

# A Vision for Transportation Safety

## Framework for Identifying Best Practice Strategies to Advance Vision Zero

Arielle Fleisher, Megan L. Wier, and Mari Hunter

The Traffic Safety Best Practices Matrix is presented. It is a tool to help U.S. cities to identify the landscape of strategies being used domestically and internationally to advance Vision Zero, as pioneered by Sweden. Many cities across the United States have expressed an interest in Vision Zero, with a growing number passing policies calling for the elimination of traffic-related fatalities over the next decade. Despite the increase in interest, little guidance exists around what Vision Zero is and what actions can be implemented to help realize zero deaths. The matrix culls together the results of an extensive examination of the measures that cities and countries are pursuing to reduce traffic-related fatalities and improve safety. The matrix attempts to bridge the gap by presenting a framework that cities can use to identify effective strategies, benchmark their efforts relative to other jurisdictions, and reach out to cities and countries pursuing Vision Zero policies for additional information. An analysis of the matrix, focuses on three categories: measures with widespread adoption, limited implementation, and minimal utilization. There is discussion of how these findings can inform the next steps for Vision Zero implementation, with a focus on implications for U.S. cities. The main recommendations are to develop mechanisms that institutionalize Vision Zero across sectors, focus education on supporting changes in organizational practices and policy reform, improve collaboration across all levels of government, explore technology that meets the unique needs of cities, and create data systems that facilitate accountability and encourage public participation.

Vision Zero is a road safety policy that aims to achieve a transportation system in which there are zero fatalities or serious injuries for all modes of transportation. Adopted by Sweden in 1997, the safety platform attempts to create a safe system by taking an ethical approach to road safety (1). Vision Zero is widely accepted as an innovative road safety policy and is noted for its departure from the traditional road safety paradigm with regard to its charge that the road safety problem to be addressed is the shortcomings in the design of the transportation system, assertion that transportation system designers are responsible for road safety, call for road users to demand safety, and insistence that the ultimate objective of road safety is zero deaths (2).

Many cities across the United States have expressed an interest in Vision Zero. As of July 2015, the following cities have passed

a Vision Zero policy, calling for the elimination of traffic-related fatalities and in some cases serious injuries over the next 10 years: San Francisco, San Jose, San Mateo, and San Diego, California; Seattle, Washington; Portland, Oregon; New York City; Washington, D.C.; and Boston, Massachusetts. Despite the increase in interest, little guidance exists for local transportation planners, policy makers, public health practitioners, police, and others working as part of this effort around what Vision Zero is and what actions could be implemented to help realize zero deaths. This paper aims to bridge that gap by presenting a tool, the Traffic Safety Best Practices Matrix, to help cities identify the landscape of strategies being used domestically and internationally to advance Vision Zero. The matrix culls together the results of an extensive examination of the measures that cities and countries are pursuing to reduce traffic-related fatalities and serious injuries.

By identifying the landscape of strategies being used by cities pursuing Vision Zero, and specifying strategy efficacy as currently known, the matrix presents a framework for strategy identification and evaluation, as well as opportunity benchmarking. Analysis of the matrix focuses on three categories: measures with (a) widespread adoption, (b) limited implementation, and (c) minimal utilization. Also, the research offers findings that can inform next steps for Vision Zero implementation. While the potential for Vision Zero to reduce fatalities and serious injuries is significant based on Sweden's experience (3), there is currently a knowledge gap with respect to specific implementation measures utilized to advance the policy. It is anticipated that the matrix, in addition to the analysis presented in this paper, will help cities, especially those considering adopting the policy, to develop comprehensive strategies, benchmark their efforts, and reach out to other jurisdictions pursuing Vision Zero for additional information.

### CALL FOR SAFE SYSTEM APPROACH TO SAFETY: WHAT IS VISION ZERO?

Vision Zero is based on two premises: people make mistakes, and there is a critical limit beyond which survival and recovery from an injury are not possible (4). Vision Zero does not assume that collisions will not happen—people make mistakes no matter how well-educated and compliant in obeying traffic laws (5). Rather, the focus for road safety analysis and planning is on eliminating the risk of chronic health impairment or death caused by a collision (4). To do so, Vision Zero focuses on decreasing the likelihood that crashes will result in serious injury or death by designing the transportation system in a way that ensures that road users can tolerate the kinetic energies produced by the collision. It is kinetic energy that kills and injures the road user—not the collision. The level of physical force the human body can tolerate thus forms the basic parameter in the

A. Fleisher and M. Hunter, San Francisco Municipal Transportation Agency, 1 South Van Ness Avenue, San Francisco, CA 94103. M. L. Wier, San Francisco Department of Public Health, 1390 Market Street, Suite 210, San Francisco, CA 94102. Corresponding author: A. Fleisher, arielle.fleisher@sfmta.com.

*Transportation Research Record: Journal of the Transportation Research Board*, No. 2582, Transportation Research Board, Washington, D.C., 2016, pp. 72–86. DOI: 10.3141/2582-09

design of the transportation system, the core around which all safety interventions are to be based (4, 6).

One of the main implications of this is that traffic speeds should be reduced to prevent injuries (7). If the impact of crash energy is to be kept below the critical limit, speeds must be lowered and set according to the safety of the road and roadside (4). Vulnerable road users, including pedestrians, have a 10% chance of surviving if hit by vehicles traveling at speeds above 45 mph, but this level rises to 90% at speeds of 17 mph (8). Speed management underpins nearly every consideration in Vision Zero (5).

While Vision Zero places a strong emphasis on reducing speeds, it does so in the context of the road system in its entirety—referred to as a safe system approach to road safety (4, 5). The approach encourages countermeasures that address the three key elements of the road system—roads and roadsides, vehicles and speed—because the interaction of these elements determines physical force and thus trauma levels in a crash (4). Considering the inputs in isolation ignores the power of their interactions. To prevent collisions, the whole system must be considered and all its parts strengthened (5): If one part fails, the other parts must be able to offer protection. Core activities are supported by a range of countermeasures (such as education, regulation, and enforcement) that encourage alert and compliant behavior on the part of road users (9).

Vision Zero alters the view on responsibility for road safety. In the United States, responsibility has been placed on the individual road user: bad drivers, careless bicyclists, and distracted pedestrians are the causes of collisions; perfecting human behaviors through licensing, testing, education, training, and publicity are the appropriate solutions (6, 7). Under the Vision Zero framework, actions and responsibilities are attributed to the system designers who include engineers, public health professionals, policy makers, and law enforcement (4, 10). It remains the responsibility of individuals to abide by laws and regulations, that is, to follow the rules for using the transportation system set by the system designers. If fatalities do still occur, or if the rules are not followed, the burden is placed back on the system designers to take further measures (1).

Although Vision Zero is closely associated with Sweden's efforts, the safe system approach on which it is based has also provided the foundation for Netherlands' Sustainable Safety policy, as well as the safety platforms of Australia, New Zealand, Denmark, Iceland, Norway, and London (5). Vision Zero and Sustainable Safety represent the longest and most well-established safe system approaches (9). In the United States, state governments are required to develop strategic highway safety plans that detail the state's approach to reducing traffic injuries. Since the early 2000s, many states have framed this work as Toward Zero Deaths (TZD), an approach that traces its roots Vision Zero (11). In 2014, FHWA published *Toward Zero Deaths: A National Strategy for Highway Safety*, which similarly frames safety as a systems approach (12).

## METHODS

To provide guidance for U.S. cities as they seek to implement Vision Zero, research was conducted into the measures that cities in the United States and countries abroad, as of May 2015, pursuing to reduce pedestrian-, bicycle-, or traffic-related injuries and fatalities. Those data are compiled into the Traffic Safety Best Practices Matrix.

The safety strategies of eight U.S. cities, one European city, and three countries were reviewed for the matrix: San Francisco; New

York City; Chicago, Illinois; Portland; Seattle; Washington, D.C.; Boston; Los Angeles, California; London; Sweden; the Netherlands; and Australia. The U.S. cities included in the matrix were the early adopters or early considerers of Vision Zero, either by cities or departments of transportation. Sweden and the Netherlands are international leaders in road safety. Australia was selected because it was one of the first countries to follow Sweden in adopting the safe system approach; London was selected because it is a large city that also subscribes to a systems approach to road safety (9, 13). These locations were also selected because information about their safety platforms is widely available online and in English. While Norway, Finland, Iceland, and Denmark have all adopted Vision Zero or Vision Zero–like policies, these countries were not included in the review because their safety documents were not readily available (5).

The matrix is divided into nine categories:

1. Supportive infrastructure and planning;
2. Engineering;
3. Education;
4. Enforcement;
5. Monitoring, analysis, and evaluation;
6. Policy;
7. Large vehicles;
8. Vehicle technology; and
9. Taxi services and transportation network company.

Countries and cities received a  $\checkmark$  (i.e., checkmark) for a measure if it was referred to in one of their safety documents, defined as their city's safety resource webpage, safety action plan, or bicycle or pedestrian strategy, as either in practice or as a priority/planned/in process. Cities and countries received an NA (not applicable) for measures if implementation was not feasible. For example, New York City received an NA for "Align state level Towards Zero Death efforts with local level Vision Zero policy" (6.9) because its state did not adopt the TZD approach. A total of 106 measures are included in the matrix. There is no hierarchy to the matrix; rather, measures are listed alphabetically within subsections. The matrix is not exhaustive but attempts to provide a full scope of the safety measures being used by cities and countries. Matrix review did not take into account prioritization of the measures, scale of implementation (e.g., one intersection versus routine strategic implementation) or funding.

The matrix also includes a category that indicates the efficacy of a measure, defined as capacity to reduce injury, both directly (i.e., collision reduction factor) or indirectly (i.e., through creation of the institutions, structures, and political will that drive or create frameworks for changes in system design). Measures were given a designation of proven (P), recommended (R), or unknown (U), as described in Table 1. This methodology was used by Washington State in its 2013 Washington State Strategic Highway Safety Plan (14), which is a target zero plan. This plan was chosen as the model of the current research not only because of the rigor it applied to the efficacy assessments, but also because consistency in efficacy methodology among plans related to Vision Zero was felt to be a potential strength. As in Washington State, the researchers relied on three main sources to make the designations; if an action was not found in one of these primary sources, the researchers surveyed the academic literature as well as other countermeasure reference documents. For supplemental sources, designations were given based on the outcomes, quality, and breadth of the evaluation. A list of these sources can be found in Table 2.

