Vision Zero and Beyond: A Simple Yet Powerful Data Strategy for Evaluating Potential Engineering Solutions

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ABSTRACT

As cities adopt Vision Zero goals to eliminate traffic fatalities, many find they are limited in resources to carry out such an ambitious program. With constraints in time, funding, and staffing, many cities are taking a data-driven approach to reduce fatalities as quickly and cost-effectively as possible. The Los Angeles Department of Transportation (LADOT), in collaboration with the Los Angeles County Department of Public Health (LACDPH), developed a simple—yet powerful—database and analysis tool that now plays a key role in how Los Angeles prioritizes projects, applies for grant funding, and designs for safety on our streets. Moving beyond the macro-level Vision Zero strategy development, this tool provides a more targeted approach to estimating the safety benefit of specific engineering countermeasures. Providing highly customizable queries, the process proposed in this paper can be implemented quickly and applied to improve the work transportation planners and engineers already do on a daily basis, such as apply for grants to fund basic safety improvements.

Keywords: Vision Zero, collision analysis, database, geospatial, pedestrian safety

INTRODUCTION AND PURPOSE

Vision Zero is a road safety policy that aims to eliminate traffic fatalities (*1*). Originating in Sweden, this policy is quickly gaining momentum in the United States—since January 2014, 16 cities have formally adopted Vision Zero, several more cities are considering adopting the program, and a few state transportation agencies have made a similar "Towards Zero Deaths" commitment (*2*).

These Vision Zero goals almost always come with a target date by which each city aims to achieve zero traffic fatalities. Reflecting the moral urgency of this initiative, these target dates are often quite aggressive—San Francisco, San Jose, Seattle, Portland, and now Los Angeles have all committed to eliminating traffic fatalities within ten years. Despite adopting such ambitious timelines, the resources available to achieve these goals are limited. Given these constraints, a key strategy among U.S. cities includes adopting a data-driven approach to reduce fatalities as quickly and cost-effectively as possible.

The City of Los Angeles adopted Vision Zero in August 2015 with two goals: reduce traffic fatalities by 20 percent by the end of 2017, and eliminate all traffic fatalities by 2025 (*3*). In meeting these goals, Los Angeles faces many of the same resource challenges found elsewhere. Although the City has hired a few additional staff to help direct the effort, Los Angeles faces an especially difficult challenge with the largest roadway network among cities in the United States. Even after finding that nearly two thirds of all pedestrian fatalities were located within just six percent of the City's roadway miles, this six percent totals to over 450 miles of roadway. The vastness of this network and the incredible number of assets managed by the City necessitates data-driven selection and prioritization.

Following the approach outlined by Morris and Weir (2015), LADOT and LADPH began building an extensive database featuring transportation assets, roadway characteristics and features, collisions, and a health atlas (*4*).This database served as the backbone of Los Angeles' initial strategy to develop a prioritized corridor list and categorize collisions by similar contributing factors, following the example in San Francisco (*5*). This collision profiling and countermeasure pairing process provided a high-level view of safety issues in Los Angeles: the prioritized corridors highlight where the problems occur, and the collision profiles provide additional context on the types of collisions occurring. This corridor prioritization and collision countermeasure pairing process informed the City's Vision Zero Action Plan development and has been a powerful method for communicating these safety issues to the public.

Beyond this macro-level view of the collision landscape, LADOT staff realized that the database could also be adapted to perform micro-level analysis to support grant applications, estimate the safety benefit of countermeasures, and evaluate projects after they are completed. Initially, the tool requires only a few key datasets—collisions, the centerline network, and some infrastructure data—and thus could be done without the full extent of variables in San Francisco Department of Public Health's TRANSBase model (*4*). However with more integrated assets and characteristics planned for inclusion, the tool can become more powerful, as it can take into account additional relevant variables.

With the use of simple Python scripts, this tool provides advanced querying capabilities using existing datasets, and is adaptable to allow for dynamic updating of both these datasets and the parameters used for querying, keeping this tool relevant in future efforts.

PREVIOUS WORK

Because cities in the U.S. have only begun to adopt Vision Zero programs, very little has been written about the use of "big data" to inform Vision Zero work. A survey of existing literature reveals that data is mostly informing where to implement new engineering projects. However, the City of San Francisco has demonstrated how this same data-driven process can also suggest the types of engineering treatments that could work best at each prioritized location.

