



Serious Injuries 2018



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1 Overview

“Every fatal or serious crash on our roads is a tragedy. It is our moral obligation – our shared responsibility – to take road safety seriously.”

**Violeta Bulc, Commissioner for Transport,
Foreword to Road Safety in the European Union, Trends, statistics and main challenges, March 2015**

While road deaths are typically used as the benchmark for defining and comparing road safety performance internationally, it is estimated that for every death there are four permanently disabling injuries, ten serious injuries and forty minor injuries. While progress has been made towards their reduction – an average 44% decrease in serious injuries has been achieved since 2001 across Member States – serious but non-fatal road traffic injuries present a major EU health problem with substantial humanitarian impacts and economic costs to society:

- In 2014, the number of serious injuries in the EU countries that distinguish between seriously and slightly injured was more than 135.000.
- Since 2010 the number of people seriously injured on roads of 23 EU countries has been reduced by just 1,6%, compared to an 18% decrease in the number of road deaths.
- The number of serious injuries in 2014 increased by more than 3% compared to 2013 results.
- Research indicates that 50% of the total social costs of road crashes in high, middle and low-income countries relate to injuries. Two thirds of these are serious injuries.

The World Health Organisation states that serious and fatal injuries are predictable and preventable. Accordingly, the road safety focus is turning away from the need to try and prevent all crashes (which is seen as unrealistic and of insufficient priority) to the prevention of death and serious injury. At the same time the acknowledged need is to define better, understand the scale and cost of, target the prevention of and monitor both fatal and serious injury in road traffic crashes. The *Safe System* approach calls for a broader focus on the ultimate prevention of both fatal and serious injury as well as targeting improvements in intermediate outcomes which are causally related to these. It calls for government-led shared responsibility in addressing goals and targets amongst system providers and users, different sectors and levels of government, business and the community.

At EU and national levels there is an increasing concern about seriously injured casualties, alongside road traffic deaths. New attention is being given to serious injury at EU policy level and in the High level Group on Road Safety given the prevalence of serious injuries, the slower improvement achieved for serious injury as opposed to fatal injury and the new reporting for MAIS ≥ 3 serious injury expected in 2015. EU action falls mainly within the framework of the European Commission’s Transport White Paper (2010); Road Safety Strategy (2011-2020), the Horizon Research Programme (2015) and vehicle standards initiatives, crossing many sectors.

The reduction of serious road traffic injuries was one of the seven strategic objectives set by the Commission in 2010 in Policy Orientations for Road Safety (2011-2020). A strategy of action on

serious road injuries was subsequently identified as a priority initiative in the Commission's 2011 White Paper on a Single European Transport Area. The Commission has noted that "a focus on serious injuries does not compete with a focus on fatalities – the objectives complement each other". The Commission also recently reported in the interim evaluation of the road safety strategy that "the strategic target and the actions under the Policy Orientations are not seen to sufficiently tackle the large number of serious road traffic injuries. Monitoring of injury reduction at EU level is weak."

Major research studies – SUSTAIN and SafetyCube – have recently been launched by the Commission on serious injury to assess and improve the estimation of the numbers of serious road injuries; determine and quantify health impacts of serious road injuries; estimate economic and immaterial costs related to serious road injuries and identify key risk factors related to serious injuries and their health impacts.

In view of these developments this synthesis, therefore, should be seen as an introduction to the important problem of serious injuries in road traffic crashes. It discusses what we mean by serious injury; discusses key factors and how we might make better progress towards preventing and mitigating costly humanitarian and socio-economic outcomes; and reviews key activity to date as well as briefly outlining recommended action at EU and national levels.

2 What do we mean by serious injury?

2.1 Defining, measuring and recording serious injury

Serious injuries are very diverse in nature and outcomes. In some cases, victims may fully recover from their injury within a few weeks, whereas other victims are permanently disabled as a result of a road crash (SafetyCube, 2014).

A range of definitions of injury severity and approaches to measuring serious health loss are used throughout the EU. Criteria used in police records and official statistics to classify the severity of a crash vary from country to country. The following list provides examples but is not exhaustive:

- The length of hospitalisation (used in many countries), a person seriously injured is a person hospitalised, other than for observation, for more than 24 hours.
- The type and level of injury. In some countries an injury scale is used (e.g. MAIS).
- The inability to work.
- The length of recovery.
- Long-term disability.

Due to differing definitions of serious injuries in national road crash reporting systems, comparisons of performance and target-setting have not been possible at EU level. Whereas a casualty which might be recorded as seriously injured in one country, the level of injury might be recorded as slight or minor in another. While most fatalities are reported to national crash data systems, studies have indicated that only around 70% of all serious injuries are reported (Elvik and Myersen, 1999). Misreporting and underreporting are largely due to the fact that in most EU countries, the national road traffic injury databases are only based on police reports. However, the police are not alerted to every traffic crash and the police cannot be expected to

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perform a medical assessment. The police diagnosis of injury is, generally, only a rough on-the-spot estimate. Furthermore the initial assessment by the police is not always checked against subsequent medical reports about injury severity.

Prior to their recent agreement on a new common definition of serious injury, the key issues acknowledged by the High Level Group of Road Safety as being in need of urgent resolution were 1) how to best define serious injury to reduce misreporting 2) how to define and identify the scale of long-term impairment and 3) how to allow for under-reporting. A complete picture of serious casualties is needed to fully assess the consequences of road crashes, to target results and intervention and to monitor progress. Comparison with other serious health loss is being called for increasingly as is a better estimate of the medical costs of road crash injury especially in relation to permanent impairment (Breen, 2012).

It is widely acknowledged that no single database provides enough information to give a complete picture of serious road traffic injuries and to fully understand underlying injury mechanisms. Road safety experts agree that the use of health sector data for meaningful injury classification at country level is necessary to complement police data and to provide an optimal means of defining serious injury (Broughton et al., 2008; IRTAD, 2011).

An example from Sweden is outlined in Box 1. Furthermore, in-depth data is needed from crash injury research to lead to meaningful conclusions concerning serious crash and serious injury causation (Breen, 2012).

