Best Practice lessons from cities implementing Vision Zero and Safe Systems Road Safety

The quest for an end to deaths and life changing injuries on Bristol's road network.

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Acknowledgements: Bristol Health Partners (BHP) for funding this work through the Supporting Healthy Inclusive Neighbourhoods Environments Health Implementation Team, and to Jan Connett of the BHP staff for comments on report drafts; to the International Transport Forum of OECD for advice on evidence sources; to colleagues from Bristol City Council's Road Safety Team, and to the Paediatric Major Trauma Service, at University Hospitals Bristol and Weston NHS Foundation Trust.

Suggested citation: Davis, A. 2022 Best Practice lessons from cities implementing Vision Zero and Safe Systems Road Safety – the quest for an end to deaths and life changing injuries on Bristol's road network. Bristol, Bristol Health Partners, UK.

Foreword

Bristol City Council developed a Safe Systems Road Safety Plan in 2015. This laid the foundations for future development. In 2021 the SHINE Health Improvement Team of Bristol Health Partners proposed work to help the City Council move forward from the 2015 Plan. Recognising that in aiming for the goal of zero road traffic fatalities and life changing injuries, there are key partners that will need to be core to the endeavour if it is to become a reality. Not the least of these is the Paediatric Major Trauma Service at the city-centre hospital, University Hospital Bristol and Weston NHS Foundation Trust. With these two key city agencies in support, a review of the evidence was undertaken as to effective interventions implemented in cities in High Income Countries to achieve the goal of zero road traffic fatalities and life-changing injuries. What could Bristol learn from these?

The review found a relatively small volume of evidence, with a mix of Australian, US, and Norwegian city-level case studies. No case studies or other reports came from UK highway authorities.

The case studies report on a series of key findings that are hopefully of value to the City of Bristol, not least to the Road Safety Team in the Council, the Paediatric Major Trauma Services, and wider One City partners with an interest in safer and healthier transport environments for all. Where understanding of Safe Systems Road Safety or Vision Zero is not shared this acts as a barrier to progressing with effective actions (noted in Victoria, Australia). Positively, where the vision is shared and understood and so when road safety is prioritised then the most vulnerable road users start to benefit from safer environments.

The International Transport Forum (ITF) of the OECD has taken a leading role in drawing on lessons from implementing Safe Systems Road Safety (Vision Zero). Not the least of these is the need for political leadership, and an upstream approach in terms of systems thinking to understand the connections to many other areas of public policy. A key ingredient in any Safe System is speed management. Bristol was one of the first UK cities to implement city-wide 20mph speed limits, when that programme was completed in 2016 and I remain proud that I was able to instigate and see that programme of work through along with many others. It means Bristol has a significant advantage over other UK cities yet to improve safety through lowering speeds driven.

We know that road safety has to compete with many other calls on local authority budgets so is often not a number one priority. Its advocates have to argue its case along with many other pressing needs that local authorities have statutory responsibilities for. The Council needs, therefore, to be supported within a wider coalition of advocates in the vision for zero and Safe Systems Road Safety. Where we succeed, where we avoid deaths and life-changing injuries by changing how the system operates, making environments safer for the most vulnerable, we have truly contributed to human health and wellbeing.

Dr Adrian Davis

March 2022

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Executive Summary

In most cities including in High Income Countries, approximately 80% of road traffic deaths are pedestrians and cycle users with pedestrians comprising the majority and with poorer residents significantly more likely than wealthier residents to be among the injured and killed. As the OECD notes, in some cities the figure is higher. While speeds may largely be low enough to avoid fatalities for people inside vehicles, those who are often termed 'vulnerable road users' are truly most vulnerable to being hit and seriously injured if not killed by people driving motorised vehicles. This is not a new phenomenon but whilst safety has certainly improved over recent decades for car occupants it still hasn't for vulnerable road users.

In 1997 the Swedish Parliament made a historic decision to no longer accept deaths and life changing injuries in the traffic system as a price for personal mobility. They adopted Vision Zero. In the intervening 25 years many countries and settlements within countries, mostly cities, have followed and joined in that vision for zero. That vision has been supported and promoted by the major organisations concerned with health and transport: the World Health Organisation, the OECD, and World Bank. Vision Zero from Sweden has now become part of the wider concept of Safe Systems Road Safety. One of the first cities in the UK to develop a Safe Systems Road Safety Plan was Bristol. In 2019 Bristol City Council issued its first One City Plan. This had a target for 2040: "*There will be zero people killed or seriously injured due to avoidable incidents on Bristol's roads*".[1]

In this report, taking case examples from across cities in High Income Countries and the learning that has gone with Safe Systems Road Safety programmes, a first set of steps is offered. These are steps that can be taken on a path which could ultimately deliver on that One City Plan target to end road traffic fatalities and life-changing injuries in the City of Bristol. To move beyond the rhetoric of a target there needs to be a coalition of support from across the city that buys in to the necessary decisions and actions along the pathway. This is likely to need advocacy from community groups pressing the case for freedom from fear which is a necessary marker of road safety, as noted in New York, US. From this it will be possible to gain a shared understanding of the ambition. In all, eight steps are provided in this report. Efforts to end serious injury will also help with enabling people to choose to walk more and perhaps to feel safe enough to cycle, as has been shown in some of the case examples, when city networks of protective infrastructure are provided from motorised traffic.

As Oslo has shown, a Safe Systems programme also enabled and was supported by other interventions including a congestion charge. The success of various measures in Oslo in turn gave city leaders the political support and the confidence to introduce more measures to reduce traffic casualties, even if they disadvantaged car traffic. In US cities pedestrian crossings have been made safer through changes which introduced 'all walk' phases. Safety cameras have been combined with road engineering and education programmes to enhance the impact of safety measures. Across all locations speed management to 30kmph (20mph) has been, as one author reported it, a critical tenet of the ambition for zero fatalities and life-changing injuries. Achieving the zero target may seem impossible. Yet, Nordic cities, including Oslo reported zero pedestrian or cycle users deaths in 2019; there were also zero road traffic death among children. The ambition *is* possible.

The proposed 'Eight steps' can be found on page 11 of this report. Further, international recommendations are summarised within the evidence on pages 16-17, and 27-29.

[1] Bristol City Council, 2019. One City Plan. About the One City Plan - Bristol One City accessed 26th March 2022.

Introduction

In 2021 Bristol Health Partners (BHPs)[1] approved funding of a small-scale desk-based study of the international literature in High Income Countries on best practice in the application of Safe Systems Road Safety. The focus was to be at the city level. The Supportive Healthy and Inclusive Neighbourhood Environments (SHINE) Health Improvement Team of BHP had submitted a bid as part of its work of SHINE to address aspects of the built and natural environment in order to improve the health of citizens, in this case its most vulnerable citizens. This is because SHINE has placed a strong emphasis on support for and promotion of walking, not least through environmental interventions which improve the perceived safety and attractiveness of the city's local walking environment. The bid was specifically focused on helping Bristol City Council to move forwards with its One City Plan target of zero road traffic deaths by 2040.(2) This work also contributes to lowering the baseline load on the NHS from avoidable injury admissions. The work builds on Bristol City Council's Safe System Road Safety Plan.[2] The bid was supported by the Major Trauma Lead clinicians at University Bristol and Weston Hospital Trust UBWHT as well as the lead for Bristol City Council's Road Safety Team.

It might be assumed that road safety is a top priority for local authorities. And that the organisations that are responsible for managing traffic safety have a strong safety culture. It often is not the case. Only these organisations have the resources and authority to implement and sustain the types of integrated strategies that are necessary to transform traffic safety culture. This will be true where priority is given to safety above all other decision criteria. This can be described as a social climate in which traffic safety is highly valued and rigorously pursued. This type of climate emerges only with the inspiration and innovation of transformational leaders – those with the professional competence, visionary courage, and personal charisma to instigate and inspire innovative change in the vision, strategy and culture of the organisation **(Ward, et al, 2014)**.[3]

Yet, the dominant approach to policy-making in this country – as set out, for example, in the Treasury Green Book – very clearly implies that safety should not be a "first" priority, but one priority to be valued consistently alongside others in the appraisal of options. Other stances on safety exist which are logically coherent and defensible. Secondly, at a cultural level, what matter most are not espoused values – the things we say we care about – but values in action – the values we actually demonstrate in what we do. And seen from this perspective, it is clear that organisational safety cultures vary greatly: for example, in how reactive or proactive an organisation is about addressing risk, or in its tolerance of different kinds and sources of risk. As a simple matter of fact, safety is not everybody's first priority.

[2] Bristol City Council, 2015 A Safe Systems Approach to Road safety in Bristol. Bristol. A+Safe+System+Approach+to+Road+Safety+in+Bristol.pdf Accessed 20th January 2022.

Safe Systems approach to road safety

Road safety is increasingly considered a major public health problem. The World Health Organization has labelled road traffic collisions as a major global health hazard as it is one of the leading and fastest growing causes of disability and death globally.[4] As all countries in the world—even the safest—are still unsatisfied with the current level of safety, the question of how to make even more progress remains an important one to address.

