International Transport Forum

Best Practice for Urban Road Safety

Case Studies

Safer City Streets

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The International Transport Forum

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Foreword

Every minute, someone in the world dies in urban traffic.[1] To stop this, cities have taken a leadership role in the battle for road safety. With speed limit reductions and radical changes in street design, their actions deliver measurable results. In 2019, two major European capital cities, Helsinki and Oslo, have reduced the number of pedestrians and cyclists killed in traffic to zero.

Safer streets are crucial for making a city more liveable. If streets remain dangerous, efforts to promote walking and cycling are undermined. Reducing the risks of urban traffic not only saves lives, it enables sustainable forms of transport which reduce pollution, cut emissions, fight congestion and improve the physical and mental health of citizens.

Carefully considered road safety policies ensure that cities have a critical and growing role towards achieving the United Nations Global Sustainability Goals and implementing the New Urban Agenda. Cities offer countless opportunities for experimentation and policy innovation. Efforts made by cities complement important actions led by other stakeholders, including national governments and inter-governmental organisations, whose impact on vehicle design standards, research and training are substantial.

The International Transport Forum (ITF) launched the ITF Safer City Streets initiative at the UN Habitat III conference in 2016. It brings together road safety experts working in cities and explores the solutions developed at a local level. Cities in the network improve their urban road safety performance by sharing data, experiences and knowledge – by learning from each other.

Safer City Streets replicates the global road safety network of countries hosted by the ITF at city-level. This network, known as the International Road Traffic Safety Analysis and Data Group (IRTAD) has existed for more than 25 years. The IRTAD Group has been hailed by the World Health Organization as “a model of a multicounty effort” and its crash data as “simply the best in the world” by Global NCAP, the network of crash test programmes.

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The main author of the report is Rafaella Basile (ITF). She worked under the supervision and in co-ordination with Alexandre Santacreu (ITF), the project lead of the Safer City Streets initiative. The document was reviewed internally by Alexandre Santacreu and Stephen Perkins at the ITF. External comments were received from Adriana Jakovcevic, Catherine Pérez, Dante Rosado, Maria Andrea Forero Moncada, Remco Smit and Rob Viola. Special thanks to Edwina Collins (ITF) for reviewing and editing the report.

This report presents a selection of best practices shared during Safer City Streets meetings. They illustrate the diverse approaches available to better understand road crashes and to prevent road traffic deaths and serious injuries. The report draws on interviews held with city officials by telephone or email. The ITF would like to fully acknowledge their contributions and also take responsibility for any errors in representing the policies of their jurisdictions. The interviewees were:

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This International Transport Forum (ITF) report is a part of the Safer City Streets initiative. This initiative is delivered by the ITF and funded by the FIA Foundation through the FIA Road Safety Grant Programme. The Safer City Streets initiative has brought together road safety experts working in cities since its launch in 2016 at the UN Habitat III conference. The initiative includes a network of cities and an objective to share best practice in urban road safety management and to develop a database of city-level road safety data.

Table of contents

Figures

Table

Introduction

Road safety is a growing concern in the many cities that aim to become more liveable. The lives of the most vulnerable road users, those walking and cycling, are often most at stake. Vulnerable users are highly disproportionate in urban casualty statistics, and constitute the majority of road deaths in the cities participating in the ITF's Safer City Streets initiative (ITF, 2019). If people feel unsafe, the efforts of policies to promote walking and cycling are seriously compromised. Safety is therefore an essential part of a sustainable urban mobility plans.

There is much to learn from cities that have been able to achieve large reductions in traffic fatalities. This report presents seven case studies of cities implementing data-driven road safety policies with the aim of disseminating best practices in urban road safety.

The case studies from Bogotá, Barcelona, New York City, Buenos Aires, Fortaleza, Rotterdam and London illustrate the diversity of approaches available to better understand and prevent serious road crashes. They also include experiences of developing reliable traffic injury data, enforcing speed limits, implementing safer street design, and predicting and preventing road crashes. Each case study exemplifies best practice in one or more of the areas examined.

Managing speed to reduce casualties

Speed management is one of the most effective road safety policies. When speed increases, the risk of a crash and its severity increases as well. That is because the higher the driving speed, the longer the distance covered by a vehicle when the driver starts to react, therefore reducing the opportunity to avoid a crash (ITF, 2018). Speed not only makes a crash more likely, but also exacerbates the severity of any injury if a crash occurs. The speed of motor vehicles is a primary factor in the safety of people walking and cycling.

Cities address excessive speed in several ways. They set speed limits, increasingly in accordance with international guidelines such as the recommendations of the Stockholm Declaration.[2] These guidelines include establishing a 30 km/h limit where there is a mix of vulnerable road users and motor vehicle traffic, and limiting all speeds on urban roads to 50 km/h. It is well established that a 1% decrease in average speed results in an approximate 2% decrease in injury crash frequency, a 3% decrease in severe crash frequency, and a 4% decrease in fatal crash frequency (ITF, 2018). Cities can also improve speed-limit enforcement and implement new speed control systems. Yet, benchmarking the effectiveness of these actions is a challenge. Survey methods for assessing road user behaviour and attitudes vary across countries and guidelines for consistent methodologies have yet to be developed (Santacreu, 2018). Examining the experience of individual cities that have achieved large reductions in injury crashes through speed management interventions are important sources of tangible knowledge.

This section focuses on the case of Bogotá, in Colombia, and its programme of speed management to reduce traffic fatalities.

Introducing safe speed limits on the most dangerous roads in Bogotá

Bogotá, the largest and most populous city of Colombia, has made significant efforts to reduce traffic fatalities and injuries in recent years. The administration adopted a Vision Zero approach as the roadmap for their road safety strategy in 2016. With support from international experts, the city implemented new street design, traffic safety checkpoints, and mass communication campaigns aimed at eliminating traffic casualties. Bogotá also invested in consolidating data on road casualties from different sources of information, including the Police, the National Institute for Legal Medicine and the Public Health Ministry.