TABLE 1 Efficacy Definitions and Criteria (14, p. 168)

Strategy Effectiveness	Definition	Countermeasures That Work (CTW)	NCHRP Report 500	Crash Modification Factors (CMF) Clearinghouse
Proven (P)	Proven to be effective based on several evaluations with consistent results	***** Demonstrated to be effective by several high-quality evaluations with consistent results	Proven (P). Those strategies that have been used in one or more locations and for which properly designed evaluations have been conducted that show them to be effective.	***** = 14 quality points
Recommended (R)	Generally accepted to be effective based on evaluations or other sources	**** Demonstrated to be effective in certain situations or *** Likely to be effective based on balance of evidence from high-quality evaluations or other sources	Tried (T). Those strategies that have been implemented in many locations, and may even be accepted as standards or standard approaches, but for which there have not been found valid evaluations.	**** = 11–13 quality points *** = 7–10 quality points
Unknown (U)	Lower quality rating; limited evaluation or evidence; experimental; outcomes inconsistent and inconclusive between studies	** Effectiveness still undetermined; different methods of implementing this countermeasure produce different results or * Limited or no high-quality evaluation evidence	Experimental (E). Those strategies represent ideas that have been suggested, with at least one agency considering them sufficiently promising to try them as an experiment in at least one location.	** = 3–6 quality points

TABLE 2 Matrix Sources

Document	Link
San Francisco	
San Francisco Pedestrian Strategy	<a href="http://archives.sfmta.com/cms/rpedmast/documents/1-29-13PedestrianStrategy.pdf">http://archives.sfmta.com/cms/rpedmast/documents/1-29-13PedestrianStrategy.pdf</a>
SFMTA Bicycle Strategy	<a href="https://www.sfmta.com/sites/default/files/BicycleStrategyFinal_0.pdf">https://www.sfmta.com/sites/default/files/BicycleStrategyFinal_0.pdf</a>
Vision Zero San Francisco: two-year action strategy	<a href="http://visionzerosf.org/about/two-year-action-strategy/">http://visionzerosf.org/about/two-year-action-strategy/</a>
Walk First	<a href="http://walkfirst.sfplanning.org/">http://walkfirst.sfplanning.org/</a>
New York	
Vision Zero Action Plan	<a href="http://www.nyc.gov/html/visionzero/pdf/nyc-vision-zero-action-plan.pdf">http://www.nyc.gov/html/visionzero/pdf/nyc-vision-zero-action-plan.pdf</a>
NYC Pedestrian Safety Study and Action Plan	<a href="http://www.nyc.gov/html/dot/downloads/pdf/nyc_ped_safety_study_action_plan.pdf">http://www.nyc.gov/html/dot/downloads/pdf/nyc_ped_safety_study_action_plan.pdf</a>
Truck Side Guards	<a href="http://www.nyc.gov/html/dcas/downloads/pdf/fleet/nyc_fleet_newsletter_05_16_2014.pdf">http://www.nyc.gov/html/dcas/downloads/pdf/fleet/nyc_fleet_newsletter_05_16_2014.pdf</a> ; <a href="http://www.volpe.dot.gov/news/engineers-passion-pedestrian-and-bike-safety-leads-partnership-with-nyc">http://www.volpe.dot.gov/news/engineers-passion-pedestrian-and-bike-safety-leads-partnership-with-nyc</a>
Chicago	
Chicago Forward: Department of Transportation Action Agenda	<a href="http://www.cityofchicago.org/dam/city/depts/cdot/Admin/ChicagoForwardCDOTActionAgenda.pdf">http://www.cityofchicago.org/dam/city/depts/cdot/Admin/ChicagoForwardCDOTActionAgenda.pdf</a>
Chicago Forward: Department of Transportation Action Agenda 2013 Update	<a href="http://www.cityofchicago.org/content/dam/city/depts/cdot/ChicagoForward/ChicagoForwardUpdate2013_web-lo.pdf">http://www.cityofchicago.org/content/dam/city/depts/cdot/ChicagoForward/ChicagoForwardUpdate2013_web-lo.pdf</a>
Chicago Pedestrian Plan	<a href="http://chicagopedestrianplan.org/pedestrian-plan/">http://chicagopedestrianplan.org/pedestrian-plan/</a>
Chicago Streets for Cycling Plan 2020	<a href="http://www.cityofchicago.org/content/dam/city/depts/cdot/bike/general/ChicagoStreetsforCycling2020.pdf">http://www.cityofchicago.org/content/dam/city/depts/cdot/bike/general/ChicagoStreetsforCycling2020.pdf</a>
Portland	
Portland Bicycle Plan for 2030	<a href="http://www.portlandoregon.gov/transportation/article/289122">http://www.portlandoregon.gov/transportation/article/289122</a>
Portland Bicycle Plan for 2030: One-Year Progress Report	<a href="http://www.portlandoregon.gov/transportation/article/345419">http://www.portlandoregon.gov/transportation/article/345419</a>
Real Solutions to Traffic Safety Problems	<a href="https://www.portlandoregon.gov/transportation/article/299189">https://www.portlandoregon.gov/transportation/article/299189</a>
Traffic Safety Resources	<a href="https://www.portlandoregon.gov/transportation/55303">https://www.portlandoregon.gov/transportation/55303</a>
Vision Zero	<a href="https://www.portlandoregon.gov/transportation/article/518952">https://www.portlandoregon.gov/transportation/article/518952</a>
Seattle	
2012 Action Agenda: Laying the Groundwork	<a href="http://www.seattle.gov/transportation/docs/SDOTActionAgenda2812.pdf">http://www.seattle.gov/transportation/docs/SDOTActionAgenda2812.pdf</a>
Action Agenda: 2013 Progress Report	<a href="http://www.seattle.gov/transportation/docs/SDOTActionAgendaProgRep_2013-01.pdf">http://www.seattle.gov/transportation/docs/SDOTActionAgendaProgRep_2013-01.pdf</a>
Pedestrian Master Plan: Implementation Overview	<a href="http://www.seattle.gov/transportation/pedestrian_masterplan/pmp_implementation.htm">http://www.seattle.gov/transportation/pedestrian_masterplan/pmp_implementation.htm</a>
Vision Zero: Seattle's Plan to End Traffic Deaths and Serious Injuries by 2030	<a href="http://www.seattle.gov/visionzero">http://www.seattle.gov/visionzero</a>

(continued)

TABLE 2 (continued) Matrix Sources

Document	Link
Washington, D.C.	
District DOT: Safety Programs Overview	<a href="http://ddot.dc.gov/page/safety-programs">http://ddot.dc.gov/page/safety-programs</a>
District of Columbia Bicycle Master Plan	<a href="http://ddot.dc.gov/sites/default/files/dc/sites/ddot/publication/attachments/bicycle_master_plan_2005_final_document_0.pdf">http://ddot.dc.gov/sites/default/files/dc/sites/ddot/publication/attachments/bicycle_master_plan_2005_final_document_0.pdf</a>
District of Columbia Pedestrian Master Plan	<a href="http://ddot.dc.gov/sites/default/files/dc/sites/ddot/publication/attachments/pedestrianmasterplan_2009.pdf">http://ddot.dc.gov/sites/default/files/dc/sites/ddot/publication/attachments/pedestrianmasterplan_2009.pdf</a>
District of Columbia Strategic Highway Safety Plan	<a href="http://www.ddot-hso.com/ddot/hso/documents/Publications/SHSP/2014/DDOT%20SHSP%20-%20October%202014.pdf">http://www.ddot-hso.com/ddot/hso/documents/Publications/SHSP/2014/DDOT%20SHSP%20-%20October%202014.pdf</a>
Toward Zero Deaths website	<a href="http://www.towardzerodeathsdcc.com/">http://www.towardzerodeathsdcc.com/</a>
Boston	
Access Boston 2000–2010: Boston's Citywide Transportation Plan	<a href="http://www.cityofboston.gov/transportation/accessboston/default.asp">http://www.cityofboston.gov/transportation/accessboston/default.asp</a>
Boston Bicycle Plan	<a href="http://www.cityofboston.gov/transportation/accessboston/pdfs/bicycle_plan.pdf">http://www.cityofboston.gov/transportation/accessboston/pdfs/bicycle_plan.pdf</a>
Boston Bike Network Plan	<a href="http://www.cityofboston.gov/images_documents/Boston%20Bike%20Network%20Plan%2C%20Fall%202013_FINAL_tcm3-40525.pdf">http://www.cityofboston.gov/images_documents/Boston%20Bike%20Network%20Plan%2C%20Fall%202013_FINAL_tcm3-40525.pdf</a>
Boston Bikes	<a href="http://www.cityofboston.gov/bikes/">http://www.cityofboston.gov/bikes/</a>
Boston Cyclist Safety Report	<a href="http://www.cityofboston.gov/images_documents/Crash%20Report%202013%20FINAL%20reduced%20_tcm3-38304.pdf">http://www.cityofboston.gov/images_documents/Crash%20Report%202013%20FINAL%20reduced%20_tcm3-38304.pdf</a>
City of Boston–Transportation	<a href="http://www.cityofboston.gov/transportation/">http://www.cityofboston.gov/transportation/</a>
Pedestrian Safety Guidelines For Residential Streets	<a href="http://www.cityofboston.gov/transportation/accessboston/pdfs/pedestrian_safety_guidelines.pdf">http://www.cityofboston.gov/transportation/accessboston/pdfs/pedestrian_safety_guidelines.pdf</a>
Update on Safety Efforts in Boston	<a href="http://www.bostonglobe.com/metro/2013/03/18/boston-launches-traffic-safety-initiative-along-busy-commonwealth-ave/rpIzq1bJTz8LuxvALlu0UJ/story.html">http://www.bostonglobe.com/metro/2013/03/18/boston-launches-traffic-safety-initiative-along-busy-commonwealth-ave/rpIzq1bJTz8LuxvALlu0UJ/story.html</a>
Los Angeles	
2010 Bicycle Plan	<a href="http://planning.lacity.org/cwd/gnlpln/transelt/NewBikePlan/Txt/LA%20CITY%20BICYCLE%20PLAN.pdf">http://planning.lacity.org/cwd/gnlpln/transelt/NewBikePlan/Txt/LA%20CITY%20BICYCLE%20PLAN.pdf</a>
Greater Streets for Los Angeles Strategic Plan	<a href="http://www.smartgrowthamerica.org/documents/cs/impl/ca-losangeles-dot-strategicplan2014.pdf">http://www.smartgrowthamerica.org/documents/cs/impl/ca-losangeles-dot-strategicplan2014.pdf</a>
LA DOT Bicycle Services	<a href="http://bicycleda.org/">http://bicycleda.org/</a>
LA DOT Safety	<a href="http://www.ladot.lacity.org/WhatWeDo/Safety/index.htm">http://www.ladot.lacity.org/WhatWeDo/Safety/index.htm</a>
Traffic Study Policies and Procedures	<a href="http://ladot.lacity.org/stellent/groups/departments/@ladot_contributor/documents/contributor_web_content/lacityp_026875.pdf">http://ladot.lacity.org/stellent/groups/departments/@ladot_contributor/documents/contributor_web_content/lacityp_026875.pdf</a>
Watch the Road	<a href="http://www.watchtheroad.org/">http://www.watchtheroad.org/</a>
Sweden	
Achieving Traffic Safety Goals in the United States: Lessons from Other Nations	<a href="http://onlinepubs.trb.org/onlinepubs/sr/sr300.pdf">http://onlinepubs.trb.org/onlinepubs/sr/sr300.pdf</a>
An Independent Review of Road Safety in Sweden	<a href="http://publikationswebbutik.vv.se/upload/4314/2008_109_an_independent_review_of_road_safety_in_sweden.pdf">http://publikationswebbutik.vv.se/upload/4314/2008_109_an_independent_review_of_road_safety_in_sweden.pdf</a>
International Transport Forum: Road Safety Annual Report 2014	<a href="http://www.internationaltransportforum.org/pub/pdf/14IrtadReport.pdf">http://www.internationaltransportforum.org/pub/pdf/14IrtadReport.pdf</a>
Management by Objectives for Road Safety Work Stakeholder Collaboration Towards New Interim Targets 2020	<a href="http://publikationswebbutik.vv.se/upload/4253/89217_management_by_objectives_for_road_safety_work_stakeholder_collaboration_towards_new_interim_targets_2020_summary.pdf">http://publikationswebbutik.vv.se/upload/4253/89217_management_by_objectives_for_road_safety_work_stakeholder_collaboration_towards_new_interim_targets_2020_summary.pdf</a>
Urban Mobility Strategy	<a href="http://international.stockholm.se/globalassets/ovriga-bilder-och-filer/urban-mobility-strategy.pdf">http://international.stockholm.se/globalassets/ovriga-bilder-och-filer/urban-mobility-strategy.pdf</a>
The Netherlands	
Advancing Sustainable Safety: National Road Safety Outlook for 2005–2020	<a href="http://www.swov.nl/rapport/dmdv/Advancing_sustainable_safety.pdf">http://www.swov.nl/rapport/dmdv/Advancing_sustainable_safety.pdf</a>
Cycling in the Netherlands	<a href="http://www.fietsberaad.nl/library/repository/bestanden/CyclingintheNetherlands2009.pdf">http://www.fietsberaad.nl/library/repository/bestanden/CyclingintheNetherlands2009.pdf</a>
International Transport Forum: Road Safety Annual Report 2014	<a href="http://www.internationaltransportforum.org/pub/pdf/14IrtadReport.pdf">http://www.internationaltransportforum.org/pub/pdf/14IrtadReport.pdf</a>
Road Safety Strategic Plan: 2008–2020	<a href="http://www.fietsberaad.nl/library/repository/bestanden/5a-Philippens_ICSC2012.pdf">http://www.fietsberaad.nl/library/repository/bestanden/5a-Philippens_ICSC2012.pdf</a>
Signalized Intersection Safety in Europe	<a href="http://international.fhwa.dot.gov/pubs/pl03020/pl03020.pdf">http://international.fhwa.dot.gov/pubs/pl03020/pl03020.pdf</a>
Sustainable Safety	<a href="http://www.fietsberaad.nl/index.cfm?lang=en&amp;section=kennisbank&amp;mode=list&amp;kennisbankPage=Categorisering+en+fietsen+in+verblijfsgebieden">http://www.fietsberaad.nl/index.cfm?lang=en&amp;section=kennisbank&amp;mode=list&amp;kennisbankPage=Categorisering+en+fietsen+in+verblijfsgebieden</a>