As Fred Wegman, a lead designer of the Dutch Sustainable Safety programmes notes, there are two good reasons why the traditional approach to road safety (working on reducing "spikes in distributions" such as at cluster crash sites around junctions[3]) will become less effective and efficient in countries with mature road safety policies.[5] The first reason lies in the fact that serious road crashes[(4)] will occur as long as we leave the inherent unsafe conditions in road traffic untouched: the inherent risks come from a combination of the physical vulnerability of the human body and the levels of kinetic energy in crashes (a combination of speed and mass). These inherent risks, Wegman states, also stem from human error, the fact that the road transport system cannot be designed from the perspective of the human being as long as it fails to defend against human errors and offenses that can result in crashes. Because of this, we are almost fully dependent on how well drivers, riders, and pedestrians perform their tasks.

According to the OECD, World Bank and World Health Organisation, Safe Systems Road Safety is the best and fastest way to reduce traffic fatalities. Its widespread application will be necessary to meet the Sustainable Development Goals target of halving the number of global road deaths by 2030. Beyond saving lives, the approach yields many other benefits, including economic, health, and environmental improvements. As a report from the **World Resources Institute (2018)** noted:

> "A Safe System … is about designing roads, vehicles, and any new mobility technology that enters the system to be forgiving of human fallibility. It does so by reducing speeds in rural and urban areas, crafting urban development policies that create safe new development as urbanization occurs, protecting bicyclists and pedestrians, designing roadways in rural areas and on highways that prevent head-on collisions, strictly enforcing road safety laws, ensuring that vehicles are safe, reducing post-crash response times, and much more. The approach requires ongoing revision and proactivity, as mobility[5] is extremely dynamic. Adjustments may be needed over time as improvements are made, travel patterns shift, and technologies change."[6]

According to the **International Transport Forum (2016)** (ITF) of OECD, a Safe System proactively and holistically reduces risks in all areas of a road safety system. It fosters safe behaviour while also addressing risks inherent in the design of the road network. Crashes are prevented by elements of the system that guide users to act safely. At the same time, measures are taken to reduce the likelihood that the crashes that inevitably still occur do not result in serious injury or death.

Four guiding principles are central to a Safe System:

> 1. People make mistakes that can lead to crashes. The transport system needs to accommodate human error and unpredictability.

[3] Transport for London estimates that between 2014-2016 62% of road traffic deaths and serious injuries occurred at junctions Vision Zero action plan (tfl.gov.uk) accessed 3rd March 2022.
[4] The word 'crash' is purposefully used rather than 'accident'. See 75: Accident: No such thing? - Travelwest
[5] Throughout this report 'mobility' means movement of people or goods

2. The human body has a known, limited physical ability to tolerate crash forces before harm occurs. The impact forces resulting from a collision must therefore be limited to prevent fatal or serious injury.

3. Individuals have a responsibility to act with care and within traffic laws. A shared responsibility exists with those who design, build, manage and use roads and vehicles to prevent crashes resulting in serious injury or death and to provide effective post-crash care.

4. All parts of the system must be strengthened in combination to multiply their effects, and to ensure that road users are still protected if one part of the system fails.[7]

Many countries, states, and cities that have adopted a Safe System approach have reduced road fatalities at a faster rate than others that followed the traditional approach (e.g. crash site clusters). Analysis of traffic fatalities in 53 countries between 1994 and 2015 revealed that countries that have adopted a Safe System approach have both the lowest rates of fatalities per 100,000 inhabitants and the fastest rate of change in fatality levels.[8]

Across the peer reviewed literature and publications of key organisations central to the promotion of SSRS (e.g. OECD, World Bank, WHO) the volume of studies addressing the core elements of the concept are numbered in hundreds, if not thousands of studies. In terms of studies addressing best practice there are far fewer, perhaps reflecting the lag between strong rhetorical support for Safe Systems and the actuality of planning, design, delivery, monitoring and evaluation. This is a phenomena reported on more widely in the literature including in seeking the most robust study designs (see Elvik, 2021). Below the findings from the studies located through library searchers which address aspects of best practice in SSRS in cities in High Income Countries is presented.

It is maybe a useful starting point to note that Safe Systems Road Safety (SSRS hereafter) is a concept which has its origins in Vision Zero, the strategy approved by the Swedish Parliament in 1997 which first articulated the ethically-based goal of zero road deaths and life changing injuries.[6, 7] It is widely noted that road traffic injuries are largely avoidable. Road systems should be designed so that human error does not have a serious or fatal outcome. The Safe System approach is guided by core elements for planning, implementation, evaluation, and monitoring. Increasing numbers of countries, towns and cities across the globe have committed themselves to achieving zero road traffic deaths and this is a shift witnessed in the past two decades in the wake of Sweden's Vision Zero policy.

If we never actually risk exposing people to the kind of impact that their bodies cannot withstand, the road system is finally safe, and fatalities need not occur, or only very infrequently, as is the case for injuries in many other sectors of society. Typically, the road system has been compared to air traffic and the railway, and to professional spheres such as hospitals and businesses, in order to illustrate that safety margins and requirements are unacceptably low in road traffic.[8]

In order to advance SSRS it was agreed by BHP and SHINE that a review of best practice in High Income Countries and specifically in cities would be undertaken in order to identify possible next steps for Bristol City Council and potentially other parties. In this endeavour, support was gained

[6] SSRS and Vision Zero are treated as the same for the purposes of this research

[7] Kristianssen, A. et al., 2018 Swedish Vison Zero policies for safety – A comparative policy content analysis, *Safety Science*, 103: (March); pp 260-269.

[8] Elvebakk, B., Steiro, T. 2009 First principles, second hand: Perceptions and interpretations of vision zero in Norway, *Safety Science*, 47(7): 958-966.

from Bristol City Council's Road Safety Team and likewise sought and was forthcoming from the Paediatric Trauma Lead and lead Consultant at the University Hospitals of Bristol and Weston NHS Foundation Trust.

Key facts and actions from cities

In drawing all of the material together a summary of key facts and findings reported on below is first provided in helping cities in High Income Countries, and in this case the City of Bristol, UK, move forward on SSRS. Following from this a set of recommendations are made.

Key facts and recommendations from OECD's Safer City Streets Initiative

- Almost half of road fatalities in cities are pedestrians, a user group which experiences a risk of fatality ten times higher than the risk experienced by car occupants. Moreover, in Safer City Streets cities the median share of fatalities among vulnerable road users is 78% against 43% nationally. These are baseline figures which have galvanised cities and communities to take action.
- When city-level road safety performance analysis is limited to fatalities, much insight and statistical significance are lost, reducing the relevance of monitoring efforts. Developing reliable data on injuries is therefore important.
- Fatalities in Safer City Streets cities fell more rapidly outside of cities – indicating the changes of improving VRU safety.
- Whilst Berlin, Copenhagen and The Hague have the highest shares of bicycle fatalities, further examination of the level of risk indicates that these are among the safest cities for cycling. This highlights the importance of appropriate denominators such as exposure time (trip length) and provision of cycle infrastructure.
- In order to measure, monitor and benchmark the level of risks experienced by a specific road user group, the volume of travel should be controlled for. For this reason, the number and length of trips in each mode should be estimated and monitored. Household surveys are encouraged.
- More local governments should establish a framework for the collection and reporting of relevant urban mobility data. This would include both mobility and casualty figures, thus facilitating the interpretation of road safety trends.
- Establish protocols for the collection of injury data from the health and emergency services. Their goal should be to complement police records, often the only source of information on casualty numbers in spite of the notorious underreporting of casualties in police records.
- There are large performance gaps between cities. Drawing attention to these gaps could help secure political support for rapid casualty reduction targets. Targets should also be set to improve the most critical behaviour indicators, most importantly speeding.

Key actions from individual cities:

Oslo, Norway

- Reducing car traffic target for next decade
- Expanded designated bus and bike lanes, transfer of parking bays for bike lanes
- Launched a smart phone app for children in school, where they can report traffic hazards and request road safety measures directly to the road authority
- Car-free city-centre
- Narrowing traffic lanes and tight junction curb radii requiring drivers to turn more slowly
- Analysis Investigation for all Road Traffic Deaths

Victoria, Australia

In reviewing their work on SSRS for over 15 years the reviewers found challenges and barriers:

- SSRS is significantly limited by not having a shared, consistent understanding of how Safe System is to be actioned
- The purpose of Safe System is unclear, stemming from multiple, differing perspectives on the intended outcomes and objectives
- Community support for Safe System is mixed with acceptance of a forgiving road safety system but a continued reliance on the attributions of blame. In part this is explained through poor engagement and a reluctance in some parts of government to adopt Safe System

US cities of New York City (NYC); Seattle (Se); Boston (Bo); San Francisco (SF)

- Had support of a well-organized, politically influential advocacy group that publicised the basic Safe Systems concepts as early as 2011, highlighting advances made in other nations and laying out a blueprint for adoption (NYC) (SF)
- Addressing dangerous driver choices, like speeding and failing to yield, which are the primary cause of 70 percent of pedestrian fatalities. (ALL)
- Installing Leading Pedestrian Intervals to minimize turning vehicle/pedestrian conflicts. Pedestrians receive the "Walking Man" display for approximately six to ten seconds prior to the parallel movement of traffic getting a green indication. This allows pedestrian to start their crossing free from conflict with turning vehicles and establish a presence in the crosswalk. (NYC, Se)
- Pedestrian advocacy, not least by families of those killed as well as survivors (NYC)
- Protected bike lanes, found to be highly cost effective (NYC, Se, Bo)
- Neighbourhood Slow Zones and default speed limit 20mph for residential 25mph for arterial road and implementation supported and promoted as saving money and lives (NYC, Se, Bo)
- Improving Pedestrian visibility through improved sight-lines (Se, Bo)
- Developed Vision Zero Plans (NYC, Se, Bo)
- Specific training programmes for lorry drivers in urban environments (SF)

Recommendations

Overall, considering all of the evidence contained in this report a range of '*structural issues*' and '*intervention approaches*' have been identified. From these a bespoke set of 8 steps are proposed for the City of Bristol to move forward on SSRS. It is important that at least some of Steps 1-4 (structural) are taken before much progress can be made with steps 5-8 (interventions).