From this robust crash database, Bogotá identified that pedestrians, cyclists and motorcycle riders account for most of its road deaths. Most such fatal crashes occur on arterial roads. In 2017, 70% of the fatal victims and 57% of the injured were registered on these routes (Secretaría de Movilidad de Bogotá, 2019). The city identified collision hotspots for each road-user group on these corridors (see Table 1).

Table 1. Collision hotspots by road-user group in Bogotá

Road user group	Most dangerous road sections (locations with the highest number of fatalities or serious injuries)
Pedestrians	Arterial roads with high speed and high density of activities
Cyclists	Arterial roads with no cycle infrastructure or with discontinuous cycle infrastructure
Motorcyclists	Arterial roads with high speeds and wide sections

Source: Secretaría de Movilidad de Bogotá (2019).

Bogotá developed a speed management programme, the *Programa de Gestión de la Velocidad* (PGV) in response to the identification of the main factors contributing to crashes. The city evaluated current speed limits in relation to road function, infrastructure condition, land use and operational characteristics. An appropriate speed was then defined for each road type. The PGV also provides guidelines to assure compliance with speed limits that aim to improve the road environment and guarantee the safety of all road users.

The PGV found that three out of four traffic deaths occurred on Bogotá's arterial roads (Secretaría de Movilidad de Bogotá, 2019). The initiative first targeted the five corridors with the highest casualty rates. The speed limit was lowered by 10 km from 60 km/h to 50 km/h and speed cameras installed to enforce compliance on these five corridors: *Avenida de las Américas, Avenida Boyacá, Calle 80, Avenida Ciudad de Cali,* and *Avenida Carrera 68*. The programme took an incremental approach, testing the benefits of speed reduction and disseminating results before expansion to other roads. Fatal crashes were monitored corridor by corridor and results compared with the average for the preceding three years. Results were reported weekly to the public via social media[3], using headline indicators of lives saved since implementation and days accumulated without recording a death. The demonstrated reduction in lives lost convinced many of the administration's strongest critics to accept the speed management programme as effective.

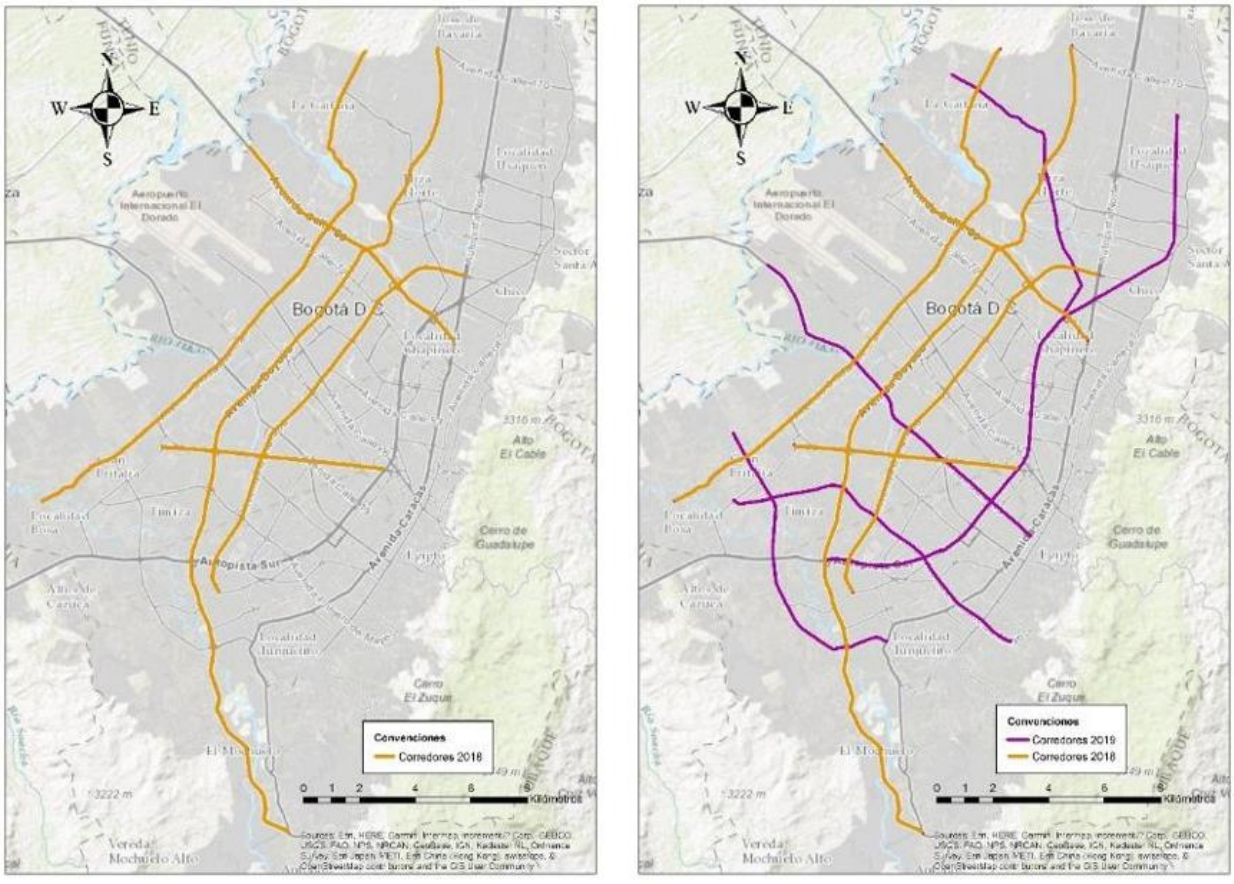
Figure 1. New signs of 50 km/h safer speed limit placed on most fatal arterial roads in Bogotá

Source: Secretaría de Movilidad de Bogotá (2018).

