reduce run-time.
    - Revised the left-side navigation to include a “How to use” section with links to the user guide, and a “Notes” section with details about the meaning and source of the “pedestrian volume” estimates.

Following these changes, the research team released the updated pedestrian data platform on GitHub as PEDAT Version 1 (Rafe & Singleton, 2024). A containerized version was created as a Docker image to enable users to easily install the platform on their own computer environments. After working with UDOT technical staff, this version was published by UDOT as an online dashboard for early-stage users (UDOT, USU, & STL, 2024). The dashboard's interface was last updated in late May and early June 2024, with data from January 2018 through December 2022. More details about PEDAT Version 1.0 are described in Chapter 3.0. There are no resources currently available to the research team to provide continuing support or updates for this version. Development has been turned over to UDOT and its contractors, who have developed a new version of PEDAT—integrated with ATSPM—as described in Chapter 4.0.

3.0 PEDAT VERSION 1

3.1 Overview

This chapter describes how the PEDAT pedestrian data platform Version 1 works. Details are provided about the back-end data processing, from the raw traffic-signal-controller log data to the final estimated pedestrian volumes displayed in the dashboard. This chapter also presents screenshots and descriptions of the front-end data visualizations and a walk-through of how the tool works. A complete User Guide is contained in Appendix A.

3.2 Back End: Data Processing

In PEDAT Version 1, data processing takes place offline, using reproducible scripts written in R, but happening periodically through the efforts of the research team. This section summarizes the process of turning push-button presses from traffic signal data into the final pedestrian-volume-estimate datasets used in the dashboard. More details about these processes can be found in an earlier UDOT research project report (Singleton et al., 2020) and its companion datasets and scripts (Singleton, Runa, & Humagain, 2021).

3.2.1 Traffic Signal Data

Many traffic signals include pedestrian push-buttons that people can use to request to cross the intersection. In Utah, nearly all traffic signals in the state record everything that happens in high-resolution signal controller logs (Smaglik et al., 2007) that include time-stamped information about each event. For the purposes of this project, key pedestrian events include times when the pedestrian indication changes (begin walk, begin flashing don't walk, begin steady don't walk), when a pedestrian call is registered, and, critically, when someone presses (or waves at) the push-button. These push-button or pedestrian detection events are recorded with event code 90, and an additional event parameter describes the detector channel (usually the pedestrian phase) associated with the push-button.

The sequence of pedestrian-related events shown in Table 3.1 shows traffic signal events around noon on 1 January 2019 at signal 5306 (Main St. & 400 N, Logan, UT). At 32.6 seconds after noon, someone pressed the push-button (event code 90) associated with Phase 8 (the north crosswalk across Main St.), and a pedestrian call was placed (event code 45) at the same time. Half a second later (at 33.1 seconds), the push-button was pressed again, but a new call was not placed. At 55.0 seconds, the walk indication for phase 8 came on (event code 21) at the same time as the parallel vehicle green (event code 1), switching to flashing don’t walk (event code 22) at 12:01:00 and subsequently to steady don’t walk (event code 23) at 12:01:22.

Table 3.1: Traffic Signal Controller Log Data (Example Rows)

Signal ID	*Timestamp*	*Event Code*	*Event Parameter*
5306	2019-01-01 12:00:32.6	90	8
5306	2019-01-01 12:00:32.6	45	8
5306	2019-01-01 12:00:33.1	90	8
5306	2019-01-01 12:00:55.0	0	8
5306	2019-01-01 12:00:55.0	1	8
5306	2019-01-01 12:00:55.0	21	8
5306	2019-01-01 12:01:00.0	22	8
5306	2019-01-01 12:01:22.0	23	8

At the time of the study, these signal controller logs were archived by UDOT in a centralized traffic signal database. To obtain raw pedestrian data from all traffic signals in Utah, the research team queried this database using SQL, often for all signals for one week at a time. The resulting CSV files were stored and organized on the research team’s local computers.

3.2.2 Aggregation

PEDAT Version 1 works with base spatial and temporal units established during a prior UDOT research project (Singleton, Runa, & Humagain, 2020). Specifically, the smallest spatial units are each pedestrian phase at each traffic signal; and the smallest temporal units are each hour of each day. Therefore, these raw pedestrian traffic signal data were aggregated to these units, creating a database where each row is one hour of a given day for a particular phase/crossing at a given signal.

However, the research team did not simply add up the number of times each pedestrian-relevant event occurred for each signal phase within each hour. Prior research in Utah (Singleton, Runa, & Humagain, 2020; Singleton & Runa, 2021) found that pedestrian volumes can be estimated with reasonable accuracy from two pedestrian signal metrics:

- **A45B**: In a sequence of events with just {0, 21, 90}, the number of 90 events immediately preceded by a 0 or 21 event. This approximates the number of phases in a given hour when there was a pedestrian push-button press while the walk indication was not "Walk."
- **A90C**: In a sequence of events with just {90}, the number of events with a time difference of 15 seconds or more from the previous 90 event. This approximates the number of "unique" pedestrian push-button presses, assuming that ones within 15 seconds of a prior one were made by the same person or group of people.

In addition to calculating these two metrics, the research team also obtained information from signal data about whether the phase was likely set to pedestrian recall, as well as the approximate average cycle length. This information was necessary for applying the appropriate pedestrian volume estimation equation, as described in the next section. See prior work (Singleton, Runa, & Humagain, 2020) for how these additional metrics were calculated.

This aggregation process was conducted by the research team using custom R scripts that read the raw CSV data and aggregated and calculated the pedestrian signal metrics. The resulting data were saved in compact data formats (RDS, a binary file format that is native to R). Table 3.2 presents example rows resulting from this aggregation and calculation process.

Table 3.2: Aggregated Pedestrian Signal Data (Example Rows)

SIGNAL	*P*	*TIME1*	*A00*	*A21*	*A45*	*A90*	*A45B*	*A90C*	*RECALL*	*CYCLE*
5807	2	2022-07-01 00:00:00	11	2	2	3	2	3	FALSE	5.45
5807	2	2022-07-01 01:00:00	3	0	0	0	0	0	FALSE	20.00
5807	2	2022-07-01 02:00:00	3	0	0	0	0	0	FALSE	20.00
5807	2	2022-07-01 03:00:00	5	0	0	0	0	0	FALSE	12.00
5807	2	2022-07-01 04:00:00	5	0	0	0	0	0	FALSE	12.00
5807	2	2022-07-01 05:00:00	9	4	4	4	4	4	FALSE	6.67
5807	2	2022-07-01 06:00:00	26	2	2	2	2	2	FALSE	2.31
5807	2	2022-07-01 07:00:00	58	31	33	41	30	40	FALSE	1.03
5807	2	2022-07-01 08:00:00	60	21	22	28	19	27	FALSE	1.00
5807	2	2022-07-01 09:00:00	59	30	31	39	29	38	FALSE	1.02
5807	2	2022-07-01 10:00:00	58	45	47	64	44	61	FALSE	1.03
5807	2	2022-07-01 11:00:00	59	38	38	47	33	44	FALSE	1.02

3.2.3 Volume Estimation

The processed and aggregated data from the previous step were now ready to be used to estimate the pedestrian volume for each crossing (phase) for each hour. Estimation equations were borrowed from prior Utah-based research (Singleton, Runa, & Humagain, 2020; Singleton & Runa, 2021). In that project, over 10,000 hours of data from 90 signals counted nearly 175,000 pedestrians and associated these outcomes with pedestrian signal metrics using multiple regression equations. The resulting predictions exhibited good accuracy: estimated volumes were highly correlated (0.84) with observed volumes with relatively low average error (+/− 3.0 pedestrians per hour). One of the equations in Table 3.3 were applied, depending on conditions:

- Pedestrian hybrid beacon signal crossings: Equation 1.
- Crossings on pedestrian recall: Equation 2 at higher-volume signals (> 350 annual average daily A45Bs), Equation 3 at lower-volume signals (≤ 350 A45Bs per day).
- Crossings not on pedestrian recall: Equation 4 for shorter cycle lengths (average < 1.5 minutes per cycle), Equation 5 for longer cycle lengths (average ≥ 1.5 minutes).

Equations 1, 4, and 5 rely on the unique pedestrian push-button metric A90C, while Equations 2 and 3 rely on the actuated pedestrian phases metric A45B. Equations 1, 2, and 3 are quadratic equations, while Equations 4 and 5 are piecewise linear equations. These were the best-fitting regression equations from previous research (Singleton, Runa, & Humagain, 2020; Singleton & Runa, 2021).

Table 3.3: Pedestrian Volume Estimation Equations

#	***Equation***
1	$PED = 1.790 \cdot A90C + 0.083 \cdot A90C^2$
2	$PED = 2.304 \cdot A45B + 0.148 \cdot A45B^2$
3	$PED = 1.310 \cdot A45B + 0.083 \cdot A45B^2$
4	$PED = 1.215 \cdot A90C + 4.292 \cdot (A90C - 28) \cdot (if\ A90C > 28)$
5	$PED = 1.215 \cdot A90C + 7.214 \cdot (A90C - 28) \cdot (if\ A90C > 28)$

These equations were applied by the research team using custom R scripts. Results were saved in multiple data formats (compact RDS, portable CSV). In addition, the by-hour by-phase pedestrian volume estimates were aggregated to a by-day by-signal format for later use in the dashboard. The next subsection describes these resulting datasets.

3.2.4 Final Data

The PEDAT dashboard relies upon three core datasets: (1) map data; (2) hourly pedestrian data; and (3) daily pedestrian data. Each of these datasets is described in turn.

The **map data** include the following information about each traffic signal: signal ID, address, city, county, latitude, and longitude. Example rows for the map data are shown in Table 3.4. The address field concatenates the signal ID, the street intersection, and the city, so that this information can be displayed in later sections of the dashboard. These data were originally obtained from UDOT's traffic signal database. They were processed into the required columns and stored in a JSON file, available alongside the tool's code in GitHub (Rafe & Singleton, 2024).

Table 3.4: Map Data (Example Rows)

SIGNAL	*ADDRESS*	*CITY*	*COUNTY*	*LAT*	*LON*
5314	5314 -- 400 N (US-89) 600 E, Logan	Logan	Cache County	41.73882934	-111.8193297
5806	5806 -- 1000 N 800 E, Logan	Logan	Cache County	41.75012373	-111.813886
5807	5807 -- 700 N 800 E, Logan	Logan	Cache County	41.74448829	-111.8141882
5808	5808 -- 700 N 1200 E, Logan	Logan	Cache County	41.74440542	-111.8042952
5816	5816 -- 1000 N 600 E, Logan	Logan	Cache County	41.749868	-111.819045

The **hourly pedestrian data** are the product of the pedestrian-volume-estimation process described in the previous section. They include, for each hour and phase number (crossing) at each signal, the estimated number of pedestrians crossing there, based on push-button data. The minimum number of columns required are signal ID, phase number (P), timestamp (start of hour), and estimated pedestrian volume. Table 3.5 shows an example subset of these hourly data. The **daily pedestrian data** are simply an aggregation of the hourly pedestrian data, processed outside of the PEDAT dashboard. They start with the same data but sum over all phases at each signal and all hours of each day. Therefore, the minimum columns are signal ID, timestamp (start of day), and estimated pedestrian volume. Table 3.6 contains example rows from this daily dataset. Additional columns—address, city, latitude, longitude (not shown here)—were added to both pedestrian data tables for context and faster filtering. These two pedestrian datasets were stored in Google Cloud BigQuery (rather than locally) due to their large size and to support fast querying.

Table 3.5: Hourly Pedestrian Data (Example Rows)

SIGNAL	*P*	*TIME1*	*PED*
5807	2	2022-07-01 00:00:00	3.65
5807	2	2022-07-01 01:00:00	0.00
5807	2	2022-07-01 02:00:00	0.00
5807	2	2022-07-01 03:00:00	0.00
5807	2	2022-07-01 04:00:00	0.00
5807	2	2022-07-01 05:00:00	4.86
5807	2	2022-07-01 06:00:00	2.43
5807	2	2022-07-01 07:00:00	100.10
5807	2	2022-07-01 08:00:00	32.81
5807	2	2022-07-01 09:00:00	89.09
5807	2	2022-07-01 10:00:00	215.75
5807	2	2022-07-01 11:00:00	236.82
5807	2	2022-07-01 12:00:00	144.16
5807	2	2022-07-01 13:00:00	30.38
5807	2	2022-07-01 14:00:00	20.66
5807	2	2022-07-01 15:00:00	133.15
5807	2	2022-07-01 16:00:00	204.74
5807	2	2022-07-01 17:00:00	78.08
5807	2	2022-07-01 18:00:00	21.87
5807	2	2022-07-01 19:00:00	122.13
5807	2	2022-07-01 20:00:00	19.44
5807	2	2022-07-01 21:00:00	15.80
5807	2	2022-07-01 22:00:00	15.80
5807	2	2022-07-01 23:00:00	0.00

Table 3.6: Daily Pedestrian Data (Example Rows)

SIGNAL	*TIME1*	*PED*
5314	2022-07-01 00:00:00	199.30
5806	2022-07-01 00:00:00	460.49
5807	2022-07-01 00:00:00	3,134.12
5808	2022-07-01 00:00:00	1,468.04
5816	2022-07-01 00:00:00	204.12

3.3 Front End: Visualization Dashboard

The dashboard itself is built using Streamlit, an open-source framework (in Python) focused on creating high-functional data apps with limited coding. The app's code is available on GitHub (Rafe & Singleton, 2024), and the code can be deciphered using Streamlit's documentation (Snowflake, 2026). Most of the lines of code are about processing the data upon user input, or customizing the app's layout, appearance, and outputs. The app is simply a Python script that imports the Streamlit module (alongside others); when run, the code is interpreted to create what the user sees in the dashboard.

Figure 3.1 shows the first part of the PEDAT pedestrian data dashboard, titled "Pedestrian Volume in Utah." Initial text outlines the purpose of the dashboard and how to navigate it. A second paragraph provides information on the date range and when the platform was last updated.

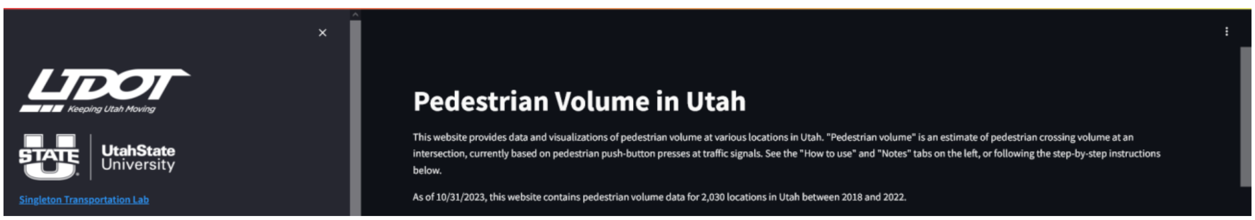


Figure 3.1: PEDAT Version 1: Header

3.3.1 Selections

Step 1: Select data type and location(s). In the first step, the user is prompted to select the location(s) they want to retrieve data for, as well as the type of data to retrieve. Step 1 is shown in Figure 3.2 and described in the following paragraphs.

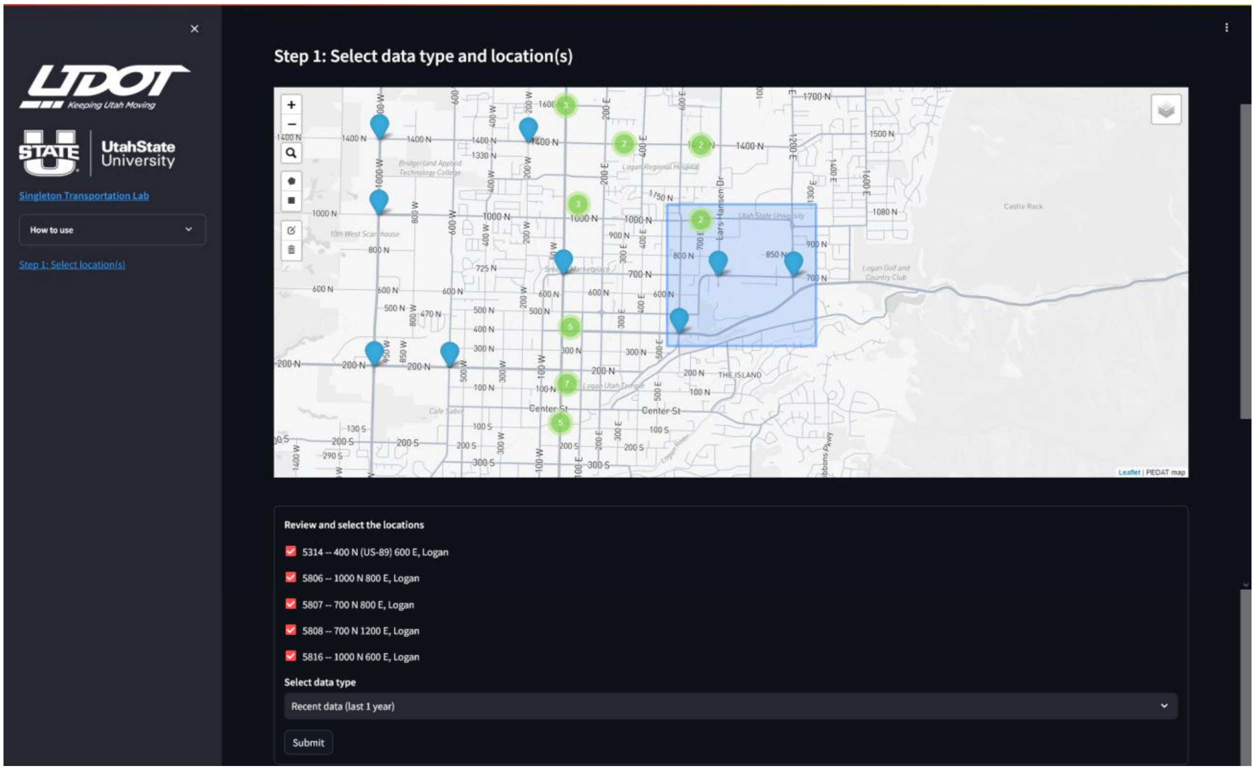


Figure 3.2: PEDAT Version 1: Step 1: Select Data Type and Location(s)

There are multiple ways to select one or more locations. To go to an area, the user can zoom in or out of the map using a mouse or the + / − buttons. Alternatively, the user can click the magnifying glass button and search for a location by its Signal ID, intersection, or city; the map will then zoom to that location. Once at a location, the user can click one or more marker symbols, and/or use a rectangular bounding box or a drawn polygon to select all locations within the shape. Once locations are selected, they appear in a checkbox list below the map. Users can deselect locations as desired.

Next, the user selects the data type. Current options are “Recent data (last 1 year)” or “Historical data (last 5 years).” Recent data include hourly estimated volumes by signal and phase, whereas historical data include daily estimated volumes by signal. This distinction is meant to represent different uses or flavors of PEDAT (see Section 1.1.2): "recent data" for PEDAT Live/History, and "historical data" for PEDAT Planning. This is also employed as a strategy to reduce the amount of data processing that happens in the app and improve its speed.