(continued on next page)

TABLE 2 (continued) Matrix Sources

Document	Link
London	
Intelligent Pedestrian Technology	<a href="http://www.tfl.gov.uk/info-for/media/press-releases/2014/march/tfl-to-launch-worldleading-trials-of-intelligent-pedestrian-technology-to-make-crossing-the-road-easier-and-safer">http://www.tfl.gov.uk/info-for/media/press-releases/2014/march/tfl-to-launch-worldleading-trials-of-intelligent-pedestrian-technology-to-make-crossing-the-road-easier-and-safer</a>
The Mayor's Vision for Cycling in London	<a href="http://www.tfl.gov.uk/cdn/static/cms/documents/gla-mayors-cycle-vision-2013.pdf">http://www.tfl.gov.uk/cdn/static/cms/documents/gla-mayors-cycle-vision-2013.pdf</a>
Lorry Drivers Have No More Excuses When It Comes to Cycling Blind Spots	<a href="http://www.theguardian.com/environment/green-living-blog/2010/aug/02/hgv-lorries-cycling-campaign">http://www.theguardian.com/environment/green-living-blog/2010/aug/02/hgv-lorries-cycling-campaign</a>
Pedestrian Safety Action Plan	<a href="http://www.tfl.gov.uk/cdn/static/cms/documents/pedestrian-safety-action-plan.pdf">http://www.tfl.gov.uk/cdn/static/cms/documents/pedestrian-safety-action-plan.pdf</a>
Plans for New Out-of-Hours Delivery Trials	<a href="http://www.tfl.gov.uk/info-for/media/news-articles/plans-for-new-outofhours-delivery-trials">http://www.tfl.gov.uk/info-for/media/news-articles/plans-for-new-outofhours-delivery-trials</a>
Puffin Crossing Study	<a href="http://www.trl.co.uk/reports-publications/trl-reports/traffic-management/report/?reportid=6680">http://www.trl.co.uk/reports-publications/trl-reports/traffic-management/report/?reportid=6680</a>
Safe Streets for London: The Road Safety Action Plan for London 2020	<a href="https://www.tfl.gov.uk/cdn/static/cms/documents/safe-streets-for-london.pdf">https://www.tfl.gov.uk/cdn/static/cms/documents/safe-streets-for-london.pdf</a>
Safer Lorries Scheme	<a href="http://www.tfl.gov.uk/info-for/media/press-releases/2014/july/safer-lorries-scheme-consultation">http://www.tfl.gov.uk/info-for/media/press-releases/2014/july/safer-lorries-scheme-consultation</a>
Trial of Roadside Safety Mirrors for Cycle Visibility	<a href="https://www.tfl.gov.uk/cdn/static/cms/documents/trial-of-roadside-safety-mirrors-for-cycle-visibility-report.pdf">https://www.tfl.gov.uk/cdn/static/cms/documents/trial-of-roadside-safety-mirrors-for-cycle-visibility-report.pdf</a>
Supplemental Efficacy Sources	
Section 1. Supportive infrastructure and Planning	
1.1 Safety Action Plan (Vision Zero) and Strategy Health in All Policies: A Guide for State and Local Governments	Rudolph et al. (22)
Health in All Policies: Taking Stock of Emerging Practices to Incorporate Health in Decision Making in the United States	Gase, L.N., R. Pennotti, and K.D. Smith. Health in All Policies: Taking Stock of Emerging Practices to Incorporate Health in Decision Making in the United States. <i>Journal of Public Health Management and Practice</i> , Vol. 19, No. 6, 2013, pp. 529–540.
1.2 Vision Zero Policy (or Vision Zero–like policy) <i>Towards Zero: Ambitious Road Safety Targets and the Safe System Approach</i>	Organisation for Economic Co-operation and Development/International Transportation Forum. <i>Towards Zero: Ambitious Road Safety Targets and the Safe System Approach</i> . OECD Publishing, Paris, 2008.
<i>The Vision Thing: Actors, Decision-Making, and Lock-In Effects in Swedish Road Safety Policy Since the 1990s</i>	Andersson, F., and T. Pettersson. <i>The Vision Thing: Actors, Decision Making, and Lock-In Effects in Swedish Road Safety Policy Since the 1990s</i> . Umeå, Sweden, Umeå Universitetet, 2008.
1.3 Vision Zero Steering Committee Governance Tools and Framework for Health in All Policies	St-Pierre, L. Governance Tools and Framework for Health in All Policies. National Collaborating Centre for Healthy Public Policy. <a href="http://www.ci.richmond.ca.us/DocumentCenter/Home/View/9047">http://www.ci.richmond.ca.us/DocumentCenter/Home/View/9047</a> .
Section 2. Engineering	
2.1a Informative signage: advisory or cautionary signs (e.g., “State law: stop for pedestrians”; “high bicycle activity zone”) <i>Evaluation of Pedestrian-Related Roadway Measures: A Summary of Available Research</i>	Mead, J., C. Zegeer, and M. Bushell. <i>Evaluation of Pedestrian-Related Roadway Measures: A Summary of Available Research</i> . Pedestrian and Bicycle Information Center, Chapel Hill, N.C., April 2013.
2.1b Informative signage: dynamic message signs with safety messaging <i>Effectiveness of Safety and Public Service Announcement Messages on Dynamic Message Signs</i>	Federal Highway Administration. <i>Effectiveness of Safety and Public Service Announcement Messages on Dynamic Message Signs</i> . Publication FHWA-HOP-14-015. FHWA, U.S. Department of Transportation, 2014.
2.2 Perform engineering reviews at all traffic fatality and high collision locations and at scenes of crashes <i>Highway Safety Improvement Program Manual</i>	Federal Highway Administration. <i>Highway Safety Improvement Program Manual</i> . Publication FHWA-SA-09-029. FHWA, U.S. Department of Transportation, 2010.
Road Safety as a Shared Responsibility and a Public Problem in Swedish Road Safety Policy Presentation at Workshop on Independent and Transparent Accident Investigation Recommendations	McAndrews (7). Bergfalk, L. Presentation at Workshop on Independent and Transparent Accident Investigation Recommendations, Brussels, 2007. <a href="http://erso.swov.nl/safetynet/fixed/WP4/Workshop_3_2007/sn_wp4_Brussels_WSgust4_SwedishTrafficInspectorate_LB.pdf">http://erso.swov.nl/safetynet/fixed/WP4/Workshop_3_2007/sn_wp4_Brussels_WSgust4_SwedishTrafficInspectorate_LB.pdf</a> .
2.3b Restrictions on street access: restrict car access in the city center Green Light for Midtown Evaluation Report Vehicle Restrictions: Limiting Automobile Travel at Certain Times and Places	<a href="http://www.nyc.gov/html/dot/downloads/pdf/broadway_report_final2010_web.pdf">http://www.nyc.gov/html/dot/downloads/pdf/broadway_report_final2010_web.pdf</a> <a href="http://www.vtpi.org/tdm/tdm33.htm">http://www.vtpi.org/tdm/tdm33.htm</a> .

(continued)



**TABLE 2** (continued) **Matrix Sources**

Document	Link
2.4 Shared-space area for cars, bicyclists, and pedestrians Lesson 20: Traffic Calming	U.S. Department of Transportation. <i>Lesson 20: Traffic Calming</i> . July 2006. <a href="http://www.fhwa.dot.gov/publications/research/safety/pedbike/05085/pdf/lesson20lo.pdf">http://www.fhwa.dot.gov/publications/research/safety/pedbike/05085/pdf/lesson20lo.pdf</a> .
2.5b Signal hardware additions: pedestrian countdown signal	
2.8h Road design and maintenance: restrict parking near intersections (aka “daylighting”) <i>Toolbox of Countermeasures and Their Potential Effectiveness for Pedestrian Crashes</i>	Federal Highway Administration (17).
2.7b Slow zone: senior slow/safety zones	
2.7c Slow zones around schools/local streets Safe Streets for Seniors Neighborhood Slow Zones	<a href="http://www.nyc.gov/html/dot/html/pedestrians/safeseniors.shtml">http://www.nyc.gov/html/dot/html/pedestrians/safeseniors.shtml</a> . <a href="http://www.nyc.gov/html/dot/html/motorist/slowzones.shtml">http://www.nyc.gov/html/dot/html/motorist/slowzones.shtml</a> .
Slow Zones: Their Impact on Mode Choices and Travel Behaviour	O’Fallon, C., and C. Sullivan. <i>Slow Zones: Their Impact on Mode Choices and Travel Behaviour</i> . <i>Research Report 438</i> , NZ Transport Agency, 2011.
2.8a Road design and maintenance: Advance stop or yield lines	
2.8c Road design and maintenance: high visibility crosswalk Achieving Vision Zero: A Data-Driven Investment Strategy for Eliminating Pedestrian Fatalities on a Citywide Level	Kronenberg, C., L. Woodard, B. DuBose, and D. Weissman. <i>Achieving Vision Zero: Data-Driven Investment Strategy to Eliminate Pedestrian Fatalities on a Citywide Level</i> . In <i>Transportation Research Record: Journal of the Transportation Research Board</i> , No. 2519, Transportation Research Board, Washington D.C., 2015, pp. 146–156.
2.8b Road design and maintenance: enhanced sharrow marking <i>Evaluation of Bicycle-Related Roadway Measures: A Summary of Available Research</i>	Mead, J., A. McGrane, C. Zegeer, and L. Thomas. <i>Evaluation of Bicycle-Related Roadway Measures: A Summary of Available Research</i> . Pedestrian and Bicycle Information Center, Chapel Hill, N.C., February 2014.
Section 3. Education	
3.2 Educate state level organizations on city actions and Vision Zero commitments to broaden understanding of Vision Zero’s impact on pedestrian/bike/traffic fatalities and injuries Road Safety as a Shared Responsibility and a Public Problem in Swedish Road Safety Policy Health In All Policies: A Guide for State and Local Governments	McAndrews (7). Rudolph et al. (22).
3.3 Engage with community-based organizations and advocates Health in All Policies: A Guide For State and Local Governments	Rudolph et al. (22).
3.10 Training for senior citizens on walking and biking Safe Routes for Seniors: Improving Walkability for Seniors in New York City  Evaluation of the Walkable Neighborhoods for Seniors Project in Sacramento County	Shin-pei, T. <i>Safe Routes for Seniors: Improving Walkability for Seniors in New York City</i> . <a href="http://activelivingresearch.org/safe-routes-seniors-improving-walkability-seniors-new-york-city">http://activelivingresearch.org/safe-routes-seniors-improving-walkability-seniors-new-york-city</a> . Hooker, S.P., L.A. Cirill, and A. Geraghty. <i>Evaluation of the Walkable Neighborhoods for Seniors Project in Sacramento County</i> . <i>Health Promotion Practice</i> , Vol. 10, No. 3, 2011, pp. 402–410.
Section 4. Enforcement	
4.1e Automated enforcement: point to point camera Effects of Average Speed Enforcement on Speed Compliance and Crashes: A Review of the Literature  <i>Austrorads Research Report: Point to Point Speed Enforcement</i>	Soole, D. W., B. C. Watson, and J. J. Fleiter. <i>Effects of Average Speed Enforcement on Speed Compliance and Crashes: A Review of the Literature</i> . <i>Accident Analysis and Prevention</i> , Vol. 51, 2013, pp. 46–56. Soole, D. W., J. Fleiter, and B. Watson. <i>Austrorads Research Report: Point to Point Speed Enforcement</i> . Publication AP-R415-12. Centre of Accident Research and Road Safety, Sydney, New South Wales, Australia, 2012.
4.2 Convene regular meetings of transportation leaders and the police department to review traffic safety performance and determine strategies for improvement <i>Road Safety in the Context of Urban Development in Sweden and California</i> <i>Country Guidelines for the Conduct of Road Safety Management Capacity Reviews and the Specification of Lead Agency Reforms</i>	McAndrews, C. <i>Road Safety in the Context of Urban Development in Sweden and California</i> . University of California, Berkeley, City and Regional Planning, 2010. Bliss, T., and J. Breen. <i>Country Guidelines for the Conduct of Road Safety Management Capacity Reviews and the Specification of Lead Agency Reforms</i> . World Bank Global Road Safety Facility, Washington, D.C., 2009.
4.6 Investigate crashes that result in fatalities as well as crashes that result in critical injuries <i>Independent Review of Road Safety in Sweden</i> Presentation at Workshop on Independent and Transparent Accident Investigation Recommendations	Breen, J., E. Howard, and T. Bliss. <i>Independent Review of Road Safety in Sweden</i> , 2008. Bergfalk, L. <i>Presentation at Workshop on Independent and Transparent Accident Investigation Recommendations</i> , Brussels, 2007. <a href="http://erso.swov.nl/safetynet/fixed/WP4/Workshop_3_2007/sn_wp4_Brussels_WSguest4_SwedishTrafficInspectorate_LB.pdf">http://erso.swov.nl/safetynet/fixed/WP4/Workshop_3_2007/sn_wp4_Brussels_WSguest4_SwedishTrafficInspectorate_LB.pdf</a> .