Prioritizing Locations

Brozen and Shockley (2015) reviewed analysis methodologies for the first seven cities that formally adopted a Vision Zero program and found that all implemented some form of a priority area to focus efforts. At the very least, this included heat maps that show spatial concentrations of collisions. Other cities, including New York, San Francisco, San Jose, Portland, and Los Angeles have taken a more comprehensive approach, mapping every collision to a street corridor and/or intersection and then creating rankings based on either collisions or injuries as the prioritization metric (*6*).

Although prioritizing areas may appear to be a straightforward task, there are number of critical decisions that ultimately influence which areas are highlighted. For example, does the unit of analysis include all collisions, collisions resulting in injury, or only collisions resulting in severe injury or death? Secondly, should all modes of travel be included? Although the long term goal is eliminate all traffic fatalities, Vision Zero emphasizes the need to focus on the most vulnerable users of the road network, specifically those walking and bicycling (*1*). Finally, how many years of data should be included? One or two years of data may be too short of a timeframe to capture longer trends, but ten years of data may be too long, spotlighting problems that have since been resolved. Brozen and Shockley found many similarities in how cities answered these questions: analysis methodologies tended to focus on the most recent five years of pedestrian- and bicycle-related collisions resulting in severe and fatal injuries (*6*).

The Los Angeles Vision Zero team began prioritizing locations by creating a High Injury Network (HIN) map, a visual representation of the corridors with the highest rates of severe and fatal injury for bicyclists and pedestrians for the most recent five years of available collision data (2009-2013). The team further prioritized these 450 roadway miles by soliciting stakeholder input and establishing additional weighting criteria.

Collision Profiling and Countermeasure Pairing

Beyond merely prioritizing where improvements are focused, the City of San Francisco has best demonstrated how this data-driven process can inform what is done at these locations. After creating the HIN to specify areas with the most need, the City then looked for patterns in the factors that were causing the collisions. The project team formalized these patterns into a set of collision profiles that included pertinent characteristics of the collision (e.g. movements preceding the collision), the parties involved (e.g. age of victim), and the built environment at the site of the collision (e.g. presence of a marked crosswalk). After assigning each collision a profile, the project team aggregated the profiles to determine the predominant safety issues at each location and then matched a physical design intervention (countermeasure) to address those profiles (*5*). Following this model, the Los Angeles Vision Zero team also developed a set of collision profiles and paired countermeasures, providing a snapshot of the safety issues throughout the City.

Although the San Francisco model provides an interesting use of data to inform engineering improvements, the strategy of matching collision patterns to physical design treatments is not new and has for decades been the method by which traffic engineers work on a daily basis. For example, the Crash Modification Factors (CMF) Clearinghouse, widely used by traffic engineers, is a research database that documents the effect of engineering treatments on different crash types (*7*). In addition, the California Manual on Uniform Traffic Control Guidelines

(CA MUTCD) provides strict criteria based on specific crash patterns to warrant the installation of traditional traffic control devices (*8*). Because these criteria are so specific, the Los Angeles Vision Zero team adopted a more targeted strategy to streamline the Department's engineering work.

METHODOLOGY

Assemble Data

The two most critical pieces of information for the database include collision data and a geospatially enabled street centerline network with lines representing street segments and points representing intersections. Additional datasets, including assets such as traffic signals and street lighting, can easily be related back to the street centerline network for analysis.

The California Highway Patrol's Statewide Integrated Traffic Records System (SWITRS) provides collision data collected by California law enforcement agencies and standardized into easily digestible tables. The collision table provides information specific to the collision (e.g. date and time of occurrence, location), the party table provides information about each party (e.g. mode and direction of travel, sobriety), and the victim table includes person-level information (e.g. degree of injury, demographics). For our analysis, the project team used the most recent five years of collision data that was available at the time of compilation (2009-2013). This time horizon was long enough to demonstrate clear collision patterns where they existed, but also recent enough to reduce the potential for flagging problem intersections and/or corridors that may have since been addressed.

The second core input is a street centerline network. As recommended by Morris and Weir (2015), each street segment and intersection within this network should have a unique identifying key that distinguishes it from every other asset in the database (*4*). The Los Angeles project team was able to obtain a nearly complete street centerline network from the City's Bureau of Engineering. For cities and towns that may not already have a geospatial representation of the roadway network, one solution could involve downloading volunteered geospatial data from OpenStreetMap, which is often of comparable quality to proprietary formats (*9*).