Upon clicking "Submit," the app forms and makes an SQL query to the specified dataset hosted in UDOT's Google Cloud BigQuery database for the selected locations. This returns a dataset (one year of hourly data, or five years of daily data) specific to the selected locations, for use in the rest of the app.

Step 2: Select Parameters. In the second step, the user is prompted to select several parameters that filter and/or aggregate the data as desired. Step 2 is shown in Figure 3.3 and described in the following paragraphs.

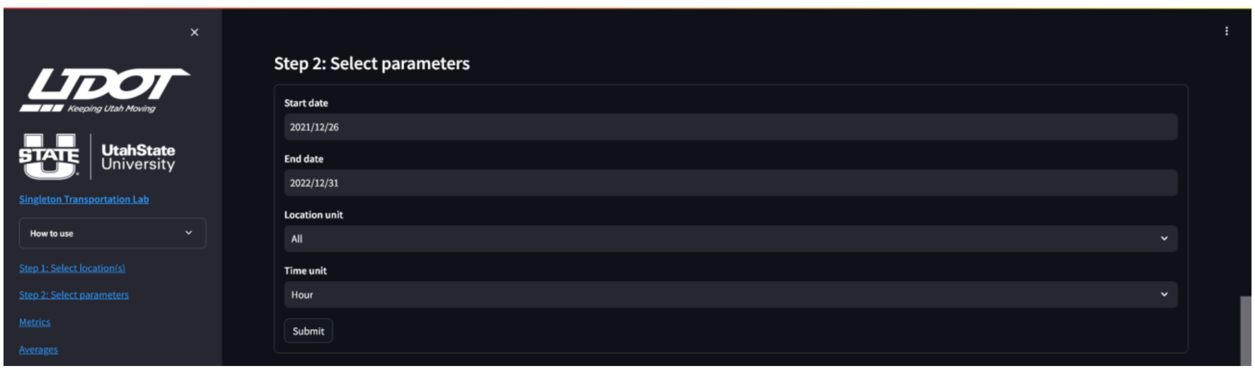


Figure 3.3: PEDAT Version 1: Step 2: Select Parameters

The user can adjust the start date and end date, in case they want to look at a narrower time period than the one-year (recent) or five-year (historical) defaults. Dates can be typed or selected using a calendar interface. If "recent data" was selected in Step 1, parameters include a "location unit." This defines the spatial aggregation at each intersection: "all" (all phases/crossings combined) or which phase (the equivalent of a single crosswalk). Allowable phases are those that appear in the queried data from Step 1. The final parameter is a "time unit," defining the temporal aggregation of the data. Options include hour (only available for "recent data"), day, week, month, or year.

Upon clicking "Submit," the app filters the data using the selected dates and aggregates the data (if necessary) using the selected location and time units. This filtered and aggregated dataset is then used for displaying the following results to the user.

3.3.2 Results

Results produced by the PEDAT dashboard are split into six sections, as shown in Figure 3.4: Metrics, Averages, Figures, Map, Data, and Report. Each section has a different objective to meet specific user needs. The **Metrics** in Figure 3.4 provide a high-level overview of the processed data, including the number of locations, the selected start and end dates, and the total number of pedestrian crossings estimated for those data.

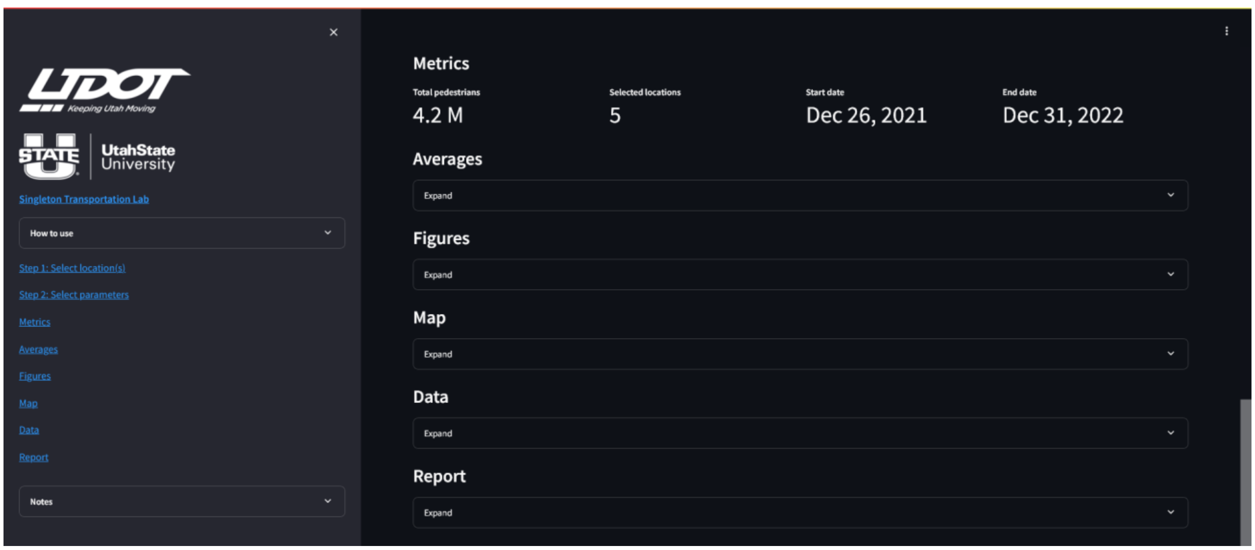


Figure 3.4: PEDAT Version 1: Metrics and Other Results

The figures in the **Averages** section—see Figure 3.5—provide averages that users may want to know, including differences between sites and temporal patterns. The first figure compares the average daily pedestrian volumes across locations. The second figure shows the distribution of average hourly pedestrian volumes by hour of day, summed across all selected locations. The third and fourth figures show the distributions of average daily pedestrian volumes by day of week and month of year, respectively, also summed across all selected locations. All figures allow the user to save the image as a PNG file, and to download the data contained within the chart as a CSV file.

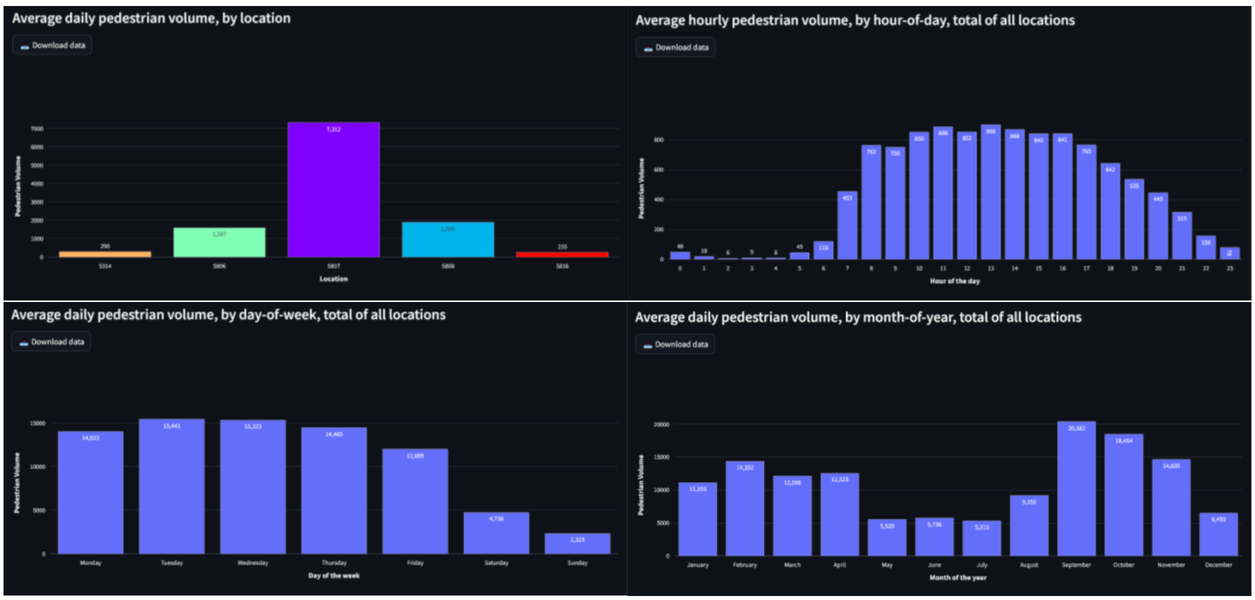


Figure 3.5: PEDAT Version 1: Averages

The **Figures** section, depicted in Figure 3.6, contains three figures. The first two aid the comparison of estimated pedestrian volumes across locations, showing first a pie chart and a treemap of total pedestrian volumes by location, and second a box plot of hourly pedestrian volumes by location. The third figure is a time series plot with all locations superimposed, allowing users to view the patterns of pedestrian activity over time. A user can adjust the window shown in the plot using the scroll bars or by zooming in or out. With these figures, a user can also click the legend to select or deselect a location from being shown. This and other interactive functionality are native to the Streamlit app platform. Again, the app allows users to save a figure's image as a PNG file and/or download a figure's data as a CSV file.

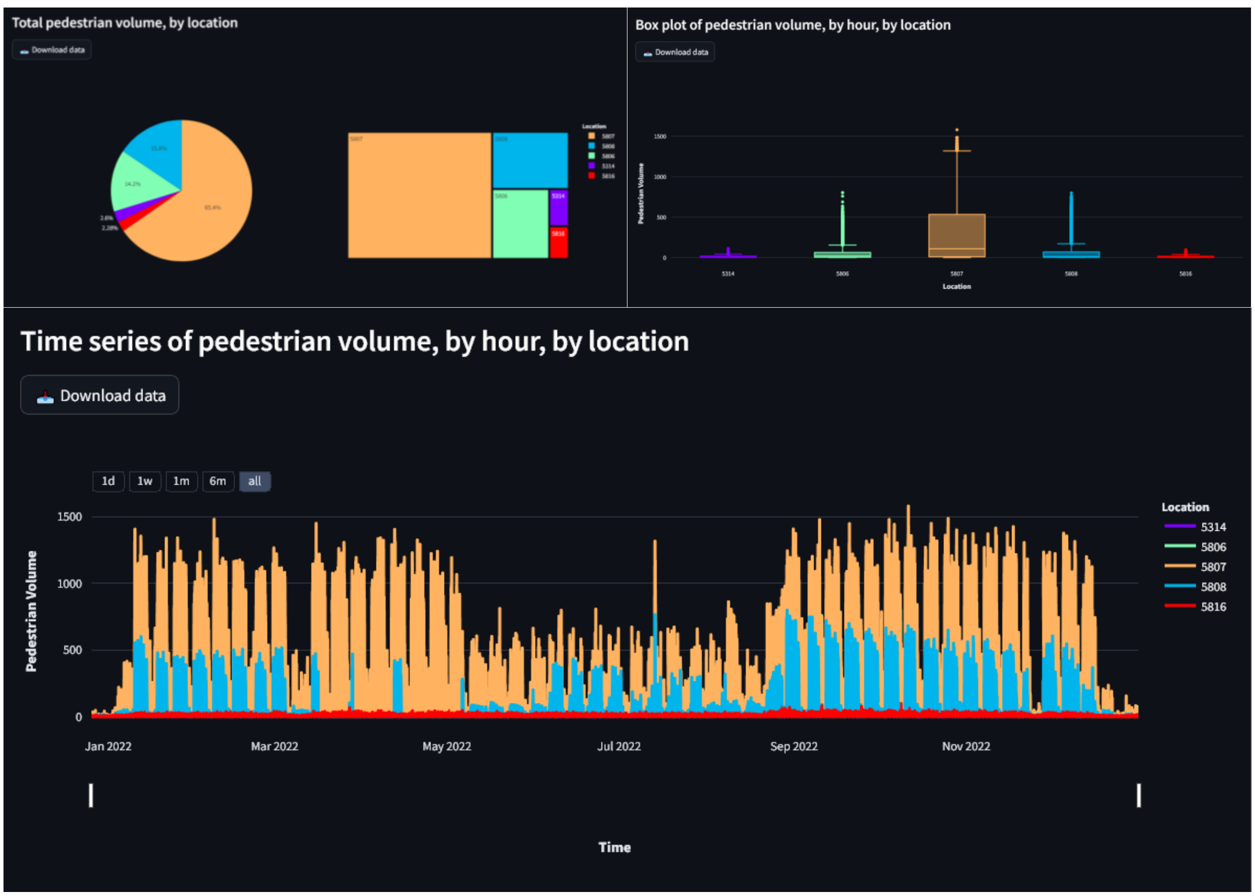


Figure 3.6: PEDAT Version 1: Figures

The next section is a **Map** plotting the data spatially. The map can show one value for each location at a time. Before the map is produced, a user must select the date range, (if available) the hour range, and the aggregation method: total, average daily, or average hourly. For instance, the default is to include the entire date range, and all 24 hours of the day. Total would plot the sum of all estimated pedestrians while the averages would show either the average daily or average hourly pedestrian volumes at each location. In the example shown in Figure 3.7, the selected date range is 15 May 2022 through 14 August 2022, and the selected hour range is 14 through 16. Thus, the map shows the average hourly pedestrian volume at each location during the late afternoon (2pm through 4pm) during the summer months. This is a simple way for users to ask custom queries and visualize the results on a map.

The map displays the data in multiple ways. The size and color of the circles both show the pedestrian volume. Additionally, a user can click on a circle and see both the location and the pedestrian volume number. This redundancy allows users to interact with and understand the data in multiple ways.

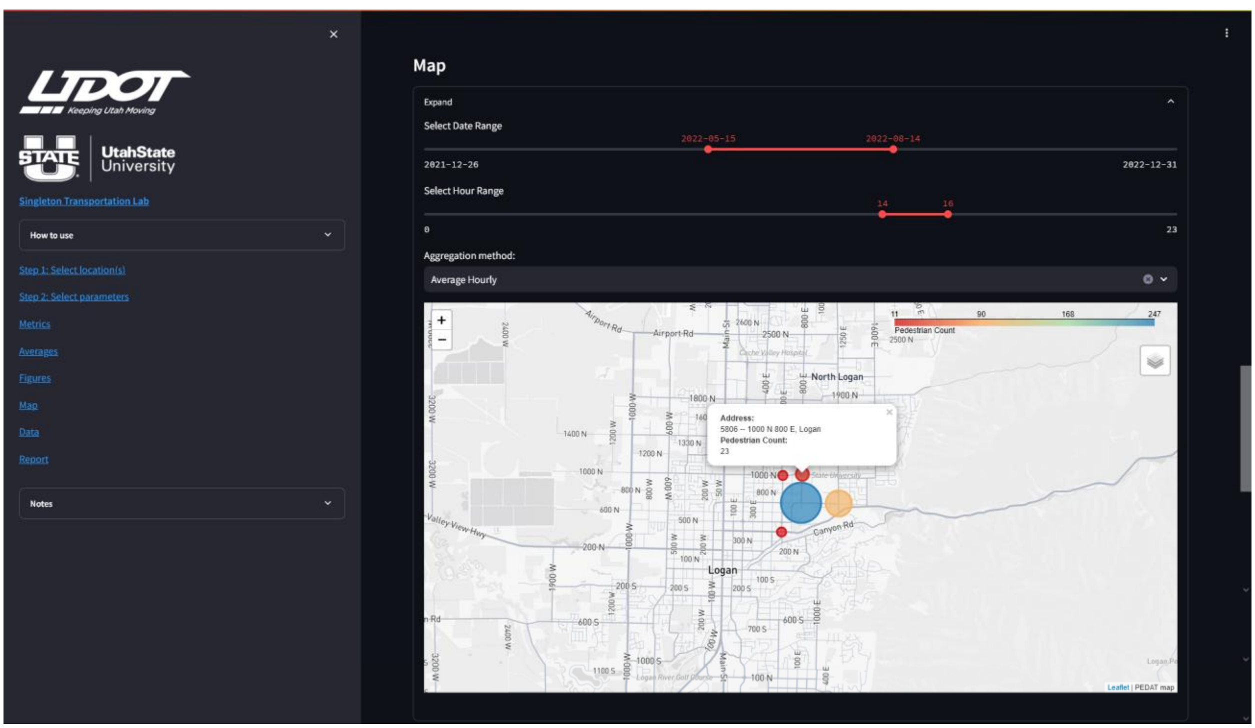


Figure 3.7: PEDAT Version 1: Map

For advanced users, the **Data** section provides a way to view and download the raw data being used to populate the dashboard's results. An abbreviated table shows the basic data structure, while a "Download" button downloads the data as a CSV file. Specifically, this is the data queried and processed at the end of Step 2. A second table presents descriptive statistics (count, mean, standard deviation, minimum, maximum, quartiles, and count of missing) for this data, by location. See Figure 3.8 for a screenshot of this section of the tool.