In addition, there are a range of recommendations and source material including the Traffic Safety Best Practices Matrix (Appendix 1) with its list of 106 measures which could be considered for implementation guided by their 'proven' and 'recommended' status.

Structural issues

Step 1 - Leadership

In 2015, Bristol City Council was one of the first UK highway authorities to develop a SSRS Plan. Since then, however, Bristol City Council nor any other agency has a clear programme for SSRS. This includes the political leadership from the City Council and leadership from other key agencies. A clear signal of political leadership from the City Council is required to help galvanise resources and promote a vision for a safer traffic environment, not least for those most vulnerable. This will also require the creation of a alliance of key agencies including the NHS, advocacy groups, the emergency services, academic researchers, and the private sector as the vision should be shared across the city and its institutions and agencies, as well as establishing strong community engagement. It is of note that a number of the city exemplars listed above, worked in close collaboration with public health agencies in their localities. In England public health returned to top-tier local government in 2013 and that the author of this report was the public health adviser to the City Council's Transport Department (2008-2018, and co-drafted the SSRS Plan of 2015. Re-engaging with the public health team to help move forward with the SSRS is part of Step 1.

Step 2 – Upstream approach

SSRS requires a shift to an up-stream approach, which is pro-active and ethically led in seeking the eradication of deaths and life-changing injuries on the highway. A clear and shared understanding of what SSRS is should be established at the earliest opportunity and how it should be actioned. Here the value of public health approaches, with whole population strategies, and systems thinking, is likely to help move beyond traditional approaches focused on influencing individual behaviour, with its attendant risk of victim blaming.

Step 3 – The system and system designers

Acknowledgement that humans will make mistakes, so transport systems should be planned to minimize the severity of repercussions. Greater attention should be focused on improving the transport system itself, particularly the built environment, policies, and technologies that influence behaviour. Furthermore, that system designers - highways engineers, planners, urban designers and other professionals - play a primary role.

Step 4 – Speed is critical

Commit to speed management as a fundamental of SSRS. Bristol is helped by the implementation of city-wide 20mph speed limits across the majority of the road network and this gives the city a substantial advantage over other cities. Research by UWE Bristol reported that between 2008 and 2016, the 20mph speed limit intervention was associated with a city-level reduction of fatal injuries

of around 63% (95% CI 2% to 86%), controlling for trends over time and areas. There was also a general trend of reduction of the total number of injuries at city level and in 20mph roads.[9] This intervention was also proposed and developed through public health from 2008 which again creates a strong foundation for future public health collaboration on SSRS.

Intervention approaches

Step 5 – Data, intelligence, networks

Data and intelligence are critical elements to understanding intervention priorities and programmes. This includes the need for regular measurements and reporting. It includes the establishment of protocols for the collection of injury data from NHS and emergency services. The Maximum Abbreviated Injury Scale (MAIS), sets an international standard. The City Council is part of the ITF (OECD) Safer City Streets Initiative, and this provides a 'ready-made' network for international comparisons. UK networking on SSRS should also be established or developed. It is of note also that Bristol City Council is a member of Bristol, North Somerset and South Gloucestershire NHS Integrated Care System which is developing a system-wide data set. This would be an opportunity to expand and connect hospital-collected data on injuries with other road traffic data.

Step 6 – Focus on protecting vulnerable road users

Prioritise protecting vulnerable road users given the disproportionate burden of injury and death placed on these groups. This should include measurements of risk and exposure and the use of household and other survey methods can help gain such information. Noting that a relatively small number of roads tend to be where a disproportionate number of KSI events occur there are lessons available in terms of proactive intervention approaches to be drawn on in providing greater protection to vulnerable road users. Some of these measures can be seen through the implementation approaches of cities like Oslo, through expanded designated bus and bike lanes, the transfer of parking bays for bicycle lanes, and a car-free city-centre. Moreover, addressing dangerous driver choices, like speeding and failing to yield are also key to vulnerable road user safety, as highlighted in the US examples. Linking to the recently revised Highway Code where drivers are now required to yield to pedestrians at side roads would be an area to focus on.[9]

Step 7 – Enforcement remains important

Enforcement has always been a part of the approach to road safety whether through camera technology or officers on the streets. Therefore, it remains important that Avon and Somerset Constabulary retain a clear role, understand and are wholly supportive of the SSRS approach. This includes being part of networks and data and intelligence sharing.

Step 8 – The importance of advocacy and community engagement

Community advocacy and engagement has been shown to be a powerful force through which to create an environment supportive of SSRS – such as in New York City and San Francisco. While it is the role of advocacy groups to engage and press their elected Councillors and others to promote and implement SRSS, the Council can engage with and encourage greater activity by community groups in support of the overall goal of ending deaths and life changing injuries on the highway in the city. The example from Oslo of the development of a smart phone app for children in school, where they can report traffic hazards and request road safety measures directly to the road authority provides a good example of empowerment of a particular group of VRUs. In Bristol key groups at likely to

[9] The Highway Code: 8 changes you need to know from 29 January 2022 - GOV.UK (www.gov.uk) accessed 3rd March 20202.

include the Bristol Walking Alliance, Bristol Cycling Campaign, Playing Out, and the Civic Society, and representative groups for young people, among others.

In conclusion, whilst there is not a large evidence base as to what cities in High Income Countries have been doing to make SSRS the default approach to the elimination of road traffic deaths and life-changing injuries, where it has been implemented it can be highly effective (Oslo, New York, San Francisco, Boston). Bristol, like most UK cities, is in the early stages of a journey to bring the Safe Systems approach to bear on its work to make the city inherently safer to travel around, and mostly to improve conditions for those most vulnerable on city streets.

The 8 steps set out above provide an initial route-map in helping find a pathway. Some of the steps may seem too ambitious, while others already well advanced. On the way there will be barriers to progress, from funding, lack of will and kick-back from some of the existing systems operatives holding different values, and more generally traditional traffic safety cultures. Indeed, as noted above by Australian researchers, implementation challenges of Safe System are political and social, rather than technical. But these are simply challenges along the way to be met and overcome. The important action now is in taking some of these steps to save lives and reduce injury and trauma.

Literature Review

Method

A Literature search was undertaken using the follow criteria:

Inclusion criteria

Target audiences/populations included in interventions

All adults and children.

Study design

All study designs, peer reviewed and grey literature.

Inclusion dates

January 2010 to November 2021.

Geography

Searches of the global literature for papers published in English addressing High Income Countries.[10]

Literature searches

Search terms used: Safe Systems Road Safety; Vision Zero, roadway safety; city road safety; safe cities; urban road safety; best practice.

Search engines used were TRIDS; ScienceDirect; Scopus; Taylor & Francis; Emerald; Psychinfo; and Google Scholar. In addition, grey literature was also included such as governmental departments and road safety institute reports. The websites of some national road safety bodies including SWOV in The Netherlands https://www.swov.nl/en ; the Nordic Road and Transport Research site http://nordicroads.com/ ; the Swedish National Road & Transport Institute (VTI) https://www.vti.se/en/ were searched for relevant studies as was that of the International Transport Forum of the OECD Home | ITF (itf-oecd.org).

The searches generated 13 peer reviewed papers and reports which focused specifically on SSRS and Vision Zero best practice within High Income Countries.

[10] New World Bank country classifications by income level: 2021-2022 Accessed 20th January 2022.

Evidence from the literature

ITF Safer City Streets Initiative

The ITF of the OECD has published a number of reports on aspects of SSRS. Of particular relevance to SSRS in cities is their Global Benchmarking for Urban Road Safety report, **(Santacrue, 2018)**.[10] The ITF collected mobility and road safety data from 31 cities, the majority of which are in Europe, 10 in the Americas and 2 in Oceania. Indicators were developed to evaluate, monitor and benchmark road safety outcomes. Together, the global city-level road safety database and the network of road safety experts make up the Safer City Streets initiative. The report's analysis revealed considerable differences in road safety performance between cities, suggesting cities should do more to share best practice and learn from their peers.