(continued on next page)

TABLE 2 (continued) Matrix Sources

Document	Link
4.7 Random breath testing A National Examination of Random Breath Testing and Alcohol-Related Traffic Crash Rates	Ferris, J., L. Mazerolle, M. King, L. Bates, S. Bennett, and M. Devaney. Random Breath Testing in Queensland and Western Australia: Examination of How the Random Breath Testing Rate Influences Alcohol Related Traffic Crash Rates. <i>Accident Analysis and Prevention</i> , Vol. 60, 2013, pp. 181–188.
Random Breath Testing: A Canadian Perspective	Solomon, R., E. Chamberlain, M. Abdoullaeva, and B. Tinholt. Random Breath Testing: A Canadian Perspective. <i>Traffic Injury Prevention</i> , Vol. 12, No. 2, 2011, pp. 111–119.
4.8 Update technology that assists with capturing crash data and/or speed detection Data Systems: A Road Safety Manual for Decision-Makers and Practitioners	World Health Organization. <i>Data Systems: A Road Safety Manual for Decision-Makers and Practitioners</i> , 2010. <a href="http://apps.who.int/iris/bitstream/10665/44256/1/9789241598965_eng.pdf">http://apps.who.int/iris/bitstream/10665/44256/1/9789241598965_eng.pdf</a> .
Section 5. Monitoring, analysis, and evaluation	
5.1 Comparative data system linking social and environment factors with injury data	
5.6 Publish citywide collision report <i>Data Systems: A Road Safety Manual for Decision-Makers and Practitioners</i>	World Health Organization. <i>Data Systems: A Road Safety Manual for Decision-Makers and Practitioners</i> , 2010. <a href="http://apps.who.int/iris/bitstream/10665/44256/1/9789241598965_eng.pdf">http://apps.who.int/iris/bitstream/10665/44256/1/9789241598965_eng.pdf</a> .
5.2 Continual, proactive monitoring and feedback gathering from the community on their safety issues and concerns <i>Pedestrian Safety: A Road Safety Manual for Decision Makers and Practitioners</i>	World Health Organization. <i>Pedestrian Safety: A Road Safety Manual for Decision Makers and Practitioners</i> . World Health Organization, Geneva, 2013.
5.3 Engage in public health surveillance on traffic-related hospitalizations and fatalities <i>Data Systems: A Road Safety Manual for Decision Makers and Practitioners</i>	World Health Organization. <i>Data Systems: A Road Safety Manual for Decision Makers and Practitioners</i> , 2010. <a href="http://apps.who.int/iris/bitstream/10665/44256/1/9789241598965_eng.pdf">http://apps.who.int/iris/bitstream/10665/44256/1/9789241598965_eng.pdf</a> .
<i>Review of Swedish Experiences Concerning Analysis of People Injured in Traffic Accidents</i>	Howard, C., and A. Linder. <i>Review of Swedish Experiences Concerning Analysis of People Injured in Traffic Accidents</i> , 2013. <a href="https://www.vti.se/en/publications/pdf/review-of-swedish-experiences-concerning-analysis-of-people-injured-in-traffic-accidents.pdf">https://www.vti.se/en/publications/pdf/review-of-swedish-experiences-concerning-analysis-of-people-injured-in-traffic-accidents.pdf</a> .
5.4 Independent review/audit of safety program <i>Independent Review of Road Safety in Sweden</i> Evaluating the Effectiveness of State Toward Zero Deaths Program <i>NCHRP Synthesis of Highway Practice 336: Road Safety Audits</i>	Breen, J., E. Howard, and T. Bliss. <i>Independent Review of Road Safety in Sweden</i> , 2008. Munnich et al. (11).  Wilson, E.M., and M.E. Lipinski. <i>NCHRP Synthesis of Highway Practice 336: Road Safety Audits</i> . Transportation Research Board of the National Academies, Washington, D.C., 2004.
5.5 Interagency sharing of collision and other key data Road Safety as a Shared Responsibility and a Public Problem in Swedish Road Safety Policy <i>Data Systems: A Road Safety Manual for Decision Makers and Practitioners</i>	McAndrews (7).  World Health Organization. <i>Data Systems: A Road Safety Manual for Decision-Makers and Practitioners</i> . 2010. <a href="http://apps.who.int/iris/bitstream/10665/44256/1/9789241598965_eng.pdf">http://apps.who.int/iris/bitstream/10665/44256/1/9789241598965_eng.pdf</a> .
5.7 Routine evaluation of effectiveness of traffic safety interventions Presentation at Workshop on Independent and Transparent Accident Investigation Recommendations  <i>Road Safety Inspections: Best Practice and Implementation Plan</i>  Policy Instruments for Managing Road Safety on EU-Roads	Bergfalk, L. Presentation at Workshop on Independent and Transparent Accident Investigation Recommendations, Brussels, 2007. <a href="http://erso.swov.nl/safetynet/fixed/WP4/Workshop_3_2007/sn_wp4_Brussels_WSguest4_SwedishTrafficInspectorate_LB.pdf">http://erso.swov.nl/safetynet/fixed/WP4/Workshop_3_2007/sn_wp4_Brussels_WSguest4_SwedishTrafficInspectorate_LB.pdf</a> . European Road Safety Observatory. <i>Road Safety Inspections: Best Practice and Implementation Plan</i> . <a href="http://ec.europa.eu/transport/wcm/road_safety/erso/knowledge/Content/70_qrst/monitoring_targets.htm">http://ec.europa.eu/transport/wcm/road_safety/erso/knowledge/Content/70_qrst/monitoring_targets.htm</a> . Laurinavicius, A., L. Jukneviute-Zilinskiene, K. Ratkeviciute, I. Lingyte, L. Cygaite, V. Grigonis, R. Ušpalyté-Vitkūnienė, D. Antov, T. Metsvahi, Z. Toth-Szabo, and A. Varhely. Policy Instruments for Managing Road Safety on EU-Roads. <i>Transport</i> , Vol. 27, No. 4, 2012, pp. 397–404.
5.8 Website with relevant safety data collected in a timely manner What Do the Best Government Websites of 2015 Have in Common?  <i>Using Technology to Promote Transparency in City Government</i>	Wood, C., S. Towns, N. Knell, and J. Mulholland. What Do the Best Government Websites of 2015 Have in Common? <i>Government Technology</i> , September 2015. <a href="http://www.govtech.com/internet/2015-Best-of-the-Web-Award-Winners-Announced.html">http://www.govtech.com/internet/2015-Best-of-the-Web-Award-Winners-Announced.html</a> . Pulidindi, J. <i>Using Technology to Promote Transparency in City Government</i> . National League of Cities, Washington, D.C., 2010.
Section 6. Policy	
6.1 Measures to reduce traffic volumes <i>Traffic Accidents and the London Congestion Charge</i>	Green, C.P., J.S. Heywood, and M. Navarro. <i>Traffic Accidents and the London Congestion Charge</i> . Economics Working Paper Series, Lancaster University Management School, 2014.

(continued)