The positive results of less fatalities led to the reduction of speed limits on another set of five corridors at the beginning of 2019. Criteria such as average speed and traffic volume contributed to identifying priority corridors, with plans to cover the entire arterial road network by the end of 2020. Responses to the Covid-19 crisis accelerated implementation and extended the 50 km/h limit to the whole of the city (see Box 1).

Forty-six lives were saved in 2019 due to the programme's efforts on the ten arterial corridors targeted. This is a 21% decrease in traffic fatalities compared to the average for the three preceding years 2015-18. Data from speed cameras indicates an improvement in compliance, with lower excess speeds although the rate of vehicles exceeding speed limits was unchanged at around 20%.[4]

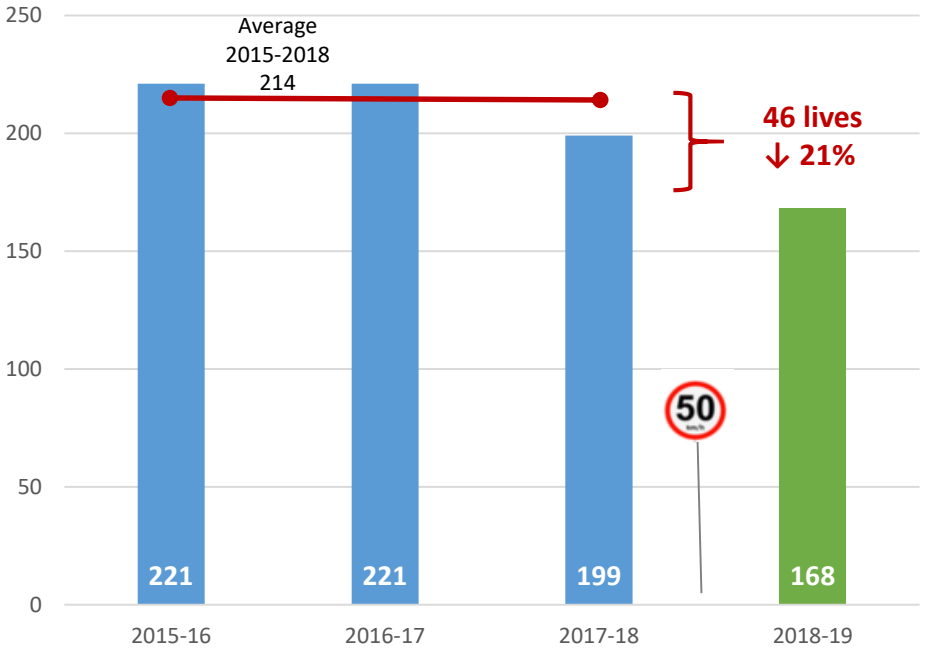
Figure 2. Progress on roads selected for new speed limit of 50 km/h in 2018 and 2019 in Bogotá



Note: 2018 = yellow, 2019 = purple.

Source: Secretaría de Movilidad de Bogotá (2019).

Figure 3. Result of reducing speed to 50 km/h on ten arterial corridors in Bogotá, 2019



Note: Preliminary data as of 31 December 2019 from SIGAT II.

Source: Adapted from Secretaria de Movilidad de Bogotá (2020).

Box 1. Road safety and the Covid-19 pandemic in Bogotá

The Covid-19 pandemic brought many changes to urban mobility across the world. Public transport use, road traffic and general mobility fell sharply, even in places with no lockdown orders (ITF, 2020). Injury crashes declined in many cities, but not as much as traffic. One of the factors believed to account for the difference is that the drop in traffic levels may have resulted in widespread speeding, increasing crash risks.

In Colombia, Bogotá experienced more than six weeks of mandatory lockdown between the end of March 2020 and early May 2020. The city announced a permanent 10 km/h reduction of the maximum general speed limit for roads in the city from 60 km/h to 50 km/h in May 2020[5], bringing forward a measure originally planned for the end of 2020.

The expected reduction in road crashes resulting from this measure was designed to clear hospitals of traffic injury victims during the Covid-19 crisis, as well as protecting the lives of citizens in the long term. In addition, 92 speed cameras placed at 40 points in the city now monitor speeding and issue automatic sanctions for offenders.

Source: Secretaría de Movilidad de Bogotá (2020).[6]

Developing reliable traffic injury data to guide effective road safety policies

Better knowledge of crash circumstances and injury outcomes is important to develop effective road safety policies and save lives. Many authorities around the world acknowledge the importance of a reliable framework for regular collection and reporting of road traffic crash data. A database that includes casualty figures, data on mobility, crashes, behaviours, attitudes and enforcement facilitates the interpretation of road safety trends (Santacreu, 2018). These elements help to elaborate and evaluate effective policies.

Accurate road injury data should include information from hospitals, and not only from police records. This is because police databases notoriously underreport injuries and lack precision of detail of a severity assessment. Road safety performance analysis is usually limited to fatality figures for this reason. Focussing on road deaths alone is a great loss in terms of representativeness and statistical significance at city level (Santacreu, 2018). A reliable database on traffic injuries facilitates various tasks such as risk mapping, progress monitoring and international benchmarking.

This section of the report explores the experiences of Barcelona and New York City developing reliable traffic injury data. It demonstrates the importance of appropriate protocols for the collection of injury data from health and emergency services and illustrates the value of linking police and hospital records.

Using hospital data to monitor road injuries in Barcelona

For the past 20 years, Barcelona has monitored which factors are most frequently associated with traffic injuries; establishing important insights to the design of road safety interventions. Such factors include crash circumstances, modes of transport involved, demographics, injury nature and severity. In the city, a permanent crash data collection system is maintained by the Public Health Agency, the *Agència de Salut Pública de Barcelona* (ASPB). The system uses data[7] from hospital accident and emergency services to monitor road traffic injuries. The information provided by hospitals includes the main diagnosis and two following diagnoses, demographic data and data related to police attendance at the crash site and to details of the crash itself. These records are complemented by reports from the Police of Barcelona and the Institute of Legal Medicine of Catalonia.