Table 1: National definitions of serious injury

Country	Country definitions of serious injury (2013)
AT	> 24 days health impairment
BE	> 24 hours in hospital
BG	As defined in penal code
CH	>= 24 hours inability to perform normal activities or in hospital >=24 hours
CY	Hospitalised
CZ	As decided by medical doctor or >=24h hospital
DE	>=24h in hospital
DK	According to national definition: Intracranial injury, skull fracture, face or eye injury; injury of trunk (chest and/or abdomen); injury of spine and/or pelvis; fracture/dislocation or severe sprain of shoulder, arm or hand; fracture/dislocation or severe sprain of hip, leg or foot; serious injuries in more than one main region, burn. The statistics only include injuries reported by the police.
EE	Not defined
ES	>=24 hours in hospital
FI	Not defined
FR	>=24 hours in hospital
GB	Hospitalised or according to national definition: An injury for which a person is detained in hospital as an "in-patient", or any of the following injuries whether or not they are detained in hospital: fractures, concussion, internal injuries, crushings, burns (excluding friction burns), severe cuts, severe general shock requiring medical treatment and injuries causing death 30 or more days after the accident. An injured casualty is recorded as seriously or slightly injured by the police on the basis of information available within a short time of the accident. Hospitalisation procedures will vary regionally.
GR	Police records; presumed >=24h in hospital
HR	Definition unknown
HU	Injuries needing hospital care or >8 days to heal
IE	Hospitalised or according to national definition: An injury for which the person is detained in hospital as an 'in-patient', or any of the following injuries whether or not detained in hospital: fractures,

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	concussion, internal injuries, crushings, severe cuts and lacerations, severe general shock requiring medical treatment.
IS	According to national definition: Fractures, concussion, internal lesions, crushing, severe cuts and laceration, severe general shock requiring medical treatment and any other serious lesions entailing detention in hospital.
IT	Not defined
LU	>=24 hours in hospital
LV	>=24 hours in hospital
MT	Health department/Police definition
NI	Fractures/concussion/internal injury/severe cuts/lacerations/severe shock
NL	>=24 hours in hospital
NO	Life-threatening, permanent or major injuries
PL	According to national definition: Serious disability, serious incurable illness or a long term illness actually endangering life, permanent mental illness, complete or a significant loss of ability to work or a permanent disfigurement of the body as well as injuries such as fractures, damage of the internal organs, serious cut or irregular wounds
PT	>=24 hours in hospital
RO	Hospitalised or according to national definition: Injuries requiring hospitalisation or any of the following injuries whether or not they are detained in hospital: Organ injuries, permanent physical or psychological disability, body disfiguration, abortion, fractures, concussions, internal wounds, serious cuts or broken parts, or severe general shock which requires medical care and injuries causing death 30 or more days after the accident.
SE	Injuries expected to result in hospitalisation
SI	>=24 hours in hospital
SK	Doctor's opinion + change of state between 1 and 30 days

Source: European Commission, 2013

Box 1: STRADA – Swedish Traffic Accident Data Acquisition

STRADA (Swedish Traffic Accident Data Acquisition) is a national information system run by the Swedish Transport Agency containing data on road crashes and injuries occurring in the Swedish road transport system. The data is based on two separate sources: crash reports provided by the police, and medical reports provided by the hospitals that are part of the STRADA system. By combining data from two sources, more detailed descriptions of road crashes and their consequences can be provided. In particular, the hospital data broadens the knowledge of injuries sustained and their severity. Furthermore, since certain types of road traffic collision are often unreported to the police (mainly those including unprotected road user such as pedestrians, cyclists and moped drivers), including hospital data decreases the total number of unrecorded cases. Conversely, police reports often contain information that is not available in the hospital reports, for instance, information regarding specific traffic and crash characteristics.

Nationwide reporting to STRADA by the police has been carried out continuously since 2003 (early trials of the system began in 1999). Hospital reporting to STRADA has increased gradually from 29 hospitals in 2003 to 68 hospitals in 2012 (Sweden has around 80 hospitals in total). The goal is that STRADA should encompass all hospitals that have emergency wards with orthopaedic or other surgical capabilities. Currently, 69 hospitals in Sweden participate with only one hospital remaining to be included to reach the desired goal.

Source: Howard and Linder, 2014

Different measurement approaches are also used in hospital reporting and in the public health sector, as shown in Box 2. These are used for assessing injury severity, the probability of survival and long-term serious health loss. They are also used for determining the appropriate hospital for the crash victim, evaluating trauma system performance and for research purposes.

Box 2: Measurement scales of serious health loss and injury severity

Abbreviated Injury Scale (AIS)	Measures the severity of each injury on a scale from 1 (slight injury) to 6 (non-treatable usually fatal injury) for each of the 9 regions of the body (Head, Face, Neck, Thorax, Abdomen, Spine, Upper Extremity, Lower Extremity, External, other).
Maximum AIS (MAIS)	Determines the highest AIS-score out of all injuries sustained.
Injury Severity Score (ISS)	Summarises a person's injuries calculated as the sum of the 3 highest AIS-scores squared in different body regions.
International Classification of Diseases (ICD)	Codes diseases, signs and symptoms, abnormal findings, complaints, social circumstances and external causes of injury or diseases
International Classification of Functioning, Disability and Health	Classifies the health components of functioning and disability.
Functional Capacity Index (FCI)	Measures a person's level of function for the following 12 months after sustaining injury and incorporates 10 physical functions and gives a numerical value on a scale of 0 to 100, with 100 representing no limitations on a person's everyday function
Years Lived in Disability (YLDs)	The sum of the years lived in disability following a road traffic crash.
Disability-adjusted life years (DALYS)	When YLDs are added to the number of years of life lost for a certain disease or disorder the burden of disability associated with a disease or disorder can be reported in units called DALYs.
Quality of life-years remaining (QALYs)	The sum of life expectancy combined with a measure of quality of life-years remaining.
The Glasgow Coma Scale	Assesses levels of consciousness after actual or suspected head injury.

2.2 A new common EU definition of serious injury

While a common definition of fatal injury in road traffic crashes has been in place for many years, no common definition of serious injury has been available until recently. In order to start to address these issues the European Commission and the High Level Group on Road Safety agreed on a new common definition of serious injuries in January 2013. Serious injury is newly defined as an injury level of MAIS3+ which was recommended by EU projects such as SafetyNet and international organisations such as the International Transport Forum.

The Maximum Abbreviated Injury Scale (MAIS) is a globally accepted and widely used trauma scale used by medical professionals. It provides an objective and reliable basis for data collection and international comparisons. The injury score is determined at the hospital with the help of a detailed classification key. The score ranges from 1 to 6, with levels 3 to 6 considered as serious injuries. Injuries classified as ≥ 3 on the MAIS scale are the most serious injuries and ones that

involve significant or long-term damage, consequences and costs and where efforts should be focused. The aim is for serious injury data to also be made available in the longer term in disaggregated form allowing more detailed analysis, as is already the case with road fatalities (European Commission, 2013).

All EU countries are expected to provide data to the new definition of serious injury commencing with the 12 months ending December 2014. New data is expected to be available during 2015 and this reporting system is running in parallel with reporting using Member States own definitions for a transitional period.

The High Level Group identified three main ways Member States can collect data: 1) by applying a correction on police data. The Commission has entered into a contract with the AAAM for making available a methodology and conversion algorithm from ICD codes to MAIS codes to all Member States, 2) by using hospital data and 3) by using linked police and hospital data (European Commission 2013).

The European Commission reports that many EU countries have provided data to the new common definition but in some access to hospital data will require more time with some working on bilateral agreements between transport and health sectors or in a law. Countries are either using conversion from ICD to AIS in health sector data or using a linking process between health and police data and an algorithm to calculate totals or using conversion from ICD to IAS directly on the national hospital discharge files or encoding AIS directly at hospitals using transport resources or using conversion from ICD to AIS in a linked representative sample.