TABLE 2 (continued) Matrix Sources

Document	Link
6.5 Pre-pay for morning parking to discourage drinking and driving Overnight options  Successful Pre-Paid Parking Program Saves Lives	Estey, M. Overnight Options. <i>International Parking Institute</i> , November 2015. <a href="http://www.parking.org/media/320165/prepaid%20parking%20in%20seattle.pdf">http://www.parking.org/media/320165/prepaid%20parking%20in%20seattle.pdf</a> . <a href="http://sdotblog.seattle.gov/2013/03/18/successful-pre-paid-parking-program-saves-lives/">http://sdotblog.seattle.gov/2013/03/18/successful-pre-paid-parking-program-saves-lives/</a> .
6.6 Restrict deliveries to off peak hours to remove trucks from the busiest streets to improve road safety and ease congestion Delivering a Road Freight Legacy: Working Together for Safer, Greener and More Efficient Deliveries in London SWOV Fact Sheet: Blind Spot Crashes	Transport for London. Delivering a Road Freight Legacy: Working Together for Safer, Greener and More Efficient Deliveries in London. 2013. <a href="http://content.tfl.gov.uk/delivering-a-road-freight-legacy.pdf">http://content.tfl.gov.uk/delivering-a-road-freight-legacy.pdf</a> . SWOV Institute for Road Safety. SWOV Fact Sheet: Blind Spot Crashes. <a href="https://www.swov.nl/rapport/Factsheets/UK/FS_Blind_spot_crashes.pdf">https://www.swov.nl/rapport/Factsheets/UK/FS_Blind_spot_crashes.pdf</a> .
6.7b Policies targeted at protecting vulnerable users: illegal to harass (threaten verbally or physically) a vulnerable user Good Intentions: The Enforcement of Hate Crime Penalty-Enhancement Statutes. Improving Road Safety Through Deterrence-Based Initiatives: A Review of Research	Franklin, K. Good Intentions: The Enforcement of Hate Crime Penalty-Enhancement Statutes. <i>American Behavioral Scientist</i> , Vol. 46, No. 1, 2002, pp. 154–172. Davey, J. D., and J. E. Freeman. Improving Road Safety Through Deterrence-Based Initiatives: A Review of Research. <i>Sultan Qaboos University Medical Journal</i> , Vol. 11, No. 1, 2011, pp. 29–37.
6.8 Target safety improvements to school areas Healthy Urban Environments for Children and Young People: A Systematic Review of Intervention Studies  Effectiveness of a Safe Routes to School Program in Preventing School-Aged Pedestrian Injury	Audrey, S., and H. Batista-Ferrer. Healthy Urban Environments for Children and Young People: A Systematic Review of Intervention Studies. <i>Health and Place</i> , Vol. 36, 2015, pp. 97–117. DiMaggio, C., and L. Guohua. Effectiveness of a Safe Routes to School Program in Preventing School-Aged Pedestrian Injury. <i>Pediatrics</i> , Vol. 131, No. 2, 2013, pp. 290–296.
6.11b State level policies targeted at protecting vulnerable users: mandatory for cars to give at least three feet of clearance when passing a bicycle in the same lane (aka “three-foot rule”) Is the Three-Foot Bicycle Passing Law Working in Baltimore, Maryland?  <i>The 3-ft. Law: Lessons Learned from a National Analysis of State Policy and Expert Interviews</i>	Love, D. C., A. Breaud, S. Burns, J. Margulies, M. Romano, and R. Lawrence. Is the Three-Foot Bicycle Passing Law Working in Baltimore, Maryland? <i>Accident Analysis and Prevention</i> , Vol. 48, 2012, pp. 451–456. Brown, C. <i>The 3-ft. Law: Lessons Learned From a National Analysis of State Policy and Expert Interviews</i> . New Jersey Bicycle and Pedestrian Resource Center. <a href="http://njbikeped.org/wp-content/uploads/2013/04/3-Foot-Final-Report-Draft_V7.pdf">http://njbikeped.org/wp-content/uploads/2013/04/3-Foot-Final-Report-Draft_V7.pdf</a> .
6.11d State level policies targeted at protecting vulnerable users: vulnerable user law Is It Time to Advocate for a Vulnerable Road User Protection Law in New Zealand? The Deterrent Effect of Increasing Fixed Penalties for Traffic Offences: The Norwegian Experience	Weiss, H., and A. Ward. Is it Time to Advocate for a Vulnerable Road User Protection Law in New Zealand? <i>New Zealand Medical Journal</i> , Vol. 126, No. 1374, 2013, pp. 5–10. Elvik, R., and P. Christensen. The Deterrent Effect of Increasing Fixed Penalties for Traffic Offences: The Norwegian Experience. <i>Journal of Safety Research</i> , Vol. 38, No. 6, 2007, pp. 689–695.
6.14 Lower alcohol limit <i>Reaching Zero: Actions to Eliminate Alcohol-Impaired Driving</i> The Effects of Introducing or Lowering Legal per se Blood Alcohol Limits For Driving: An International Review.	National Transportation Safety Board. <i>Reaching Zero: Actions to Eliminate Alcohol-Impaired Driving</i> . Safety Report NTSB/SR-13/01. NTSB, Washington, D.C., 2013. Mann, R. E., S. Macdonald, G. Stoduto, S. Bondy, B. Jonah, and A. Shaikh. The Effects of Introducing or Lowering Legal per se Blood Alcohol Limits for Driving: An International Review. <i>Accident Analysis and Prevention</i> , Vol. 33, No. 5, 2001, pp. 569–583.
Section 7. Large vehicles 7.1 Heavy goods and large vehicle task force to suggest safety improvements and monitor regulations <i>Industrial HGV task Force Review of First Six Months of Operations</i>	Transport for London. <i>Industrial HGV Task Force Review of First Six Months of Operations</i> . <a href="http://democracy.cityoflondon.gov.uk/documents/s37699/Road%20Safety-%20Casualties%20and%20Collisions-%20Appendix.pdf">http://democracy.cityoflondon.gov.uk/documents/s37699/Road%20Safety-%20Casualties%20and%20Collisions-%20Appendix.pdf</a> .
7.4 Outfit large vehicles with front and side mirrors to improve visibility <i>Truck Mirrors, Fields of View, and Serious Truck Crashes</i>	Blower, D. F. <i>Truck Mirrors, Fields of View, and Serious Truck Crashes</i> . Publication UMTRI-2007-25. University of Michigan Transportation Research Institute, Ann Arbor, 2007.
7.5 Outfit large vehicles with rear wheel and side guards <i>Truck Sideguards for Vision Zero: Review and Technical Recommendations for Safe Fleet Transition Plan Pilot Deployment</i>	Epstein, A. K., S. Peirce, A. Breck, C. Cooper, and E. Segev. <i>Truck Sideguards for Vision Zero: Review and Technical Recommendations for Safe Fleet Transition Plan Pilot Deployment</i> . Publication DOT-VNTSC-DCAS-14-01. U.S. Department of Transportation, Cambridge, Mass., John A. Volpe National Transportation Systems Center, 2014.
Section 8. Vehicle technology 8.3 Intelligent speed adaption technologies that alert or slow the vehicle if traveling over the speed limit Is Intelligent Speed Adaptation Ready for Deployment?	Carsten, O. Is Intelligent Speed Adaptation Ready for Deployment? <i>Accident Analysis and Prevention</i> , Vol. 48, 2012, pp. 1–3.

(continued on next page)



TABLE 2 (continued) Matrix Sources

Document	Link
How Much Benefit Does Intelligent Speed Adaptation Deliver: An Analysis of Its Potential Contribution to Safety and Environment.	Lai, F., O. Carsten, and F. Tate. How Much Benefit Does Intelligent Speed Adaptation Deliver: An Analysis of its Potential Contribution to Safety and Environment. <i>Accident Analysis and Prevention</i> , Vol. 48, 2012, pp. 63–72.
8.5 Partner with industry groups and vehicle manufacturers to further the use of technology to achieve safety aims Vision Zero: Adopting a Target of Zero for Road Traffic Fatalities and Serious Injuries <i>Road Safety: Impact of New Technologies</i>	Whitelegg and Haq (6).  Organisation for Economic Co-operation and Development. <i>Road Safety: Impact of New Technologies</i> , 2003. <a href="http://www.internationaltransportforum.org/Pub/pdf/03SRnewTech.pdf">http://www.internationaltransportforum.org/Pub/pdf/03SRnewTech.pdf</a> .
Section 9. Taxi services and transportation network company 9.2 Black box data recorders in taxis Vehicle Safety Technology Pilot Program Driver Characteristic Using Driving Monitoring Recorder	<a href="http://www.nyc.gov/html/tlc/html/industry/veh_safety_tech_pilot_program.shtml">http://www.nyc.gov/html/tlc/html/industry/veh_safety_tech_pilot_program.shtml</a> . Ueyama, M. J. Driver Characteristic Using Driving Monitoring Recorder. <i>Proceedings of the 17th International Technical Conference on the Enhanced Safety of Vehicles Conference</i> , June 4–7, 2001, Amsterdam, Netherlands. June 2001.
9.3 Increase late-night taxi stand zones Overnight Options	Estey, M. Overnight Options. <i>International Parking Institute</i> , November 2015. <a href="http://www.parking.org/media/320165/prepaid%20parking%20in%20seattle.pdf">http://www.parking.org/media/320165/prepaid%20parking%20in%20seattle.pdf</a> .

To support accuracy, each city and country that was included in the matrix reviewed its entries. Cities designated a reviewer, typically their Vision Zero lead or safety expert. Reviews took place from May to July 2015, and 11 of 12 cities or countries initially included in the analysis participated. The representative from Australia opted to not review the Traffic Safety Best Practices Matrix because he felt there was too much variation among cities to make an assessment at the country level. As a result, Australia was removed from the final version of the matrix. Reviewers were contacted via email and were sent a copy of the matrix that included data for their jurisdiction only with a column titled review and a column titled comments as well as a letter that explained the purpose of the project. Reviewers were instructed to indicate if a measure erroneously received a checkmark (i.e., their city was not in fact pursuing or considering the measure) by placing an X in the review column and to indicate if a measure was missing a checkmark (i.e., their city was in fact pursuing or considering the measure) by placing a √ in the review column; to indicate that a measure was accurate, reviewers were asked to leave the review column blank. The matrix was then revised to reflect reviewer feedback.

The majority of reviewers corrected some measures and expressed either an eagerness to use the matrix to further their efforts or were neutral toward the exercise. One region initially identified is not represented in the matrix, for the primary contact opted to not participate because of too much variation between cities to make an assessment at a regional level; the region was thus removed from the matrix.

## DISCUSSION OF RESULTS

The Traffic Safety Best Practices Matrix (Figure 1) lists measures that cities in the United States and cities and countries abroad are pursuing as of May 2015 to reduce pedestrian-, bicycle-, and traffic-related injuries and fatalities. Also included for each measure are efficacy designations based on existing evidence. Table 2 provides a list of the sources used for the review.

Big cities across the United States, in adopting Vision Zero, are leading efforts to reframe the way in which traffic safety is viewed and managed. While this effort is commendable, and speaks to the role of cities as catalysts for change, cities are doing so without

much guidance as to what Vision Zero is and what actions could be implemented to reach zero deaths. The Traffic Safety Best Practices Matrix attempts to bridge this gap by presenting a framework for cities to understand and identify potential strategies for Vision Zero implementation. The discussion details the ways in which the matrix can assist jurisdictions in identifying the range of tools available to them to reduce severe and fatal collisions and further the Vision Zero movement. In addition, the discussion includes an analysis of the matrix throughout which are recommendations for implementation that are supported by lessons learned from Vision Zero implementation abroad, as well as insights from other fields.

## Uses of the Matrix

### Strategy Identification

To move the needle on Vision Zero further and faster, cities need to understand the Vision Zero landscape and be able to share best practices in real time. The matrix can help cities understand the range of levers available to advance the safety platform. The measures listed in the matrix, organized by categories, can help cities understand the breadth of strategies available while also providing a structure for strategy organization. This aspect of the matrix can be especially useful for cities considering implementing the policy.

This is not to suggest that there is only one way to implement Vision Zero. Sweden and the Netherlands, for example, have the longest and most well-established safe system approach; yet they differ in how they articulate the safety platform. Sweden's Vision Zero has focused on issues of rural transportation safety, while the Netherlands has focused on pedestrian and bicycle safety in urban areas (15). Both have achieved great success in their efforts (16). That said, Sweden, as it is the birthplace of Vision Zero, is looked to as providing the blueprint for Vision Zero implementation. Nonetheless, it is inevitable—and appropriate as informed by analysis of safety issues and crash patterns in specific jurisdictions—that the safety measures advanced in the United States will deviate from those of Sweden (and the Netherlands, and other counties that have for some time pursued a systems approach to road safety).