The accurate monitoring of road injuries in Barcelona is supported by the Abbreviated Injury Scale (AIS), a harmonised injury severity scale promoted by the European Commission across member states. Barcelona can assess and improve estimations of road injuries in the city through information with a consistent injury severity scale on hospital data. This is essential for both monitoring and benchmarking purposes. The city acknowledges the potential of a robust traffic injury database to face road safety issues despite challenges to continuously create linkages between police and hospital records in its administration.

Box 2. Maximum Abbreviated Injury Scale (MAIS)

The Maximum Abbreviated Injury Scale (MAIS) is a globally accepted injury severity scale. It ranges from 1 (minor injuries) to 6 (non-treatable injuries) and reflects the threat to life associated with the most severe injury across all body regions. Following a recommendation by the ITF (2011), a level of injury of MAIS3+ became the accepted cut-off for a serious injury, with anything below falling into the category of minor injury. The European Commission adopted this definition and published in 2016, for the first time, a figure for the number of people seriously injured on Europe's roads: 135 000 serious injuries in 2014 (European Commission, 2016).

Several methods exist to collect robust, comparable injury data; many are documented in ITF (2011), FERSI (2016) and SafetyCube (2016). They are classified into three groups by the European Transport Safety Council (Adminaite et al., 2018):

1. Continue to use police data but apply a correction coefficient based on samples.
2. Report the number of injured based on data from hospitals.
3. Create a link between police and hospital data.

Source: Santacreu, (2018).

Barcelona managed to consolidate emergency hospital data over the past 20 years from seven different hospitals into relevant insights for supporting road safety policies. It has allowed the evaluation of the effectiveness of safety interventions such as speed cameras (Mendivil et al., 2012; Pérez et al., 2007), motorcycle license requirements (Pérez et al., 2009) and advanced stop lines for motorcycles (Pérez and Santamariña-Rubio, 2019). Information on brain trauma of motorcyclists involved in collisions also pushed for helmets to be compulsory (Ferrando et al., 2000). More recently, with the expansion of micromobility services such as e-scooters in Barcelona, ASPB started to gather specific injury information from this road user group to bring inputs on how to improve their safety. The police also uses injury data to frame their campaigns and communication strategies.

Surveillance systems of road traffic injuries is a strong asset for evaluating projects implemented in the city. A study on Barcelona's superblocks (*superilles)* is currently assessing their impact. In these areas, motorised traffic is limited to serving local access and delivery. The space formerly occupied by cars has been given over to pedestrians, with the addition of playgrounds, benches and tables. Police and emergency hospital data is being used to evaluate the hypothesis that there will have been a decrease in injuries at these locations. The municipality also aims to check for the impacts of superblocks on the whole city, investigating if there was an increase in air pollution and road traffic injures in the surrounding areas of superblocks due to displaced motorised traffic.

Figure 4. Pedestrianised Superblock in *Poblenou* neighbourhood in Barcelona

Source: Agència de Salut Pública de Barcelona (ASPB) (2018).

Using traffic injury data to target interventions in New York City

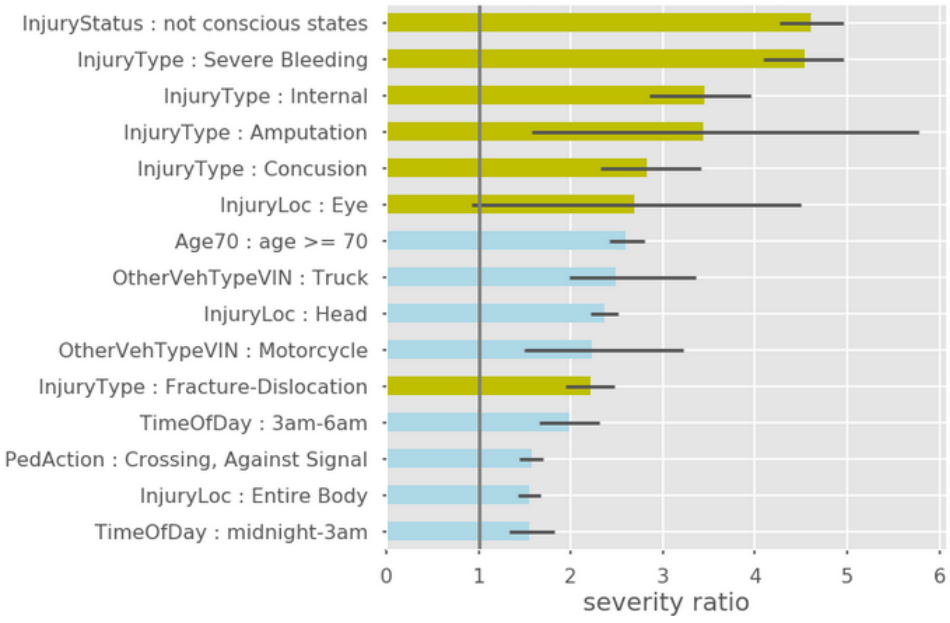
New York City is one of the safest cities in the United States in terms of road fatalities, but remains far from European performance levels, with a mortality rate twice that of London, Paris or Berlin (ITF, 2020 forthcoming). To speed up progress, the administration adopted a Vision Zero approach in 2014, along with an action plan involving the department of transport (DOT), the police department and other agencies (New York City, 2014). With an ambitious vision and action plan, authorities will heavily rely on data to diagnose problems, develop evidence-based policy responses and monitor progress.