2.3 Measuring long-term impairment

There is wide acknowledgement in the literature that little is known about the long-term health impacts of serious injury. Use of the new EU common definition of serious injury is widely accepted as the best means of counting serious injuries, it uses the best 'threat to life scale' and is an advance over considering road fatalities in isolation. However, some experts believe that it may not be the best measure of 'long-term impairment' and that further work is required towards this. For example, more serious injuries e.g. neck injury may develop some time after the road traffic crash but may be initially reported as a minor injury. Injuries which pose a lesser threat to life on the Abbreviated Injury Scale (AIS) such as lower leg injuries may take longer to heal or cost more in terms of clinical response and rehabilitation (Blincoe et al., 2015). These considerations are especially important with an ageing road user population and in new efforts to improve the safety of vulnerable road users.

Disability is usually defined as an individual's inability to carry out a normal range of daily activities due to physical and/or psychological consequences. Permanent disability, such as paraplegia, quadriplegia, loss of eyesight, or brain damage, can deprive an individual of the ability to achieve even minor goals and result in dependence on others for economic support and routine physical care (See Erso Post Impact Care web text). Less serious – but more common – injuries to ankles, knees and the cervical spine can result in chronic physical pain and limit an injured person's physical activity for long periods. Serious burns, contusions and lacerations can lead to emotional trauma associated with permanent disfigurement. Road crashes can also result in a variety of long-term psychiatric and psycho-social problems (Peden et al., 2004).

Beyond using the EU definition to calculate the number of serious injuries some countries such as Sweden also work with a disability scale, as outlined in Box 3.

Box 3: Measuring disability from road crashes in Sweden

Sweden defines a serious injury as a health loss following a traffic injury, reflecting that a person does not recover their previous health condition within a reasonable amount of time. The measure used is “medical impairment”. Medical impairment is a concept for evaluating various functional impairments, regardless of the reason. The concept has been used since the end of the 19th century in Sweden and in many other countries. The concept originated from German private accident insurance. The concept is used today in individual and collective accident insurance and is often decided by the compensation an injured person receives from his/her insurance company. The disability scale is built up from functional impairment; e.g. total paralysis is regarded as 100% disability, the loss of one hand as 50-65%, and the loss of the outer joint of the ring finger as 2%. A person with any percentage of medical disability has not recovered their previous physical health condition and is therefore defined as seriously injured. The cut-off percentage is 1% or higher.

The EU SafetyCube project (2015) which has commenced recently will estimate the health impacts of road traffic injuries in terms of impairment and disability with reference to the International Classification of Functioning Disability and Health (ICF) (WHO, 2001). Health impacts will be quantified by calculating YLDs (Years Lived with Disability) and social costs of serious injuries will be examined.

2.4 What forces can be tolerated in the human body?

The tolerance of the human body to kinetic forces released in road traffic crashes is limited. Injury is broadly related to the amount of kinetic energy applied to the human frame. Biomechanical research reported over many years to international scientific conferences (e.g. IRCOBI, STAPP, ESV) indicates that the relationship between crash forces and injury is known for a number of parts of the body and types of injury for different categories of road user as well as for different age groups. See Erso Vehicle Safety web text.

Age and type of road user have a substantial effect on injury outcomes in road traffic crashes. For example, a crash load applied to the chest of a young male may result in a bone fracture, but if applied to an elderly female, may produce a life-threatening injury. While younger drivers are more likely to be involved in road crashes due to riskier behaviours, the elderly body is fragile and more likely to sustain serious or fatal injuries in the event of a crash. See Erso Older Road Users web text. Unprotected road users such as pedestrians, cyclists and two wheeled motor vehicles are at much higher risk of serious and fatal injury than car occupants.

The energy of a crash is related to the square of the velocity, so small increases in speed produce major increases in the risk of injury. Increased speed greatly increases the kinetic energy which must be absorbed in a collision. Research indicates that a 1% decrease in average speed corresponds with a 2% decrease in injury crashes, a 3% decrease in serious injury crashes and a 4% decrease in fatal crashes and vice versa (Nilsson, 2004; Elvik, 2009). Speed is thus a primary factor determining the severity of an injury.

Research provides general rule of thumb information about safe speeds and limits. It indicates that human tolerance to serious and fatal injury of a pedestrian hit by well-designed cars may

be exceeded if the vehicle is travelling at over 30 km/h (Tingvall and Haworth, 1999). Research shows that the probability of a pedestrian being killed rises by a factor of 8 as the impact speed of the car rises from 30 km/h to 50 km/h (Ashton and Mackay, 1983). The best-designed cars provide crash protection against serious health loss up to travel speeds of 70 km/h (Tingvall and Haworth, 1999) for car occupants wearing seat belts in frontal impacts and 50 km/h (Tingvall and Haworth, 1999) in side impacts. A later codification (Lie and Tingvall, 2013) foresees slightly higher speeds for these scenarios as potential future improvements in crash avoidance such as braking are introduced more widely. It should also be noted that, in practice, the time taken for new designs and technologies to be fitted in whole vehicle fleets can often be long, sometimes overly long, even when benefits to cost have been identified.

In the *Safe System* approach, the amount of biomechanical energy to which people can be exposed without sustaining serious injury is now promoted as a basic road and vehicle design parameter. Professional road safety work means taking account increasingly of these realities and acknowledging that the road traffic system is imperfectly designed for general safe use when planning intervention for the interim and longer term (Breen, 2015).

2.5 Other critical factors influencing serious health loss and its prevention

In addition to age, road user type and external factors such as economic growth and recession, the critical factors which influence serious health loss and its prevention are related to the planning, design and use of the road network and of the products and services within it, the conditions for entry and exit of those products, services and users, as well as the recovery and rehabilitation of road traffic crash victims. The International Standards Organisation (ISO 39001, 2012) identified these as including:

- road design and safe speed, especially considering separation (on-coming traffic and vulnerable road users), side areas and intersection design;
- use of appropriate roads, depending on vehicle type, user, type of cargo and equipment;
- safe journey planning, including consideration of the need to travel, the amount and mode of travel and choice of route, vehicle and driver;
- using safe driving and riding speeds, also considering vehicle type, traffic and weather conditions;
- use of personal safety equipment, especially considering seat belts, child restraints, bicycle helmets and motorcycle helmets, and the means to see and be seen;
- fitness of drivers and riders, especially considering distraction, alcohol and drugs and fatigue;
- safety of vehicles, especially considering occupant protection, protection of other road users (vulnerable as well as other vehicle occupants), road traffic crash avoidance and mitigation, roadworthiness, vehicle load capacity and securing of loads in and on the vehicle;

- appropriate authorization to drive/ride the class of vehicles being driven/ridden and the removal of unfit vehicles and drivers/riders from the road network;
- post-crash response and first aid, emergency preparedness and post-crash recovery and rehabilitation (ISO 39001, 2012).

These issues are addressed in-depth in a range of Erso web texts (www.erso.eu) and ETSC reviews (www.etsc.eu). As part of new attention to the issue of serious injury and in addition to establishing a common EU-wide definition, the European Commission has also recently launched a study on serious injuries to better understand their causes and effects (SUSTAIN Project, 2015).