Additional data, as long as it has been related back to a unique key, can also be added and joined to injury data or other environmental data. Under the direction of LADPH, the project team continues to assemble additional health datasets related to obesity, mortality, perception of safety, and other sociodemographic variables.

Relate Infrastructure Data

The second major task includes assigning each collision to an intersection and segment in the street centerline network. Because the raw SWITRS data is not already geocoded, the project team used data from the proprietary RoadSafeGIS system, which provided latitude and longitude coordinates for each collision.

Each geocoded collision is then assigned the unique identifier of the nearest street segment, which is then associated with unique identifiers for the intersections at either end of the segment. After calculating the distance to each intersection, the collision is also assigned the unique identifier for the nearest intersection. Each collision has thus been assigned attributes for two new fields: nearest segment identifier, and nearest intersection identifier.

Any infrastructure data, such as the location of a city's traffic signals, should be associated with either a street segment or intersection so that collisions and injuries can then be joined to infrastructure or environmental data.

Run Evaluation Tool

Establish Collision Criteria

Based on the guidelines set forth by the CA MUTCD and input from LADOT engineers, the project team outlined criteria, specific to each engineering treatment, by which to evaluate every collision in the data set. For example, to qualify for Traffic Signal Warrant 7, Crash Experience, there must be a minimum of five correctable collisions within a recent 12 month period (*8*).

Criteria were divided into two categories: those at the collision-level (e.g. alcohol involvement, distance from the intersection) and those at the party level (e.g. direction of travel, movement preceding the collision). Because the vast majority of information to evaluate each collision by the established criteria are within the SWITRS tables, this process can easily be replicated among cities in California because they will share the same table format. For cities that receive collision data formatted differently, such as according to the recommendations of the Model Minimum Uniform Crash Criteria Guideline, this process can also be adapted.

Develop Python Scripts

With the criteria established, the project team then developed Python scripts tailored to each potential infrastructure upgrade. In identifying candidates for new traffic signal installations, the script begins by evaluating each unsignalized intersection, looping through all collisions related to that intersection. If the collision is within 100 feet of the intersection and doesn't involve alcohol, the script then evaluates each party, excluding preceding movements that would not be directly affected by a signal installation. If there are at least two qualifying parties that are not moving in a parallel direction, the collision is added to a list for further review. Finally, with all qualifying collisions, the script checks whether five or more occurred during any recent 12 month period. Figure 1 diagrams the programming logic and specifies the required criteria for this specific exercise.

In the evaluation of protected left-turn phasing, the script began by evaluating collisions at signalized intersections. As with the process for identifying new traffic signals, the script began by weeding out those collisions that involved alcohol and were greater than 100 feet from the intersection. Specific to this exercise, however, at least one party needed to have made a left turn as the preceding movement. For both the new signal and protected left turn phasing exercises, the project team configured the script to identify all qualifying intersections to help identify trends beyond the 12 month qualification period, so as to confirm or refute that collision patterns remain present to some degree, if the qualification period was older than the most recent year of available data.

In estimating the potential benefit of a roadway reconfiguration, or "road diet", the project team configured the script to identify all possible collision types that could be mitigated to a proven extent by the engineering change. Since this proposal included an entire corridor, the script searched all possible collisions assigned to the related segments, rather than intersections.

These Python scripts for these analyses are currently hosted on GitHub, freely available for download and adaptation (*10*).