Pedestrians, cyclists, wheelchair users, and motorcyclists, together called VRU, make up about eight out of ten road users killed in city traffic. As others have reported, ITF found that almost half of road fatalities in cities are pedestrians, a user group which experiences a risk of fatality ten times higher than the risk experienced by car occupants. This analysis has yet to control for potentially confounding factors and to examine the number of third-party casualties but clearly makes the case for a greater focus on pedestrians in cities.

Injury data are not (yet) comparable across cities. This is due to a combination of inconsistent definitions and reporting rates and the absence of data from hospital admissions. When city-level road safety performance analysis is limited to fatalities, much insight and statistical significance are lost, reducing the relevance of monitoring efforts. Developing reliable data on injuries is therefore important.

The number of fatalities recorded in cities was lower in 2011-2015 compared to the previous five-year total. However, Figure 1 indicates that fatalities in cities decreased more slowly than the corresponding national level. In Barcelona for instance, the number of fatalities fell by 25%, whereas the Spanish total fell by 44%. In the Paris Area, the number of fatalities remained stable whereas the French total fell by 20%. In other cities, the gap is statistically less significant. The overall picture is clear nonetheless: fatalities fell more rapidly outside of cities.

The causes of this lag are yet to be thoroughly investigated. A faster population growth in cities may be one of the factors involved. Another factor could be the high share of vulnerable road users (VRUs) in cities, a group which didn't benefit from the development of air-bags and other safety features protecting car occupants. Some cities indeed report a rapid fall in car occupant fatalities, which they explain by the safety features integrated into new cars.

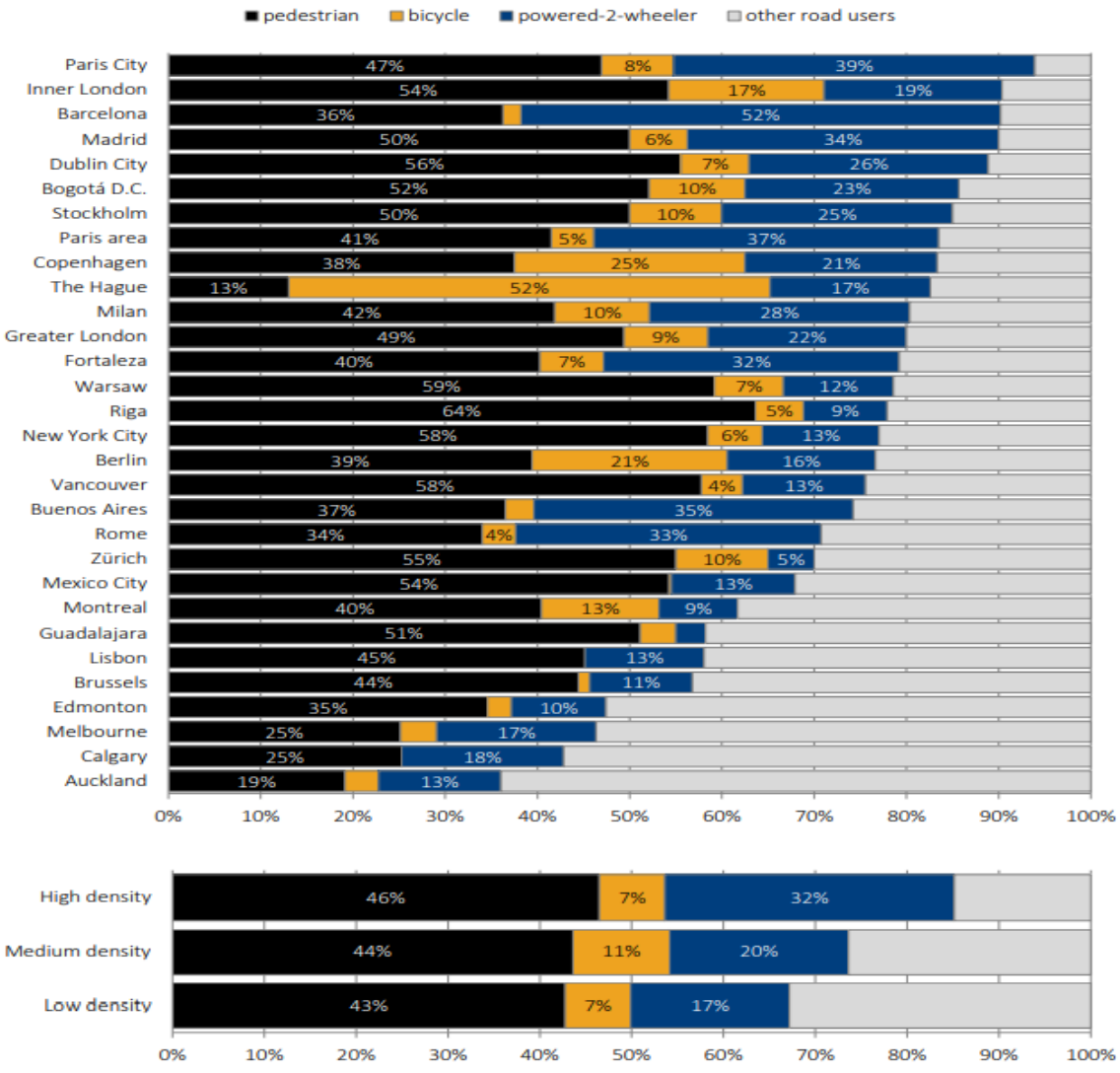
ITF says,

> "to put it simply, in cities where fatalities are disaggregated by mode, we observe a typical (median) 20% reduction in VRU fatalities, but a typical 25% reduction in car occupant fatalities."

When considering urban traffic casualties by user groups ITF found that, in most cities, the proportion of vulnerable road users (VRUs) in the total number of fatalities is high (Figure 1). The median is close to 80% and figures range from 36% to more than 90%. In Paris for instance, of the 41 road users killed annually on average during 2011-2015, 93% were VRU fatalities. Across the 16 areas with figures available at both local and national level, the median share of vulnerable road users is 78% in cities, against 43% in the country as a whole. This is a considerable difference which explains the high level of interest for VRUs in the Safer City Streets network. VRUs make up 85% of

fatalities in high-density cities, those with over 10 000 inhabitants per square kilometre. In cities where the population density is lower than 5 000 inhabitants per square kilometre, VRUs still make up two thirds of road fatalities. It is remarkable that much of the difference can be attributed to the lower share of powered-2-wheeler fatalities in low-density cities. Pedestrians and cyclists together still make up 50% of fatalities in low density-cities. Whilst Berlin, Copenhagen and The Hague have the highest shares of bicycle fatalities, further examination of the level of risk indicates that these are among the safest cities for cycling. Cycling is common and risk of injury per trip (or unit of exposure is low) compared to many other European cities. This is because these cities have placed a high importance to safe cycling infrastructure and research suggests that this in the main reason for the high safety.[11] The corollary is that one should be cautious when making an interpretation of this graph. Above all, it shows the importance of protecting VRUs in cities so that risk of injury, as a function of exposure, is low.

Figure 1: Modal shares of road fatalities, by city and by population density group, 2013-2015



Note: low population density (n=12) is less than 5 000 inhabitants per square kilometre, medium (n=13) is less than 10 000, high (n=5) is 10 000 and above. Where cities are grouped, we represent the unweighted average across n cities in the group

ITF's seven recommendations

1 Develop mobility observatories in cities

More local governments should establish a framework for the collection and reporting of relevant urban mobility data. This would include both mobility and casualty figures, thus facilitating the interpretation of road safety trends. This would also include data on behaviours, attitudes and enforcement. Such observatories are best developed as part of a sustainable urban mobility plan (SUMP).

2 Collect traffic casualty data from hospitals, not only from police records

All stakeholders should seek to establish protocols for the collection of injury data from the health and emergency services. Their goal should be to complement police records, often the only source of information on casualty numbers in spite of the notorious underreporting of casualties in police records. The categorisation of injury severity using an international medical standard called MAIS3+ is recommended to enable the monitoring of progress over time and to make meaningful comparisons across cities. Population surveys, with all their challenges and potential biases, shouldn't be regarded as a substitute for hospital data but could nonetheless help estimate and monitor the actual number of people injured in traffic. See Footnote[11] and reference for further details.

3 Adopt ambitious targets to reduce the number of casualties

Cities should adopt ambitious targets to reduce fatalities and serious injuries, in line with the Safe System approach. The Safer City Streets benchmarking effort reveals large performance gaps between cities. Drawing attention to these gaps could help secure political support for rapid casualty reduction targets. Targets should also be set to improve the most critical behaviour indicators, most importantly speeding.

4 Focus on protecting vulnerable road users

Cities should intensify their efforts on improving the safety of vulnerable road users, who make up the vast majority of urban traffic fatalities and who experience a greater level of risk. Cities should enhance streets so that people walk and cycle more in safe conditions. Riders of powered-2-wheelers should also be the focus of road safety policies, such as speed enforcement, since they are associated with the greatest risk of fatality, by far, in comparison to other modes, not only risking their own life but also the life of other road users.