3 Serious road traffic injuries in EU countries

3.1 Reported seriously injured casualty numbers and rates using Member States definitions of serious injury

Since 2001 a 29% decrease in serious injuries has been achieved compared to a 53% decrease in deaths with the majority of EU countries experiencing more rapid reductions in road deaths than in serious injuries. In 2014, the number of officially reported serious injuries in the 23 EU countries that distinguish between seriously and slightly injured (using Member States' differing definitions) was estimated by the European Commission to be 000more than 203.000. This represents a 1,6% reduction compared with 2010. The number of serious injuries is not decreasing as rapidly as road deaths and increased by 2,6% in 2014 compared to 2013. There are 8 to 9 reported serious injuries for every road death (European Commission, 2015). Many serious injuries, however, go unreported. For every person killed on the roads it is estimated that there are around 10 serious injuries, 4 of which involve permanent disability (Mackay, 2003).

In EU countries more than half of all serious injuries occur inside built-up areas. 45% of all seriously injured persons are vulnerable road users (pedestrians, cyclists, powered two-wheeler drivers). Within urban areas the vulnerable road users are almost 67% of those who are seriously injured. The young and the elderly are over-represented among the seriously injured in road crashes and especially the elderly pedestrians.

3.2 Reported seriously injured casualty numbers and rates using new EU common definition of MAIS ≥ 3

Systematic data describing seriously injured casualties to the new definition is not yet available for every EU country and the task is expected to take a little time before all Member States report. In the meantime, the Commission's Sustain project (2015) is expected to provide early fact-based analysis based on available data of the most common circumstances and types of road traffic crashes leading to serious injuries of MAIS3+ severity. More specifically, the study will provide information on the following issues:

- Setting out for pedestrians, cyclists, motorcyclists and car occupants respectively, the most common circumstances of a road traffic crash causing serious road injury.

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- The proportion of serious injury crashes accounted for by each identified most common crash scenario.
- Information at the most detailed level possible, e.g. differentiating between the most common serious injury crash scenarios per gender, for different age groups, crash opponents etc.
- For the crash types and crash scenarios found to be most common for each road user group, factors that could be found to have an impact on the level of injury severity.

3.3 Patterns of injury in serious road traffic crashes

There is no EU-wide collated data at present on patterns of injury in serious road traffic crashes, although a new study has recently been launched. In-depth studies conducted in different parts of Europe and elsewhere have indicated that:

- Motor vehicle crashes are the leading cause of traumatic brain injury. Some 25% of road accident victims admitted to hospital sustain traumatic brain injuries. Brain injuries often have long-term consequences for victims and their ability to function.
- The priorities for preventing MAIS ≥ 3 injuries in road collisions are head and spinal injuries. Neck and spine injuries require on average the longest hospital stays and can also cause chronic pain or permanent disability. Injuries to legs and pelvis are often not life-threatening, but are very common and also entail a risk of permanently impaired mobility.
- Serious burns and wounds can lead to permanent disfigurement affecting the individual psychologically as well as physically. In addition, survivors of crashes, including their families and carers, often suffer from social and psychological trauma.
- Pedestrians and motorcyclists suffer the most severe injuries as a result of motor vehicle collisions, report more continuing medical problems and require more assistance, compared with other types of road user. Some 81% of all seriously injured motorcyclists have head injuries. Lower-leg motorcyclist injuries are frequent but may be less severe in terms of threat to life, resulting either from direct contact with the impacting vehicle or result from impact between the motorcycle and the ground.
- Head or brain injury is present in about 50% of all younger hospitalised crash victims.
- Around 1 in 5 patients attending hospital with fractures to the upper or lower limb, or a soft tissue injury to their cervical spine (whiplash) have some form of disability 4 years after the crash (See Post Impact Care text, European Commission SWD, 2013).

The current EU SUSTAIN study on serious injuries is expected to produce updated data based on in-depth research and record linkage between hospital and policy data on patterns of injury in serious road traffic crashes.

4 The cost of serious road traffic injuries

The methodology for assessing the cost of serious injuries, where this is carried out, varies amongst EU Member States (See Erso Cost Benefit Analysis web text). The estimated social costs of traffic injuries also vary amongst EU Member States see table 2).

Table 2: Average social costs of traffic injuries at market prices (PPP) in Euro, 2010

Country	Fatality	Severe injury	Slight injury
Austria	2,395,000	327,000	25,800
Belgium	2,178,000	330,400	21,300
Bulgaria	984,000	127,900	9,800
Croatia	1,333,000	173,300	13,300
Cyprus	1,234,000	163,100	11,900
Czech Republic	1,446,000	194,300	14,100
Denmark	2,364,000	292,600	22,900
Estonia	1,163,000	155,800	11,200
Finland	2,213,000	294,300	22,000
France	2,070,000	289,200	21,600
Germany	2,220,000	307,100	24,800
Greece	1,518,000	198,400	15,100
Hungary	1,225,000	164,400	11,900
Ireland	2,412,000	305,600	23,300
Italy	1,916,000	246,200	18,800
Latvia	1,034,000	140,000	10,000
Lithuania	1,061,000	144,900	10,500
Luxembourg	3,323,000	517,700	31,200
Malta	2,122,000	269,500	20,100
Netherlands	2,388,000	316,400	25,500
Poland	1,168,000	156,700	11,300
Portugal	1,505,000	201,100	13,800
Romania	1,048,000	136,200	10,400
Slovakia	1,593,000	219,700	15,700
Slovenia	1,989,000	258,300	18,900
Spain	1,913,000	237,800	17,900
Sweden	2,240,000	328,700	23,500
Great Britain	2,170,000	280,300	22,200
EU average	1,870,000	243,100	18,700

Source: Ricardo-AEA, Update of the Handbook on External Costs of Transport, Report for the European Commission DG MOVE, 8 January 2014

As indicated previously, the long-term impacts of road traffic injuries within the EU are to a large extent unknown. Many national estimates, therefore, do not take account of the cost of long-term disability resulting from road traffic crashes and associated intangible costs.

While more work is being carried out at EU level on serious injury costs within the SafetyCube project, it is clear that reported serious injuries in road traffic crashes already amount to substantial socio-economic costs. One study found that around 50% of the total social cost of road crashes in high-income countries is related to injuries, of which about two thirds are serious injuries (Wijnen, 2013). Motorcycle leg and head injuries and injuries to vulnerable road users

are particularly costly (Peden et al, 2004). The large burden of costly injuries is borne by society in general, but particularly by the health sector and by employers with the premature loss or disablement of the EU's most economically active citizens. Road traffic crashes also have implications for social equity and have a disproportionate impact on disadvantaged citizens. The loss of the major family wage earner in road traffic crashes can push people into poverty as well limiting the ability of victims to cope with the consequences.

The potential for socio-economic savings is thus very large. Estimates undertaken by ETSC show that, if all serious injuries recorded in 2010 could have been prevented, the benefits to society would have been more than 50 billion Euro in that year (ETSC, 2015).