Traffic Safety Best Practices												
	SF	NYC	Chicago	Portland	Seattle	DC	Boston	LA	Sweden	Netherlands	London	Efficacy
	Domestic							International				
1. Supportive infrastructure/ Planning												
1.1 Safety Action Plan (Vision Zero)/ Strategy	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	R, LIT
1.2 Vision Zero Policy (or VZ like policy)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	R, LIT
1.3 Vision Zero Steering Committee	✓	✓		✓	✓	✓	✓	✓		✓	✓	R, LIT
2. Engineering												
2.1 Informative signage												
a. Advisory/cautionary signs (e.g. "State Law: Stop for Pedestrians"; "High Bicycle Activity Zone")	✓		✓		✓	✓					✓	R, LIT
b. Dynamic message signs with safety messaging	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	R, LIT
c. Remove unnecessary and/or confusing signage		✓		✓	✓				✓	✓	✓	R, NCHRP
d. Speed indicator signs	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	R, NCHRP
2.2 Perform engineering reviews at all traffic fatality and high collision locations and at scenes of crashes	✓	✓	✓		✓		✓		✓	✓	✓	R, LIT
2.3 Restrictions on street access												
a. Pedestrian only streets		✓		✓		✓	✓			✓	✓	R, NCHRP
b. Restrict car access in the city center	✓								✓	✓	✓	R, LIT
2.4 Shared-space area for cars, bicyclists and pedestrians	✓		✓	✓			✓		✓	✓	✓	R, LIT
2.5 Signal hardware additions												
a. Bicycle signals	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	R, NCHRP
b. Pedestrian countdown signals	✓	✓	✓	✓	✓	✓	✓		✓		✓	P, LIT
c. Hawk signal	✓			✓		✓						R, CMF
d. Protected turns (turn pockets & signal phasing)	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	R, CMF
e. Puffin Crossing											✓	R, CMF
f. Rapid flash beacons	✓		✓	✓	✓	✓		✓				R, CMF
2.6 Signal hardware uses												
a. Leading bike interval	✓	✓	✓		✓	✓			✓	✓	✓	R, NCHRP
b. Leading pedestrian interval	✓	✓	✓	✓	✓	✓	✓			✓		R, CMF
c. Pedestrian scrambles (exclusive pedestrian phase)	✓	✓	✓		✓	✓	✓	✓			✓	U, CMF
2.7 Slow Zones												
a. Arterial slow zones	✓	✓	✓	✓	✓				✓	✓	✓	U
b. Senior slow/safety zones	✓	✓			✓			✓				P, LIT
c. Slow zones around schools/ local streets	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	P, LIT
2.8 Road design												
a. Advance stop or yield lines	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	R, LIT
b. Enhanced sharrow markings	✓	✓	✓	✓			✓					R, LIT
c. High visibility crosswalk (continental crosswalk)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	P, LIT
d. Increase street lighting to improve visibility in high crash locations	✓	✓	✓	✓	✓	✓	✓	✓			✓	R, CMF
e. Lane narrowing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	R, NCHRP
f. Pedestrian refuge islands and medians	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	R, NCHRP
g. Separated bike lanes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	R, CMF
h. Restrict parking near intersections (aka "daylighting")	✓	✓	✓			✓	✓	✓		✓	✓	P, LIT
i. Road diet	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	P, CTW
j. Roundabouts	✓			✓	✓	✓	✓	✓	✓	✓	✓	P, NCHRP
k. Speed humps, chicanes, diagonal parking, bulb outs, raised crosswalks (general traffic calming measures)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	P, NCHRP
3. Education												
3.1 Bike and safety/crosswalk ambassadors	✓	✓	✓	✓	✓	✓		✓		✓	✓	U, CTW
3.2 Educate state level organizations on city actions and Vision Zero commitments to broaden understanding of Vision Zero's impact on pedestrian/bike/traffic fatalities and injuries	✓	✓		✓		NA	✓		✓	✓	✓	R, LIT
3.3 Engage with community based organizations and advocates	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	R, LIT
3.4 Helmet focused education	✓	✓	✓	✓	✓		✓	✓	✓		✓	U, CTW
3.5 Mass media/communication education campaign focused on pedestrian awareness, bike safety, and/or speeding	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	R, NCHRP
3.6 Measures to increase the conspicuousness of bicyclists (e.g. promotion of reflector vests, lights, etc.)	✓	✓		✓	✓	✓			✓	✓	✓	R, CTW
3.7 Outreach to schools to educate students on bike/pedestrian/traffic safety	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	R, CTW
3.8 Targeted education/outreach to high priority areas	✓	✓	✓	✓		✓		✓			✓	R, NCHRP
3.9 Train city staff on Vision Zero safety priorities	✓	✓	✓	✓	✓		✓	✓			✓	R, NCHRP
3.10 Trainings for senior citizens on walking and biking	✓	✓	✓			✓				✓		R, LIT
3.11 Update officer trainings to reflect new safety priorities and regularly conduct trainings	✓	✓	✓	✓	✓	✓	✓	✓			✓	R, NCHRP
3.12 Website dedicated to bike/pedestrian/traffic safety issues and concerns	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	R, LIT
4. Enforcement												
4.1 Automated enforcement												
a. Block the box camera						✓					✓	U
b. Failure-to-yield crosswalk camera						✓				✓		U
c. Illegal turn camera												U
d. Oversize vehicle camera						✓					✓	U
e. Point to point camera											✓	P, LIT
f. Red light camera	✓	✓	✓	✓	✓	✓		✓		✓	✓	P, NCHRP
g. Speed camera	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	P, CTW
4.2 Convene regular meetings of transportation leaders and the police department to review traffic safety performance and determine strategies for improvement	✓	✓	✓		✓		✓		✓		✓	R, LIT
4.3 DUI checkpoints	✓	✓	✓			✓		✓	✓		✓	P, NCHRP
4.4 High visibility enforcement	✓	✓	✓		✓	✓	✓				✓	P, NCHRP
4.5 Increase enforcement against dangerous moving violations (speeding, failing to yield to pedestrians, signal violations, improper turns/illegal turns, phoning/texting while driving)	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	R, CTW
4.6 Investigate crashes that result in fatalities as well as crashes that result in critical injuries	✓	✓	✓		✓				✓	✓		R, LIT
4.7 Random breath testing									✓	✓		P, LIT
4.8 Update technology that assists with capturing crash data and/or speed detection	✓	✓						✓			✓	R, LIT

(a)

FIGURE 1 Traffic Safety Best Practices Matrix (SF = San Francisco; NYC = New York City; DC = Washington, D.C.; LA = Los Angeles).  
(continued on next page)

Traffic Safety Best Practices												
	SF	NYC	Chicago	Portland	Seattle	DC	Boston	LA	Sweden	Netherlands	London	Efficacy
	Domestic								International			
5. Monitoring, Analysis, and Evaluation												
5.1 Comparative data system linking social and environment factors with injury data	✓	✓					✓	✓			✓	P, LIT
5.2 Continual, proactive monitoring and feedback gathering from the community on their safety issues and concerns	✓	✓	✓		✓		✓			✓	✓	R, LIT
5.3 Engage in public health surveillance on traffic-related hospitalizations and fatalities	✓	✓	✓		✓		✓		✓	✓	✓	P, LIT
5.4 Independent review/audit of safety program									✓	✓	✓	R, LIT
5.5 Interagency sharing of collision and other key data	✓		✓		✓		✓	✓	✓		✓	R, LIT
5.6 Publish city-wide collision report	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	R, LIT
5.7 Routine evaluation of effectiveness of traffic safety interventions		✓		✓	✓				✓	✓	✓	R, LIT
5.8 Website with relevant safety data collected in a timely manner	✓	✓			✓				✓		✓	R, LIT
6. Policy												
Local												
6.1 Measures to reduce traffic volumes									✓		✓	R, LIT
a. Congestion pricing									✓		✓	R, LIT
6.2 Crosscutting measures to reduce car dependence/ improve transit /promote walking and biking												
a. Implement Complete Streets policy	✓		✓	✓	✓		✓			✓	✓	U
b. Transportation Demand Management Program	✓	✓	✓	✓	✓	✓	✓	✓			✓	U
6.3 Mandatory helmet law (18+)					✓							R, CTW
6.4 No right turn on red (city-wide)		✓				✓			✓	✓	✓	R, NCHRP
6.5 Pre-pay for morning parking to discourage drinking and driving					✓							R, LIT
6.6 Restrict deliveries to off peak hours to remove trucks from the busiest streets to improve road safety and ease congestion	✓	✓								✓	✓	R, LIT
6.7 Policies targeted at protecting vulnerable users												
a. Classify traffic-related incidents as collisions and not accidents	✓	✓	✓	✓			✓				✓	U
b. Illegal to harass (threaten verbally or physically) a vulnerable user								✓				U, LIT
6.8 Target safety improvements to school areas	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	R, LIT
State												
6.9 Align state level Towards Zero Death policy with local level Vision Zero policy	✓	NA			✓	✓			NA	NA	NA	U
6.10 State policies targeted at collision reduction												
a. Change DMV point penalty structure so that dangerous offenses are punished with the most severe point values		✓							NA	NA	NA	U, CTW
b. Increase penalties for driving with a suspended license		✓	✓						NA	NA	NA	R, CTW
c. Increase penalties for leaving the scene of a crash		✓	✓						NA	NA	NA	R, CTW
6.11 State level policies targeted at protecting vulnerable users												
a. Increase consequences (fines, tickets, jail time) for careless driving (e.g. injuring a pedestrian/bicyclist, failing to stop and give right of way to pedestrians in crosswalks, etc.)		✓	✓			✓				✓		U, CTW
b. Mandatory for cars to give at least three feet of clearance when passing a bicycle in the same lane (aka "three-foot rule")	✓		✓			✓		✓				U, LIT
c. Ticket and fine motorists who open a door into the path of other traffic, including bicycles and pedestrians (aka "dooring")	✓	✓	✓	✓	✓	✓	✓	✓			✓	U
d. Vulnerable User law		✓	✓	✓	✓		✓			✓		U, LIT
6.12 Variable speed limits via signage		✓							✓	✓	✓	R, NCHRP
Federal												
6.13 Identify opportunities to advance Vision Zero policies, practices and projects in federal programs with US DOT and Congress	✓	✓	✓						NA	NA	NA	U
6.14 Lower alcohol limit									✓	✓		P, LIT
7. Large Vehicles												
7.1 Heavy Goods/ Large Vehicle Task Force to suggest safety improvements and monitor regulations	✓	✓				✓				✓	✓	R, LIT
7.2 Install blind spot mirrors at the most hazardous intersections to help large vehicle drivers better see bicyclists									✓	✓	✓	U
7.3 Large vehicle driver education on bike/pedestrian safety	✓	✓	✓						✓		✓	R, NCHRP
7.4 Outfit large vehicles with front and side mirrors to improve visibility	✓	✓	✓			✓				✓	✓	P, LIT
7.5 Outfit large vehicles with rear wheel and side guards	✓	✓				✓	✓			✓	✓	P, LIT
8. Vehicle Technology												
8.1 Alcohol interlocks in government and commercial fleets									✓	✓		P, NCHRP
8.2 Driver awareness systems to alert the driver to the presence of pedestrians near the vehicle cameras, sensors)		✓							✓		✓	R, CMF
8.3 Intelligent speed adaption technologies that alert or slow the vehicle if traveling over the (speed limit)									✓	✓	✓	P, LIT
8.4 Lane departure warning assistance									✓	✓		R, CMF
8.5 Partner with industry groups and vehicle manufacturers to further the use of technology to achieve safety aims	✓	✓							✓	✓	✓	R, LIT
9. Taxi Services and Transportation Network Company												
9.1 Automatic meter shut-off in taxis that speed									✓			U
9.2 Black box data recorders in taxis	✓	✓										U, LIT
9.3 Increase late-night taxi stand zones					✓						✓	R, LIT
9.4 Issue tickets to taxi drivers identified by red light cameras			✓	✓	✓						✓	R, CTW
9.5 TNC regulations (training, devices, safety equipment)	✓		✓	✓	✓	✓						U
9.6 Update taxi education to reflect safety priorities	✓	✓	✓	✓	✓						✓	R, NCHRP
9.7 Window stickers warning passengers to not open their door into passing bicyclist	✓	✓	✓	✓			✓	✓			✓	R, CTW
KEY												
✓ = Planned/ A Priority/ In Process/ In Practice												
NA = Not applicable												
P = Proven R = Recommended U = Unknown												
CTW = Countermeasures that Work NCHRP = NCHRP 500 Report CMF = Crash Modification Factors Clearinghouse LIT = Literature												

(b)

FIGURE 1 (continued) Traffic Safety Best Practices Matrix.

Adaptation and implementation of Vision Zero in the United States should be mindful of the core principle of Vision Zero: to reduce severe and fatal injuries and shield the human body from excessive force, speed must be managed. This can best be achieved by lowering speeds and redesigning streets to support low speeds (4).

### *Efficacy Assessment and Future Research Needs*

By identifying the known efficacy of measures, the matrix can help cities select evidence-based measures to assist them in their efforts to reach zero. However, since Vision Zero is so new to the U.S. context, many measures have yet to be evaluated (or evaluated consistently), and thus may yet prove to be effective. Several of these measures are concentrated in the policy section of the matrix. For example, the change in classification of traffic-related incidents as collisions and not accidents (6.7a, U) is a recent linguistic shift, and its impact on road safety has yet been studied. Strategies that promote walking, biking, and transit (6.2a, U; 6.2b, U) have the potential to affect safety dependent of the extent to which they include changes in system design that have proven safety benefits (i.e., to ensure increases in active transportation are not accompanied by increases in severe and fatal injury), beyond encouraging mode shift.