5 Use appropriate indicators to measure the safety of vulnerable road users in cities

The absolute number of road traffic fatalities and injuries are important indicators for monitoring road safety trends and setting road safety targets. However, to measure, monitor and benchmark

[11] Hospitals in many countries are applying a medical definition of injury based on the amount and severity of the injuries sustained. These definitions are contained in the widely used the Injury Severity Scale (ISS), the Abbreviated Injury Scale (AIS) and the Maximum Abbreviated Injury Scale (MAIS). They reflect the threat to life associated with the injury, rather than a comprehensive assessment of the severity of the injury. Following the recommendation made by the **ITF (2011),** a level of injury of MAIS3+ has become the accepted cut-off for a serious injury, with anything below falling in the category of minor injury.

the level of risks experienced by a specific road user group, the volume of travel should be controlled for. For this reason, the number and length of trips in each mode should be estimated and monitored. Household travel surveys or other solutions could be used. Where funding is an issue, we recommend working in partnership with metropolitan authorities, national authorities, and authorities in charge of public health or using simplified, innovative, standardised survey methods.

6 Estimate daytime population to improve the comparability of traffic safety statistics

Cities should estimate a daytime population figure, accounting for the contribution of commuters, and visitors. This is to improve the comparability and relevance of mortality rates, especially in central urban zones where the resident population doesn't always reflect the true daytime activity.

7 Prioritise research on urban road crashes

Research questions will require data collection from a larger set of cities, something which can be envisaged as the Safer City Streets network grows and welcomes new cities. In particular, the relationships between urban shape, density, speeds, mode share and road user risk will require further investigation. Gender, age and social aspects of road safety should also be investigated. This will require not only good casualty data sources, but also good data on trips, most likely from household surveys. Another area of focus should be the collection of crash participant matrices so as to better understand the impact of each user group on casualty numbers in other groups.

Single city reports

Oslo

In 2015, the political climate and public will in the City of Oslo changed away from accepting continued road transport fatalities **(Hartmann, Abel, 2020)**.[12] The Mayor, City Council, and transport division staff all supported a shift in roadway decision-making from car-centric to people-centric. Reductions in serious injury and fatal crashes in Oslo's accelerated from 2015. This coincided with several important changes made that year:

- The city government set a goal to reduce car traffic by one-third by 2030, in effect doing away with the regime of "predict and provide," meaning that road safety measures could largely be implemented without traffic studies even if they were believed to cause congestion or slow down traffic.
- The authority to designate bus lanes, bike lanes, one way traffic and close streets to traffic was transferred from the police to the city government, allowing swift transformation of parking lanes to bike lanes and closure of cut through streets.
- The city implemented a bicycle strategy, with an aim to increase the bicycle mode to 25 percent by 2025.
- The city launched a smart phone app for children in school, where they can report traffic hazards and request road safety measures directly to the road authority. It is used by children at 98 schools (more than half of all schools in the city), and has gathered more than 60,000 reports from children so far.
- Oslo received attention in 2015 when it announced that it would make the city centre car-free by 2019. In the end, the project has led to a removal of all regular street parking in the city centre, and the centre has been closed to through traffic.

Oslo also relies on national road safety efforts, especially when it comes to vehicle standards, driver education, and enforcement of road rules. Vision Zero was adopted in Norway in 2002, and is currently one of the safest countries for road users in the world.

The Norwegian Public Roads Administration was also shifting goals and metrics nationally at the same time as Oslo, with plans like the National Cycling Strategy, which was a factor in driving decision making in the Norwegian capital of Oslo. The National Cycling Strategy in Norway had one goal, to make it safer and more attractive to cycle. Then, in June 2016, the City of Oslo released *The Oslo Standard for Bicycle Facilities,* which prioritized safety and mode share for bicycles through rigorous design standards and exceptions to accommodate bicyclists in a safe manner on all road types. The Oslo Standard for Bicycle Facilities was the city's effort to figure out the best possible bicycle infrastructure that could be implemented within the boundaries set by the national laws and regulations. Contraflow cycling has been one of the measures most widely implemented, to allow cyclists to choose the safest possible route. Before 2015, when the city gained authority to allow contraflow cycling, it was only allowed on two streets. Contraflow cycling is now allowed on most one-way streets in Oslo.

The City of Oslo also prioritized safety in road design and road user decisions from 2015 to present for vulnerable road users. The Norwegian Public Roads Administration transferred the authority of traffic-controlling signage and markings from the police to the cities. Additionally, there was a citywide shift of installing dedicated bus lanes, restricting traffic on light rail corridors, and installing bicycle lanes in lieu of on-street parking on high mode split streets, and where increased transit and bicycle riding was needed and encouraged. Formerly, the city had to apply to the police or the national road authority to install bike lanes, bus lanes or close streets to traffic, often through formal planning proposals involving consultations and hearings, often delaying projects for years. With the authority to place traffic control signs and markings, the city can now implement such measures in a matter of weeks. This change has helped the city increase the rate of bike lane implementation ten-fold, from an average of 1.5 km (1 mile) per year, to more than 15 km (9 miles) in 2019.

Another driver in reducing road fatalities in the City of Oslo is a goal set by the city government in 2015 to reduce car traffic by one third by 2030. To reach this goal, the city implemented a congestion charge, increased the number of road toll gates, and increased the tolls. While data indicate traffic has started falling, the main outcome of this goal so far is not reduced traffic. Instead, it is that the political climate is such that many measures can now be implemented even if they cause congestion or delays to car traffic. This has enabled more bus lanes, bike lanes, and speed humps to be installed quickly.

Figure 1. The City Ring Road used to have four lanes for cars. It was upgraded after five fatal crashes and 13 serious injuries in the 10 years from 2008 to 2017. There has only been one serious injury since the upgrade. It now has a raised, curb-separated bike lane; bus lanes; and just one lane for cars in each direction. Images show before and after of pedestrian and bicycle improvements to City Ring Road.

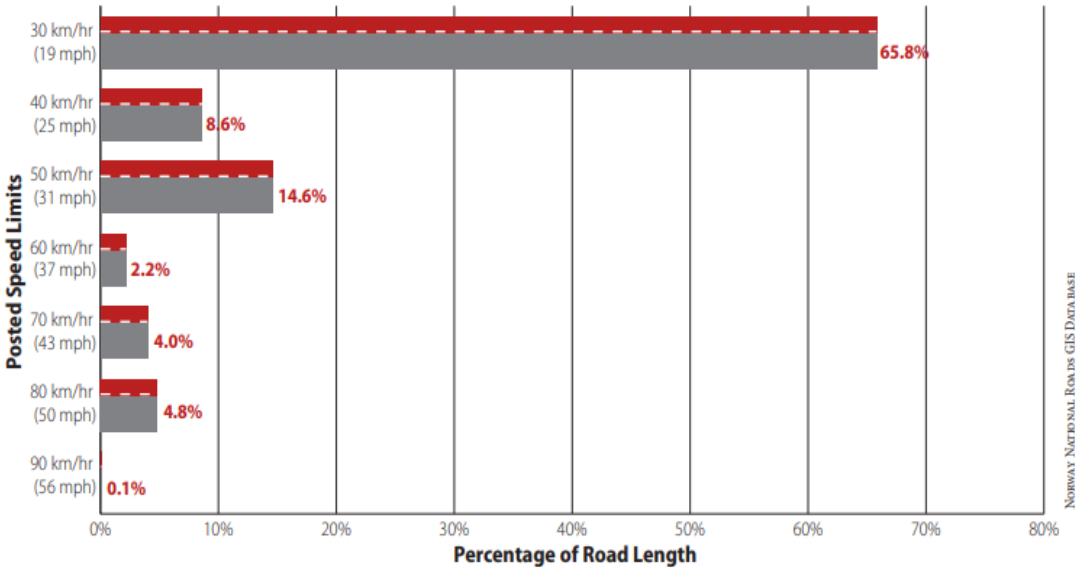
Another big shift for the City of Oslo was closing some streets to car traffic, either at peak pedestrian and bicyclist times, or permanently. The city also looked at streets with high pedestrian and bicycle crashes in the selection of converting car streets to people streets. Oslo quickly found that separating vulnerable road users from car traffic would be an effective road design priority toward achieving zero. While some of Oslo's achieving zero pedestrian and bicycling fatalities in 2019 is circumstance, a major factor was prioritizing safety across the city.

Every time a fatal crash happens, an analysis investigation is conducted by the Norwegian Public Roads Administration, with input from the police investigation, where they look at factors that contributed to the crash and its severity. Such investigation reports in Norway regularly include recommendations for road improvements, both at the crash site, and general improvements to prevent similar crashes elsewhere. The crash analysis investigation reports also provide recommendations to ensure similar crashes are avoided on similar roads. For example, a single fatal cyclist crash in 2018 led to the redesign of four bus stops, four intersections, and widened bike lanes over a distance of 1 km that included signal timing and separated junctions for cyclists at similar intersections to where the fatal crash occurred. These reports also give transport professionals an understanding of crash causation, an element of a Safe System approach to transport safety.