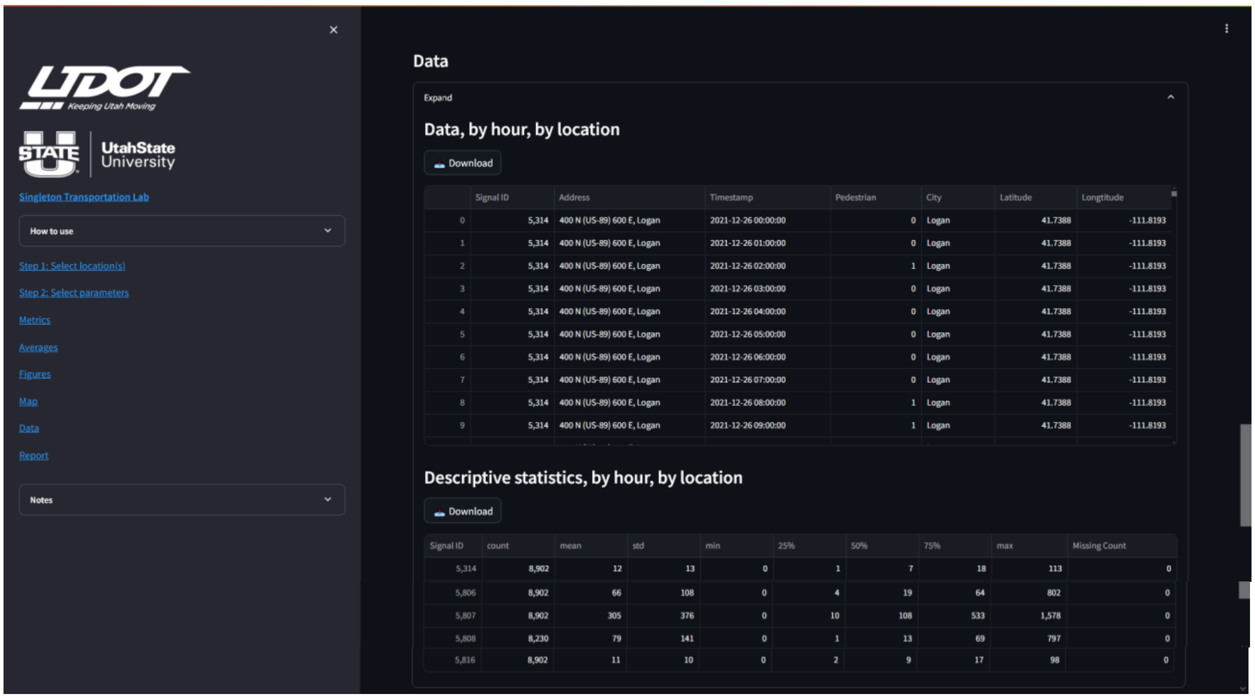
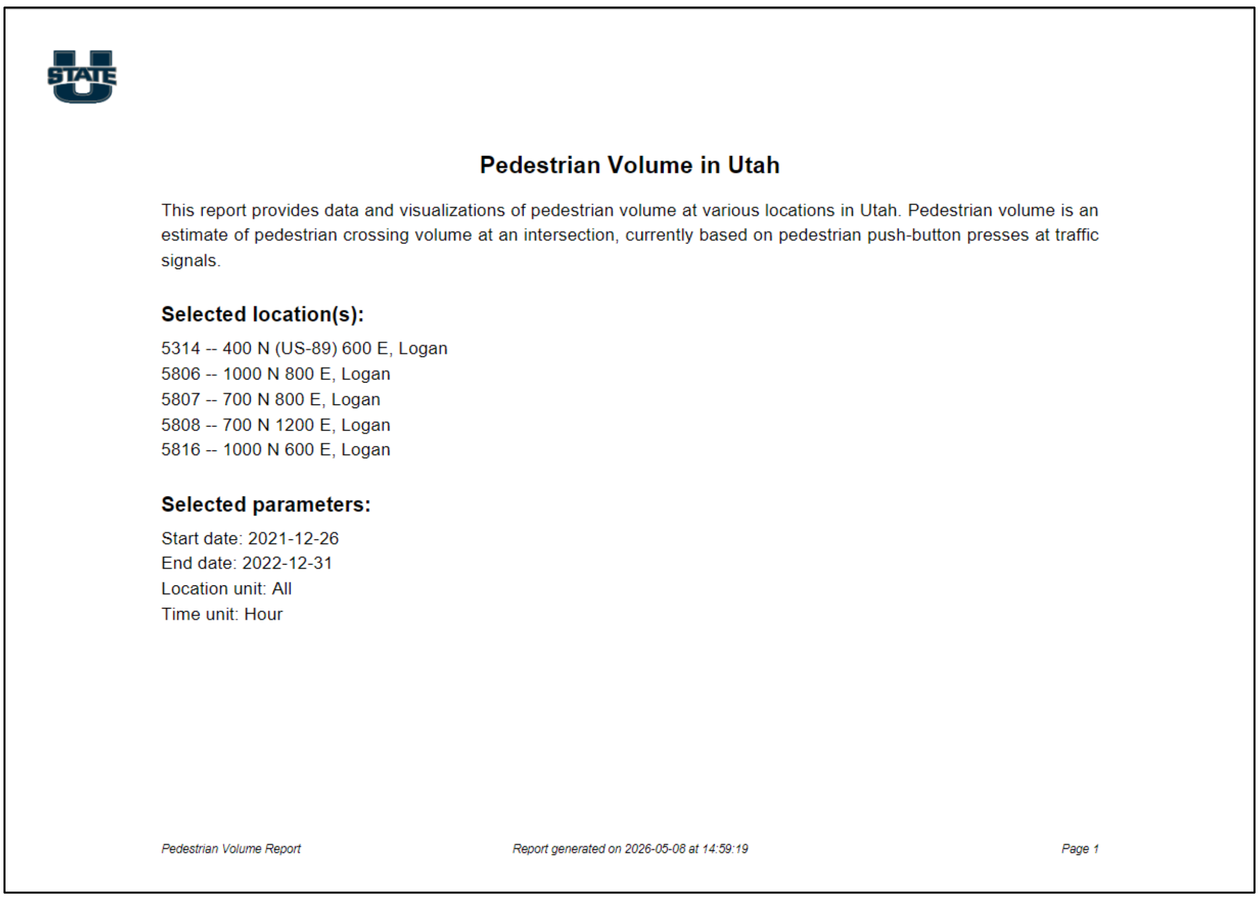


Figure 3.8: PEDAT Version 1: Data

Finally, the dashboard has a **Report** section that allows the user to generate and download a PDF report. The report is not auto-generated when loading the app, only upon request, to reduce back-end processing. The report is fairly simple, with a header and informative footer (title, date and time generated, page number), in a landscape-oriented letter-sized page (11” x 8.5”). The first page—shown in Figure 3.9—contains a brief description of the report and documents the selected locations and parameters. The subsequent pages print all of the figures in the Averages and Figures sections, one figure per page. This provides an option to easily save most of the relevant results in one report without having to save each figure individually.



Pedestrian Volume in Utah

This report provides data and visualizations of pedestrian volume at various locations in Utah. Pedestrian volume is an estimate of pedestrian crossing volume at an intersection, currently based on pedestrian push-button presses at traffic signals.

Selected location(s):

5314 -- 400 N (US-89) 600 E, Logan
5806 -- 1000 N 800 E, Logan
5807 -- 700 N 800 E, Logan
5808 -- 700 N 1200 E, Logan
5816 -- 1000 N 600 E, Logan

Selected parameters:

Start date: 2021-12-26
End date: 2022-12-31
Location unit: All
Time unit: Hour

Pedestrian Volume Report *Report generated on 2026-05-08 at 14:59:19* *Page 1*

Figure 3.9: PEDAT Version 1: Report Page 1

3.3.3 Sidebar

Sidebar: The app also includes an informative left-side navigation bar, shown in Figure 3.10. The first section displays UDOT and USU logos, as well as a link to the Singleton Transportation Lab. The next section is a collapsible box providing brief details about "How to use" the dashboard. This also includes a link to the PEDAT User Guide (see Appendix A). The third section is an interactive navigation, allowing the user to jump to any section of the dashboard. The navigation links are added/updated as the app is updated. The fourth and final section is a collapsible "Notes" box providing details about the meaning and source of "pedestrian volume," as well as information with links to the research and ATSPM.

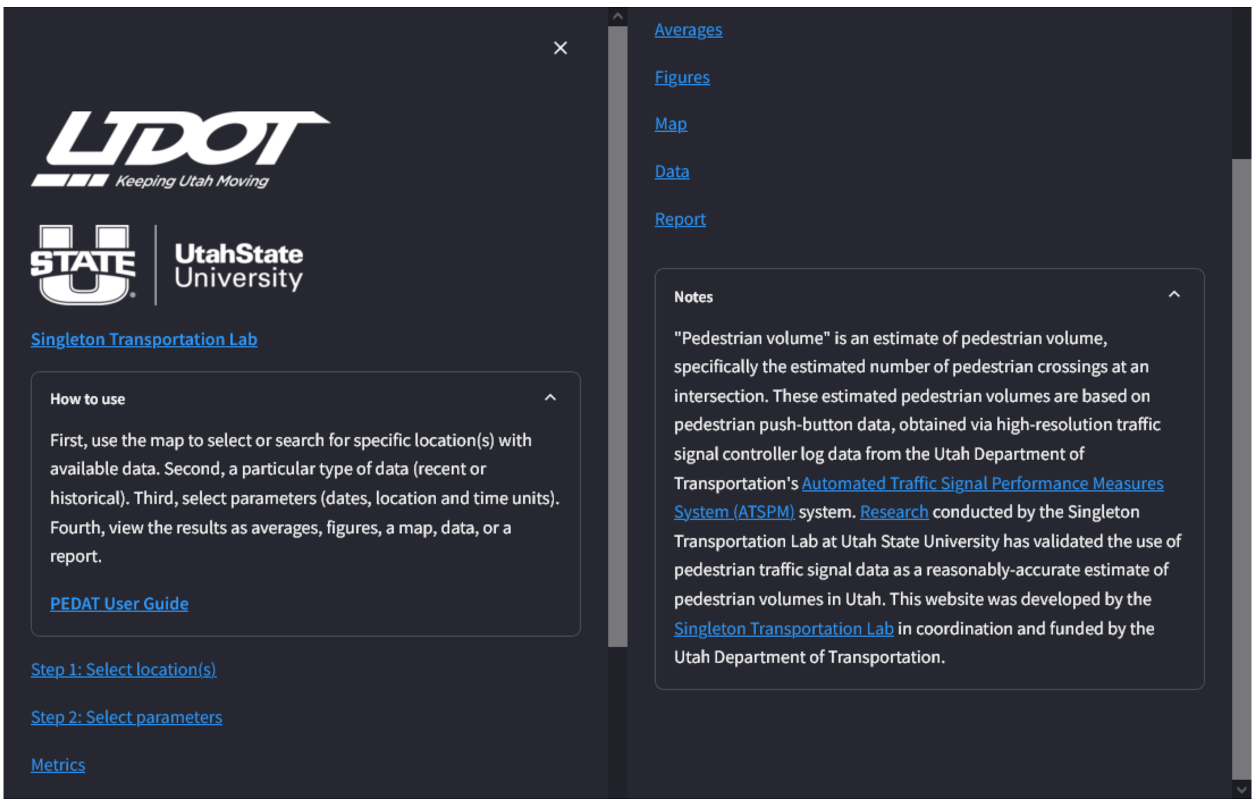


Figure 3.10: PEDAT Version 1: Sidebar

4.0 IMPLEMENTATION

4.1 Overview

This chapter describes the implementation of the Version 1 PEDAT pedestrian data platform, as a standalone report and dashboard integrated into the latest Version 5.2 of UDOT's ATSPM website. Details are provided about the automatic processing and aggregation of raw traffic signal data into records useful for constructing pedestrian volume estimates, as well as how the latest PEDAT version works for users.

4.2 Implementation Plan

During the later stages of the project, the research team worked with UDOT staff and consultants to support implementation of the project's work as recommended. This entailed converting the PEDAT Version 1 pedestrian data platform into a dashboard that is directly integrated into UDOT's ATSPM system and website. As of March 2026, this newest version of PEDAT has been implemented into ATSPM Version 5.2 and is live and operational on UDOT's ATSPM website. Data are available from 1 January 2026 to present.

The USU research team did not directly develop this PEDAT "Version 2" within ATSPM Version 5.2. Primary work was conducted by Avenue Consultants under contract to UDOT, and with UDOT technology and traffic signal staff support. The research team provided the PEDAT Version 1 source code and met with Avenue Consultants periodically throughout the development process to provide feedback and clarify technical questions. One key effort was confirming that the traffic signal data processing and pedestrian volume estimation were replicated accurately; see the following section for more details.

A critical enhancement made in this version of PEDAT is the direct integration with ATSPM databases and automated data processing (see Section 4.2.1). This significantly reduces the amount of manual effort needed to maintain the tool. The consultant team also made several enhancements to the user interface to improve usability (see Section 4.2.2). The following sections describe the data processing and visualization user interface of the PEDAT dashboard within ATSPM Version 5.2.

4.2.1 Back End: Data Processing

A critical limitation of PEDAT Version 1 was the need to periodically and manually retrieve raw traffic signal data, process and aggregate it, and apply pedestrian volume estimation equations. This was time consuming for the research team and not sustainable. The key innovation in this PEDAT version—that makes it an operational tool—is the direct integration with ATSPM, its databases, and its automatic data processes. In this way, the data underlying the user interface are generated automatically on a regular basis, and maintenance and attention are only needed if something breaks or when improvements are desired.

The data feeding this version of PEDAT utilize custom ATSPM data aggregations. Raw traffic-signal-controller log data is massive—totaling more than 600 GB per day across over 2,000 signals in Utah—and storing such data in accessible locations is cost-prohibitive. Therefore, UDOT and its consultants have developed methods to aggregate raw traffic signal data (and calculate other metrics) to 15-minute intervals for longer-term archiving and storage. The idea is that data necessary for calculating ATSPMs and estimating pedestrian volumes can be constructed in the aggregation database, and this is what the ATSPM website queries for displaying many performance metrics and reports.

When the ATSPM data aggregations were being constructed, it was critical to ensure that the process of constructing pedestrian signal metrics in the 15-minute aggregations mirrored the way the research team processed the data (see Section 3.2), so that pedestrian volume estimates from the ATSPM-integrated tool would match those obtained from PEDAT Version 1. To begin, the research team shared reports, memos, and R scripts documenting how signal data were processed for use in the pedestrian-volume-estimation equations (Singleton, Runa, & Humagain, 2020; Singleton & Runa, 2021; Singleton, Runa, & Humagain, 2021). Then, the contractors working on the data aggregation process took this information and created an initial attempt to replicate the process and results. Sidenote: A version of this process was integrated into the ATSPM “Pedestrian Delay” metric as “time-buffered presses.” Next, the research team reviewed the stated process, the aggregated data, and the resulting estimated pedestrian volumes for sample data (4-5 days in early October 2022, from all available signals in Utah), comparing the research team's process/data/results to those for/from the aggregations.

The results of this comparison indicated that most aggregation processes and metrics matched what the research team had done, and that most aggregated data necessary to construct pedestrian volume estimates were identical or comparable. Some major discrepancies were later identified to be the result of missing data, not the result of data processing or aggregation. One important difference was about how the research team created the A90C metric—15-second time-buffered push-button presses—versus how the aggregation process constructed this metric, a critical input to the pedestrian-volume-estimation equations (Table 3.3). The USU method (Singleton, Runa, & Humagain, 2020) filtered and sorted just event code 90s (push-button presses) by timestamp, calculated the time difference between each event and the previous one, and removed push-button presses that happened less than 15 seconds after a previous press (at the same signal and for the same phase/crossing). In contrast, the original aggregation method split time into 15-second bins, identified a baseline push-button press (either the first in a bin, or one within 15-seconds of the first in the previous bin), and ignored any presses that happened within the next 15 seconds. In most cases, these methods produced identical results for "unique" pedestrian push-button presses. However, in rare cases, the original aggregation method generated more unique presses than the USU method (and thus, higher estimated pedestrian volumes). For instance, assume that a push-button is pressed every 10 seconds for one minute. The USU method would count the first press and ignore the rest, because the time differences were all less than 15 seconds. The original aggregation method would count the first and several other presses (depending on how they fall within the bins), because it ignores presses within 15 seconds of the baseline and then resets. While rare, this situation could happen at a busy intersection or if there is a malfunctioning or "stuck-on" push-button. After some discussion, this aggregation method was subsequently revised to better match the USU method, counting only those push-button press events (code 90) that occur at least 15 seconds after the previous press.

The current (as of this report) process for aggregating pedestrian-related traffic signal data for use in the PEDAT included within ATSPM Version 5.2 works as one of several aggregation workflows. The aggregation process takes signal controller event logs, runs them through a "PhasePedAggregation" process, and saves the results in the aggregation database

(UDOT, 2026b). This process generates the following information in 15-minute bins (which can be rolled-up to 60-minute hours for PEDAT), for each signal and pedestrian phase number:

- **PedCycles**: The number of pedestrian service intervals, measuring sequences where begin walk (event code 21) is followed by begin change interval (22), flashing don't walk. This is used to calculate the cycle length (instead of A00 in Table 3.2).
- **PedCallsRegistered**: The number of pedestrian calls registered (event code 45), replicating A45 in Table 3.2.
- **PedRequests**: The number of pedestrian detection events (event code 90), replicating A90 in Table 3.2.
- **ImputedCalls**: The number of imputed pedestrian calls registered, measuring sequences where pedestrian detection (event code 90) follows begin walk (21) or phase on (0). This replicates pedestrian signal metric A45B.
- **UniquePedDetections**: The number of unique pedestrian detection events, measuring sequences where a pedestrian detection (event code 90) is 15+ seconds after the previous pedestrian detection (90). This replicates pedestrian signal metric A90C.

Simultaneous to constructing signal data aggregations, UDOT and its partners moved data supporting ATSPM Version 5 from servers to the cloud. Specifically, UDOT currently utilizes Google Cloud with data accessed using BigQuery. The current data process works as follows: Daily, raw traffic-signal-controller log data from all available Utah traffic signals are processed and aggregated into 15-minute bins, with records stored in cloud databases. This includes constructing the variables necessary to estimate pedestrian volumes (see Section 3.2). Then, when the dashboard runs, these data in the aggregation database are queried by the tool, they are rolled up to hour or daily bins, the pedestrian-volume-estimation equations (see Table 3.3) are applied, and the results are reported in the dashboard.

4.2.2 Front End: Visualization Dashboard

The latest Version 2 of PEDAT can be found on UDOT's ATSPM website (UDOT, 2026a), accessed through the left-side navigation → Reports → Pedestrian Activity. The raw code is available on GitHub (UDOT, 2026b). As shown in Figure 4.1, the page is titled "Pedestrian Activity." This name is to indicate that the numbers are not true volumes but estimated ones. The subheading acknowledges “Utah State University” for developing the pedestrian-volume-estimation methods and earlier versions of this dashboard. Clicking on the page info opens a window with some brief information about the report, including links to references from the earlier UDOT research project (Singleton, Runa, & Humagain, 2020; Singleton & Runa, 2021).

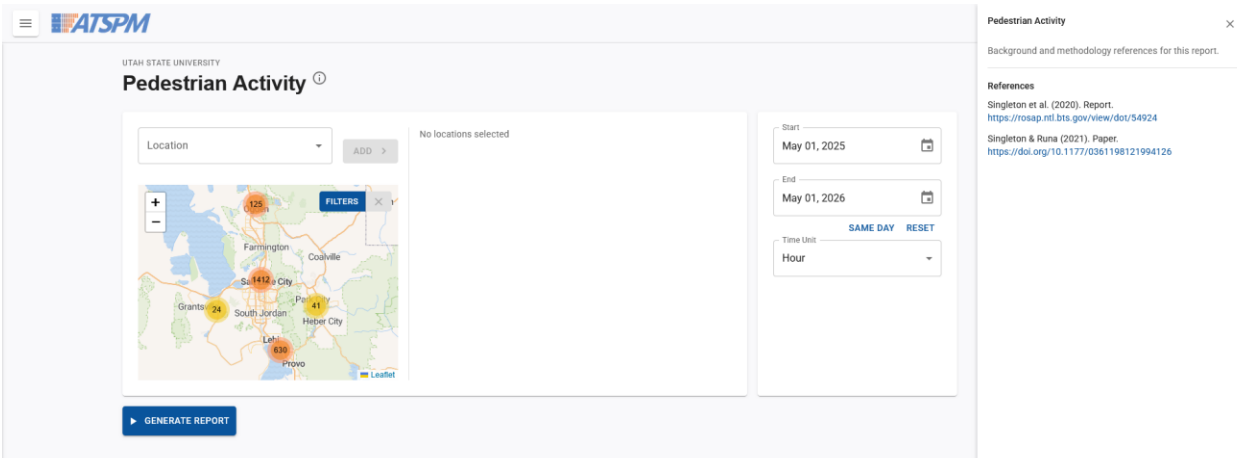


Figure 4.1: PEDAT in ATSPM 5.2: Page Info

The first step in the report is to select one or more locations. Like with PEDAT Version 1, this can be done in multiple ways, as shown in Figure 4.2. A search bar allows for searching by the signal ID or the intersection street address. A map allows navigating to various locations by clicking and dragging or zooming in or out. Clicking on a signal pulls up its information in the search bar. Lastly, one can use a filter to zoom the map to a given region or city/county. To add a location to the selected locations, a user clicks the “Add” button. Each selected location can also be removed if desired.