5 Targeting the prevention and mitigation of serious road traffic injury

5.1 Serious injury and the long-term *Safe System* goal and approach

The *Safe System* goal and strategy has evolved over many years and derives most notably from the Swedish Vision Zero and Dutch Sustainable Safety strategies and the concepts and good practice in other fields. *Safe System* represents an aspiration to a high level of performance, embraces well-established safety principles and builds upon demonstrably effective practice using innovative solutions and new technologies. *Safe System* is being taken up increasingly in Europe, Australasia and North America at regional, national levels and city levels and by organisations adopting ISO 39001. *Safe System* represents the new safety culture for road safety in Europe and beyond (See Erso Road Safety Management web text).

Safe System has as its long-term goal a road traffic system which is eventually free from death and serious injury. It involves an important paradigm shift from trying to prevent all crashes to preventing death and serious injury in road traffic crashes. The adoption of this 'Towards Zero' goal is fundamental to using a *Safe System* approach since it has an important influence on the choice of intervention. Measures which prevent death and prevent and mitigate serious injury may be quite different from measures to prevent crashes in general. *Safe System* tolerates the occurrence of crashes as long as they do not lead to serious health loss. *Safe System* is based on the underlying principles that:

- human beings make frequent mistakes that lead to road crashes;
- the human body has a limited ability to sustain crash forces – tolerance to injury thresholds are well-known (See Box 3); and
- it is a shared responsibility between stakeholders (road planners and managers, vehicle manufacturers, emergency medical system providers and road users etc.) to take appropriate actions to ensure that road crashes do not lead to serious or fatal injuries (ITF/OECD, 2008)

The extent to which road traffic system elements address known human tolerance thresholds and other human characteristics is critical. A focus on road network safety factors, vehicle safety factors, emergency medical system factors that address common human error as well as offering crash protection and injury mitigation to address known human characteristics is key to identifying actions to address goals and targets for serious and fatal injury. The speed of motorised vehicles is central since it affects both crash causation and crash severity and

influences the effectiveness of a range of measures. This understanding forms the basis of the *Safe System* approach which is being promoted widely by international organisations and adopted increasingly all over the world (Breen, 2015):

In its Transport White Paper (European Commission, 2010), the European Commission set out a highly ambitious long-term goal of virtually eliminating road deaths by 2050 – a *Vision Zero* for EU road safety activity which could now be extended to include serious injury (ETSC, 2015; Breen, 2015). In support of the long-term goal the Commission has in various working documents promoted the *Safe System* approach to intervention aimed at better addressing common human error and human vulnerabilities.

“The Safe System philosophy takes a wider perspective of road accidents, recognising that human beings are fallible, that their errors must be anticipated and the risk of serious consequences from these errors minimised. The responsibility for reducing fatalities and serious injuries is therefore not solely placed on the road users but shared with e.g. vehicle producers and infrastructure managers. The basic ethical assumption is that it is not acceptable to pay a price in deaths for the mobility the society needs.”

Source: European Commission, 2013.

5.2 Interim targets at EU and national levels

The value of targets

The long-term *Safe System* goal needs to be backed up by interim, quantitative targets over a defined period to reduce numbers of deaths and serious injuries (OECD, 2008). In a *Safe System* approach there is much focus on targeting intermediate outcomes that are casually related to death and serious injury. Intermediate outcome targets include percentage increases in seat belt use and crash helmet use; percentage reductions in average speeds or speeding over the limit; percentage reductions in levels and drinking and driving; improving the safety quality of the new vehicle fleet through use of Euro NCAP star ratings or for the road infrastructure using road assessment programme ratings Euro RAP and improvements in emergency medical response. This approach is highly recommended as international best practice by the OECD, World Bank, ISO and other organisations and EU countries are increasingly working with these factors.

Research indicates that:

- targets provide a strong focus and motivation for meaningful shared responsibility and collaboration (OECD, 2008; World Bank, 2009; Allsop, 2003).
- targets result in fewer deaths and serious injuries than without targets (Allsop, 2003)
- the positive effects of targets are sustained (Allsop et al., 2011).
- ambitious targets lead to greater savings than less ambitious targets (Elvik, 1993; Elvik, 2001, Locke et al., 2002; Allsop et al., 2011).
- targets lead to closer management and more effective road safety strategies and programmes (OECD, 1994; OECD, 2008).
- and, not least, they provide a focus for more efficient and accountable use of public resource (OECD, 1994; OECD, 2008).

While many measures simultaneously address serious and fatal outcomes, specific targeting of serious injury is warranted since, for a number of reasons, preventing serious injury can require different countermeasures from those selected to address fatal injury prevention.

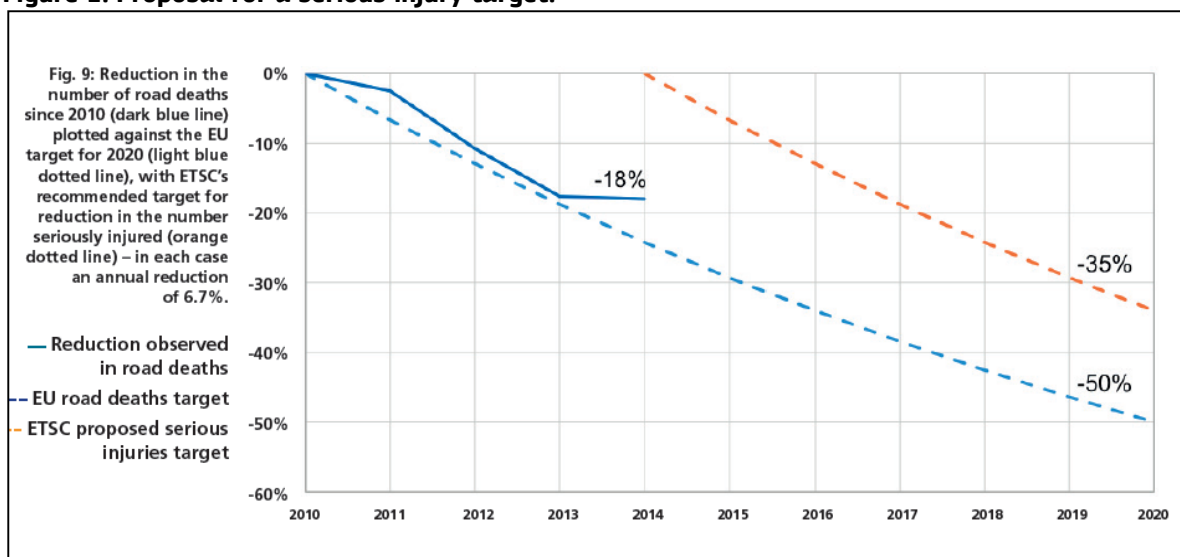
EU targets?