Lastly, the City of Oslo also looked at certain land uses, such as schools and high-density mixed-use areas, that may cause pedestrians and bicyclists to be particularly vulnerable in making roadway decisions. On a city-wide scale, city officials put safety standards around schools, including limiting speeds to 30 kilometres per hour (km/hr) (18 miles per hour [mph]) (Figure 2 below), installing speed humps to slow speeds, and reducing pedestrian crossing distances to 8 meters (m) (26 feet [ft.]). In high density mixed-use areas with many pedestrians and bicyclists present where closing streets to cars is not an option, the City of Oslo considers approaches such as limiting speeds through roadway interventions, or limiting traffic by implementing one-way streets. Roadway interventions the City of Oslo considers include narrowing and shifting lanes with vertical elements, installing tight curb radii requiring drivers to turn at intersections more slowly, ensuring streets have separated bicycle facilities wherever possible, and designing wide sidewalks to allow many pedestrians to walk. Transportation experts in Oslo have found that these interventions make for a more complex street environment where drivers are forced to pay attention, drive slower, and be

cautious of pedestrians and bicyclists. In most cases, the city combines revision of speed limits with measures such as speed humps, tighter curb radii and bulb outs, to ensure that an acceptable share of drivers adhere to the new speeds. Arterials are typically posted at 50 km/hr (31 mph), smaller streets with bus traffic are posted at 40 km/hr (25 mph) and local streets at 30 km/hr (19 mph).

Figure 2: Most roads in Oslo have a 30km/hr speed limit.



In Norway in 2019, no children died in traffic crashes, and there were only two fatal injuries per 100,000 inhabitants. The risk of fatal or serious road traffic injuries, on a trip-by trip basis, has fallen 47 percent for cyclists, 41 percent for pedestrians, and 32 percent for drivers between 2014 and 2018. Oslo reported no pedestrian or cycle user road traffic deaths in 2019.

Victoria, Australia

SSRS has been the dominant approach to road safety in Victoria for over fifteen years, guiding the development and implementation of policy. Researchers in Australia undertook a study focused on SSRS where the aims of the research were to describe the intentions of Safe System in Victoria, and analyse how well this aligns with models of successful public policy **Green et al, (in press)**. Using a qualitative approach, semi-structured interviews were undertaken with Australian and international experts (n = 10). In spite of Australia having adopted Safe System in 2006, the forecasted reductions in the road toll and other key indicators have not been met. A review of the Australian National Road Safety Strategy in 2018 identified a failure to meet the targets set out in the Strategy, and suggested potential failures of Safe System implementation.

Researchers have reported a lack of will to pursue the changes required to adopt Safe System within Australia **(Woolley and Crozier, 2018)**.[13] This is also supported by others who reported that the implementation challenges of Safe System are political and social, rather than technical **(Muir, Johnston and Howard, 2018)**.[14] Whilst these challenges could be overcome, it has been found that each of the Australian jurisdictions they examined interpreted Safe System differently and seek to apply it in different environments **(Mooren, Grzebieta, and Job, 2020)**.[15] While there has been

systematic examination of implementation issues, the concept and intentions of Safe System have not been considered in existing research.

The research by Mooren, Grzebieta, and Job**,** (2020) explored SSRS through six themes and then sought to investigate how the Safe System was designed and implemented in Victoria, with the aim of determining how well it aligns with principles of public policy. Public policy has been described as decisions and actions governments take to address a problem. However, research into how Safe System has been integrated into the formulation and implementation of public policy is limited. The discussion compares the findings against a policy success mode through process, programme, political, and temporal assessments which are summarised in Table 1.

Table 1: Assessment of Safe System aligned with a policy success framework

Process assessment (evaluation against policy cycle)	Programmatic assessment (evaluation of performance)	Political assessment (evaluation of perception)	Temporal assessment (evaluation over time)
• Safe System identifies the root cause of the road safety problem through a punctuated equilibrium process • In developing Safe System, the problem identification and policy analysis stages merged • Whilst the strategy and policy are framed in literature as actionable, Safe System has numerous descriptions, making the development of a cohesive strategy and policy difficult • Safe System has been successfully enacted (ie endorsed) in road safety strategies • Implementation has been challenging which indicates a degree of failure in the policy process	• In Victoria an assessment of Safe System has not been undertaken • The original intentions and outcomes of Safe System are not uniform across road safety experts • There are multiple and sometimes differing perspectives of Safe System's purpose • What Safe System intends to achieve for road safety is unclear • A pragmatic assessment cannot be undertaken due to the ill-defined outcomes that Safe System seeks	• Safe System has achieved success through its presence in road safety strategies • Political class has shown a commitment to Safe System • Safe System provides a means to address road safety in a politically acceptable form • Understanding of Safe System principles in the community and media is deficient • There has been limited community engagement surrounding Safe System	• Parts of the policy cycle have been less effective, which has been demonstrated over time • Safe System is conceptually static, however interventions continue to advance • Safe System continues to be politically engaging
Process Assessment: partial success	Programmatic assessment: unsuccessful	Political assessment: partial success	Temporal assessment: partial success

The researchers conclude that:

- From a process perspective, Safe System has successfully identified the root cause of the road safety problem. A systematic review and analysis of policy options did not occur, with Safe System becoming the singular method for addressing fatal and serious injuries in Victoria.
- While the strategy and policy development phases have had some successes in highlighting a vision for road safety, it is significantly limited by not having a shared, consistent understanding of how Safe System is to be actioned. Endorsement of Safe System policy has been widespread, however what is required to be implemented is unclear.
- In spite of the lack of clarity of what is required to be implemented, some gains have been made, including a move away from a user focused approach to acknowledgement of a shared responsibility (although this is disputed depending on the author).

The programmatic assessment identified that Safe System has not been evaluated. The purpose of Safe System is unclear, stemming from multiple, differing perspectives on the intended intentions, outcomes and objectives. The result is that it is not possible to undertake a programmatic assessment and determine the public value proposition and approaches to change.

There is political commitment as evidenced by the adoption of Safe System in road safety strategies, however the generalised description of Safe System can also be used to appeal to differing

audiences without committing to a singular course of action. Community support for Safe System is more mixed with acceptance of a forgiving road safety system but a continued reliance on the attributions of blame. In part this is explained through poor engagement and a reluctance in some parts of government to adopt Safe System, resulting in limited legitimacy towards Safe System. While community engagement has been lacking, Safe System has been successful in linking government agencies with academia in addressing the road safety problem.

Finally, the temporal assessment has found that Safe System has changed over time, in part to address some of the initial weaknesses. Road safety agencies have renewed their efforts in improving community engagement and understanding of Safe System. Viewing the process, programmatic and political assessment over time suggests some adaptability, although Safe System continues to be impeded by a fundamental differing of views in what it intends to achieve and how it is meant to achieve stated objectives.

Green et al, (in press) conclude with the coda that research has therefore shown that Safe System can provide a framework to address road safety in Victoria. Successful public policy needs to ensure that it is not only effective but the development of the policy addresses the identified problem and results are maintained for some time. Safe System meets some of these requirements, but principally lacks explanation for how its overarching approach is meant to be understood and utilised. Whilst Safe System requires additional clarification, it has garnered additional interest and debate in road safety and from this perspective has advanced public policy.

New York City, USA

The New York City (NYC) Vision Zero program began with the support of a well-organized, politically influential advocacy group, Transportation Alternatives, that publicised the basic Safe Systems concepts as early as 2011, highlighting advances made in other nations and laying out a blueprint for adoption in New York City. The report gained the attention of safety advocates and was subsequently adopted as part of the political platform of the leading candidates in the 2013 mayoral election (**Michael et al, 2021**).[16] New York Mayor, Bill de Blasio, announced adoption of the City's Vision Zero Action Plan in January 2014 **(Vision Zero in New York City, 2016).**[17] Previous to Vision Zero adoption, the Action Plan reported that approximately 4,000 New Yorkers were seriously injured and more than 250 were killed each year in traffic crashes. Being struck by a vehicle is the leading cause of injury-related death for children under 14, and the second leading cause for elders. On average, motor vehicles seriously injure or kill a New Yorker every two hours (New York City Vision Zero Action Plan, 2016).[18] According to the Action Plan, dangerous driver choices, like speeding and failing to yield, are the primary cause of 70 percent of pedestrian fatalities.

During early work on Vision Zero, a large number of signal re-timings, have been found to be an integral part of initial success being seen from NYC's Vision Zero efforts. For example, NYC started with approximately 250 Leading Pedestrian Intervals (LPI) in 2013, and by the close of 2015, the NYC Department of Transportation (NYCDOT) had brought the total number of installations to more than 700. A LPI is a signal timing strategy that is designed to minimize turning vehicle/pedestrian conflicts. Under this operation pedestrians receive the "Walking Man" display for approximately six to ten seconds prior to the parallel movement of traffic getting a green indication. This operation allows pedestrian to start their crossing free from conflict with turning vehicles and establish a presence in the crosswalk. There are more than 12,932 signalized intersections in New York City, the majority of which use concurrent pedestrian signal timing (where pedestrians receive the "Walking Man" display

at the same time the parallel movement of traffic gets a green indication). Under this operation, turning vehicles must yield to pedestrians in the crosswalk as required under New York City Traffic Regulations. However, as the Action Plan noted, dangerous driver choices including failing to yield are the primary cause of 70 percent of pedestrian fatalities. In UK cities including Bristol, many pedestrians are injured by motorised traffic, often failing to yield.