Figure 4.2 shows other selection options. Above the list of selected locations, a drop-down field allows users to select all phases (combined) or a specific phase/crossing. On the right side of the selection section, users can select a start and end date for retrieving data, either by typing in a date or selecting one from the calendar. The default end date is the current day, and the default start date is one year prior. The final selection parameter is the time unit, defining the temporal aggregation of the data for use in later figures, maps, and tables. Like in PEDAT Version 1, the available options include hour, day, week, month, and year.

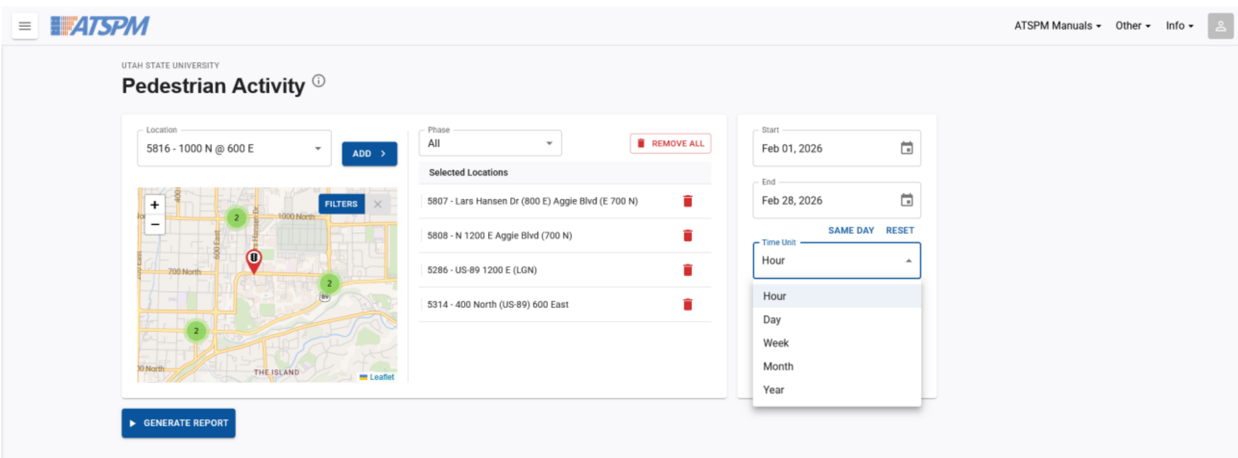


Figure 4.2: PEDAT in ATSPM 5.2: Selections

After clicking the "► Generate Report" button, data are queried, and several new sections are created. The first section is **Averages**, containing the figures shown in Figure 4.3. These are replications of the Averages figures from PEDAT Version 1, showing average daily pedestrian volume for each location, average hourly pedestrian volume by hour of day, and average daily pedestrian volume by both day of week and month of year. All figures allow the user to download the image as a PNG file, or switch to a "data view" that shows the data underlying the figure.

Figure 4.3: PEDAT in ATSPM 5.2: Averages

The second **Figures** section again replicates the similar section from PEDAT Version 1. As shown in Figure 4.4, these figures include a pie chart and a treemap of total pedestrian volumes by location; a time series plot for each location (stacked); and a box plot of pedestrian volumes (per time unit) by location. Although these figures cannot be downloaded, they can be screenshot, and hovering over them displays the values.

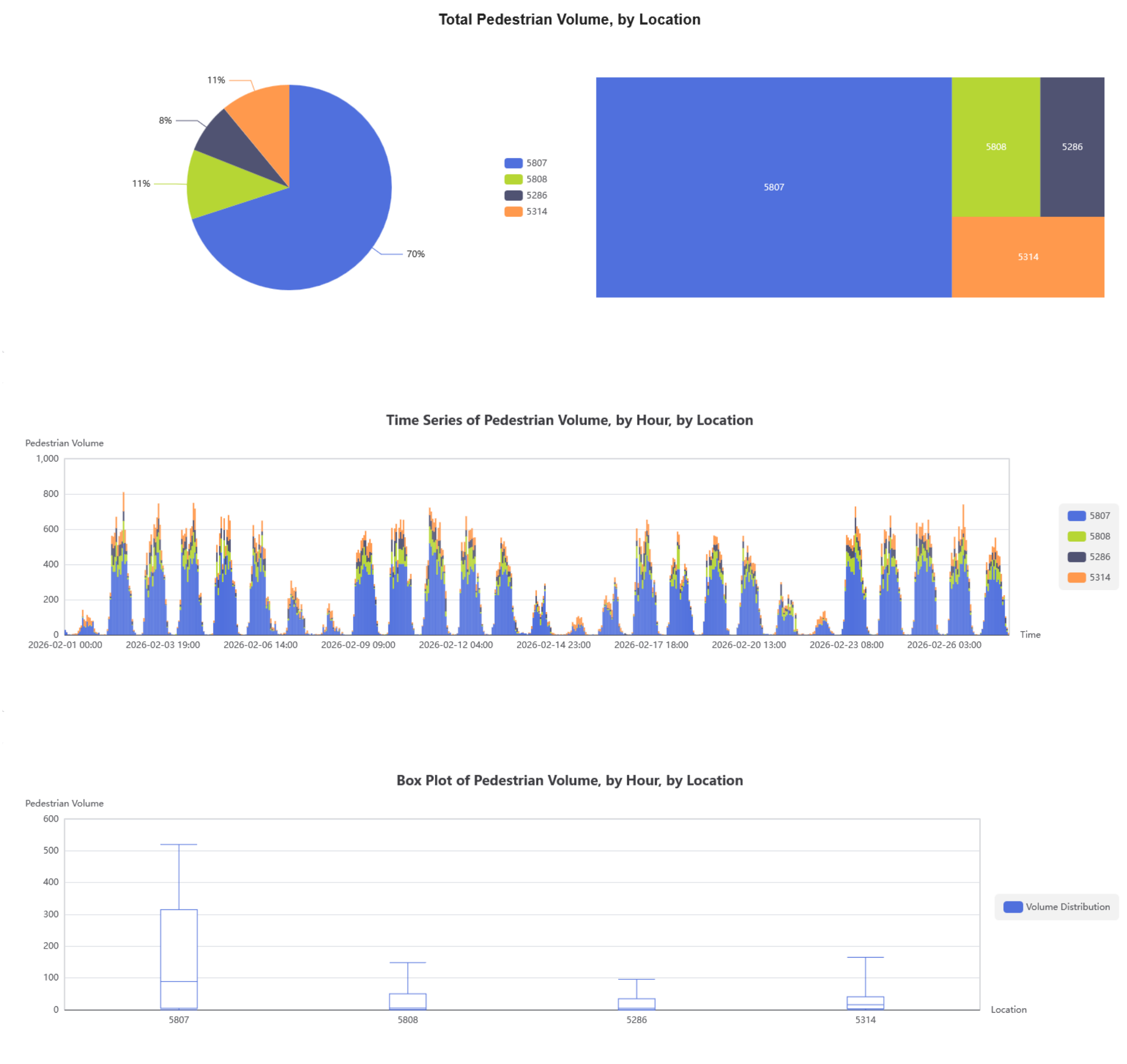


Figure 4.4: PEDAT in ATSPM 5.2: Figures

The **Map** section provides a means of visualizing the data spatially, showing one value (for a given time) for each location, as shown in Figure 4.5. Just like in PEDAT Version 1, a user can select an aggregation method (average hour, average daily, or total), a date range (within the dates selected earlier), and an hour range, in case a user wants to focus on just one time of day. The ATSPM interface is an improvement upon PEDAT Version 1 by orienting the filters more compactly and not requiring a selection to initially display the map.

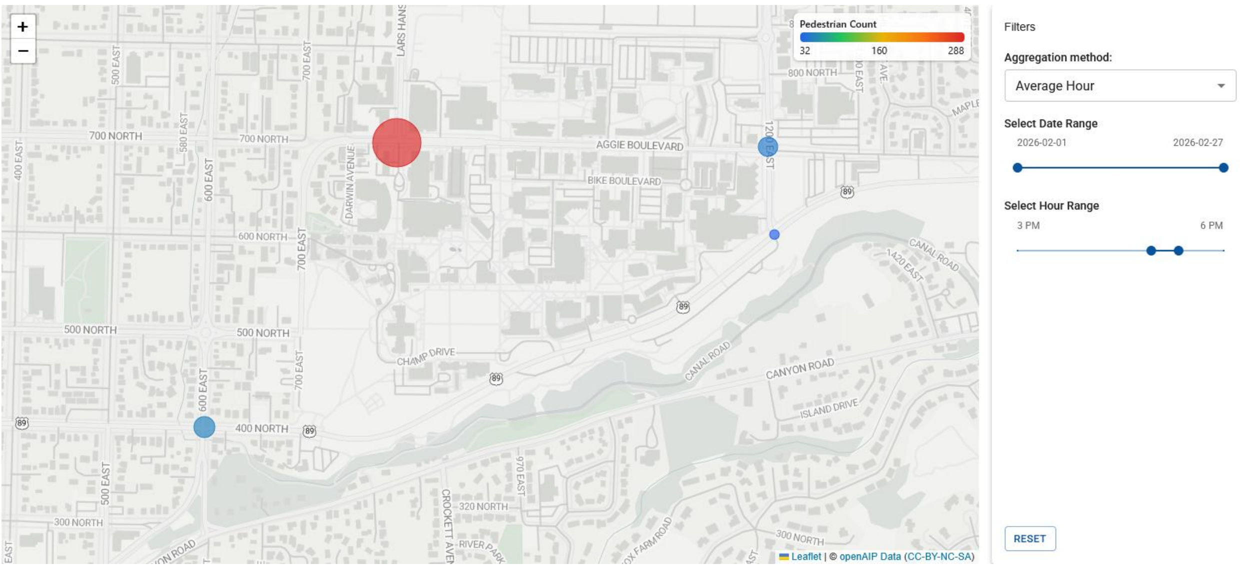


Figure 4.5: PEDAT in ATSPM 5.2: Map

The fourth and final **Data** section displays data tables that replicate those shown in PEDAT Version 1. As shown in Figure 4.6, the first table shows the queried data, with information about the signal ID, address, city, latitude longitude, timestamp, and estimated pedestrian volume. The second table presents descriptive statistics for these data.

Data By Hour By Location

Signal ID	Address	Timestamp	Pedestrians	City	Latitude	Longitude
5286	US-89 & 1200 E (LGN)	2/1/2026, 12:00:00 AM	0	Logan	41.742655	-111.804134
5314	400 North (US-89) & 600 East	2/1/2026, 12:00:00 AM	0	Logan	41.738829	-111.819330
5807	Lars Hansen Dr (800 E) & Aggie Blvd (E 700 N)	2/1/2026, 12:00:00 AM	28		41.744488	-111.814188
5808	N 1200 E & Aggie Blvd (700 N)	2/1/2026, 12:00:00 AM	0		41.744405	-111.804295
5286	US-89 & 1200 E (LGN)	2/1/2026, 1:00:00 AM	0	Logan	41.742655	-111.804134
5314	400 North (US-89) & 600 East	2/1/2026, 1:00:00 AM	1	Logan	41.738829	-111.819330
5807	Lars Hansen Dr (800 E) & Aggie Blvd (E 700 N)	2/1/2026, 1:00:00 AM	15		41.744488	-111.814188
5808	N 1200 E & Aggie Blvd (700 N)	2/1/2026, 1:00:00 AM	0		41.744405	-111.804295
5286	US-89 & 1200 E (LGN)	2/1/2026, 2:00:00 AM	0	Logan	41.742655	-111.804134
5314	400 North (US-89) & 600 East	2/1/2026, 2:00:00 AM	1	Logan	41.738829	-111.819330
5807	Lars Hansen Dr (800 E) & Aggie Blvd (E 700 N)	2/1/2026, 2:00:00 AM	2		41.744488	-111.814188
5808	N 1200 E & Aggie Blvd (700 N)	2/1/2026, 2:00:00 AM	0		41.744405	-111.804295
5286	US-89 & 1200 E (LGN)	2/1/2026, 3:00:00 AM	0	Logan	41.742655	-111.804134
5314	400 North (US-89) & 600 East	2/1/2026, 3:00:00 AM	0	Logan	41.738829	-111.819330
5807	Lars Hansen Dr (800 E) & Aggie Blvd (E 700 N)	2/1/2026, 3:00:00 AM	2		41.744488	-111.814188

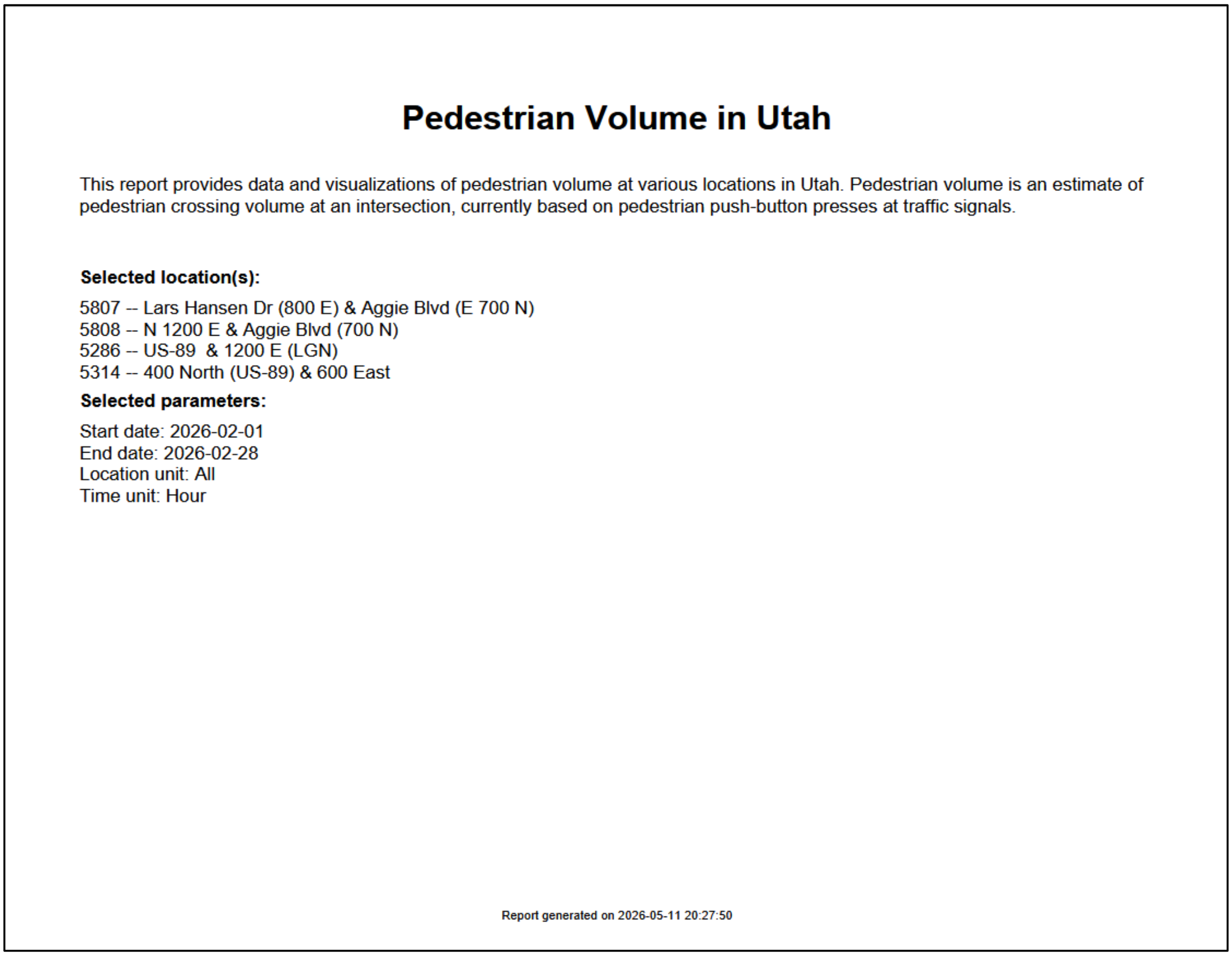
Descriptive Statistics By Hour by Location

Signal ID	Total Sum	Mean	Std Dev	Min	25%	50%	75%	Max	Missing
5807	103,418	160	159	0	5	89	315	520	0
5808	16,626	26	34	0	0	5	50	148	0
5286	11,740	18	24	0	0	5	35	96	0
5314	16,298	25	26	0	3	16	41	165	0

Figure 4.6: PEDAT in ATSPM 5.2: Data

At the bottom of the Pedestrian Activity page are three boxes. The first “Download Data” downloads the first data table. The second “Download Statistics” downloads the second data table. Both downloaded files are CSVs.

The third button is “Generate Report” and this creates and downloads a PDF report. Just like in PEDAT Version 1, this report begins with a simple description of the selected locations and selected parameters, as shown in Figure 4.7. The subsequent pages contain all of the figures from the Averages and Figures sections, one per page.



Pedestrian Volume in Utah

This report provides data and visualizations of pedestrian volume at various locations in Utah. Pedestrian volume is an estimate of pedestrian crossing volume at an intersection, currently based on pedestrian push-button presses at traffic signals.

Selected location(s):

5807 -- Lars Hansen Dr (800 E) & Aggie Blvd (E 700 N)
5808 -- N 1200 E & Aggie Blvd (700 N)
5286 -- US-89 & 1200 E (LGN)
5314 -- 400 North (US-89) & 600 East

Selected parameters:

Start date: 2026-02-01
End date: 2026-02-28
Location unit: All
Time unit: Hour

Report generated on 2026-05-11 20:27:50

Figure 4.7: PEDAT in ATSPM 5.2: Report Page 1

5.0 RECOMMENDATIONS

5.1 Overview

This chapter presents additional recommendations (beyond what has already been implemented) arising from the PEDAT pedestrian-data-platform research project. Recommendations are organized into three areas: improving the underlying data, enhancing the tool and its user interface, and conducting further research.