In New York City, understanding traffic-related injuries is now easier thanks to the linkage between police crash data and hospitalisation records. The linkage enabled an evaluation of the quality of the methods to collect traffic injury data. The New York City Department of Transportation (NYC DOT) translates information on potential injuries collected by police officers at the crash scene into a severity rating called KABCO. A formula is applied using the field assessment to organise people involved in a crash into five categories: K (killed), A (severe injury), B (moderate injury), C (minor injury) and O (no injury).

The evaluation of the precision of the KABCO formula for New York City revealed that it was largely aligned with hospital-derived findings. The linkage of hospital records with police crash reports was possible for 52% of total motor vehicle traffic-related hospital injury records, with no need to improve the KABCO formula (Patel et al., 2019). Therefore, KABCO was maintained by NYC DOT as the method to select areas with high concentrations of killed or severely injure (K or A) for street redesign safety projects.

Other findings from the KABCO assessment allowed NYC DOT to better understand traffic-related injuries and prioritise interventions. The linkage of the hospital and police datasets revealed which attributes predict a severe injury among pedestrian or cyclists (see Figure 5). Findings revealed that age over 70 was the most important non-medical attribute, before late night crashes or crossing against a red pedestrian signal. Older adults are more than twice likely to have severe hospitalisation outcomes compared with an average person.

Figure 5. Top predictors of severe injury for pedestrians or cyclists in New York City



Source: Patel el al. (2019).

The KABCO assessment confirmed the need for an investigation of crash locations, types and severity outcomes of senior citizens. The number of older adults killed in crashes in New York City has not improved over the past years, although pedestrian fatalities have dropped nearly 25% since the adoption of a Vision Zero approach in 2014. People aged 65 and older are 12% of the New York City population but represented 33% of pedestrian fatalities between 2008 and 2012 (New York City, 2014). In 2018, nearly 50% of pedestrian fatalities were age 65 and older.[8]

Figure 6. A pedestrian island in Queens in New York City promoting safe crossing

Source: New York City Department of Transportation (NYC DOT) (2010).

The NYC DOT conducted a comprehensive study on crash patterns for senior persons to guide their street design interventions. The study found similarities in crash patterns between senior citizens and younger adults, but left-turn crashes are more deadly for seniors. Shorter crossing distances are associated with lower senior injury rates.[9] Measures to protect seniors identified systematic engineering interventions such as road diet (lane reduction), narrowed lanes, pedestrian islands, and curb extensions. The study also focused on new channels and methods for delivering traffic safety messages to them.

Embracing safer street design for lasting results

Street design largely determines the behaviour of road users and is at the root of many road safety issues. Many cities are transforming their roads through street redesign and provision of protected infrastructure. Pedestrians, cyclists and motorcyclists account for the vast majority of traffic deaths in cities globally and are the focus of these street transformations, in which high-risk roads are eliminated.

There are many opportunities for improving the quality and safety of streets. Many local authorities are testing solutions that are both low cost and rapid to implement. Reallocation of road space to provide safe

locations for people to walk and cycle directly contributes to a reduction of injury crash risk due to reduction in motor vehicle speed and the volume of traffic on streets.

This section highlights experience in two Latin American cities, Buenos Aires in Argentina and Fortaleza in Brazil. These cities are transforming their road networks with engineering and design solutions that save lives.

Recovering public space for pedestrians in Buenos Aires

Buenos Aires, the capital and largest city of Argentina, is making visible improvements to the street network as part of a sustainable urban mobility strategy. The city's Sustainable Mobility Plan (SMP) established goals to strengthen the relationship between transport and urban development, enhance accessibility, and prioritise public and non-motorised transport. The municipality identified high-risk areas throughout the city's neighbourhoods, using these targets, to receive street redesigns focused on improving road safety.

The government intends for walking and cycling to become more accessible to people by making streets safer. This potentially saves people money and time, especially for people making short trips of less than 5 km, at the same time as using a cleaner and healthier transportation option. The first intervention, the *Microcentro Peatonal*, offers more street space to pedestrians and cyclists in the city centre. The use of car is now restricted in the area that has pedestrianised several narrow streets. Other streets were transformed into shared spaces, where multiple road users interact while pedestrians have priority.

Figure 7. Pedestrian intervention at *Diagonal Sur* in Buenos Aires

Source: Gobierno de la Ciudad de Buenos Aires (GCBA) (2015).

Seven high-risk areas of Buenos Aires received street transformations, recovering a total of 25 000 m^2 of public space for pedestrians.[10] These pedestrian interventions targeted 116 high-risk intersections throughout the city, making pedestrian crossings more visible and reducing the radius of vehicle turning lanes to reduce speeds. The number of crashes decreased by 39% between 2013 and 2014 on the crossings that were redesigned, while no improvement was recorded on other intersections (GCBA, 2014).

Buenos Aires developed a road safety plan for the city based on the lessons learned from its street redesign experiments, and also field observations of indicators such as rates of helmet use, respect for pedestrian priority, and drink driving. The plan defines targets to be achieved in the city between 2016 and 2019, and established a road safety observatory to collect and publish crash data. Buenos Aires identified specific groups exposed to greater risk because it had a robust database on traffic casualties and driver behaviour. Pedestrians are the second group with most traffic fatalities and serious injuries after motorcyclists.

Buses were found to be involved in half of the pedestrian deaths. Actions to decrease bus-pedestrian collisions targeted Bus Rapid Transit (BRT) corridors, which accounted for the highest number of fatalities. The first intervention was installation of speed bumps. This was followed by penalties for bus drivers breaking traffic regulations, and a withdrawal of the licence to drive a bus for drivers that exceeded speed limits or failed to stop at red lights.[11] Road safety data revealed a drop of 50% of bus-pedestrian collisions in the city in 2019 (GCBA, 2020). Field observations also indicated greater respect of the 40 km/h speed limit and fewer red light violations.[12] Positive results from road design interventions reveal the need to focus on safer speed limits across the city in the new safety plan, currently under preparation, given the limits to how quickly and extensively street redesigns can be deployed.