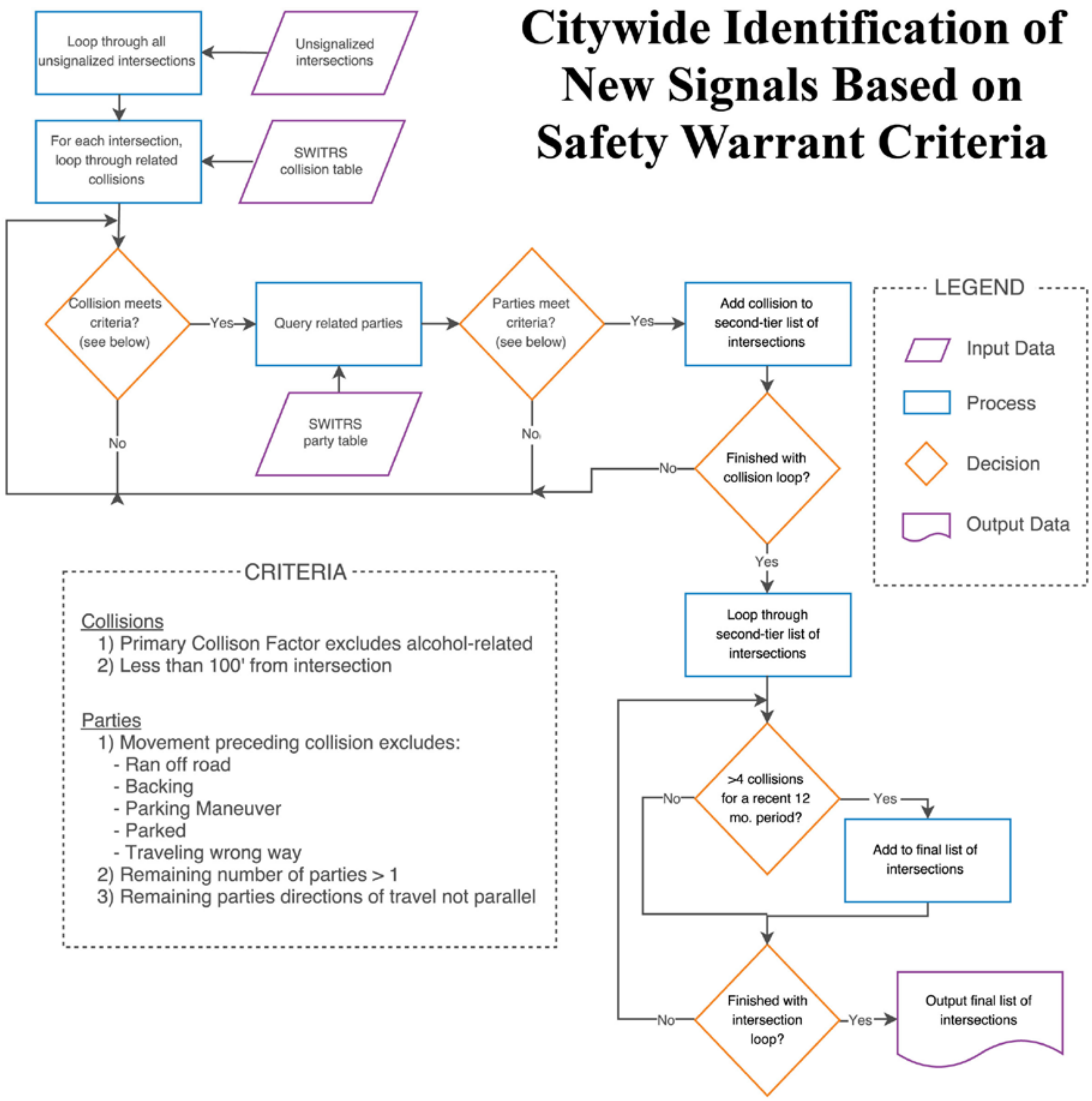

FIGURE 1 Flow Diagram of New Signal Warrant Identification Python Script.

Confirm Findings

After identifying candidate locations, LADOT engineers reviewed the qualifying collisions and subsequent pattern (if present) and performed a more thorough examination of the location and its physical characteristics. This conforms to CA MUTCD guidelines, which caution that satisfying a warrant does not itself justify making the infrastructure changes and should be accompanied by an engineering study showing that the infrastructure change will improve the overall safety of the intersection (*8*).

During this last step, LADOT engineers also screened the candidate locations for additional criteria required by the CA MUTCD to satisfy the warrant. For new traffic signals, the intersection must satisfy additional criteria related to pedestrian and vehicle volumes. Although the project team manually performed these checks, vehicle and pedestrian volumes could feasibly be incorporated into the database to further streamline this process, and as automated counters become more prevalent in the future, this information could also be updated automatically.