5.2 Recommendations: Data Cleaning

Traffic signal data are not perfect; they are subject to many of the same types of anomalies that affect any sort of automated data process. There can be connectivity losses to a traffic signal that result in time periods with missing data, due to (for instance) a power outage, construction project, traffic incident, or system maintenance. Alternatively, there could be an equipment malfunction that affects just one or a few of the pedestrian detectors at an intersection, leading to selective missing data for part or all of a crossing, or a “stuck-on” push-button that continuously or periodically registers frequent false calls or detections. In addition, special events such as major sporting events, parades, or street fairs can cause spikes in pedestrian activity that might be flagged as anomalous by an automated algorithm. Therefore, it is recommended to build in a series of additional data cleaning and quality assurance/quality control (QA/QC) processes into the PEDAT or ATSPM aggregations data processing workflow. These could include the following:

- **Missing data flag**: This check would flag an entry (e.g., 1-hour or 15-minute period) when missing data are suspected. A major challenge with developing this method is that pedestrian activity can be sparse or nonexistent, especially overnight. How can one tell whether there is no pedestrian activity (event code 90) versus missing data? The research team recommends checking other signal controller event codes—such as those associated with vehicle indicators or detectors—to see if the controller is registering any events during the candidate time period. Thresholds could also be sensitive to time of day: i.e., accept a longer time window (1 hour) without activity at night versus a shorter time window (1 minute) during busier daytime hours. Another challenge might be detecting missing data affecting just one portion of the traffic signal (e.g., one pedestrian crossing, but not the others). This could be checked by looking at a longer time period—days to weeks—and seeing if there is a sudden drop-off of activity for a particular pedestrian phase. In the PEDAT interface, entries with a missing data flag could be noted with a different color or symbol, to avoid being mistaken as indicating zero activity. Also, such missing data entries should be excluded when calculating averages for the figures and maps.

- **Erroneous data flag**: This check would flag an entry when the pedestrian data are suspected to be erroneous, such as resulting from a push-button that is stuck-on. In the research team's experience, when this happens, the controller log data often show a series of push-button press events (code 90) in rapid succession, with less than a second to a couple of seconds between them. A long-lasting issue like this could be easily detected from the aggregated ATSPM data by checking for anomalously high numbers of #90s per 15-to-60-minute time period. If instead this tends to happen for several seconds following a real button-press, this may need to be detected through a process applied to the raw-event data logs that checks for many #90 events with small time differences or high #90s per minute. Another challenge may be not flagging real spikes in pedestrian activity due to special events, so thresholds must be calibrated carefully. In any case, pedestrian volume estimates during periods with erroneous data are likely not trustworthy, so the PEDAT interface should also note these with a color or symbol and avoid including them in calculations. An advanced feature could have a checkbox to allow users to see the implications of including versus not including entries with an erroneous data flag.

5.3 Recommendations: PEDAT Enhancements

Some functionality of the PEDAT pedestrian data platform could be redesigned to make it more "future proof." One specific enhancement would be to provide the functionality to eventually support pedestrian volumes by direction of movement. Currently the tool only provides estimates of pedestrian volumes for each crosswalk (usually), because it relies on the

ATSPM signal data that is organized by pedestrian phase number. In most cases, the two push-buttons associated with a particular crosswalk (e.g., the north crosswalk) are linked to the same phase, making it impossible to know which push-button was pressed and which direction pedestrians were traveling (e.g., east-to-west or west-to-east). However, depending on signal controller hardware and software, it may be possible to split each push-button out to have a separate code (detector channel), which would allow for movement-specific volume estimates to be developed. This would require modifications to the underlying database structure (to capture direction not just phase/crosswalk) and potentially to the pedestrian-volume-estimation methods themselves, in addition to any modifications to the traffic signal programming or controller logic.

A related enhancement would be to improve how pedestrian aspects are documented in traffic-signal configuration files. It is currently not possible to know for sure which pedestrian phase is associated with which crosswalk without inspecting each intersection individually. The configuration section of ATSPM does not list pedestrian detectors. Furthermore, there is some variety in how pedestrian detection is programmed into traffic signal controllers. Historically, sometimes two different crosswalks were assigned to the same pedestrian phase; e.g., pressing the button to cross the south crosswalk would activate the north crosswalk at the same time. More recently, pedestrian push-buttons and detector channels are being used to accommodate more sophisticated signal operations, such as separate bike-specific buttons and crossings. Overall, there is an urgent need to develop standard configuration information for pedestrian detections: e.g., push-button detector 10 is associated with pedestrian phase 6, which is the west crosswalk. This could allow the PEDAT interface to not just show pedestrian volumes by phase number but by crosswalk, allowing for easier interpretation of the results as well as enhanced displays that visually show volumes by crosswalk at a particular intersection. This additional configuration information would also support future movement-specific pedestrian volume estimates (by coding each push-button as a separate detector), as described in the previous paragraph.

The PEDAT pedestrian data platform (both Versions 1 and 2) currently only presents pedestrian volume estimates for signalized intersections. During the stakeholder meetings, several users expressed a desire to see more sources of pedestrian data presented here, potentially including continuous pedestrian counts from trail counters and similar counting equipment;

short-duration pedestrian counts from traffic studies or volunteer counting efforts; and/or transit ridership (boardings and alightings) from public transit agencies for stops in the public right-of-way. Future work could add these non-signal-based pedestrian data sources to some version of PEDAT, maybe one that lives outside of ATSPM. A related potential enhancement could extend pedestrian volume estimates from signals to non-signalized intersections and/or non-intersection planning geographies (e.g., block groups, transportation analysis zones), as originally envisioned by the PEDAT Local flavor (see Section 1.1.2). One possible way to achieve this is to use signal-based volume estimates to create direct-demand pedestrian volume models, utilizing associations with land use, built environment, and population characteristics (Singleton, Park, & Lee, 2021). Such pedestrian volume estimates could vary by time of day and day of week, and/or utilize spatial interpolation to help create more time-sensitive estimates of pedestrian activity.

In stakeholder meetings, planners especially also expressed an interest in linking the pedestrian volume estimates included in the PEDAT data platform with other data sources, including traffic volumes, US Census Data, and other planning layers. This suggests a need for a more static version of PEDAT that is a geospatial layer for use in planning efforts. This could include basic information derived from the more dynamic currently developed versions of PEDAT. For instance, annual average daily pedestrian volumes (overall and by day of week and month of year) along with annual average hourly pedestrian volumes (by hour of day) would be useful metrics to produce for each calendar year and archive as feature layers in UDOT's geospatial data systems like UPlan. A workflow could be developed that, once a year, queries the same ATSPM aggregation data, applies pedestrian-volume-estimation methods, and summarizes the results into a format suitable for planning, including annual average pedestrian volumes for all signals statewide.

5.4 Recommendations: Future Research

The PEDAT pedestrian data platforms (Versions 0.5, 1, and 2) all rely upon pedestrian-volume-estimation methods (see Section 3.2.3) that were developed from large-scale Utah-based observations in 2019 (Singleton, Runa, & Humagain, 2020; Singleton & Runa, 2021). Although the methods were verified through additional data collection in late 2020 during the COVID-19 pandemic (Runa & Singleton, 2023), it is recommended that additional research periodically—

say, every five years—collects observed pedestrian volumes at a sample of locations and compares them to the model-predicted volumes. This work would examine the accuracy of the models and (if necessary) recommend recalibrations or modifications to the pedestrian-volume-estimation equations (see Table 3.3) moving forward.

Related, similar research comparing observed pedestrian volumes to push-button-based signal metrics in Oregon recently concluded (Kothuri et al., 2024). There, the authors determined that simpler equations could predict pedestrian volumes with acceptable (if not higher) accuracy and transferability. This raises the question of whether there may be simpler equations or methods that may be applied in Utah. Future research could revisit the pedestrian-volume-estimation methods (including utilizing newly collected data as described in the previous recommendation) and examine whether simpler or improved methods are warranted. This research would consider both statistical and machine learning approaches.

Finally, pedestrian detection technology continues to advance. During the COVID-19 pandemic, Utah started implementing no-touch "push-buttons" that could be activated by a wave. Also, UDOT is installing LiDAR units at many signalized intersections that have the potential to automatically detect and track pedestrians as they move throughout the intersection area. Furthermore, the original research project did not distinguish whether push-buttons had indicator lights that might show other pedestrians that the button has already been pressed. Future research should investigate how pedestrian push-button technologies might be affecting the relationships between signal-based measures of pedestrian activity and pedestrian volumes. Additionally, as the technology to passively monitor pedestrians (e.g., LiDAR) advances and becomes more widely deployed, UDOT should try to record those volumes and integrate them into this PEDAT pedestrian data platform, potentially as a replacement for push-button estimated pedestrian volumes. This work would ensure the longevity of this project's efforts at providing improved pedestrian data and monitoring throughout Utah.

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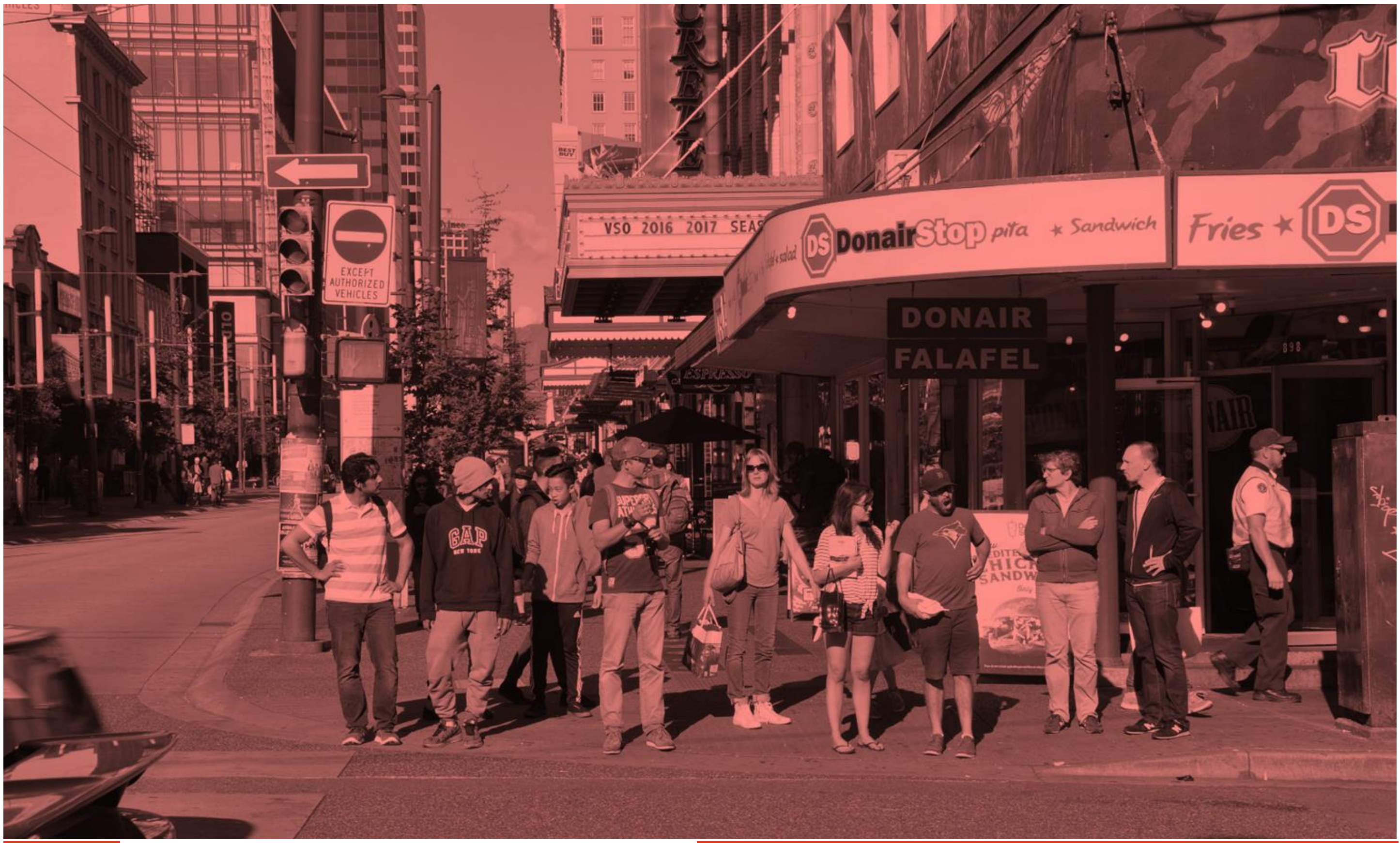
<u>APPENDIX A: PEDAT VERSION 1 USER GUIDE</u>

Attached is the *Pedestrian Activity Data Visualization Dashboard User Guide*, documenting how to use the PEDAT Version 1.0 described in Chapter 3.0 and available (as of publication) online (UDOT, USU, & STL, 2024). While this version of PEDAT is no longer being maintained—see instead the ATSPM-integrated version described in Chapter 4.0—the functionalities of both tools are similar, and many of the instructions in this user guide still apply.

Pedestrian Activity Data Visualization Dashboard User Guide

Singleton Transportation Lab, Utah State University



INTRODUCTION

This document serves as the User Guide for the Pedestrian Activity Data (PEDAT) Visualization Dashboard, an advanced analytical platform designed to present and interpret pedestrian traffic data within Utah. The guide aims to provide comprehensive insights into the dashboard's functionalities and applications, catering to the needs of researchers, urban planners, and traffic management professionals.

The dashboard, a collaborative effort between the Singleton Transportation Lab and the Utah Department of Transportation, focuses on delivering nuanced visualizations and data about pedestrian activity in various locations throughout the state. It primarily utilizes pedestrian push-button data, gathered from the high-resolution traffic signal controller log data of the Utah Department of Transportation's Automated Traffic Signal Performance Measures (ATSPM) system. In this context, "pedestrian activity" refers to the estimated number of pedestrian crossings at intersections, a metric estimated through the analysis of pedestrian push-button interactions. This methodology, validated by research from the Singleton Transportation Lab at Utah State University, ensures a reliable approximation of pedestrian volumes based on traffic signal data.

The ensuing sections of this guide elaborate on the operational aspects of the dashboard, offering detailed instructions and insights into effectively harnessing its capabilities for data-driven decision-making in urban pedestrian traffic management.

DASHBOARD OVERVIEW

This section of the user guide provides a detailed overview of the main components of the Pedestrian Activity Data Visualization Dashboard. Understanding the structure and functionalities of these components is essential for effective navigation and utilization of the dashboard. Figure 1 shows the overview of the dashboard.

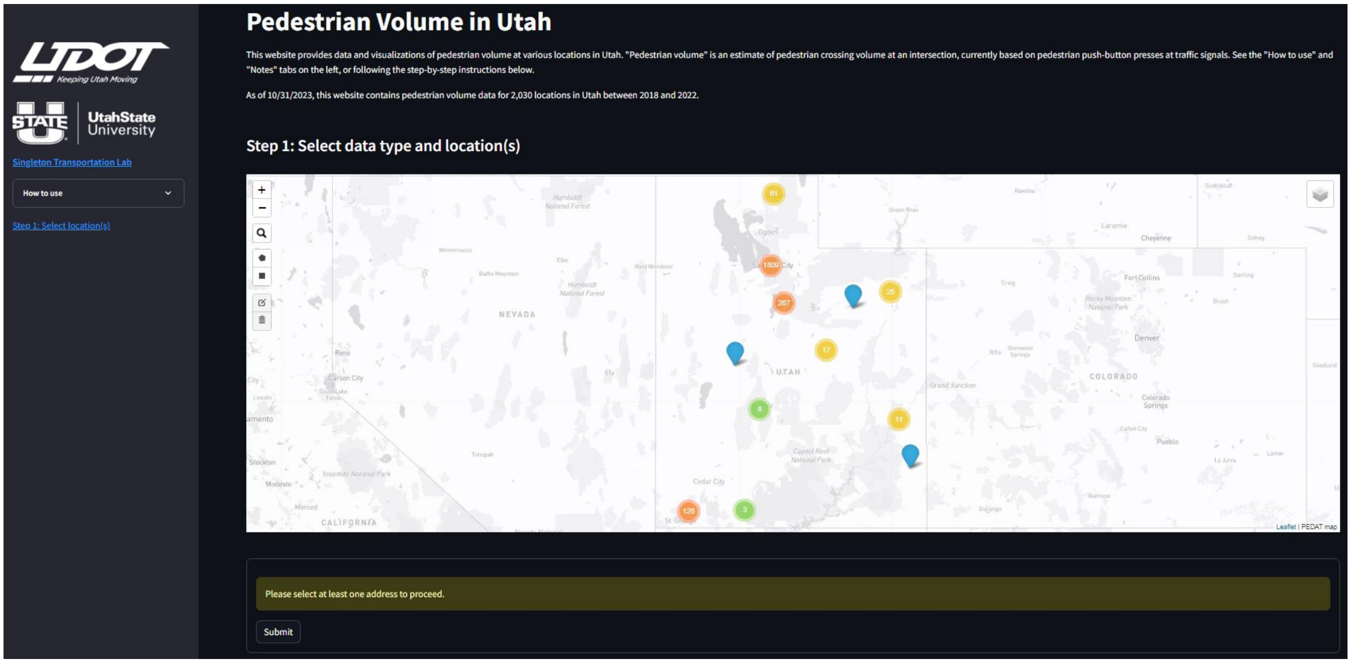


Figure 1: An overview of the PEDAT dashboard

Sidebar

The sidebar of the dashboard is a key navigational tool that aids users in efficiently accessing various features and functionalities. It is divided into the following segments:

How to Use

This section offers a concise guide on the operational aspects of the dashboard, providing users with clear instructions on how to navigate and utilize the various features effectively.

Links to Dashboard Sections

Here, users can find direct links to different parts of the dashboard. This feature enables quick navigation, allowing users to easily switch between various data views and analysis tools.

Notes

The Notes section contains important information, observations, and disclaimers relevant to the data and functionalities of the dashboard. It serves as a crucial reference point to understand the context and limitations of the displayed data.

Main Page

The main page is where the core functionalities of the dashboard are displayed and interacted with. It consists of the following elements:

Map for Selecting Locations

The interactive map allows users to select specific locations for which they wish to view pedestrian activity data. This feature enables a focused analysis of pedestrian volumes at chosen intersections or areas.

Data Type Selection

Users can select the type of data they wish to view, such as recent data (last 1 year) or historical data (last 5 years). This customization enhances the relevance and specificity of the analysis.

Dashboard Parameters

This area allows users to adjust various parameters that influence the data display and analysis, such as time unit, location unit, and other filters.

Outputs

The output section presents the results of the data analysis. It displays visualizations such as graphs, charts, maps, tables, and reports, offering an intuitive understanding of the pedestrian activity data.

HOW TO USE THE DASHBOARD

This section of the user guide outlines the step-by-step process for effectively utilizing the Pedestrian Activity Data Visualization Dashboard. By following these instructions, users can navigate the dashboard's various features to analyze pedestrian activity data based on their specific requirements.

Step 1: Selecting Locations

Location(s) Selection from the Map

Users can select one or more locations from the map. This can be done using the drawing tools available on the map or by searching for a specific address using the search icon. Figure 2 displays the process of selecting locations from the map.