Figure 8. New pedestrian path to access Bus Rapid Transit station in Buenos Aires

Source: Gobierno de la Ciudad de Buenos Aires (GCBA) (2014).

Disrupting high-speed culture with street redesign in Fortaleza

Fortaleza, in Brasil, has won international recognition for its strategy for reducing traffic fatalities. The city won the 2019 Sustainable Transport Award from The Institute for Transportation and Development Policy (ITDP) and the 2020 Vision Zero for Youth Leadership Award from FIA Foundation. These prizes acknowledge the efforts and achievements of Fortaleza in improving road safety. Between 2010 and 2019, the city achieved a decrease of more than 50% of road deaths, going from a rate of 14.9 deaths per 100 000 inhabitants to 7.4 (Prefeitura de Fortaleza, 2020). Fortaleza is one of the few cities in the world that accomplished the United Nations' target of cutting traffic fatalities by half during the Decade of Action for road safety.

Fortaleza targeted a culture of speeding with incremental actions to change behaviour through street transformations. The bike lane and dedicated bus lane networks were both expanded. Traffic calming measures were targeted in high-risk areas, with the redesign of pedestrian crossings, modernisation of the traffic light system, and speed limit reduction on arterial roads. Fortaleza also invested in safety checkpoints and media campaigns, especially targeting motorcyclists, who account for the largest share of the traffic fatalities and serious injuries.

Figure 9. Elevated crossing as part of traffic-calming measures in Fortaleza

Source: Prefeitura Municipal de Fortaleza (2017).

The city followed a similar approach to Bogotá in securing public support and winning over opposition. Each intervention was first tested on pilot projects, with positive outcomes publicised extensively. A reliable traffic casualty database contributed to monitoring progress as well as diagnosing problems. Crash data identified the need to lower speeds on one of the city's most dangerous arterial roads, the *Avenida*

Leste-Oeste, as a priority. Framed as infrastructure improvement, this pilot project aimed to achieve a broad acceptance with the population. For that, the city proposed to redesign the avenue through a package of infrastructure modifications. New traffic lights, pedestrian crossings, lighting, bike lanes, and bus lanes complemented a 10 km/h reduction in speed limit from 60 km/h to 50 km/h. With narrower lanes and more frequent stoplights, the street redesign also intended to nudge drivers towards compliance with the new speed limit.

Data from the city's camera enforcement system revealed that the strategy to change driver behaviour was successful in the *Avenida Leste-Oeste*. Radars measured a higher rate of compliance with the speed limit in the first months after the implementation.[13] The city applied a tolerance period without penalties to give drivers the time to adapt. The police notified drivers of infractions but gave no sanction to people driving between 50 km/h and 60 km/h during the first six months.

Figure 10. Redesigned *Avenida Leste-Oeste* with safer speed limit of 50 km/h in Fortaleza

Source: Prefeitura Municipal de Fortaleza (2018).

The success of the speed management solution on the *Avenida Leste-Oeste* was measureable: collisions involving motorised vehicles and pedestrians decreased by 63%.[14] The experiment drove a decision to apply the same treatment to another four avenues. Fortaleza is now working on a Road Safety Plan for the next ten years to scale up interventions and consolidate their safe system approach (Box 3) for the city.

Box 3. The Safe System

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 try to ensure 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.
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.

Source: ITF (2016).

Adopting a proactive approach to predict and prevent urban road crashes

There is a growing need to look beyond crash hotspots and move to a proactive risk-based assessment approach on road safety. Planning interventions based only on clusters of registered collisions involving fatalities or injuries is insufficient to eliminate all serious crashes. Traffic casualties can still take place in locations where historically there have been none. Worse, a hotspot elimination approach can give a false sense of success, in the very short term, due to a statistical phenomenon called regression to the mean[15] (ITF, 2019). A proactive approach aims therefore to intervene before serious crashes happen.

The availability of large volumes of data create an opportunity to develop a proactive approach. Indeed, a thorough analysis of risk factors and incidents, conducted in a holistic and integrated way, benefits from a comprehensive dataset. Information on network geometry, infrastructure defects, risky behaviours, crashes and close-call incidents is required to better understand the relationships between urban geometries, density, speed, mode share and road user risk (ITF, 2019). This knowledge makes it possible to understand where danger is located on the network, develop solutions and prevent serious crashes.

A proactive approach can also take advantage of the growing development of crash avoidance systems (ITF, 2016). Crash avoidance technologies such as electronic stability control and autonomous emergency

braking not only prevent crashes directly, but the data generated by them can identify dangerous locations on the network.

In this section, two European cities illustrate the adoption of a proactive approach to eliminating traffic fatalities and serious injuries. Rotterdam's road safety model highlights how to predict high-risk locations while London's action plan reveals the importance of requiring high standards for most dangerous vehicles.

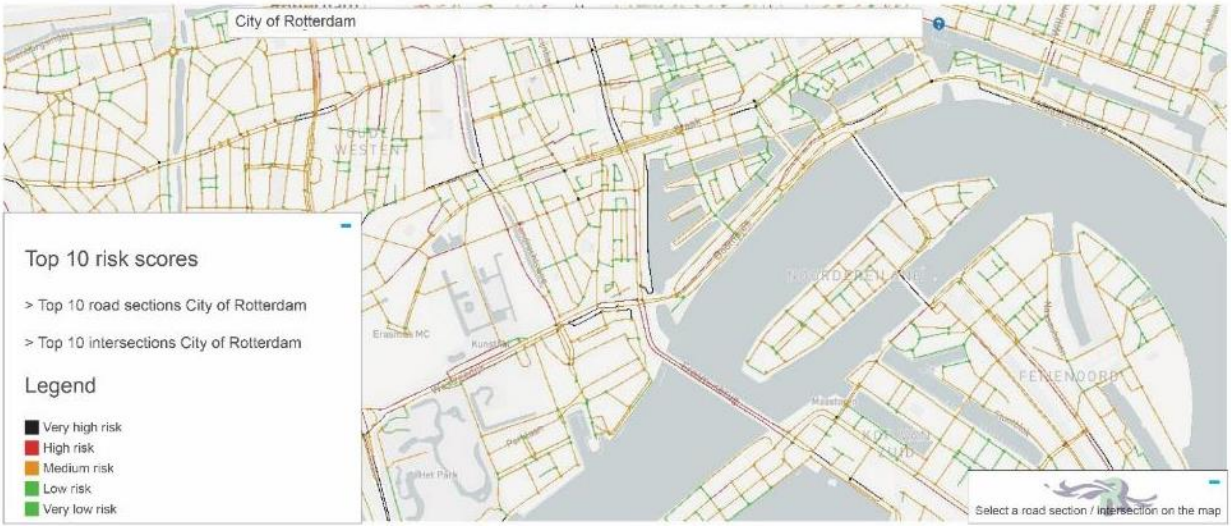
Developing an algorithm to predict high-risk locations in Rotterdam