As for the previous action programme, the existence of the EU road safety goal, fatality reduction target and road safety strategy is playing a key role in encouraging ambitious national targets, many of which replicate or align with the EU 2020 target. (Breen, 2015)

In 2010, the European Commission announced its intention to set a target to reduce injuries in its Transport White Paper and later in its road safety policy orientations strategy for the period 2011-2020. This received full support from the Council of Ministers and the European Parliament. A public consultation concluded in 2012 also showed that the introduction of a serious injury target enjoyed the clear support of a broad majority of the survey respondents (European Commission 2012). In 2013 a Commission Staff Working Document identified the setting of an EU-level strategic target for reduction of the number of serious injuries as one of three key steps to be taken. Following the agreement of a common definition of serious injury in January 2014 a Commission press release announced that a target was expected shortly (March 2015). The interim review of the current road safety strategy (June, 2015) noted that “a target on the serious road traffic injuries remains to be set.” In September 2015, the European Parliament reiterated calls for a pan-European target to reduce the number of serious road injuries calling for “the swift adoption of a 2020 target of a 40% reduction in the number of people seriously injured, accompanied by a fully-fledged EU strategy.”

The European Transport Safety Council (ETSC) recommends that the EU should adopt a target of a 35% reduction between 2014 and 2020 in the number of people seriously injured on the roads. A 35% reduction in the number of seriously injured between 2014 and 2020 would be similarly challenging and achievable for the Member States to the target to halve road deaths between 2010 and 2020.

Figure 1: Proposal for a serious injury target.



Source: ETSC, 2015

This course of action was also recommended in the consultation carried out by the Commission on the interim evaluation and in an independent review which contributed to the Commission's Interim evaluation of their road safety strategy (Breen, 2015) (See Box 4). Experts underline that any target for serious injuries set in this decade can only be aspirational since setting a target based on historic standardised figures would require at least 5 years of MAIS3+ data and experience of effects of safety policies and measures on MAIS3+ numbers (ETSC, 2015). A safety performance framework for both deaths and serious injuries was also recommended in the independent review (Breen, 2015). See Table 3.

Box 4: Recommendation on EU target-setting and strategy from independent review of Policy Orientations 2015

- A sharp focus is needed to address EU road fatality reduction objectives to ensure that interventions appropriately address goals and targets
- The current focus on preventing and reducing the number of deaths of the results framework (2020 and 2050 goals) now needs to be expanded to include serious injury. The proposal for a 35% reduction in serious injuries by 2020 compared with 2014 seems an appropriate and challenging strategic target.
- It is suggested that the framework for the future development of *Policy Orientations* is provided by the evolving *Road Injuries Strategy* addressing fatal and serious injuries.
- Consistent with good practice road safety management, future road safety strategy needs to establish a clear road safety performance framework with specific objectives to allow targeting and monitoring and evaluation.
- The scope of *Policy Orientations* might be extended to include activity towards reducing work-related road deaths and serious injuries.
- Consideration should be given to setting targets to 2020 and beyond to increase seat belt use and crash helmet use; reduce average speeds and speeding over the limit; reduce levels and drinking and driving and fatal injury outcomes; improving the safety quality of the new vehicle fleet through use of Euro NCAP star ratings or for the road infrastructure (at least for TEN-T) using road assessment programme ratings EuroRAP.
- A road safety management capacity review is recommended to assist the development of a post-2020 Towards Zero strategy, involving key Commission Directorates and road safety partners who can deliver road safety results.
- In view of the challenges to 2020 and beyond, lead road safety unit capacity needs strengthening in DG MOVE, particularly in any further development of its road safety strategy and targets, coordination, monitoring and evaluation functions, as well as in technical support for Safe System intervention.

Source: Breen, 2015

Table 3: Examples of key road safety performance indicators

<i>Risk exposure indicators</i>
Vehicle/person kilometres of travel
Number of registered vehicles
Number of licensed drivers
Gross Domestic Product levels
Population levels and age-group distribution
<i>Final outcome indicators</i>
Number of deaths
Numbers of deaths per 100.000 population
Number of deaths per 100.000 vehicle/person kilometres of travel
Number of serious injuries (\geq MAIS 3)
Number of serious injuries per 100.000 population
Number of serious injuries per 100.000 vehicle/person kilometres of travel
<i>Intermediate outcome indicators</i>
% of motor vehicles travelling within the speed limit by road type
Average speeds of motorised vehicles by road type
% of drivers and riders over the limit at roadside checks
% of fatally injured drivers and riders with excess alcohol
% of seat belt and child restraint use in front and rear seats by motor vehicle occupants
% of rural roads with Euro RAP 4* (TEN-T and secondary network)
% of the vehicle fleet with the highest Euro NCAP rating
% of passenger cars fitted with seat belt reminders in front and rear seats
% of motor vehicles using daytime running lights
% of motorcycles fitted with anti-lock braking systems
% of crash helmet use by motorcyclists and moped users
% of crash helmet use by school-aged pedal cyclists
% of correct fitment of crash helmets by motorcyclists and moped users
Average response time of emergency medical system from crash notification to scene
<i>Institutional output indicators</i>
Hours of Police enforcement targeting high risk behaviours
% of roadside alcohol breath tests per 1.000 inhabitants
% of numbers of speeding tickets per 1.000 inhabitants
% of numbers of seat belt checks per 1.000 inhabitants

Source: Breen, 2015

National targets

Several Member States have been setting serious injury targets for many years. Currently, round eleven EU Member States have set national quantitative targets to reduce serious injuries. Current best practice involves the setting of a long-term goal towards the prevention of serious injury, interim time-limited targets over a period of 10 years to reduce serious injuries, supported by interim targets for a range of intermediate outcomes causally related to the occurrence and severity of serious injury (OECD, 2008).

Table 4: National Serious Road Traffic Injury Targets

Member State	Target level	Target period	Required % decrease from one year to next
Austria	40%	2010-2020	5,0%
Belgium	-	-	-
Bulgaria	20%	2010-2020	2,2%
Croatia	-	-	-
Cyprus	50%	2010-2020	6,7%
Czech Republic	40%	2010-2020	5,0%
Denmark	50%	2013-2020	9,4%

Estonia	Max. 330 per year	2023-2025	-
Finland	25%	2010-2020	2,8%
France	-	-	-
Germany	-	-	-
Greece	-	-	-
Hungary	-	-	-
Ireland	30%	2013-2020	5,0%
Italy	-	-	-
Latvia	-	-	-
Lithuania	-	-	-
Luxembourg	-	-	-
Malta	-	-	-
Netherlands	25%	2007-2020	2,2%
Poland	40%	2010-2020	5,0%
Portugal	-	-	-
Romania	-	-	-
Slovakia	-	-	-
Slovenia	-	-	-
Spain	-	-	-
Sweden	25%	2007-2020	2,2%
UK	-	-	-

Source: European Commission, 2017

6 Addressing serious injury through the Safe System approach

The main road traffic crash types which need to be addressed to reduce both fatal and serious injury on EU roads (Euro NCAP, 2014; Breen, 2015; EuroRAP, 2015) are as follows:

Head-on crashes typically kill and seriously injure car occupants even in the best designed vehicles at speeds greater than 70 km/h. In depth research shows that frontal crashes account for about 55% of passenger car fatalities and serious injuries. Different factors influence crash severity, the most important being speed of travel, seat belt use, vehicle mass and the level of crash protection and mitigation provided in the vehicle and roadsides.

Side impacts at intersections typically kill and seriously injure car occupants even in the best designed vehicles at speeds greater than 50 km/h. Of passenger car fatalities and seriously injured, side impacts account for about 35 to 40%.