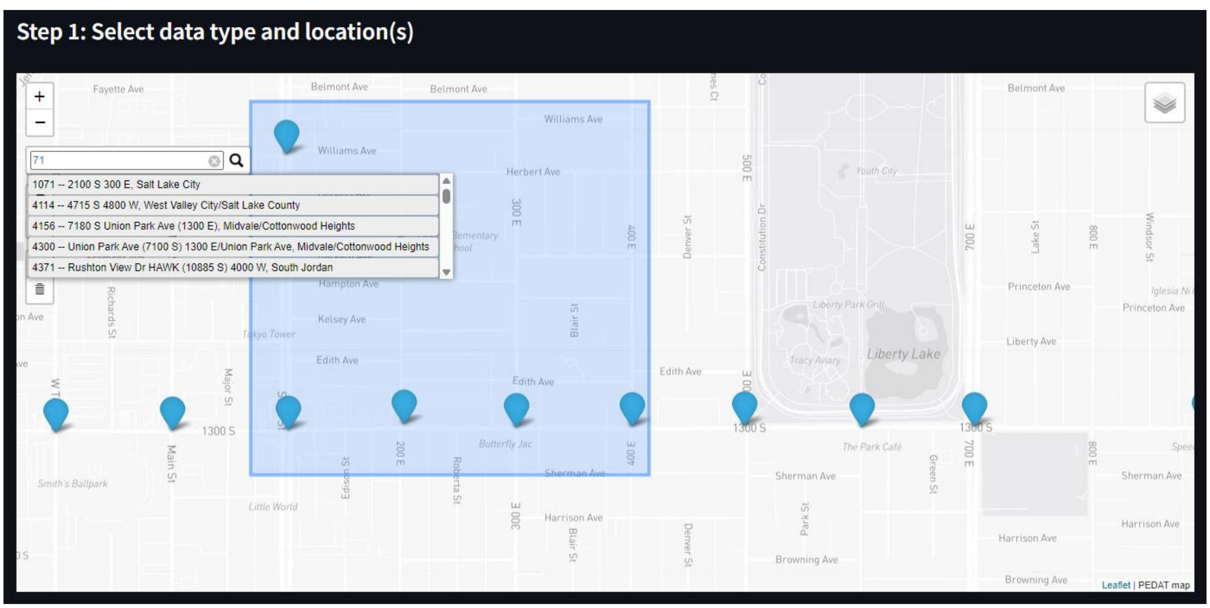


Figure 2: A view of selecting locations from the map

Important note: We recommend selecting no more than 10 locations for visualization and dashboard performance.

Review and Select the Locations

In this section, users can review the selected location, add more locations, or unselect some of them. Figure 3 depicts a view of the reviewed locations.

Figure 3: A view of reviewing locations

Choosing Data Type

Recent Data

Users can opt for recent data, which includes hourly pedestrian activity data from the last year.

Historical Data

Alternatively, historical data spanning the last five years is available for a more extended analysis. Figure 4 shows the data type selection view.

Figure 4: A view of selecting the data type section

After reviewing the locations and making some possible changes, users can submit the form. The dashboard will then start creating elements such as plots, maps, tables, and reports.

Step 2: Select Parameters

Users can set dashboard parameters and filter data. Figure 5 displays the dashboard parameters selection view.

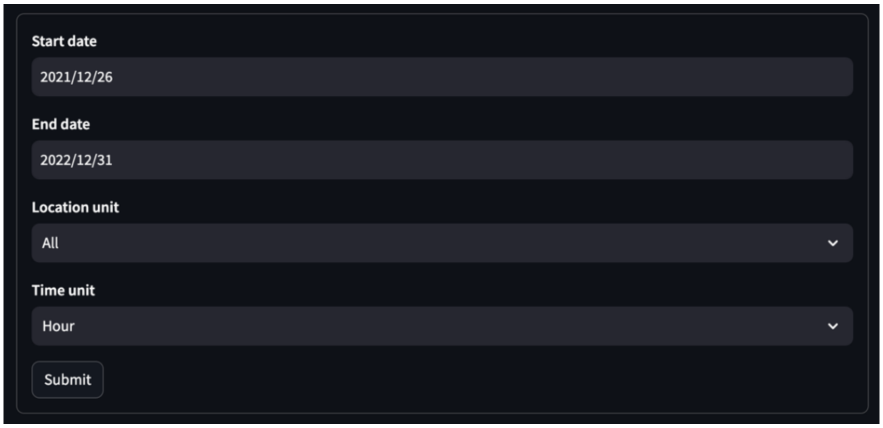


Figure 5: A view of selecting parameters section

Time Range

Users can define a specific time range for the data analysis.

Location Unit Selection

This option allows the selection of separate phases of an intersection. The default setting includes all location units.

Time Unit Selection

Users can choose the granularity of the data - hourly, daily, weekly, monthly, or yearly.

Submitting Parameters

It is crucial to press the "Submit" button to apply the selected parameters and view the changes in the dashboard.

Output Section

Figure 6 provides an overview of the outputs section.

Figure 6: An overview of the outputs section

Overall Metrics

Initially, users will see the overall metrics, including the total number of pedestrians, the number of selected signals, and the chosen start and end dates.

Averages Section

This section includes charts showing:

- Average daily pedestrian activity by location.
- Average hourly pedestrian activity by hour (for recent data).
- Average daily pedestrian activity by day-of-week and month-of-year.

Figure 7 displays a sample output from the averages section.

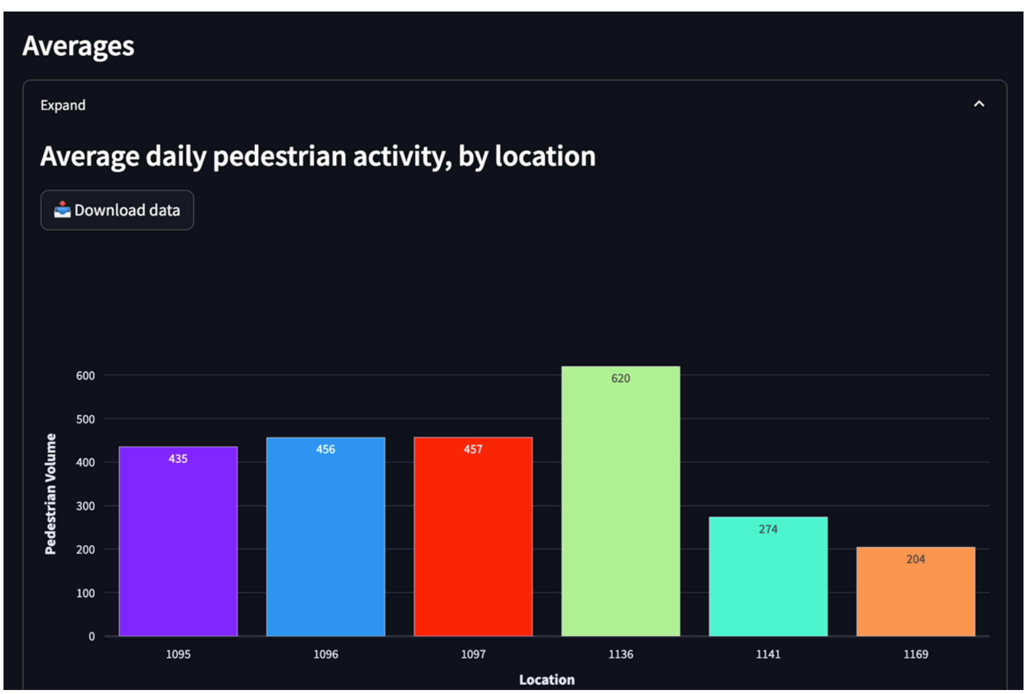


Figure 7: A sample output from the averages section

Figures Section

The figures section displays:

- Total pedestrian activity by location.
- Time series of pedestrian activity by selected time unit and location.
- Box plot of pedestrian activity by selected time unit and location.

Figure 8 displays a sample output from the figures section.

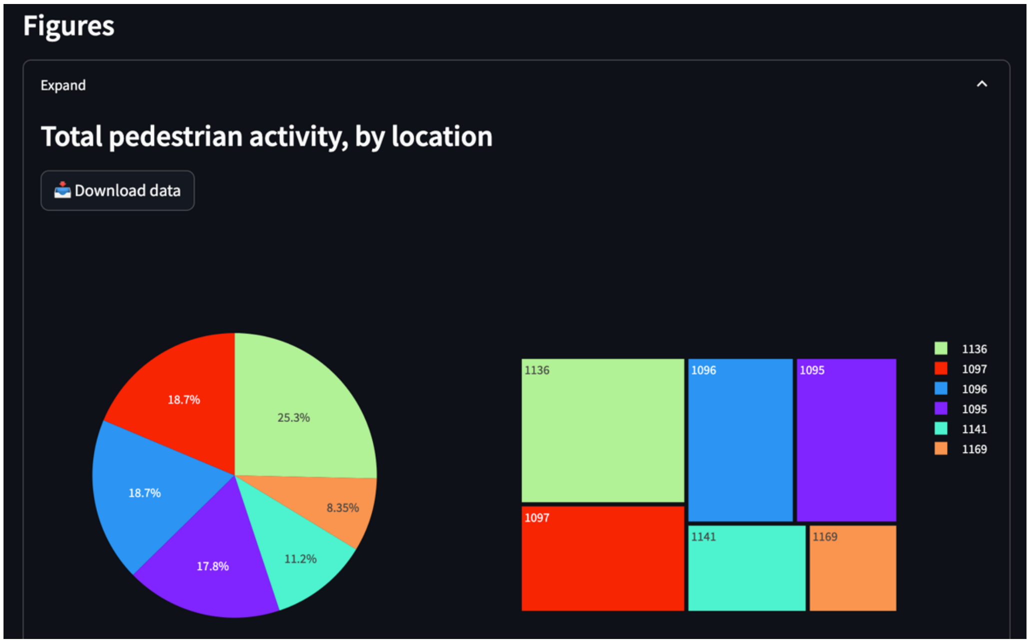


Figure 8: A sample output from the figures section

Map Section

Following the figures, the map section provides a visual representation of the data. In this section, the user can select aggregation methods or choose the desired date and time. Figure 9 shows a sample output from the map section.

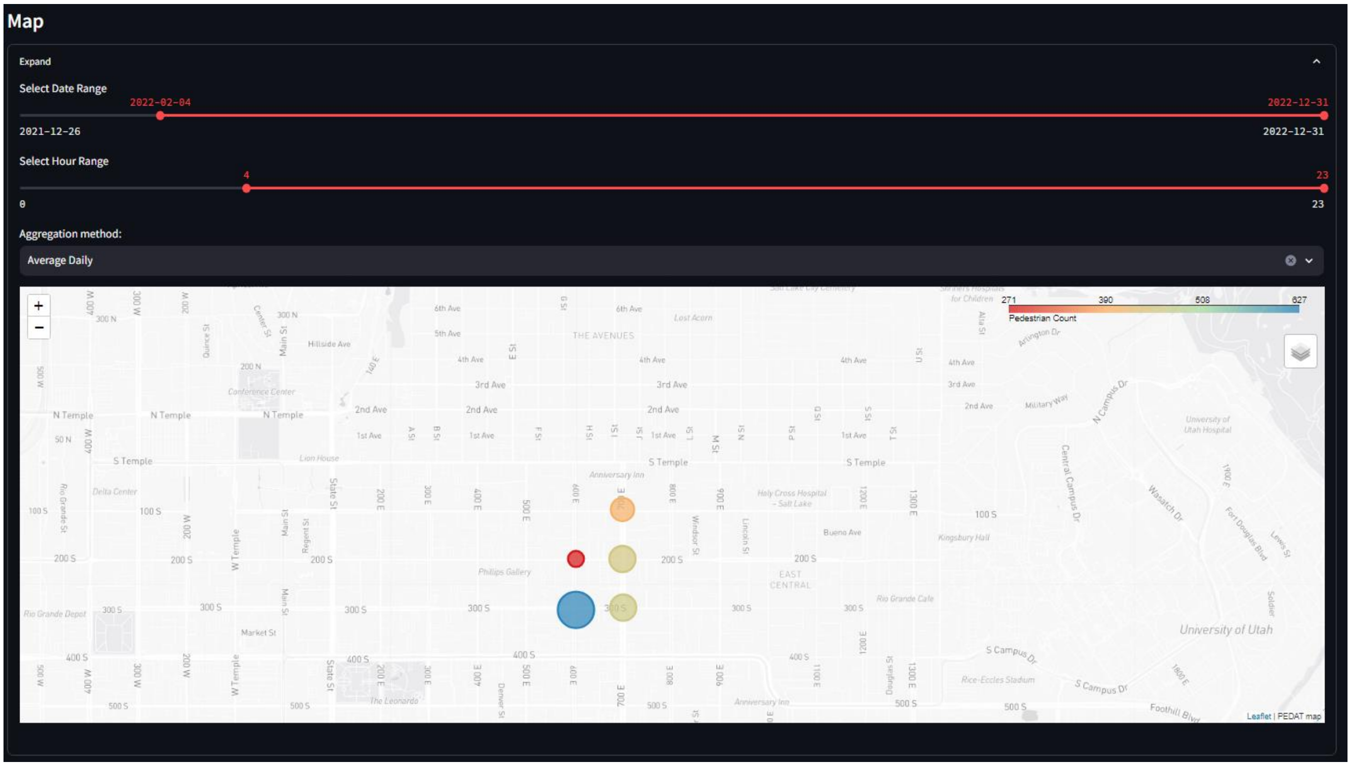


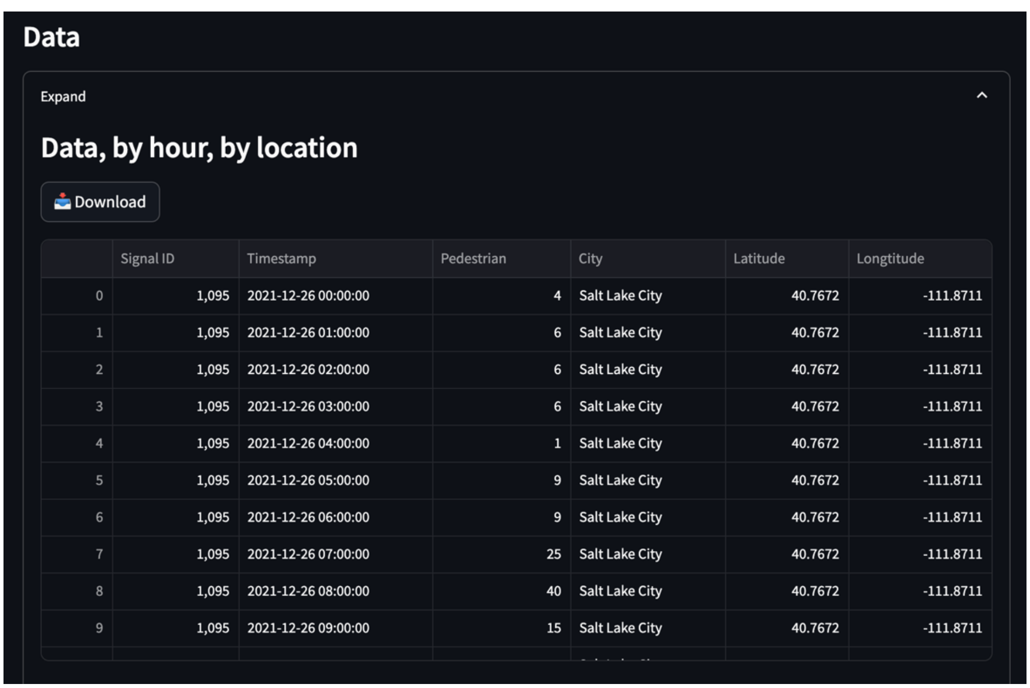
Figure 9: A sample output from the map section

Data Section

This section contains tables including:

- Data by selected time unit and location.
- Descriptive statistics by selected time unit and location.

Figure 10 displays a sample output from the data section.



	Signal ID	Timestamp	Pedestrian	City	Latitude	Longtitude
0	1,095	2021-12-26 00:00:00	4	Salt Lake City	40.7672	-111.8711
1	1,095	2021-12-26 01:00:00	6	Salt Lake City	40.7672	-111.8711
2	1,095	2021-12-26 02:00:00	6	Salt Lake City	40.7672	-111.8711
3	1,095	2021-12-26 03:00:00	6	Salt Lake City	40.7672	-111.8711
4	1,095	2021-12-26 04:00:00	1	Salt Lake City	40.7672	-111.8711
5	1,095	2021-12-26 05:00:00	9	Salt Lake City	40.7672	-111.8711
6	1,095	2021-12-26 06:00:00	9	Salt Lake City	40.7672	-111.8711
7	1,095	2021-12-26 07:00:00	25	Salt Lake City	40.7672	-111.8711
8	1,095	2021-12-26 08:00:00	40	Salt Lake City	40.7672	-111.8711
9	1,095	2021-12-26 09:00:00	15	Salt Lake City	40.7672	-111.8711

Figure 10: A sample output from the data section

Report Generation
Users can generate a PDF report based on the selected data and parameters.

Additional Notes

In each section, users have the option to download relevant data using the download button. Also, quick navigation to each section is facilitated through links in the sidebar.

ADDITIONAL SUPPORT

Should you encounter any difficulties or have questions that are not addressed in this guide, please feel free to reach out to the support team Patrick Singleton (patrick.singleton@usu.edu) or Amir Rafe (amir.rafe@usu.edu). We are committed to ensuring that your experience with the Pedestrian Activity Data Visualization Dashboard is both productive and insightful.

FEEDBACK

Your feedback is invaluable to us. We continually strive to improve the dashboard and this guide. Please share your suggestions or comments to Patrick Singleton (patrick.singleton@usu.edu) or Amir Rafe (amir.rafe@usu.edu).

Thank you for using the Pedestrian Activity Data Visualization Dashboard. We trust that this tool will be an essential component in your efforts to analyze and optimize pedestrian activity and safety in Utah.

APPENDIX B: REPORTS FROM STAKEHOLDER MEETINGS 1 AND 2

Attached are meeting notes from the two stakeholder meetings described in Chapter 2.0, held in November 2022 and February 2023, to solicit input from practitioners to inform the development and design of the PEDAT pedestrian data platform.

UDOT Pedestrian Data Platform
Stakeholder Meeting 1
23 November 2022
Meeting Notes

Meeting notes were prepared by Patrick Singleton (patrick.singleton@usu.edu) and Amir Rafe (amir.rafe@usu.edu). Contact with questions or corrections.

Agenda

- Introductions
- Project overview
- Discussion/Q&A
- Next steps

Attendees

- Utah State University (USU): Patrick Singleton, Amir Rafe
- Utah Department of Transportation (UDOT): Natalia Brown, Trevor Egan, Travis Evans, Heidi Goedhart, Andre Gwynn, Jonathan Harman, W. Scott Jones, Neda Kiani, Robert Miles, Chad Moore, Andrea Moser, Suyanka Neupany, Josh Stapley, Mark Taylor, Peter Tang, Kai Tohinaka, Evan Van Tassel

Project overview

To start the meeting, Patrick Singleton provided an overview of the UDOT Pedestrian Data Platform research project. The objective is to develop a robust pedestrian data platform for UDOT that can be useful for a variety of tasks in planning, design, operations, etc. This work addresses the general lack of pedestrian data, and builds upon previous UDOT-sponsored research projects. The first project developed a method to calculate rough pedestrian volumes using pedestrian push-button data available at most Utah traffic signals through the Automated Traffic Signal Performance Measures (ATSPM) system. Later work applied these volumes to calculate annual average daily pedestrian (AADP) crossing volumes for all signals, connected these data to built environment and land use characteristics to predict AADP for non-signalized intersections and segments, and utilized these data as measures of exposure in a statewide systemic pedestrian safety analysis. More information is available in the attached presentation.