This does not mean these and other U measures should not be pursued per se; rather, if practitioners pursue a U, they should seek to also include an evaluation component as part of the project. Researchers should consider measures designated U as opportunities for future research. Adoption of Vision Zero by U.S. cities is in many ways a natural experiment, with notable variation in how U.S. cities are adopting and implementing the platform. It is anticipated that there should be ample opportunities for researchers to evaluate the efficacy of individual measures that currently lack sufficient evaluation—as well as evaluation opportunities for the synergistic impacts of implementing multiple safety measures, consistent with the safe system approach.

### *Benchmarking*

The matrix can also be used as a means for cities to benchmark efforts to advance Vision Zero. Cities can examine the matrix to consider what additional measures other cities are implementing, toward setting realistic goals for improvement or identify opportunities for new partnerships to help advance the Vision Zero goal.

### *Discussion Among Cities*

Cities can also use the matrix to facilitate peer city exchange. The matrix allows cities to become aware of the measures that their peers are implementing. Thus, cities will know whom to engage to find out more information and to determine if a measure is appropriate for their city.

### **Analysis of Traffic Safety Best Practices Matrix**

The researchers analyzed the matrix and arranged their observations by the themes that emerged: measures with (a) widespread adoption, (b) limited implementation, and (c) minimal utilization. In the following analysis, there is discussion of how these findings can inform the next steps for Vision Zero implementation, with a focus

on implications for U.S. cities. The discussion notes the location of the measure on the matrix as well as the efficacy designation.

### *Widespread Adoption*

In several sections and individual lines in the matrix there is a clustering of checkmarks, which suggests widespread adoption of the measures among the cities included in this analysis, including implementation or plans for adoption. Clustering for a section or line is defined as its having more than 70% of the boxes checked.

Engineering, the second section, is an area in which one sees significant clustering of checkmarks. That suggests that this area has received considerable attention from the cities and countries included in the review and that many of the countermeasures are well-used. The engineering countermeasures focus on reducing speeds and range from reducing speeds limits on local streets and near schools and senior centers, and on arterials (2.7a, U; 2.7b, P; 2.7c, P); installing electronic signage that indicates speed (2.1d, R); and geometric changes, in particular pedestrian refuge islands (2.8f, R) (17); roundabouts (2.8j, P) (17); and speed humps (2.8k, P) (18). Many of these measures have an on impact road design, which is a critical way to modify speeds to make roads inherently safe (19). Engineering measures not well used or selectively used include puffin crossings (2.5e, R); senior slow zones (2.7b, P); in the United States, specifically, restrictions on street access (2.3a, R; 2.3b, R); and roundabouts (2.8j, P). Some of these measures are particularly innovative, some may necessitate significant construction, and some may require enhanced political or community support. These factors, among others, could explain their paucity in uptake. Cities leading on these efforts could be sought out for additional information.

Education, Section 3, is another section where most peer cities and counties have implemented multiple measures. The main exception in this section is Sweden, for it is the only location included in the review not using mass media or communication education (3.5, R). This is fitting with how Sweden conceptualized Vision Zero: education was considered capable of maintaining existing safety levels, but it was unlikely to generate the significant future improvement needed to achieve the paradigm's ambitious goals (5). Indeed, focusing on educating the road user is antithetical to the idea that grounds Vision Zero: Individuals make mistakes no matter how well educated (1). Under Sweden's Vision Zero, road users are responsible for following the rules, but this expectation runs parallel to system designers' efforts at continually making the road system safer (10). Sweden does not emphasize education per se, but instead creating more respect for the rules of the road, in particular with regard to speed limits, seat belt use, and intoxicated driving (6), a nuanced but important distinction. Education about road safety in the traditional sense was never emphasized in Sweden because its planning focus, since the 1960s, was to alter the built environment, by placing restriction on cars, to achieve safety. In essence, the road has provided the education (7).

It is not surprising that education is a well-used tool for Vision Zero implementation in the United States, given that education and enforcement have since the 1960s assumed a primary role in safety promotion—equally aligned with the other E: engineering. Yet these tools have been used in an environment where, unlike Sweden, the dominance of the car was never challenged so as to make streets inherently safe (7). Now many U.S. cities are focusing more on changes to the built environment to achieve safety. It

will be interesting to see how the emphasis on education shifts over time as Vision Zero is implemented, particularly if U.S. implementation maintains Sweden's focus on system design. U.S. cities could approach this transition as an opportunity to consider an alternative approach to education, advanced by the field of public health, which would be to take a socioecological approach to education efforts and focus not only on enhancing individual skills, but on how education can support changes in organizational practices and policy reform (20). This approach seems more aligned with Vision Zero principles.

Another area of widespread adoption is supportive infrastructure and planning, Section 1, which the research suggests is fundamental to successful Vision Zero implementation. Here, again, Sweden is the exception in that it does not use a Vision Zero task force or steering committee (1.3, R). In this case, that absence suggests less a fundamental difference in approach (as with education) and instead a limitation in implementation (7). While multi-sectorial thinking informed the development of Vision Zero in Sweden, this collaboration did not continue into the implementation phase. Lack of cooperation and consultation among sectors were acknowledged as reasons for which Sweden failed to reach its 2007 target of a 50% reduction in traffic-related deaths from 1997 (21). Since then, Sweden has set up structures for collaboration: six times a year representatives from municipalities, the police, occupational health, vehicle industry and insurance companies meet with representatives from the Swedish Transport Administration and Agency to discuss safety efforts. Stakeholders are also engaged at the annual result conferences, where analysis of road safety performance indicators (such as speed compliance and seat belt use) is presented (3). In addition, representatives from different sectors come together to analyze crash data. What seems to be lacking are ongoing, daily, working relationships across sectors (7). McAndrews (7) argues that public health, police, vehicle manufactures, and safety specialists have been left out of Vision Zero, and that it has concentrated responsibility in the transportation sector (7). U.S. cities can learn from this shortcoming and concentrate on developing mechanisms that support the institutionalize Vision Zero in existing institutions beyond the transportation sector, including public health, police, and other key implementation partners.

Vision Zero is an example of Health in All Policies (HiAP), an approach to policy making that has struggled since forming in the 1980s to engage across sectors and whose experience further demonstrates how lacking institutions can undermine even best intentions at collaboration. HiAP calls for incorporating health considerations into decision-making structures across sectors and policy areas (22). Like Vision Zero, HiAP has as its origins in Europe and is a nontraditional approach. It requires leadership and resources from outside public health and the formation of new structures and processes that align agency missions and identify shared agendas to advance health in nonhealth sectors (23, 24). Yet HiAP has struggled because it has had difficulty creating a foundation to support its intersectoral work. HiAP experts argue that the how of shared governance—infrastructures, tools, instruments, and processes that facilitate intersectoral partnerships—is not well understood, and that, until it is, there will be difficulty in overcoming the typical, siloed approach to government work (25). The experience of HiAP suggests the salience of investing the resources, time and personnel necessary to develop productive intersectoral collaborations. Done well, Vision Zero cities could emerge as models for HiAP efforts.

### *Limited Implementation*

Some measures are being used by only a few U.S. cities and only a few of the international cities and countries included in the review. The definition of "select" is having, for a section or line, between 40% and 69% of the boxes checked.

As can be seen in the matrix, cities are not seeking opportunities for collaboration across all levels of government, even though positioning on traffic safety policy in U.S. at the federal, state, and local level is more aligned than not. Only a select group of cities are educating state level organizations on their city's Vision Zero commitment (3.2, R), engaging with their state level TZD policy (6.9, U), or seeking opportunities to advance their efforts at the federal level (6.13, U). All the U.S. cities included in the review, with the exception of New York City, have at their state level a TZD policy. Seattle stands out in that it drafted its Vision Zero strategy to be in line with the state's Target Zero plan (J. Curtin, e-mail correspondence, July 6, 2015). TZD is an effective strategy: a 2012 evaluation of the TZD programs in Idaho, Minnesota, Utah, and Washington found that fatality rates decreased faster in these states than in states without TZD programs (11). Efforts at the federal level also have as their focus the elimination of traffic fatalities, and the government's recently published national strategy on highway safety aims to provide direction for both federal and state level TZD efforts (12).

Federal, state, and local levels of government share the vision of eliminating traffic fatalities and are all developing strategies that trace their roots to Vision Zero and the safe system approach. While the space governed by each agency is different (highway as opposed to local roads, for example), at the very least, this alignment of goals suggests an opportunity for collaboration to advance and strengthen traffic safety efforts and address challenges that lie at the intersection of federal, state, and local jurisdictions. What can cities learn from successful TZD efforts? What do city-level Vision Zero efforts have to offer state and federal TZD efforts? Where do these efforts meet and diverge? How can these policies be aligned and strengthened? These are all questions that cities can consider and pursue as they implement Vision Zero, and the answers will help practitioners and researchers better understand if and how this collaboration is effective.

### *Minimal Utilization*

Many measures are being implemented by less than 40% of the cities and countries included in the review. This suggests that there are many areas where U.S. cities could consider placing additional emphasis as they further efforts to implement Vision Zero.

Vehicle technology, Section 8, is the one with the fewest boxes checked by the peer cities and counties. So it represents an area of great opportunity for U.S. cities. Only New York City and San Francisco indicated that they are considering partnerships with industry groups and vehicle manufactures (8.5, R) as part of their approach to Vision Zero. The four technologies highlighted in the Matrix, alcohol interlocks (8.1, P), driver awareness systems (8.2, R), intelligent speed adaptation (8.3, P), and lane departure warning assistance (8.4, R) all have proven safety benefits (26–28). Vehicle safety, achieved through advances in vehicle technology, is a strong focus of Vision Zero in Sweden, but this is not surprising, given that representatives from the automobile industry and experts on motor vehicle design were involved in the conceptualization of the safety philosophy (7).



In the United States, vehicle safety is pursued at the federal level by NHTSA; cities have not historically been designated actors in this space (29). Because vehicle safety is NHTSA's domain, cities may be unsure how they fit, or if they should become involved at all. Cities do have jurisdiction over their bus fleet and may consider ways to use technology to improve the safety of their buses. For example, London is piloting intelligent speed adaptation, an innovative technology that ensures that vehicles cannot exceed speed limits on their buses (30). Perhaps the answer for U.S. cities is to not involve themselves in vehicle safety outright, but to consider ways in which private sector partnerships or technology in general can help them eliminate fatalities and serious injuries from their roads. Such an approach is consistent with Vision Zero's emphasis on systems thinking. A good example of this is New York City's request to Google to change its directions to discourage left turns (31).

Automated enforcement (4.1a–d, U; 4.1e–g, P), actively pursued in the United States by Washington, D.C., is an area where checkmarks are scant. This suggests that automated enforcement is not only a key area for pursuit, but, in addition, an area apt for peer-city information sharing. Automated enforcement is a highly effective tool for speed reduction (32). Washington, D.C., uses five types of automated cameras, while the other U.S. cities employ only red light or transit-only cameras, if they do so at all. Many cities checked the box for speed cameras (4.1g; P), but for most cities, this is something they are planning should they be able to get jurisdiction from their state. Other reasons that could explain why some U.S. cities are pursuing efforts while others are not are timing, funding, and staffing needs.

Publishing a website with relevant safety data (5.8, R)—another area on the matrix where checkmarks are lacking—is a means through which cities could help achieve Vision Zero's core principle that road users demand safety improvements—a responsibility that implies that public participation in transportation decision making is central to achieving Vision Zero (7). A website that clearly articulates the number of severe and fatal injuries, project delivery status, and relevant enforcement citation data, in addition to other key indicators, can facilitate transparency and accountability. It can thus assist the public in monitoring progress toward zero and allowing cities to achieve this key aim of the safety philosophy. To ensure this outcome, it is imperative that information on the website be presented in such that it can be easily interpreted by a lay audience and that analysis be provided where needed. In addition, staff responsible for the website should be responsive to the public's needs for additions or clarifications. Public participation and accountability for Vision Zero initiatives were not adequately captured by the matrix review. Nevertheless, they are important components for consideration as Vision Zero is implemented across U.S. cities, given the political will required to change the status quo with respect to some of the identified strategies (e.g., automated speed enforcement), as well as findings that severe and fatal injuries are often concentrated in areas that are disproportionately low-income, communities of color, and home to residents including seniors and people with disabilities reliant on walking or public transit (33).