Run-off-road crashes into rigid fixed objects produce a high number of fatal and serious outcomes at speeds greater than 70 km/h for frontal impacts and 50 km/h for side impacts even in the best designed vehicles.

Other motor vehicle impacts The remainder include rear impacts (5%) which is an important source of whiplash injury and other impact types.

Walking and cycling across or along the road The risk of being killed in traffic per kilometres travelled is 9 times higher for pedestrians than car occupants and 7 times higher for cyclists. Pedestrian and cyclist risk increases steeply in mixed speed traffic when traffic speeds are greater than 30 km/h. Research suggests that the majority of all fatally and seriously injured pedestrians in Europe are hit by the fronts of cars. The survival of these vulnerable road users depends upon their separation from the high speeds of motor vehicles or, where shared use is

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common, sufficiently low vehicle impact speed to prevent severe crash injury and provision of crash protective car fronts and, for cyclists, underrun protection on trucks. Single vehicle crashes are most common for cyclists.

Safe System intervention choices which accommodate human vulnerabilities are principally to separate dangerous mixed use (e.g. motorised vehicles and non-motorised users where speeds are high); to separate two-way motorised traffic above certain speeds; to provide adequate crash protection to prevent death and serious injury (e.g. crash protective vehicles and roadsides); to provide efficient emergency medical care to reduce the consequences of injury or to lower speeds to allow safe mixed use.

As stated by the European Commission (2013) “Reducing the seriousness of injuries from road accidents will require the introduction of a range of diverse measures. A future comprehensive strategy of action on serious injury reduction should take into account what may be done on different levels, by different actors and using many different tools.”

OECD provides a useful summary of *Safe System* intervention strategy and measures. Highly summarised this requires a systematic, multi-disciplinary and multi-sectoral approach which addresses the safety needs of all users; fatal and serious injury crash prevention, crash protection and mitigation and post-crash care and aligns with other policies for co-benefits such as health, occupational health and safety, sustainable development, poverty reduction. The range of well-documented intervention strategies which can be deployed are outlined in Box 5. Specific recommendations for EU action by an independent review are outlined in Box 6.

Box 5: *Safe System* intervention strategies

- Safety conscious planning and proactive safety engineering design
- Encouraging use of safer modes and safer routes
- Safe separation/ safe integration of mixed road use
- Managing speeds to crash protection levels
- Providing crash protective roadsides and vehicles
- Deterring dangerous behaviour and ensuring compliance with key safety rules by social marketing and increased highly visible police enforcement using camera technologies and other means, by providing proven driver assistance safety technologies in cars to help drivers keep to speed limits, wear seat belts, or avoid excess alcohol.
- Managing risk via vehicle standards/designs and driver standards e.g. graduated driver licensing.
- Fast and efficient emergency medical help, diagnosis and care.

Source: OECD (2008) Table derived from Towards Zero: Achieving Ambitious Road Safety Targets through a Safe System Approach. OECD, Paris

Box 6: Recommendation on EU intervention in support of Safe System strategy from independent review of Policy Orientations (2015).

New, effective action is needed by the EU and Member States between now and 2020 towards achieving existing targets. In terms of meeting the 2020 target and encouraged by the EU institutions, national priorities should focus on making further progress in securing compliance with the key road safety rules. More or less immediate results can be achieved in the short-term through combined publicity and policy enforcement, particularly to address speeding. Suggestions are made here for priority EU intervention to 2020 and beyond for a wide range intervention in support of a *Safe System* approach to road safety.

Planning, design, operation of road network

- Encourage knowledge transfer and the adoption of the *Safe System* approach to road safety engineering on TEN-T and the secondary network.
- Establish a safety performance framework for the TEN-T network, require measurement of safety indicators e.g. Euro RAP ratings and mean speed levels.
- Target a percentage increase in Euro RAP star rating of TEN-T roads to 2020 and beyond.
- Update TEN-T guidelines to ensure that all EU-funded infrastructure conforms to EC Directives 2004/54/EC and 2008/96.
- Set a speed limit of 120 km/h or lower on TEN-T roads.
- Promote and fund *Safe Corridor* and *Safe City/Safe Town* projects on the TEN-T and secondary network comprising road safety engineering and multi-sectoral intervention to intervention to achieve results and develop road safety management capacity.

Enforcement of key road safety rules

- Set up/support annual surveys of levels of compliance with speed limits, excess alcohol legislation and levels of front and rear seat belt use and report on findings.
- Set targets to 2020 at EU and national levels for improved compliance with speed limits, excess alcohol limits and seat belt use legislation and request annual reporting by the High Level Group on Road Safety and CARE.
- Provide new guidance on best practice enforcement of key road safety rules.
- Promote and fund enforcement activity and other intervention in *Safe Corridor* and *Safe City/Safe Town* projects on the TEN-T and secondary network.
- Mandate EU fitment of speed assistance systems and seat belt reminders in all seating positions in all motor vehicles at the earliest opportunity and take a variety of actions in the short-term to encourage the fitment and use of alcolocks e.g. in cross-border enforcement and in best practice guidance on their use in alcohol user rehabilitation.

Vehicle and equipment safety standards

- Ensure that EU vehicle safety standards need to provide a high level of protection.
- Propose a range of new EU vehicle safety legislation to reduce the number and risk of serious and fatal injury including the following priorities: Autonomous Emergency Braking Systems (AEBS) in cars, Speed Assist (advisory and voluntary systems); seat belt reminders for front and rear seat passengers; fitment of adaptive restraints in cars, protection of far-side car occupants in side impacts; improved heavy goods vehicle front end design to protect other users, rear underrun protection and side underrun protection; and lane keeping assist.
- Promote and fund a Euro SHARP consumer information programme on powered two-wheeler use crash helmets in cooperation with the UK SHARP programme.
- Monitor the usage levels of helmets by powered two-wheeler riders and cyclists across the EU and promote/propose mandatory cycle helmet use legislation for school-aged children across the EU and target increased levels of use; establish a European cycle helmet consumer information programme.
- Promote zero-rated Value Added Tax for cyclist and motorcyclist helmets.
- Revise EC Directive 2014/24/EU on public procurement to include road safety, alongside existing provisions covering environmental and social aspects.

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- Invite the High Level Group on Road Safety to consider national incentives to fast-track proven technologies via procurement, safe travel policies, and tax and insurance incentives.
- Through the EU Health and Safety at Work agency, devise safe travel policies for the European Commission as well as promoting take up of ISO 39001 on road safety management systems for organisations.

Driver and rider standards

- Review Directive 2006/126/EC towards the introduction of a package of effective Graduated Driver Licensing measures for car drivers and powered two-wheeler riders.
- Review Directive 2003/59/EC with a view to introducing new provisions/guidance on demonstrably effective training schemes for professional drivers.

Post-impact care

- Commission a study to review the scope of post impact care in reducing deaths and serious injuries in road collisions.
- Include first responder training in commercial and public transport driver training and emergency services personnel.
- Monitor and rank annually through EU databases the role of road traffic injury as cause of death and disability compared with other mortality and morbidity.