As part of previous work, the USU team developed several demo and working prototype online visualizations to help make sense of this new potential source of pedestrian data.

- Estimated AADP for intersections with traffic signals: https://arcg.is/1aTT4f
- Predicted AADP for all types of intersections: https://arcg.is/0GO0Cv
- Demo visualization for Logan, Utah: https://singletonpa.shinyapps.io/ped-viz/
- Working visualization for all of Utah: https://singletonpa.shinyapps.io/ped-covid19/

The goal of the current research project is to improve and expand these platforms, making them more robust and enhancing their capabilities to meet the needs of potential users. To accomplish this, the USU team needs to understand the needs/wants of potential users. That is the purpose of the first stakeholder meeting with potential internal-to-UDOT users.

Discussion/Q&A

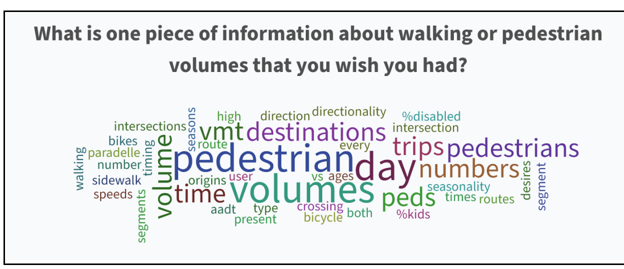
The majority of the meeting time was dedicated to soliciting feedback from attendees about what users would want to see from a pedestrian data platform. Given the large number of participants (17), Patrick Singleton facilitated a structured hour-long discussion session, assisted by polls on the Poll Everywhere platform. Thus, this summary of feedback will utilize results from the polling as well as feedback shared orally during open discussion.

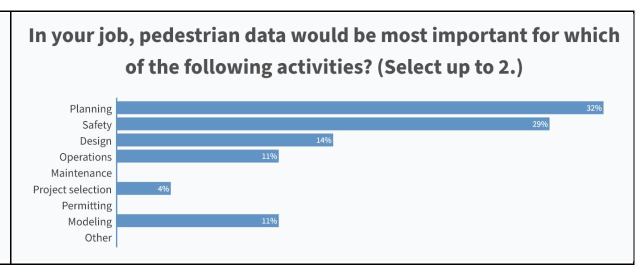
Uses for pedestrian data

The first section asked attendees about how they would use information from a pedestrian data platform. Specific questions included:

- What is one piece of information about walking or pedestrian volumes that you wish you had? {open response}
- In your job, pedestrian data would be most important for which of the following activities? (Select up to 2.) {Planning, Safety, Design, Operations, Maintenance, Project selection, Permitting, Modeling, Other}
- If you had access to data on estimates of pedestrian activity in different places and for different times, how would you use this information? {open discussion}
- What are use cases for pedestrian count analysis within your expertise? Where are you going to use it? How? {open discussion}
- What are your pedestrian data needs in more rural areas? {open discussion}

Responses to the poll responses are as follows:





The session started off with an open-ended question about desired information about pedestrians. This was designed as an ice-breaker to help people start thinking about what they might want out of a pedestrian data platform. Many people mentioned quantification of the amount of pedestrian activity: volumes, numbers, person-distances-traveled, trips, etc. Variations in travel amounts by time-of-day, day-of-week, or season. Other desired information included: directionality of travel, destinations, crossing desires, walking speeds, and user characteristics (age, disability).

To help start to focus the following discussion, the next question asked people to select one or two categories of work activities where pedestrian data would be more important. The two most frequent selected categories, were planning and safety, with around 30% each. Other commonly-selected activities were design, operations, and modeling. Project selection was picked by one person, and no-one picked maintenance, permitting, or other options. In subsequent discussion, it was noted that this shouldn't imply that these other activities are not important potential uses of pedestrian activity, just that their use isn't as urgent or necessary as for planning, safety, design, and operations.

Since **planning** (and **modeling**) were the most-frequently selected use categories, open discussion mentioned several important potential planning uses for pedestrian information:

- In general, it was mentioned that pedestrian volume is a measure of **demand** (either current/actual use or future/potential use), which has many potential planning applications.
- This demand can help in the prioritization process, when selecting projects. Priority could be placed on projects or facilities in areas with more current or future demand.
- Understanding pedestrian volumes could help to prioritize efforts to complete sidewalks / pedestrian networks.
- Pedestrian volumes are needed to help evaluate warrants for signals and crosswalks. A system could even proactively monitor the need for signal warrants in response to changing volumes.
- Pedestrian volume information could be useful context for pedestrian audits, including Walk the Road events with transportation staff and local government officials.
- Pedestrian volumes could also be used to calibrate travel demand models.
- Pedestrian volume information might even be useful for preparing environmental documents (EA, EIS). Right now, this information is based on proxies (like demographics).
- Pedestrian information could be very important for informing planning around first-mile/last-mile access to transit, such as station-area planning near rail or bus stops.

Safety was another frequently-selected application area. Discussion covered these topics:

- In general, it was mentioned that pedestrian volume is a measure of **exposure** (potential for collisions), which is highly needed for pedestrian safety applications.
- By accounting for pedestrian exposure, crash analyses can utilize crash data, study crash histories, analyze hot spots, and calculate crash rates. In other words, volumes provide context about pedestrian crashes, to tell if high numbers are due to high demand or very unsafe conditions.
- Existing processes of assessing pedestrian safety (e.g., signal warrants, hot spots based on historical crash data) are not satisfactory. Attendees would like better ways to figure out where/when/why people cross (or want to cross) the street, so that infrastructure can be designed and operated to improve safety. This would be a more proactive approach to pedestrian safety that fits within the safe systems approach.
- Other safety example uses included: using time-lapse cameras to track walking behaviors, analyzing desire lines (paths through vegetation).

There was a little discussion about how pedestrian data could help **design** tasks.

- Most design applications were connected to the use of volumes that were also useful for planning and safety activities. Knowing the volumes and origins/destinations could help to make more robust pedestrian infrastructure in places with higher demand.
- Design activities that could be informed by pedestrian data include the placement, sizing, and design of pedestrian ramps, curb extensions, sidewalks, etc. For example, wider ramps/sidewalks could be placed in areas with high pedestrian volumes.
- Design applications might also benefit from understanding who is walking: younger or older people, those with disabilities or other mobility limitations.
- This information might also assist with the design of driveways or access management activities.

Operations and **maintenance** were also discussed a little. The frequency of pedestrians at traffic signals could help to: design splits, or prioritize where to place additional ADA-related equipment needed to assist people with mobility limitations. Related to signals and safety, there was a desire to understand compliance at signals, both among pedestrians (jaywalking) and drivers (yielding, near misses). Regarding maintenance, knowing the size and timing of pedestrian crowds (seasonal pedestrian volumes) could help to inform sidewalk maintenance activities, such as snow clearance.

A few other potential uses were mentioned briefly in passing. Pedestrian volume information could help to place specific traffic limitations on construction or development projects, during the permitting phase. In the private sector, pedestrian volume information might even be valuable to developers or advertisers, to know how much foot traffic a specific location receives.

Since most of the discussion of uses focuses on more urban contexts, a discussion question also asked about potential uses in **rural areas**. In general, the audience felt like the same needs/uses applied to small town conditions. One unique rural use case was studying traffic crossing locations (and similar situations, like campgrounds and climbing areas), to inform safety and operational improvements. Another example was understanding patterns of pedestrian activity in places with discontinuous or missing sidewalks.

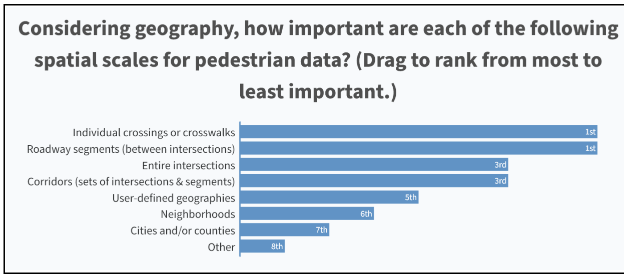
Spatial and temporal dimension

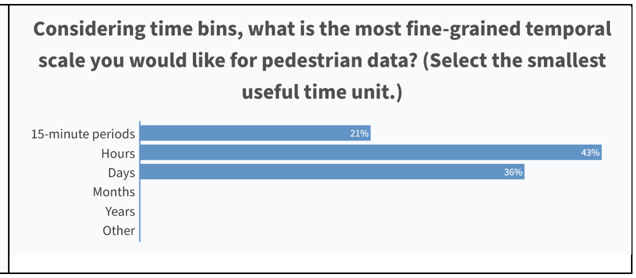
The second section asked attendees about their needs and wants for pedestrian data in terms of spatial and temporal dimensions. Specific questions included:

- Considering geography, how important are each of the following spatial scales for pedestrian data? (Drag to rank from most to least important.) {Individual crossings or crosswalks, Entire intersections, Roadway segments (between intersections), Corridors (sets of intersections & segments), Neighborhoods, Cities and/or counties, User-defined geographies, Other}
- Considering time, what is the most fine-grained temporal scale you would like for pedestrian data? (Select the smallest useful time unit.) {15-minute periods, Hours, Days, Months, Years, Other}
- Regarding temporal scales: Will you want to see total numbers of pedestrians within these time units, or averages of pedestrian activity, or both? {open discussion}

- Regarding spatial scales: For what purposes do you need pedestrian data at each of these geographic units? {open discussion}
- How important are the following features for you? (Rate on a scale: Very important, Somewhat important, Not important) {Historical pedestrian data (several years ago), Pedestrian activity in the recent past (hours, days, months), Future predictions of pedestrian activity}
- How far back in time would you want to see data? {open discussion}
- How far into the future would you want to predict? {open discussion}

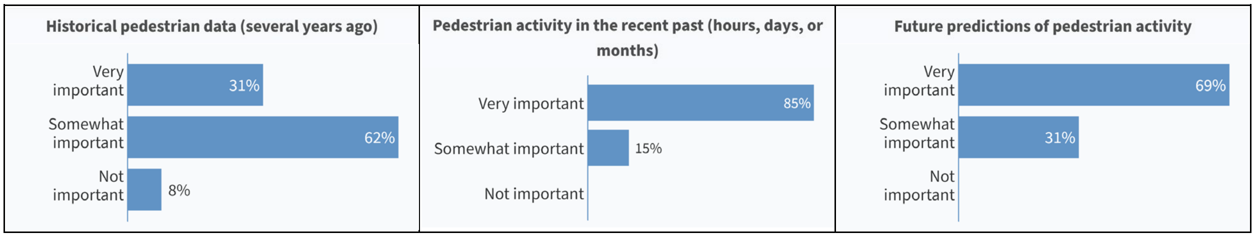
Responses to the first set of poll responses are as follows:





Regarding **geography**, being able to present information at multiple geographies seemed to be very important to respondents. Generally, they wanted to access data at more fine-grained spatial units (crossings, intersections, segments, and corridors), with less importance placed on larger-scale geographies (neighborhoods, cities, and counties). When asked, one reason provided is that larger scales are more relevant for regional planning but less actionable than scales at a corridor or less. The smaller scales are more related to specific projects that might be under planning, design, or analysis consideration. Also, smaller units could always be aggregated up to larger units when needed. The data come from the signals at the level of individual crossings or crosswalks, which are necessary for any work involving signal timing, curb ramp design, etc., and can be easily aggregated to overall intersection totals. There was a strong desire to have information on walking along and across roadway segments or corridors: this would improve understandings of pedestrian destinations, inform sidewalk widths, and provide insights into where people are or want to cross the street (whether at a designated crossing or not). Such data would also be similar to how AADT are stored (for segments); it was mentioned that it would be useful to have pedestrian data in equivalent forms as exist for motor vehicle traffic. Finally, there was some desire to have user-defined geographies, to be able to draw a shape and analyze data within that area; the reason is that active transportation projects come in different shapes and sizes, and may not fall perfectly in line with other geographies (neighborhoods or pre-existing corridors).

Regarding **time**, there was a strong desire to be able to access data at times scales of days, hours, or 15-minute periods. Generally, different uses require or would benefit from data at different time scales. 15-minute periods are standard and necessary for uses like traffic signal operations, signal warrant studies, peak-hour factors. (Real-time data might even be useful for signal operations.) Hourly data seemed to be sufficient for safety analysis, in order to observe time-of-day patterns. Hourly data could also be used to correlate volumes vs. lighting conditions (day, night) and maybe even infer trip purpose (work, school). Planning and modeling needs would likely utilize daily data and annual daily averages. Being able to compare weekdays vs. weekends and seasonal patterns also seemed useful for planning purposes.



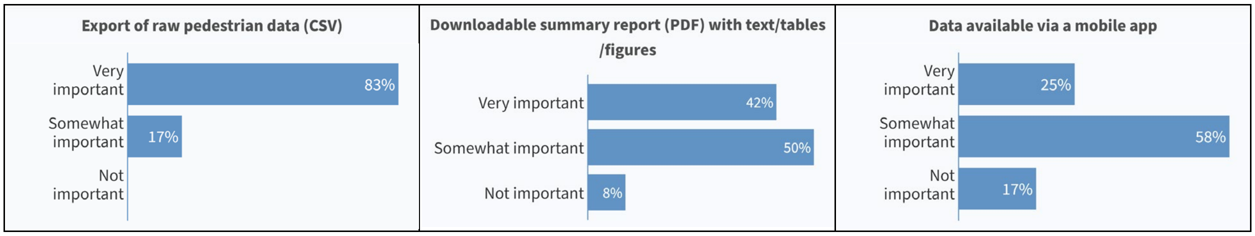
Follow-up questions asked about the importance of pedestrian data at different time points: the far past, the recent past, and the future. Generally, attendees would find the most value from data on pedestrian activity in the recent past (hours, days, or months). The importance of specific time scales seemed to depend on specific uses: for example, operations would want to see data over the last few weeks, while safety might look at data from the last couple of years (maybe 5 years maximum). There was discussion that historical pedestrian data may be useful for benchmarking: helping to measure progress. But there was also some concern that the recent past (with the COVID-19 pandemic) has been quite unusual, and in general the audience thought there is more need for current up-to-date data than data from the past. (One exception is that planning data might look up to 10 years in the past for some validation or trends.) While data about the future seemed valuable to many participants, there was concern about whether it was feasible to predict pedestrian activity into the future, how accurate that might be, and whether such predictions would have sufficient precision/granularity (e.g., for planning vs. operations). If available, long-range planning needs would likely use 10-, 20-, or 30-year time horizons, which may not be feasible using our pedestrian data sources.

Features of a platform

The third and final section focused on features that stakeholders might want to be incorporated into a platform. Specific questions asked:

- How important are the following features for you? (Rate on a scale: Very important, Somewhat important, Not important) {Export of raw pedestrian data (CSV), Downloadable summary report (PDF) with text/tables/figures, Data available via a mobile app}
- What other datasets or data sources would you want to connect with these pedestrian data? {open discussion}
- What other datasets are available (you are currently aware of them/use them) that can be a support layer to improve this ped volume data within our platform? {open discussion}
- What usability features would you want in a pedestrian data platform? {open discussion}
- How often would you use a pedestrian data platform like this? {Almost every day, Weekly, Monthly, A few times a year, Maybe just once or twice}

Responses to the first set of poll questions are as follows:



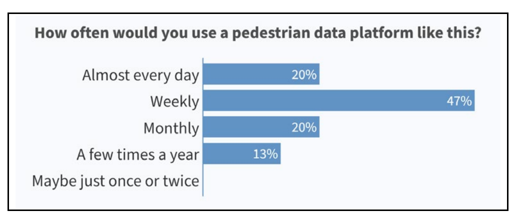
The ability to export and save the data in a machine-readable format (e.g., **CSV**) was rated as very important by most respondents. This feature seemed necessary in order to perform additional use-specific calculations and for linking the pedestrian data to other datasets. Having GIS coordinates attached to the data points was highly desirable, for compatibility with ESRI or other GIS tools. The raw data seemed most important for uses in the safety area.

Having a downloadable **report** seemed to be very or somewhat important to most attendees. People who expressed a desire to see a report mentioned being able to clearly see the summary results, diagnose issues or anomalies, and clearly communicate with decision-makers. For design uses, a report is more useful than the raw data. Multiple people expressed a desire to have a report with chart and other features be interactive rather than static. So, this could be an interactive online dashboard with the capability to customize and then download a report.

There was less interest in needed to access this data in the field or via a **mobile** app. Some examples could be gaining a live understanding of what was happening at a particular place, or future V2I and I2V connectivity between autonomous vehicles and traffic signals. It was also mentioned that ESRI has tools to build an app from GIS data.

Another line of discussion focused on **datasets** that would be useful to link to this pedestrian data platform. Datasets mentioned included: crash data, traffic volumes, various roadway assets (e.g., sidewalks, crosswalks, curb ramps, signals), Census data, and other active transportation use datasets (e.g., Strava, Streetlight, trail counters). To make it most useful to align datasets together, GIS coordinates should be included at a minimum. It also may be useful to connect with other standard identifiers (e.g., signal IDs) or spatial datasets (e.g., Road Centerlines, to allow for linking with roadway assets). The discussion about related datasets also covered other topics or processes that would benefit from pedestrian data. Linking pedestrian volumes with quality-of-life or demographic metrics could help in equity analyses. There was a desire to link these with crash data and results from the recent bicycle/pedestrian systemic safety analysis research project to improve safety analysis procedures. These data could connect with non-motorized traffic count programs in multiple directions: linking data (e.g., trail counters) but also helping to establish a count program, select count locations/times, creating temporal adjustment factors, etc.

When asked how often a pedestrian data platform might be used, the most **frequent** response was weekly. Some people would use it more frequently or less frequently, but weekly seems like the right time frame to design for.



Other notes

The audience was prompted to not be bounded by what they thought was feasible but rather consider what they might want. It was noted that there is a difference between like, want, and need. In general, any information is better than nothing.

Next steps

In early 2023, the USU team will hold another similar meeting with stakeholders external to UDOT, including city/county staff, consultants, and other partners. Based on stakeholder input and user feedback, the team will continue to refine the platform user interfaces and capabilities, and develop new interfaces as needed. Simultaneously, improvements to the data architecture will occur, including integrations with source traffic signal data. Finally, the team will develop user manuals and trainings, and publicize the availability of the beta version of the pedestrian data platform.

UDOT Pedestrian Data Platform
Stakeholder Meeting 2
15 February 2023
Meeting Notes

Meeting notes were prepared by Patrick Singleton (patrick.singleton@usu.edu). Contact with questions or corrections.