Additionally, routine evaluation of the effectiveness of traffic safety initiatives (5.7, R), while standard practice in the international regions reviewed, was notably absent among U.S. cities. Institutionalizing evaluation of the effectiveness of these measures will help ensure that resources are used most efficiently and can help inform the state of the practice. However, this requires prioritization of funding and staff resources to ensure that robust evaluation can be planned, implemented, and shared to inform local practice. Development of comprehensive surveillance systems (5.4, R) is

strongly supportive of this effort, as well as the overall data-driven approach to Vision Zero.

## LIMITATIONS

The matrix can be a useful tool for strategy identification, benchmarking, and facilitating discussion among jurisdictions implementing Vision Zero. However, the matrix is a macrolevel effort and should be approached as a screening tool. To develop targeted, efficient, evidence-based strategies, cities should consider analysis of crash types; priority locations for investments based on severe and fatal crash densities and predictive factors; funding; staffing needs; and other area-specific issues.

Two limitations are specific to the matrix. First, comparing cities with countries has the potential to obscure the analysis. However, as Vision Zero (and its iterations) in Sweden, the Netherlands, and Australia is a country-level effort, it was believed appropriate to look at the country as a whole. Further, it was believed appropriate because these countries have led on implementing systems approaches to traffic safety, and the researchers did not want to miss out on their insights and lessons. Moreover, there was great difficulty in finding sufficient city-specific information that would allow analyzing an individual city in these countries. Second, the cities and countries included in the review elected whom they wanted to review the matrix, and the researchers are unaware of the extent to which they sought corroboration from other members of their own staff. The assumption was that the checkmarks were accurate, but this is acknowledged as a limitation.

## CONCLUSIONS AND RECOMMENDATIONS

The article presents the Traffic Safety Best Practices Matrix, a tool to help cities identify the landscape of strategies being used domestically and internationally to advance Vision Zero. There are four ways in which cities implementing Vision Zero can use the tool:

1. Identify the range of levers available to advance Vision Zero,
2. Understand the currently known efficacy of the strategies and identify opportunities for future research,
3. Benchmark efforts to advance Vision Zero, and
4. Engage in peer exchange.

Through an analysis of the matrix, which was supported by lessons learned from Vision Zero implementation abroad, as well as insights from other fields, there was identification of measures with widespread adoption, limited implementation, and minimal utilization.

On the basis of matrix analysis, lessons learned from Vision Zero implementation abroad, as well as insights from other fields, the following recommendations are offered as next steps for Vision Zero implementation in cities in the United States:

1. Develop mechanisms that institutionalize Vision Zero in existing institutions needed for its implementation that extend beyond the transportation sector.
2. Consider approaching education more in line with that of Sweden, where the focus is on creating respect for the rules of the road that are being emphasized through system design, for example, slow speeds. Focus education efforts on how education can support

the changes in organizational practices and policy reform that allow for changes in system design.

3. Seek opportunities to engage with state and federal leaders on Vision Zero efforts.

4. Explore technology advances that address the unique safety needs of cities.

5. Pursue automated speed enforcement and other camera technologies that have proven safety benefits.

6. Facilitate accountability by creating web-based, publicly accessible spatial data systems that monitor, analyze, and report fatalities and severe injuries and associated factors, as well as facilitate benchmarks on policy progress, to help constituents realize the magnitude and distribution of transportation injuries and create the collective consciousness needed to achieve the policy's aims.

## ACKNOWLEDGMENTS

The authors thank Ryan Greene-Roesel, who was instrumental in the development of the matrix, for her review of this paper. In addition, the authors thank San Francisco staff and community stakeholders who provided direction for the creation of the matrix and everyone from the representative jurisdictions who reviewed the matrix for accuracy.

## REFERENCES

1. Tingvall, C., and N. Haworth. Vision Zero: An Ethical Approach to Safety and Mobility. In *Proceedings of the 6th ITE International Conference on Road Safety and Traffic Enforcement: Beyond 2000*, Melbourne, Australia, Sept. 6–7, 1999.
2. Belin, M., P. Tillgren, and E. Vedung. Vision Zero—A Road Safety Policy Innovation. *International Journal of Injury Control and Safety Promotion*, Vol. 19, No. 2, 2012, pp. 171–179.
3. *Analysis of Road Safety Trends 2013: Management by Objectives for Road Safety Work Towards the 2020 Interim Targets*. Publication 2014:129. Swedish Transport Administration, Borlänge, Sweden, 2014.
4. Johansson, R. Vision Zero—Implementing a Policy for Traffic Safety. *Safety Science*, Vol. 47, No. 2, 2009, pp. 826–831.
5. Organisation for Economic Co-operation and Development—International Transportation Forum. *Towards Zero: Ambitious Road Safety Targets and the Safe System Approach*. OECD Publishing, Paris, 2008.
6. Whitelegg, J., and G. Haq. *Vision Zero: Adopting a Target of Zero for Road Traffic Fatalities and Serious Injuries*. Stockholm Environment Institute, Sweden, 2006.
7. McAndrews, C. Road Safety as a Shared Responsibility and a Public Problem in Swedish Road Safety Policy. *Science, Technology, and Human Values*, Vol. 38, No. 6, 2013, pp. 749–772.
8. Tefft, B. C. Impact Speed and a Pedestrian's Risk of Severe Injury or Death. *Accident Analysis and Prevention*, Vol. 50, 2013, pp. 871–878.
9. Australasian College of Road Safety. *Safe System Approach*. [http://acrs.org.au/wp-content/uploads/ACRS\\_Safe-Systems\\_20100802\\_FA.pdf](http://acrs.org.au/wp-content/uploads/ACRS_Safe-Systems_20100802_FA.pdf). Accessed Nov. 16, 2014.
10. Elvebakk, B. Vision Zero: Remaking Road Safety. *Mobilities*, Vol. 2, No. 3, 2007, pp. 425–441.
11. Munnich, L. W., F. Douma, X. Qin, J. D. Thorpe, and K. Wang. *Evaluating the Effectiveness of State Toward Zero Deaths Program*. Report CTS 12-39T. Center for Excellence in Rural Safety, University of Minnesota, Minneapolis, 2012.
12. *Toward Zero Deaths: A National Strategy on Highway Safety*, June 2014. [http://www.towardzerodeaths.org/wp-content/uploads/TZD\\_Strategy\\_12\\_1\\_2014.pdf](http://www.towardzerodeaths.org/wp-content/uploads/TZD_Strategy_12_1_2014.pdf). Accessed Nov. 16, 2014.
13. Transport for London. *Safe Streets for London: The Road Safety Action Plan for London 2020*. June 2013. <https://tfl.gov.uk/cdn/static/cms/documents/safe-streets-for-london.pdf>. Accessed Nov. 16, 2014.
14. *Washington State Strategic Highway Safety Plan*, Dec. 2013. <http://www.wsdot.wa.gov/NR/rdonlyres/5FC5452D-8217-4F20-B2A9-080593625C99/0/TargetZeroPlan.pdf>. Accessed Nov. 1, 2015.
15. Shahum, L. Five Key Lessons from Europe's Vision Zero Success. *Streetsblog*, June 2015. <http://usa.streetsblog.org/2015/06/10/five-key-lessons-from-europes-vision-zero-success/>. Accessed July 11, 2015.
16. Organisation for Economic Co-operation and Development—International Transportation Forum. *Road Safety Annual Report 2014*. OECD Publishing, Paris, 2014.
17. *Toolbox of Countermeasures and Their Potential Effectiveness for Pedestrian Crashes*. Publication FHWA-SA-014. FHWA, U.S. Department of Transportation, 2008.
18. Webster, D. C., and R. E. Layfield. *Review of 20 mph Zones in London Boroughs*. Published Project Report PPR243. London Accident Analysis Unit, Transport for London, 2003.
19. Mackenbach, J., and M. McKee. *Successes and Failures of Health Policy in Europe: Four Decades of Divergent Trends and Converging Challenges*. Maidenhead, McGraw-Hill Education, New York, 2013.
20. Cohen, L., and S. Swift. The Spectrum of Prevention: Developing a Comprehensive Approach to Injury Prevention. *Injury Prevention*, Vol. 5, No. 3, 1999, pp. 203–207.
21. Lie, A., and C. Tingvall. *Government Status Report from Sweden*. ESV 2009. Swedish Road Administration, Borlänge, Sweden, 2009.
22. Rudolph, L., J. Caplan, K. Ben-Moshe, and L. Dillon. *Health in All Policies: A Guide for State and Local Governments*. American Public Health Association and Public Health Institute, Washington, D.C., and Oakland, Calif., 2013.
23. Greaves, L. J., and L. R. Bialystok. Health in All Policies—All Talk and Little Action? *Canadian Journal of Public Health*, Vol. 102, No. 6, 2011, pp. 407–409.
24. Bostic, R. W., R. L. J. Thornton, E. C. Rudd, and M. J. Sternthal. Health in All Policies: The Role of the U.S. Department of Housing and Urban Development and Present and Future Challenges. *Health Affairs (Project Hope)*, Vol. 31, No. 9, 2012, pp. 2130–2137.
25. Kickbusch, I. Health in All Policies: Where to From Here? *Health Promotion International*, Vol. 25, No. 3, 2010, pp. 261–264.
26. Voas, R. B. Monitoring Drinking: Alternative to License Suspension to Control Impaired Drivers? In *Transportation Research Record: Journal of the Transportation Research Board*, No. 2182, Transportation Research Board of the National Academies, Washington, D.C., 2010, pp. 1–7.
27. Hagiwara, T., H. Hamaoka, M. Hamaguchi, S. Nakabayashi, K. Munehiro, and R. Sakakima. Dedicated Short-Range Communication System for Pedestrians and Vehicles During Right Turns. In *Transportation Research Record: Journal of the Transportation Research Board*, No. 2299, Transportation Research Board of the National Academies, Washington, D.C., 2012, pp. 157–165.
28. Arhin, S. A., A. Eskandarian, J. Blum, P. Delaigue, and D. Soudbakhsh. Effectiveness and Acceptance of Adaptive Intelligent Speed Adaptation Systems. In *Transportation Research Record: Journal of the Transportation Research Board*, No. 2086, Transportation Research Board of the National Academies, Washington, D.C., 2008, pp. 133–139.
29. Hakkert, A. S., and V. Gitelman. Thinking About the History of Road Safety Research: Past Achievements and Future Challenges. *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol. 25, Part B, 2014, pp. 137–149.
30. *Bus Speed Safety Trial Starts*, June 2015. <https://tfl.gov.uk/info-for/media/news-articles/bus-speed-safety-trial-starts>. Accessed July 24, 2015.
31. Goodyear, S. New York Wants Google Maps to Discourage Left Turns. *CityLab*, July 2015. <http://www.citylab.com/commute/2015/07/new-york-wants-google-maps-to-discourage-left-turns/398114/>. Accessed July 24, 2015.
32. Retting, R. A., and C. M. Farmer. Evaluation of Speed Camera Enforcement in the District of Columbia. In *Transportation Research Record: Journal of the Transportation Research Board*, No. 1830, Transportation Research Board of the National Academies, Washington, D.C., 2003, pp. 34–37.
33. *Vision Zero SF Two-Year Action Strategy*, 2014. <http://www.joomag.com/magazine/vision-zero-san-francisco/0685197001423594455?short>. Accessed July 29, 2015.

*The Standing Committee on Transportation Issues in Major Cities peer-reviewed this paper.*