As an intervention to improve safety, at select intersections different timing strategies have been developed and implemented to enhance pedestrian safety. This includes LPI and other crossing types including the 'Barnes Dance' which incorporates a separate pedestrian phase into the signal cycle which allows pedestrians to cross in any direction while all vehicular traffic remains stopped. Under this operation all crossings are free from conflict with turning vehicles. However, since this is the only phase when pedestrians are permitted to cross the available crossing time will be less than what would normally have been provided under a concurrent timing plan.

Another factor that facilitated early and quick adoption of Vision Zero in New York City was a movement among residents who lost loved ones to traffic injuries. Families for Safe Streets was formed by people who lost loved ones to traffic crashes, or survived serious traffic injuries themselves. Their victim advocacy contributed to a movement away from victim blaming and enabled important progress. For instance, members of Families for Safe Streets are credited with helping to pass key legislation in the State of New York, allowing NYC to lower speed limits from 30 mph to 25 mph and to add automated speed cameras in school zones (**Michael, et al, 2021**).

Traffic deaths in New York City have fallen by a third since the year before Vision Zero began, bucking the nationwide trend towards increased fatalities.[19] In addition, a Streets Plan, launched in December 2021,[20] commits the US Department of Transportation, to meeting the following benchmarks by Dec. 31, 2026:

- 150 Miles of physically or camera-protected bus lanes
- 4,750 Transit signal priority at intersections
- 250 Miles of protected bike lanes
- 2,500 Bus stop upgrades like benches, shelters, and real-time passenger information
- 2,000 Redesigning signalized intersections
- 2,500 Accessible pedestrian signals at intersections
- Assess and amend commercial loading zones and lorry routes
- Develop parking policies to promote the master plan's goals of safety, mass transit use, reduced vehicle emissions, and access for individuals with disabilities
- Create and maintain one million square feet of pedestrian space.

An analysis using data from the New York City Department of Transportation concluded that protected bike lanes are highly cost effective (incremental cost-effectiveness ratio of $1297 per quality-adjusted life year gained, far below the conventional $50 000 per quality-adjusted life year willingness-to-pay threshold for medical interventions). Similar analyses using empirical data found that Neighbourhood Slow Zones and speed limit enforcement cameras save money and save lives. As **Staples et al, (2021)[21]** noted, instead of portraying traffic safety interventions as an onerous expense, US cities might find Vision Zero initiatives are more politically palatable when framed as both an ambitious American "moon shot" and a financially prudent investment.

Seattle

To make progress toward a goal of zero traffic deaths and serious injuries by 2030, the City of Seattle took on a range of initiatives **(Staples et al, 2021)**[22] and these included:

- performed a data-driven bicycle and pedestrian safety analysis to help prioritize intersection safety improvements
- developed a safety-focused transport master plan
- standardized speed limits on most residential streets (nonarterial, 20 miles per hour [mph]; arterial, 25 mph)
- expanded the use of red-light cameras and other forms of traffic safety enforcement
- accelerated the installation of leading pedestrian intervals (in which the "walk" signal is illuminated three to seven seconds before the vehicle green light
- enhancing pedestrian visibility),
- created a crash review taskforce,
- and committed millions of dollars to enhance a cycling network that will include almost 200 miles of protected bike lanes and greenways.[23]

Boston

In similar vein, but with some differences and similarities in selection initiatives the City of Boston[24]

- developed an interdisciplinary Vision Zero Task Force

- created a Vision Zero Action Plan

- lowered the default speed limit on city streets from 30 mph to 25 mph

- curtailed vehicle speeds in some residential neighbourhoods using speed humps and curb extensions

- opened sight lines and installed leading pedestrian intervals to improve pedestrian visibility at select intersections

- made capital investments in bicycle lane safety

- and committed to periodically publishing crash data that allow citizens to hold city decision makers accountable.[25]

San Francisco

Established as a major collaboration with the Department of Public Health, the emphasis for Vision Zero San Francisco has been a citywide effort to curb traffic injuries and deaths (**Mendoza, et al, 2017**).[26] Collision analysis identified that 70% of severe and fatal collisions occur on only 12% of San Francisco streets. In addition, 60% of pedestrian collisions occur on 6% of streets. The top 3 causes of fatal collision in San Francisco include driver failure to yield to pedestrians (29%), driver speed (26%), and drivers running red lights (13%). Lorries are one of the most dangerous traffic elements for vulnerable road users. According to Vision Zero SF, large lorries or buses were involved in 4% of all collisions with vulnerable road users yet were responsible for 17% of all fatalities in the city from 2007 to 2011. Lorries are eight times more likely to result in death of the road user than collisions involving cars. Side impact crashes comprise a large percentage of fatal lorry collisions with pedestrians and bicyclists. San Francisco has started specific training programmes on lorries in urban environments and has evaluated the implementation of side guards for city lorry fleets.

In the first 2 years of initiating the policy, Vision Zero SF has surpassed its goal of completing 24 priority projects in 24 months. In addition, it has promoted educational programmes that support pedestrian right-of-way and specific training for large vehicle safety in urban driving. Specific enforcement initiatives include fines for drivers blocking crosswalks and double parking and blocking of bicycle lanes or sidewalks. Finally, Vision Zero SF aims to affect city and state policies by reducing traffic speeds and installing automatic speed enforcement near at-risk populations, in particular children, the elderly, and people with disabilities.

WalkFirst was a San Francisco pedestrian initiative implemented before the adoption of VZ. This programme helped inform the current VZ policy implementation in the city. WalkFirst acknowledged that pedestrians faced the brunt of fatalities within the city. The programme helped identify 170 high priority locations where a majority of incidents occur. Several pedestrian safety countermeasures have been considered with public input playing a role in prioritization of projects. The public health co-chair for Vision Zero SF, Megan Wier, describes the efforts dedicated toward traffic safety as "night and day" in comparison to the last 10 years in the city. Although there has not been a drastic reduction of fatalities (average traffic fatalities in the city average around 30 people per year), the city has not shared the same upward trend in traffic-related fatalities as the rest of the country, which has seen an overall 8% increase.

USA in general[12]

Writing in the context of the USA in general, **Michael et al, (2021)[27]** note that among the greatest challenges to change are overcoming institutional inertia and addressing past, present and future inequities in transport system investments. After 100 years of designing roads and enforcing user compliance in traditional ways, the system has roots extending in all directions. Road design standards and professional practice guidelines are shaped to fit conventional methods. Funding streams, including the $40 billion annual Federal Aid Highway Program, incentivize traditional practices rather than a Safe System approach. Many small towns across the country are dependent on traffic fines for basic municipal operating revenue and will likely be reluctant to reduce traffic enforcement before alternative sources of revenue are identified.

Such inertia does not justify the status quo, but it will take thoughtful and persistent effort to overcome. Equity issues also require careful consideration if Safe Systems are to reach their potential. Low-income communities and communities of colour are disproportionately harmed by a long-time disinvestment in safe street design and problematic police enforcement, and their voices are routinely insufficiently represented in policy and planning work. While there is potential to change biased and inequitable systems with the Safe System approach, there is also understandable scepticism.

Attempting to address a broad range of challenges researchers in the US develop the Traffic Safety Best Practices Matrix **(Fleisher, Wier, Hunter, 2016)**.[28] 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 cities and countries abroad, were, as of May 2015, pursuing to reduce pedestrian-, bicycle-, or traffic-related injuries and fatalities. Those data were then compiled into the Traffic Safety Best Practices Matrix (Appendix 1).

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.;

[12] In the US there is a national Vision Zero Network | Making our streets safer accessed 30th March 2022.

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 transport. 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. These locations were also selected because information about their safety platforms is widely available online and in English.[13]

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 companies.

Countries and cities received a √ (i.e., ticked) 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" 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. The 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). 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.

In terms of results, the Traffic Safety Best Practices Matrix lists measures that cities in the United States and cities and countries abroad are pursuing as of May 2015 to reduce pedestrian-, bicycle-,

[13] 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.

and traffic-related injuries and fatalities. Also included for each measure are efficacy designations based on existing evidence. According to **Fleisher, Wier, and Hunter (2016)**, large cities across the United States, in adopting Vision Zero, are leading efforts to reframe the way in which traffic safety is viewed and managed. Yet, while they note that this effort is commendable, and speaks to the role of cities as catalysts for change, the researchers note that 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 the gap between enthusiasm to act and limited guidance by presenting a framework for cities to understand and identify potential strategies for Vision Zero implementation. The researchers set out to detail 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, they stress that their 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.

Analysis of the matrix was arranged by the themes that emerged: measures with

(a) widespread adoption,
(b) limited implementation, and
(c) minimal utilisation.

In their conclusions the researchers state that there are fours 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.

The following recommendations are offered as next steps for Vision Zero implementation in cities in the United States by the authors **Fleisher, Wier, and Hunter (2016)**:

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, analyse, 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.