OUTCOMES

Grant Applications

Cities in California routinely apply for funding through the California Highway Safety Improvement Program (HSIP) for infrastructure improvements to improve safety. Under the HSIP guidelines, locations selected for new traffic signals must satisfy Warrant 4, 5, and/or 7 in the CA MUTCD (*8*). As such, when searching for qualifying locations, screening criteria must be discretely tied to the requirements of these warrants. In the past, LADOT staff screened for HSIP candidate projects based on an existing departmental list of authorized improvements, many of which were initiated by public request. The tool allowed for a citywide automated screening process to proactively identify possible improvements.

Safety Countermeasure Benefit Estimation

Although the tool was initially designed specifically for the HSIP funding process, the project team expanded its capabilities to measure the potential safety benefit of other engineering countermeasures, including roadway reconfigurations, or “road diets”. Given a list of unique segment identifiers a corridor, the Python script is configured to break down the collisions by type. Because each collision type is tied to a proven crash reduction factor associated with a road diet treatment, LADOT can precisely estimate the safety benefit and quickly produce visually appealing charts when communicating with stakeholders.

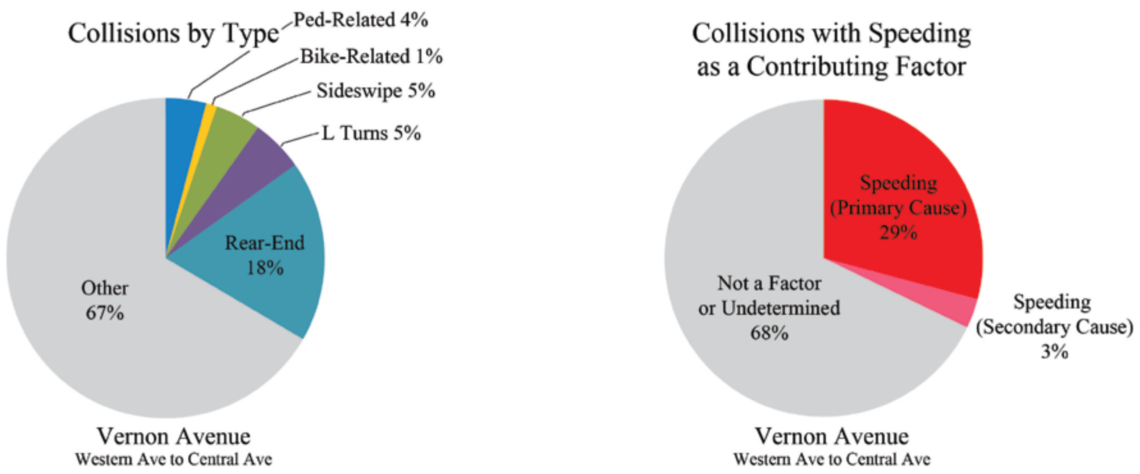

FIGURE 2 Corridor Collision Summary for Road Reconfiguration.

Post Evaluation of Projects

Tracking Los Angeles’ progress towards Vision Zero requires evaluating projects and countermeasures where they have been applied. To that end, this tool will allow for ongoing analyses of such project locations; such analyses can even be programmed to occur automatically at set time intervals, relieving the staff and resource burden.

Future plans include publishing an interactive web app that displays safety improvements completed by the City as part of the Vision Zero initiative while overlaying the location of severe injuries and fatalities in order to monitor progress and measure the effects of these projects. This will allow for greater transparency with the public, and more accountability and measuring of success.

CONCLUSIONS

Using this method, cities without the resources to build an extensive database and complete a larger collision profiling and countermeasure pairing process can still realize the benefits of a data-driven safety strategy. This process can be implemented quickly and applied to improve the work transportation planners and engineers already do on a daily basis, such as apply for grants to fund basic safety improvements.

The greatest strength of this approach is that it is flexible. Although it requires only a few datasets to perform relatively complex queries, the tool can become even more powerful as additional assets are included. Beyond being customizable, this querying can also be dynamic as both the source data and the parameters for solutions change over time. It avoids the need to produce area-wide reports for every known type of problem and solution at once--a scope which is not feasible to implement during a timeframe under which such data would remain relevant.

This approach is also flexible in that the criteria can easily be modified to meet different standards. Although this tool was designed specifically for CA MUTCD guidelines, internal LADOT safety standards may permit the installation of traffic control devices using different standards. In addition, LADOT will expand the scope of safety countermeasure benefit estimation beyond roadway reconfigurations to include other engineering treatments.

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