Rotterdam has developed a road safety model to move toward a more proactive approach to road safety. The model is based on a self-learning algorithm that searches for patterns and crash prediction factors within a large volume of data. Characteristics of roads where historically many collisions have occurred helps the model to identify high-risk locations. Once identified, interventions are planned without waiting for serious crashes happen.

The availability of large volumes of objective data on infrastructure, traffic and outdoor space made the road safety model possible. To manage such a large database, the city has set-up a Data Science Team that closely collaborates with road safety and traffic data specialists. Including approximately 1 500 variables and using data from 2014 to 2018, a first version of the model linked crash data with information on traffic, road features, buildings, weather and time. It investigated the differences between locations where collisions did and did not take place. It also mapped out risk indicators that are important for making predictions about the probability and impact of a traffic collision.

The model has a risk score ranging from 1 to 5 which determines potentially unsafe locations, pointing to where adjustments to the infrastructure are needed. It also indicates which factors contribute to a high or low risk score, bringing insights to the type of intervention that could reduce the risk of collisions. The model identifies if the risk score is a result of the intensity of car traffic, the presence of on-road parking spaces, or a combination of both for instance. Finally, a *what if* analysis calculates the effect of the various interventions on the road safety score, thereby enabling testing of hypothetical planning scenarios.

Figure 11. Road Safety Model and risk scores of Rotterdam's streets and intersections



Source: Adapted from Gemeente Rotterdam (2020).

The first predictive road safety model helped the city of Rotterdam select streets and intersections to prioritise in infrastructure programmes, focusing on locations with high-risk scores. The results from the model were combined with subjective data from people's experiences, including places that generate many citizen complaints concerning exposure to risk. If there is a connection between the outcome of the model and locations with many crashes or complaints of citizens, Rotterdam gives priority to this specific location to receive an intervention.[16]

Figure 12. Current and future redesign project for *Coosingel*, one of the main streets in Rotterdam

Source: Gemeente Rotterdam (2016).

The city performed an accuracy test of the model that confirmed its predictive power. They did the evaluation using a test dataset that was not included when 'training' the model. Results showed that 81% of the road sections and 96% of intersections labelled with a high-risk score matched with one or more traffic casualties that were unknown to the model (Gemeente Rotterdam, 2019). The reliability of the model and its machine-learning features are inspiring other municipalities and provinces. Rotterdam continues to develop the model further by collecting more data sources and improving the quality of existing data connections. The need for a more detailed crash database could push the Police of Rotterdam to improve their method of traffic collision registration.

Reducing road danger with vehicle safety standards in London

London is one of the cities at the forefront of planning to eliminate all traffic deaths and injuries. The city has established ambitious targets for the coming years, placing road safety high on their agenda. The Mayor's Transport Strategy published in 2018 set out a Vision Zero approach to reduce the number of people killed or seriously injured on London's streets by 2041 to zero. The goal also includes that no one will be killed in or by a London bus by 2030. For that, the Mayor, through Transport for London (TfL) and the boroughs, developed a Vision Zero action plan.

In the early stages, London's Vision Zero approach included a public health agenda that shaped much of the strategies. The plan to eliminate all traffic fatalities and serious injuries relied on the common point of both road safety and active mobility agendas: to discourage the use of car on London's streets. For that, Vision Zero focused on the sources of road danger to pedestrians and cyclists such as vehicle speeding and visibility. In addition to protecting people, the strategy aimed to improve citizens' perception of the safety of active modes of transport in order to increase walking and cycling rates.

Understanding the sources of road danger underpins the Vision Zero strategy in London. This is a move away from the traditional and reactive road safety approach, which focuses on hotspot treatment only. London's goal to reduce road danger takes into account all parts of a safe transport system: speeds, street purpose and design, vehicles, behaviours, and post-collision responses (TfL, 2018). The plan defined the improvement of vehicle safety as one of the crucial outcomes as part of this holistic approach. Transport for London worked on imposing safe vehicle standards for the most dangerous vehicle types.

Figure 13. Protecting pedestrians and cyclists through safe street design in London

Source: Transport for London (2018).

Crash data reveals that London's buses and heavy goods vehicles (HGV) are the most dangerous. They are associated with a disproportionate number of fatal collisions in relation to their share of traffic, despite improvements over the past decade. The number of fatalities or serious injuries involving a bus collision has decreased by 55% over the past decade, but bus conflicts still represent a high risk for vulnerable road users (TfL, 2018). Half of cyclist deaths and 23% of pedestrian deaths involved a heavy goods vehicle in 2016 (TfL, 2018). Therefore, the plan defined specific strategies targeting these vehicles.

Transport for London defined a Bus Safety Standard (BSS) that stipulates the high safety standards to be incorporated into all new London buses and bus operator contracts from the end of 2018. Standards include technologies such as intelligent speed assistance and autonomous emergency braking, improved direct and indirect vision for drivers, systems to prevent driver braking errors and runaway buses, and audio and visual signalling to alert other road users (Pratt and Williams, 2020). The BSS also includes the redesign of the front of buses to help reduce the impact of a collision.