Agenda

- Introductions
- Project overview
- Discussion/Q&A
- Next steps

Attendees

- Utah State University (USU): Patrick Singleton
- Utah Department of Transportation (UDOT): Heidi Goedhart, Neda Kiani, Kevin Nichol, Angelo Papastamos
- Others: Nuzhat Azra (Avenue Consultants), Dan Bergenthal (Salt Lake City), Alex Beim (UTA), Ari Bruening (Envision Utah), Jim Price (MAG), Jem Locquaio (UTA), Katie Romig (Salt Lake County), Suzie Swim (WFRC), Lloyd Sutton (St. George City), Hugh Van Wagenen (WFRC), Chris Wiltsie (Bike Utah)

Project overview

To start the meeting, Patrick Singleton provided an overview of the UDOT Pedestrian Data Platform research project. The objective is to develop a robust pedestrian data platform for UDOT that can be useful for a variety of tasks in planning, design, operations, etc. This work addresses the general lack of pedestrian data, and builds upon previous UDOT-sponsored research projects. The first project developed a method to calculate rough pedestrian volumes using pedestrian push-button data available at most Utah traffic signals through the Automated Traffic Signal Performance Measures (ATSPM) system. Later work applied these volumes to calculate annual average daily pedestrian (AADP) crossing volumes for all signals, connected these data to built environment and land use characteristics to predict AADP for non-signalized intersections and segments, and utilized these data as measures of exposure in a statewide systemic pedestrian safety analysis. More information is available in the attached presentation.

As part of previous work, the USU team developed several demo and working prototype online visualizations to help make sense of this new potential source of pedestrian data.

- Estimated AADP for intersections with traffic signals: https://arcg.is/1aTT4f
- Predicted AADP for all types of intersections: https://arcg.is/0GO0Cv
- Demo visualization for Logan, Utah: https://singletonpa.shinyapps.io/ped-viz/
- Working visualization for all of Utah: https://singletonpa.shinyapps.io/ped-covid19/

The goal of the current research project is to improve and expand these platforms, making them more robust and enhancing their capabilities to meet the needs of potential users. To accomplish this, the USU team needs to understand the needs/wants of potential users. That is the purpose of the first stakeholder meeting with potential internal-to-UDOT users.

Discussion/Q&A

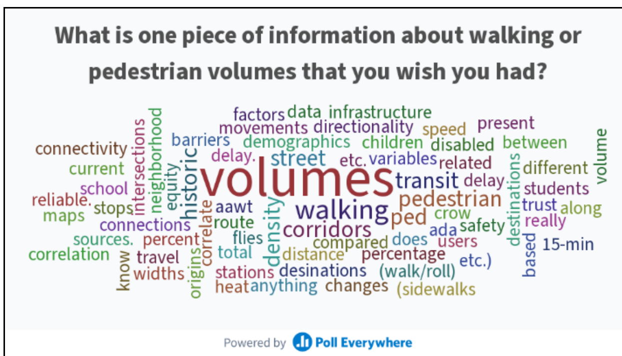
The majority of the meeting time was dedicated to soliciting feedback from attendees about what users would want to see from a pedestrian data platform. Given the large number of participants (15), Patrick Singleton facilitated a structured hour-long discussion session, assisted by polls on the Poll Everywhere platform. Thus, this summary of feedback will utilize results from the polling as well as feedback shared orally during open discussion.

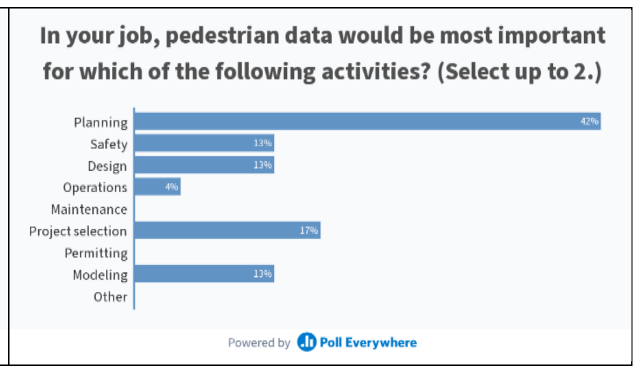
Uses for pedestrian data

The first section asked attendees about how they would use information from a pedestrian data platform. Specific questions included:

- What is one piece of information about walking or pedestrian volumes that you wish you had? {open response}
- In your job, pedestrian data would be most important for which of the following activities? (Select up to 2.) {Planning, Safety, Design, Operations, Maintenance, Project selection, Permitting, Modeling, Other}
- If you had access to data on estimates of pedestrian activity in different places and for different times, how would you use this information? {open discussion}
- What are use cases for pedestrian count analysis within your expertise? Where are you going to use it? How? {open discussion}
- What are your pedestrian data needs in more rural areas? {open discussion}

Responses to the poll responses are as follows:





The session started off with an open-ended question about desired information about pedestrians. This was designed as an ice-breaker to help people start thinking about what they might want out of a pedestrian data platform. Most people mentioned quantification of the amount of pedestrian activity, especially volumes, everywhere but especially at transit stops, along corridors, near schools, etc. Other desired information included: origins and destinations, walking speeds, pedestrian delay, circuitousness of walking routes, correlations with various factors (like density, street connectivity, or sidewalks), changes in volumes (over time, linked to infrastructure or planning changes), and user characteristics (age, disability).

To help start to focus the following discussion, the next question asked people to select one or two categories of work activities where pedestrian data would be more important. The most frequently selected category was planning, with around 42%. Other commonly-selected activities were project selection, modeling, design, and safety. One person picked operations, and no-one picked maintenance, permitting, or other options. In subsequent discussion, it was noted that this shouldn't imply that these other activities are not important potential uses of pedestrian activity, just that their use isn't as urgent or necessary as for planning, safety, design, and operations.

Since **planning** (and **project selection**) were the most-frequently selected use categories, open discussion mentioned several important potential planning and programming uses for pedestrian information:

- In general, it was mentioned that pedestrian volume is a measure of **demand** (either current/actual use or future/potential use), which has many potential planning applications.
- This demand can help in the prioritization process, when selecting projects. Priority could be placed on projects or facilities in areas with more current or future demand.
- The project development/programming process requires data-informed approaches to select and fund specific projects. Knowing where people walk and what kinds of projects/infrastructure/locations encourage walking would help in these kinds of funding decisions.
- At a planning level, pedestrian volumes could also help to encourage better design for pedestrians and/or inform pedestrian facility designs (widths, accommodations, etc.) to help develop a more accurate cost estimate.
- Pedestrian volumes are needed to help evaluate warrants for signals and crosswalks (including gap analysis).
- They could also be used to help make the economic development case for mixed-use developments, to support local government and business investment decisions to support walkability.
- Pedestrian information could be very important for informing the impact of connectivity on pedestrian activity. This includes planning around first-mile/last-mile access to transit, as well as providing safe routes to school, and access to parks and other key destinations.
- Some attendees described how they would want to also see (in addition to volumes), information on desire lines (routes, paths) as well as origins/destinations.
- Pedestrian data can help to track trends over time, for performance monitoring. Such information could also be linked to demographic information, for equity analysis.
- Advocacy organizations could use pedestrian volume data to help advocate for pedestrian improvements.
- Pedestrian data might also be useful for long-range transportation visioning, planning, and forecasting.

Safety was another important application area. Discussion covered these topics:

- In general, it was mentioned that pedestrian volume is a measure of **exposure** (potential for collisions), which is highly needed for pedestrian safety applications.
- By accounting for different levels of pedestrian exposure, crash analyses can utilize crash data, study crash histories, analyze hot spots, and calculate crash rates. In other words, volumes provide context about pedestrian crashes, to tell if high numbers are due to high demand or very unsafe conditions.
- As a result, pedestrian safety improvements can be prioritized in places with high crash rates, not necessarily just high crash frequencies.
- Existing processes of assessing pedestrian safety (e.g., signal warrants, hot spots based on historical crash data) are not satisfactory. Attendees would like better ways to figure out where/when/why people cross (or want to cross) the street, so that infrastructure can be designed and operated to improve safety.

There was some discussion about how pedestrian data could help **design** tasks.

- Most design applications were connected to the use of volumes that were also useful for planning and safety activities. Knowing the volumes and origins/destinations could help to make more robust pedestrian infrastructure in places with higher demand. Without volume data, planners/engineers may not have a good sense on where more people are walking.
- Design activities that could be informed by pedestrian data include the placement, sizing, and design of pedestrian ramps, curb extensions, sidewalks, underpasses, etc. For example, wider ramps/sidewalks/tunnels could be placed in areas with high pedestrian volumes.
- Design applications might also benefit from understanding who is walking: including people with disabilities or other mobility limitations, and who may need more time to cross the street.

A few other potential uses were also discussed. Regarding **modeling**, it was noted that most travel models don't consider pedestrians for a lack of data. It would be desirable to be able to model pedestrians and how their volumes would change in response to pedestrian infrastructure and destination proximity. Discussions around **operations** focused on traffic signal timing and phasing changes. For example, pedestrian signal timing is based on walking speeds, and it would be useful to know if people are making the crossing in time. Also, pedestrian delay is important, since people may violate the signal if they are forced to wait too long. **Maintenance** was mentioned, but only in passing. There was also a little interest in pedestrian data in rural areas.

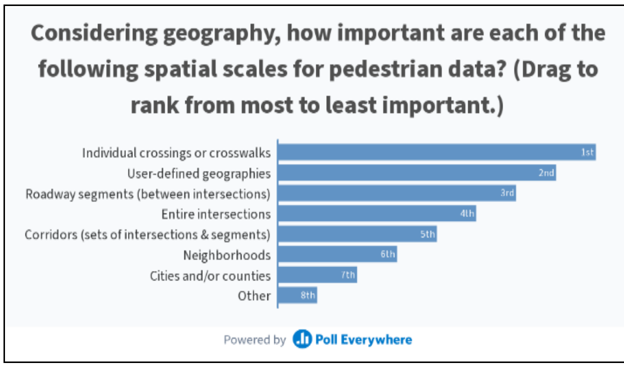
Spatial and temporal dimension

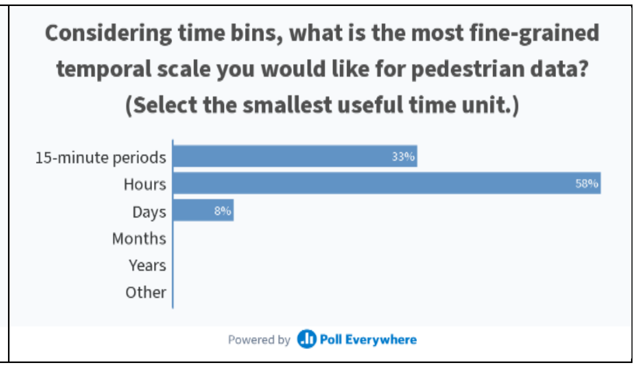
The second section asked attendees about their needs and wants for pedestrian data in terms of spatial and temporal dimensions. Specific questions included:

- Considering geography, how important are each of the following spatial scales for pedestrian data? (Drag to rank from most to least important.) {Individual crossings or crosswalks, Entire intersections, Roadway segments (between intersections), Corridors (sets of intersections & segments), Neighborhoods, Cities and/or counties, User-defined geographies, Other}

- Considering time, what is the most fine-grained temporal scale you would like for pedestrian data? (Select the smallest useful time unit.) {15-minute periods, Hours, Days, Months, Years, Other}
- Regarding temporal scales: Will you want to see total numbers of pedestrians within these time units, or averages of pedestrian activity, or both? {open discussion}
- Regarding spatial scales: For what purposes do you need pedestrian data at each of these geographic units? {open discussion}
- How important are the following features for you? (Rate on a scale: Very important, Somewhat important, Not important) {Historical pedestrian data (several years ago), Pedestrian activity in the recent past (hours, days, months), Future predictions of pedestrian activity}
- How far back in time would you want to see data? {open discussion}
- How far into the future would you want to predict? {open discussion}

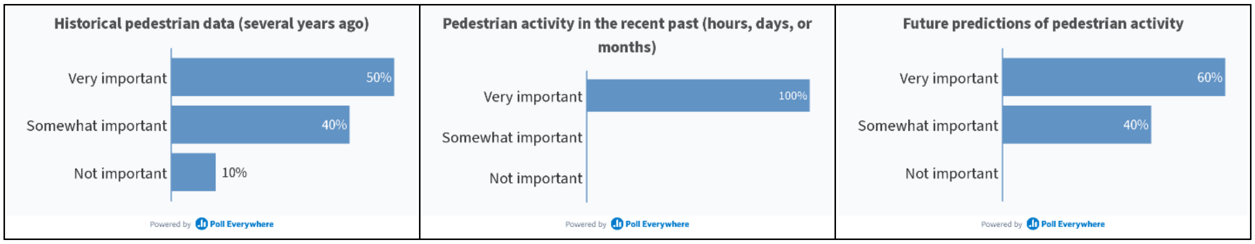
Responses to the first set of poll responses are as follows:





Regarding **geography**, being able to present information at multiple geographies seemed to be very important to respondents. Generally, they wanted access to data at more fine-grained spatial units (crossings > intersections, segments > corridors), with relatively less importance places on larger-scale geographies (neighborhoods, cities/counties). Data for individual crossings was mentioned as useful for adjusting signal timing or phasing, for linking crosswalk volumes with safety information, or knowing which crossings people are using (or not using). Data for segments (e.g., AADT for pedestrians) was mentioned as useful for linking with crashes to calculate crash rates. Some people mentioned other new data sources (e.g., Streetlight Data) that did not provide very spatially granular data. User-defined geographies also rated highly. An example use was to link pedestrian data with other pre-existing planning geographies, such as the centers that exist within the Wasatch Choice Vision.

Regarding **time**, there was a strong desire to be able to access data at times scales of hours or 15-minute periods. Many studies (like gap analysis or signal warrants) already require 15-minute periods for analysis. Several attendees mentioned the desire for more parity with vehicle data, which tends to be provided in 15-minute periods.



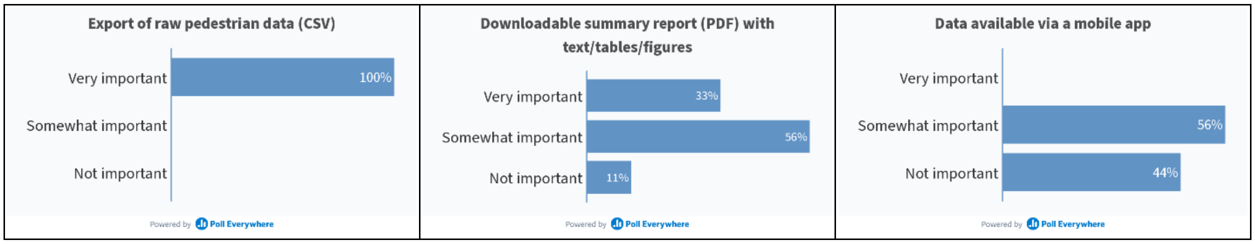
Follow-up questions asked about the importance of pedestrian data at different time points: the far past, the recent past, and the future. Generally, attendees would find the most value from data on pedestrian activity in the recent past (hours, days, or months); all respondents rated this as very important. The importance of specific time scales seemed to depend on specific uses: for example, operations and signal timing/phasing would want to see instant (real-time) data, while safety might look at data from the last couple of years (since crash data date back to 2010). There was discussion that historical pedestrian data may be useful for some specific tasks: tracking long-term trends over time, or research on how patterns of urban development and growth have influenced pedestrian activity. But there was also some concern that things are changing rapidly (development, COVID-19, etc.) that data from more than 3-5 years ago was increasingly out-of-date. This may also depend on location: developed residential neighborhoods may change more slowly than new (re-)developments on the edge or core of the region. More recent data was preferred when speaking with decision/policy-makers. Future predictions were slightly preferred to historical data, although given the uncertainties present in long-range regional planning, there was less value in very long-term forecasts of pedestrian activity (through this platform).

Features of a platform

The third and final section focused on features that stakeholders might want to be incorporated into a platform. Specific questions asked:

- How important are the following features for you? (Rate on a scale: Very important, Somewhat important, Not important) {Export of raw pedestrian data (CSV), Downloadable summary report (PDF) with text/tables/figures, Data available via a mobile app}
- What other datasets or data sources would you want to connect with these pedestrian data? {open discussion}
- What other datasets are available (you are currently aware of them/use them) that can be a support layer to improve this ped volume data within our platform? {open discussion}
- What usability features would you want in a pedestrian data platform? {open discussion}
- How often would you use a pedestrian data platform like this? {Almost every day, Weekly, Monthly, A few times a year, Maybe just once or twice}

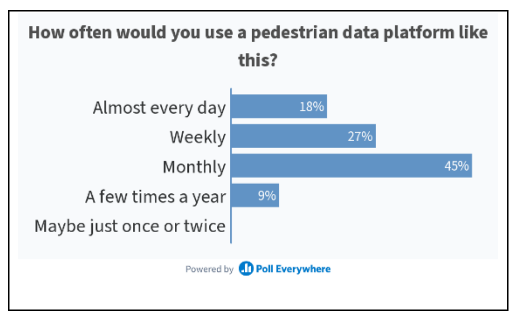
Responses to the first set of poll questions are as follows:



The ability to export and save the data in a machine-readable format (e.g., **CSV**) was rated as very important by all respondents. This feature was noted as the most important by several respondents, so that people can download and link pedestrian data to other datasets. Having GIS coordinates attached to the data points was highly desirable, for compatibility with ESRI or other GIS tools. Having a downloadable **report** seemed to be somewhat important to most attendees. People who expressed a desire to see a report mentioned being able to clearly see the summary results (e.g., maps, trends over time) and clearly communicate with decision-makers. There was some desire for an interactive report more than a static report. Having an "info sheet" (with charts, maps, and other visuals) could be useful for quick relay of information, such as in project scoping. There was less interest in needed to access this data in the field or via a **mobile** app. In terms of other data platforms that work well, some mentioned Urban Footprint, which provides easy-to-use GIS and visualization functionality.

Another line of discussion focused on **datasets** that would be useful to link to this pedestrian data platform. Many kinds of datasets were mentioned: demographics (including US Census data), crash data, land use and built environment characteristics (density, diversity, etc.), infrastructure condition/quality, accessibility for people with disabilities, street centerline data, vehicle speeds, transit routes and ridership data, law enforcement data, and aerial imagery. There was also a desire to link the pedestrian data with a pedestrian demand model / sketch planning tool, developed by UDOT and WFRC.

When asked how often a pedestrian data platform might be used, the most **frequent** response was monthly. A few people would use it less frequently while several others would use it more frequently, but monthly seems like the right time frame to design for. It was also mentioned that use might depend on time of year or the specific project. For example, someone might use it every day for a few weeks a year.



Next steps

This was the second focus group meeting, following a prior meeting with stakeholders internal to UDOT in late Fall 2022. Based on the combined stakeholder input and user feedback, the USU team will continue to refine the platform user interfaces and capabilities, and develop new interfaces as needed. Simultaneously, improvements to the data architecture will occur, including integrations with source traffic signal data. Finally, the team will develop user manuals and trainings, and publicize the availability of the beta version of the pedestrian data platform.