Lastly, a report drawing on the evidence of successful approaches to Vision Zero in Europe, for application in the US, **Shahum, (2017**)[29] argues that to be successful, Vision Zero leaders in the United States — including government, community members, and the private sector — should understand and embrace the concept's fundamental tenets, as outlined below.

• Agreement that people have the right to move about their communities safely, and so this safety must be prioritized above speed and convenience (or perceived convenience);

• Acknowledgement that humans will make mistakes, so transport systems should be planned to minimize the severity of repercussions;

• Greater attention focused on improving the transport system itself, (particularly the built environment, policies, and technologies that influence behaviour), rather than over-focusing on influencing individual behaviour; and

• Buy-in that system designers play a primary role in influencing these transport systems, along with individual roadway users. For a Vision Zero community, it is essential to build philosophical and political commitment to these fundamental concepts.

The strategies, including decisions about the design of the environment, as well as policies, programmes, and priorities (enforcement, funding, etc.) — will all follow from this grounding in the fundamental concepts. Based on this research, as well as direct experience with early-adopter Vision Zero cities in the United States, **Shahum (2017)** makes the following five policy recommendations based on their positive impacts in the researched countries.

In addition, the support of private industry is noted as important in the European examples. Vehicle makers and insurance companies have invested in research and have implemented technologies that encourage speed reduction and even reward drivers for remaining within speed limits.

1. Leadership, Collaboration, and Accountability;

This includes: An urgent, clear, and sustained public commitment of support for Vision Zero should come from the highest-ranking public officials in a community, usually the mayor and city council. Sending a clear signal of priority from City Hall is a critical first step toward aligning the multiple internal city agencies that are in integrally involved in leading Vision Zero efforts. Creating a permanent, high-level home for the city's Vision Zero effort within the city bureaucracy is another key move. Institutionalizing the work and building an expectation for accountability from all of the agencies involved is necessary for success. Cross-sector, large-scale collaboration and the inclusion of public health, law enforcement, policymakers, elected officials, and community members in traffic safety work are some of the keys that makes Vision Zero powerful. Though administratively challenging, this cross-sectoral collaboration — including using consistent data, setting shared goals, and defining clear responsibilities for all partners — is key in advancing Vision Zero.

2. Focus on System-Level Changes;

This includes: That Vision Zero calls for a shift in attention from the traditional, primarily educational approach aimed at influencing individual behaviour to an “upstream” approach that shapes policies, systems, and the built environment — key factors that most affect people’s behaviour and choices. This does not mean that individuals are not responsible for their own behaviour, or that efforts to influence individuals directly are not worthwhile. Instead, it shifts the focus to higherlevel systems and policies and those who control them because this has greater impact than trying to influence billions of individual choices. This more holistic strategic approach — adapted from public health frameworks — differentiates Vision Zero from the traditional transportation safety approach.

3. Commit to Speed Management as a Fundamental Tenet: This includes: Speed management is not simply a strategy or an optional tool in the toolkit; it is a fundamental and critical tenet of Vision Zero. According to multiple sources, speed is estimated to be a factor in nearly one-third of all traffic deaths (in many High Income Countries including the US). To be serious about Vision Zero means implementing effective speed management, including designing roadways to encourage safe speeds, setting appropriate speed limits based on safety, and using technology to influence safe behaviour

4. Measure and Report Regularly: This includes having a commitment to a data-driven approach is not only bringing more information to the fore, but also building greater cross-disciplinary understanding of the problems and stronger buy-in for solutions. The next step is to make sure that communities are collecting, analysing, and using the right data.

(US) communities should improve their data-driven approach in several key areas: Supplementing law enforcement data with hospital data. Sweden and the Netherlands significantly improved their understanding of traffic-related injuries and their responses by supplementing police-collected data with data from hospitals.

Training and setting systems for fair, full data collection by law enforcement. Police are often relied on as a primary source of crash data, but they may face resource and training limitations that result in incorrect or under-reporting. Vision Zero stakeholders should be actively working to support better resources, systems, and training to improve law enforcement’s ability to collect the necessary and sufficient data to give an accurate view of what’s happening on our streets.

Expanding analysis and measurement of severe traffic injuries, not just fatalities. Though Vision Zero sets the goal zero traffic fatalities and severe injuries among all road users, that latter part is often forgotten in planning and measurement efforts. The European Union and some individual nations have increased attention toward data collection and efforts toward reducing the number and severity of traffic injuries, acknowledging that these have traditionally received less urgency than merited.

Using data to make proactive, not just reactive, changes. Move sooner than later toward a proactive approach of assessing patterns on our streets and applying more wholesale solutions before serious problems occur. A promising, emerging strategy is to use data to conduct predictive modelling, moving beyond simply reacting to past problems at specific locations.

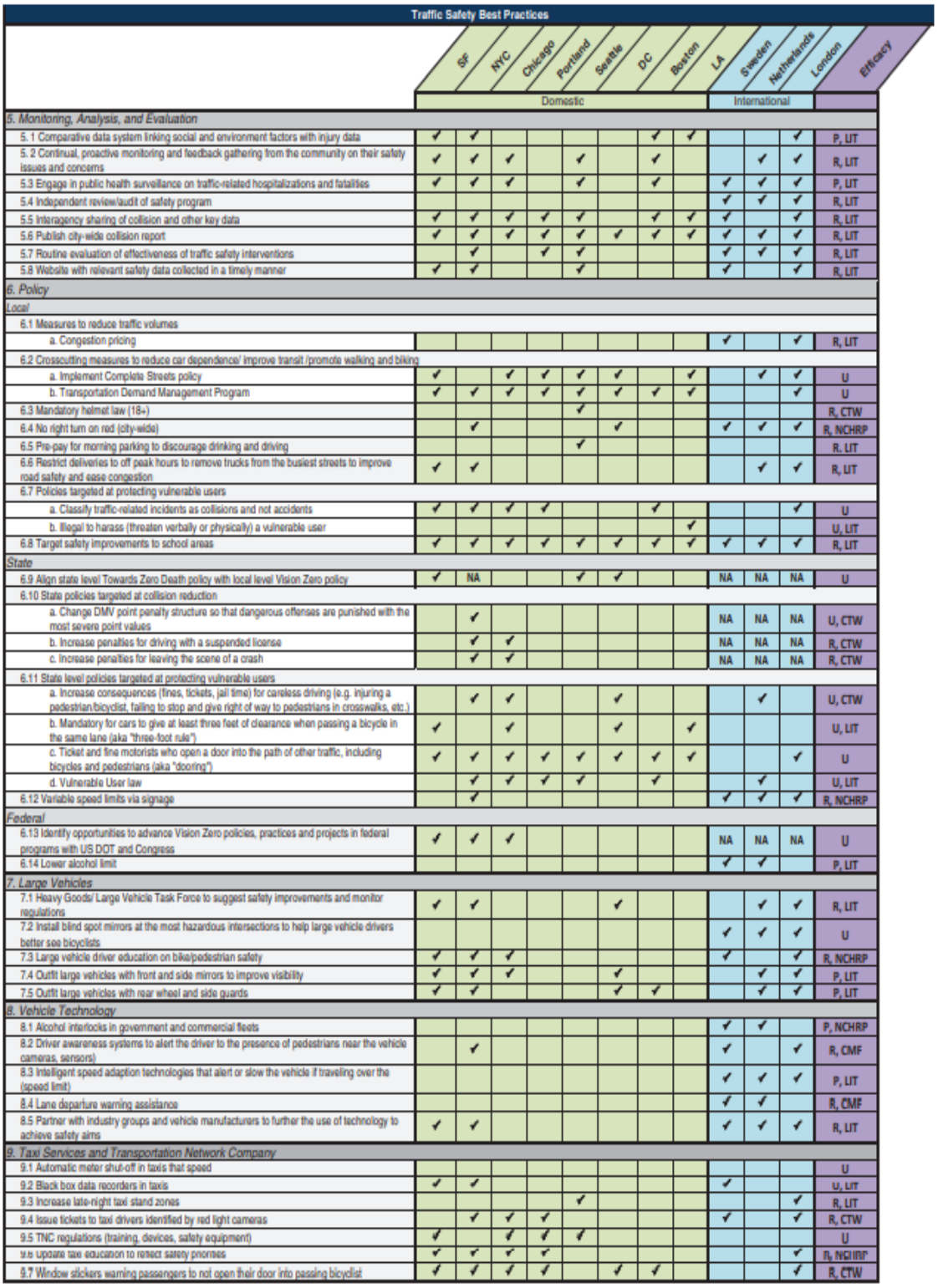
5. Prioritise Community Engagement. The Vision Zero approach to traffic safety presents both challenges and opportunities to the goal of ensuring equity in our transport systems. Vision Zero’s core principle of data-driven decision-making can shine a brighter light on existing inequities in our transport systems and help direct safety interventions where they can have the greatest positive impact.

Appendix 1

Figure 1: Traffic Safety Best Practices Matrix (SF = San Francisco; NYC = New York City; DC = Washington, D.C.; LA = Los Angeles)

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)



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												
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.

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