The progressive incorporation of safety standards also targeted the logistics and construction sectors through the HGV Safety Standard Permit Scheme. From 2020, a safety permit to enter or operate in the

city is mandatory for heavy goods vehicles of more than 12 tonnes. The permit classifies the safety of an HGV based on how much the driver can see through their windows. Additional vehicle safety technologies will be required from 2024 (TfL, 2018). London also adopted the Fleet Operator Recognition Scheme (FORS) accreditation for all heavy vehicles contracted in public procurements. FORS is a voluntary accreditation scheme that promotes best practice for commercial vehicles. By 2024, all operators must be certified by the higher FORS accreditation, which includes vehicle safety equipment. TfL is also investing in the training of drivers and in communication campaigns for the industry.

Figure 14. The current front of London buses will be redesigned to reduce the impact of collision

Source: Transport for London (2018).

Early data (TfL, 2019) suggests that London's Vision Zero action plan is delivering a safer street environment, especially due to the proactive approach of managing risk. The protection of pedestrians and cyclists in locations where active mobility rates are currently low is included in this approach.

Notes

1 This is an approximate figure. Data from 35 countries in ITF's IRTAD database indicates that 40% of overall road fatalities occur on urban roads. The database covers mainly high-income countries but there appears to be no correlation between income level and the proportion of urban fatalities. This proportion may therefore be similar in countries beyond the IRTAD group. In its global status report on road safety, the WHO (2018) estimates that 1.35 million people die in road traffic each year. Taking 40% of this number, equals one person per minute.

2 Stockholm Declaration, Declaration of the Third Global Ministerial Conference on Road Safety: Achieving Global Goals 2030, Stockholm, 19–20 February 2020, https://www.roadsafetysweden.com/about-the-conference/stockholm-declaration/

3 Twitter account of the City's Mobility Administration, https://twitter.com/sectormovilidad?lang=es

4 Interview held with Maria Andrea Moncada, Diego Castillo and Julian Flechas from the Secretaría de Movilidad de Bogotá by telephone, 20 February 2020, Colombia.

5 Measure announced through the Decree 126 of the 10th of May 2020, https://bogota.gov.co/mi-ciudad/seguridad/cuarentena/decreto-126-de-2020-medidas-para-manejo-de-la-pandemia-por-covid-19

6 Interview held with Maria Andrea Moncada from the Secretaría de Movilidad de Bogotá by email, 20 May 2020, Colombia.

7 Hospital emergency data covers all patients seen in emergency and trauma departments.

8 Interview held with Rob Viola, Director of Safety Policy & Research from the New York City Department of Transportation (NYC DOT), and Seth Hostetter, Director of Safety Analytics and Mapping from the New York City Department of Transportation (NYC DOT), by telephone, 21 February 2020, United States.

9 Interview held with Rob Viola, Director of Safety Policy & Research from the New York City Department of Transportation (NYC DOT), and Seth Hostetter, Director of Safety Analytics and Mapping from the New York City Department of Transportation (NYC DOT), by telephone, 21 February 2020, United States.

10 Interview held with Adriana Jakovcevic, Operational Manager of the Observatorio de Movilidad y Seguridad Vial, Gobierno de la Cuidad de Buenos Aires, by telephone, 5 March 2020, Argentina.

11 In Buenos Aires, license suspension is a procedure applicable to bus drivers that exceeded the speed limit or violated a red signal. Traffic police retains the driver's licence, apply a monetary penalty, and gives them a permission to keep on driving for up to three days. The driver has to pay the fine to get back the licence. According to an interview held with Adriana Jakovcevic, Operational Manager of the Observatorio de Movilidad y Seguridad Vial, Gobierno de la Cuidad de Buenos Aires, by email, 25 March 2020, Argentina, this procedure was more effective than electronic enforcement. Usually electronic enforcement releases fines that are directed to the bus company by reading the bus number plate, with little impact on drivers. It is unknown to what extent drivers are punished or warned about the violations they commit and that varies between each bus company. Finally, this type of fine arrive with a considerable delay, thus making it less effective.

12 Interview held with Adriana Jakovcevic, Operational Manager of the Observatorio de Movilidad y Seguridad Vial, Gobierno de la Cuidad de Buenos Aires, by telephone, 5 March 2020, Argentina.

13 Interview held with Luiz Saboia, Secretary from the Prefeitura Municipal de Fortaleza, and Dante Rosado, Consultant from the Bloomberg Initiative for Global Road Safety, by telephone, 17 March 2020, Brazil.

14 Interview held with Luiz Saboia, Secretary from the Prefeitura Municipal de Fortaleza, and Dante Rosado, Consultant from the Bloomberg Initiative for Global Road Safety, by telephone, 17 March 2020, Brazil.

15 In most before-and-after studies reported in road safety literature, remedial measures have been deployed after a period of "unacceptably high" collision counts. However, a period of high collision counts at a specific location is often due to random fluctuation in relatively small collision numbers. Due to these random fluctuations, it is likely that collision counts will return to a lower baseline level in subsequent time periods, regardless of the value of the intervention. This natural statistical phenomenon is known as regression to the mean (ITF, 2019).

16 Personal communication held with Remco Smit, Road Safety Coordinator from the Gemeente Rotterdam, by email, 25 February 2020.

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Best Practices for Urban Road Safety

This report presents seven case studies of cities that are implementing data-driven road safety policies. It highlights relevant experiences aimed at reducing the number of traffic casualties and protecting vulnerable road users in cities. The case studies from Barcelona, Bogota, Buenos Aires, Fortaleza, London, New York and Rotterdam illustrate the diverse approaches to better understand road crashes and to prevent road traffic deaths and serious injuries.

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