Source: Breen, 2015

While many serious injuries can be addressed by the same measures adopted to prevent fatal injury, recent research indicates that crashes resulting in serious injury may have different characteristics compared to fatal crashes, possibly requiring different countermeasures (Reurings et al., 2012). This may be one of the reasons that past road safety policies have been more effective in preventing road deaths than in preventing serious injuries.

Progressively informed by SafetyCube, Sustain and other research, EU action is needed to achieve a further reduction of serious road injuries, targeting the types of crashes which produce most serious road injuries with system-wide evidence-based intervention.

References

- Aeron-Thomas et al. (2004) The Impact of Crashes on the Poor. Study commissioned from TRL by GRSP with funding from the Swedish International Development Cooperation Agency (Sida) and TRL
- Allsop, R.E. ed. (2003) Risk assessment and target setting in EU transport programmes, ETSC Brussels
- Allsop R.E., Sze N. N. Wong S.C (2011) An update on the association between setting quantified road safety targets and road fatality reduction, Accident Analysis and Prevention 43 (2011) 1279–1283.
- Ashton, S.J., Mackay, G.M. (1979) Some characteristics of the population who suffer trauma as pedestrians when hit by cars and some resulting implications, Proceedings of the 4th IRCOBI conference 1979.
- Blincoe, L. J., Miller, T. R., Zaloshnja, E., & Lawrence, B. A. (2015) The economic and societal impact of motor vehicle crashes, 2010. (Revised) (Report No. DOT HS 812 013). Washington, DC: National Highway Traffic Safety Administration.
- Bliss T. and Breen J. (2009) Implementing the Recommendations of the World Report on Road Traffic Injury Prevention. Country guidelines for the Conduct of Road Safety Management Capacity Reviews and the Specification of Lead Agency Reforms, Investment Strategies and Safe System Projects, World Bank Global Road Safety Facility, Washington DC.
- Breen J. (2012) High-level consultation on the development of the Injuries Strategy Working Document for the meeting of the High Level Group on Road Safety, 27th June 2012, Copenhagen.
- Broughton J. et al. (2008) Estimating the real number of road accident casualties, SafetyNet Project, Deliverable D.1.15 [SafetyNet.www.erso.eu/safetynet/content/safetynet.htm](http://www.erso.eu/safetynet/content/safetynet.htm)
- Elvik, R. (1993) Quantified road safety targets: a useful tool for policy making? Accident Analysis and Prevention, 25, 569-583.
- Elvik, R. (2001) Quantified road safety targets: An assessment of evaluation methodology. Report 539. Institute of Transport Economics, Oslo.
- Elvik, R. (2009) The Power Model and the relationship between speed and road safety, Update and new analyses, TOI, Oslo.
- Elvik R, Mysen A B. (1999) Incomplete accident reporting: Meta-analysis of studies made in 13 countries. Transportation Research Record No 1665, 133-140.
- European Commission Communication (2010) Towards a European road safety area: policy orientations on road safety 2011-2020, COM (2010) 389 final.

Serious Injuries

European Commission (2011) White Paper: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system, COM (2011) 144 final.

European Commission (2013) Commission Staff Working Document on the implementation of Objective 6 of the European Commission's Policy Orientations on Road Safety 2011-2020 – First milestone towards an injury strategy, SWD(2013) 94 final, Brussels, 19.3.2013.

European Commission (2014) Interim evaluation of the Policy orientations on road safety 2011-2020. DG MOVE, Unit C4: Road safety May – 2015

European Council of Ministers (2010) Council conclusions on road safety, 3052th Transport, Telecommunications and Energy Council meeting, Brussels, 2-3 December 2010;

Euro NCAP (2014) 2020 Roadmap, European New Car Assessment Programme, Brussels.

European Parliament (2011) Resolution of 27 September 2011: European road safety 2011-2020, 2010/2235(INI).

European Transport Safety Council (ETSC) (2015a) An EU Target to reduce seriously injured on the roads Briefing, June 2015, Brussels.

European Transport Safety Council (ETSC) (2015b) 9th PIN Report, June 2015, Brussels.

Howard, C. and Linder, A. (2014) Review of Swedish experiences concerning analysis of people injured in traffic accidents, VTI Linköping VTI notat 7A-2014

IRTAD (2011) Reporting on Serious Road Traffic Casualties: Combining and using different data sources to improve understanding of non-fatal road traffic crashes, International Traffic Safety Data and Analysis Group, OECD/ITF, Paris.

Lie, A. and Tingvall, C. (2013) Safe system approach – Vision Zero: delivering the vision, Swedish Transport Administration,

Locke, E. A., Latham, G. P. (2002) Building a practically useful theory of goal setting and task motivation. A 35-year Odyssey. *American Psychologist*, 57, 705-717.

Nilsson, G. (2004) Traffic safety dimensions and the power model to describe the effect of speed on safety. Bulletin 221, Lund Institute of Technology, Lund

OECD (1994) Targeted Road Safety Programmes, Paris.

OECD (2008) Towards Zero: Achieving Ambitious Road Safety Targets through a Safe System Approach. OECD, Paris

Peden M, Scurfield R, Sleet D, Mohan D, Hyder A, Jarawan E, Mathers C Eds. (2004) World Report on Road Traffic Injury Prevention, World Health Organization and World Bank (Washington), Geneva

Serious Injuries

Reurings, M., Stipdonk, H., Minnaard, F., Eenink R (2012) Why do the development of the number of serious road injuries and the development of the number of road fatalities differ. R-2012-9. SWOV, Leidschendam.

Ricardo-AEA (2014) Update of the Handbook on External Costs of Transport, Report for the European Commission DG MOVE, 8 January 2014

SafetyCube Project (2015) Horizon 2020 Research Programme, Brussels.

Sustain Project (2015) Study on Serious Road Traffic Injuries in the EU, No MOVE C4/2015-162.

Tingvall C. and Haworth, N. (1999) Vision Zero - An ethical approach to safety and mobility, Paper presented to the 6th ITE International Conference Road Safety & Traffic Enforcement: Beyond 2000, Melbourne, 6-7 September 1999

Wijnen, W. (2013) Social costs of road crashes: an international analysis. Paper presented at the 16th international conference Road Safety on Four Continents, May 15th-17th, Beijing, China.

Notes

1. Country abbreviations

	Belgium	BE		Italy	IT		Romania	RO
	Bulgaria	BG		Cyprus	CY		Slovenia	SI
	Czech Republic	CZ		Latvia	LV		Slovakia	SK
	Denmark	DK		Lithuania	LT		Finland	FI
	Germany	DE		Luxembourg	LU		Sweden	SE
	Estonia	EE		Hungary	HU		United Kingdom	UK
	Ireland	IE		Malta	MT			
	Greece	EL		Netherlands	NL		Iceland	IS
	Spain	ES		Austria	AT		Liechtenstein	LI
	France	FR		Poland	PL		Norway	NO
	Croatia	HR		Portugal	PT		Switzerland	CH

2. This 2015 Traffic Safety Synthesis on Serious Injuries was written by Jeanne Breen, [Jeanne Breen Consulting](#).

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