The importance of the GSR for the future of vehicle safety

Casualty impact and cost-effectiveness evaluation

Richard Cuerden

11 September 2018

Vision

World leader in creating the future of transport and mobility, using evidence-based solutions and innovative thinking

Mission

Challenge and influence our chosen markets, driving sustained reductions (ultimately to zero) in:

- fatalities and serious injuries
- harmful emissions
- barriers to inclusive mobility
- unforeseen delays
- cost inefficiencies

…enabling world-class transport and mobility solutions that underpin the needs of tomorrow's economy and society

Brand Values

Inquisitive | Progressive | Trusted | Relentless

TRL…a track record of delivering impactful innovation

1939-45
Barnes Wallis' Bouncing Bomb

1949
Zebra Crossing

1950's/70's
The UK Motorway network

1960s
Early simulator

1969
The self-driving Citroën DS19

1972
The magic round-about, Swindon

1980's
Deflectometer

1997
NCAP launched

2012
London Summer Olympics

2014
TRL cycle infrastructure development

2015
Gateway driverless shuttles

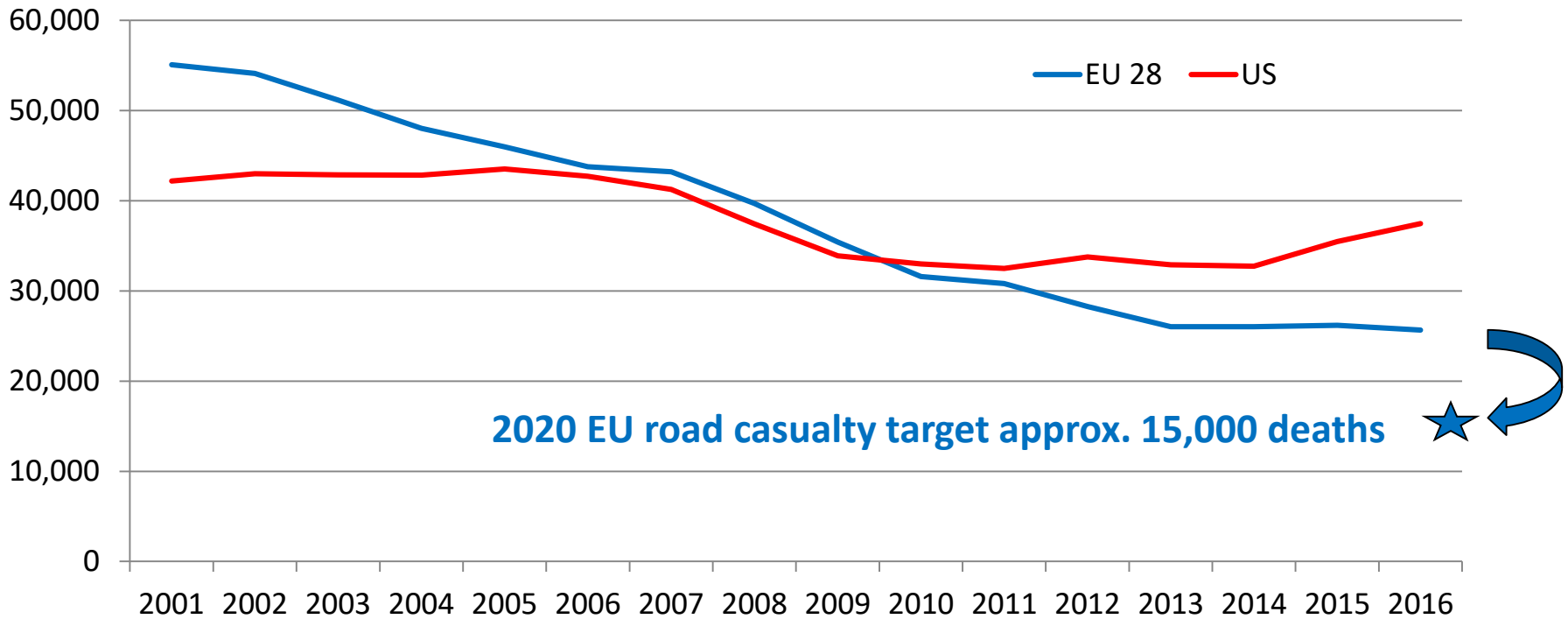
2016
Electric double decker bus

2017
HGV Truck Platooning

2018
London Smart Mobility Living Lab

Self-driving Citroën DS19, 1969

Comparison of US and EU28 Road Deaths



Policy making in a ‘Smarter World’

Changing times …

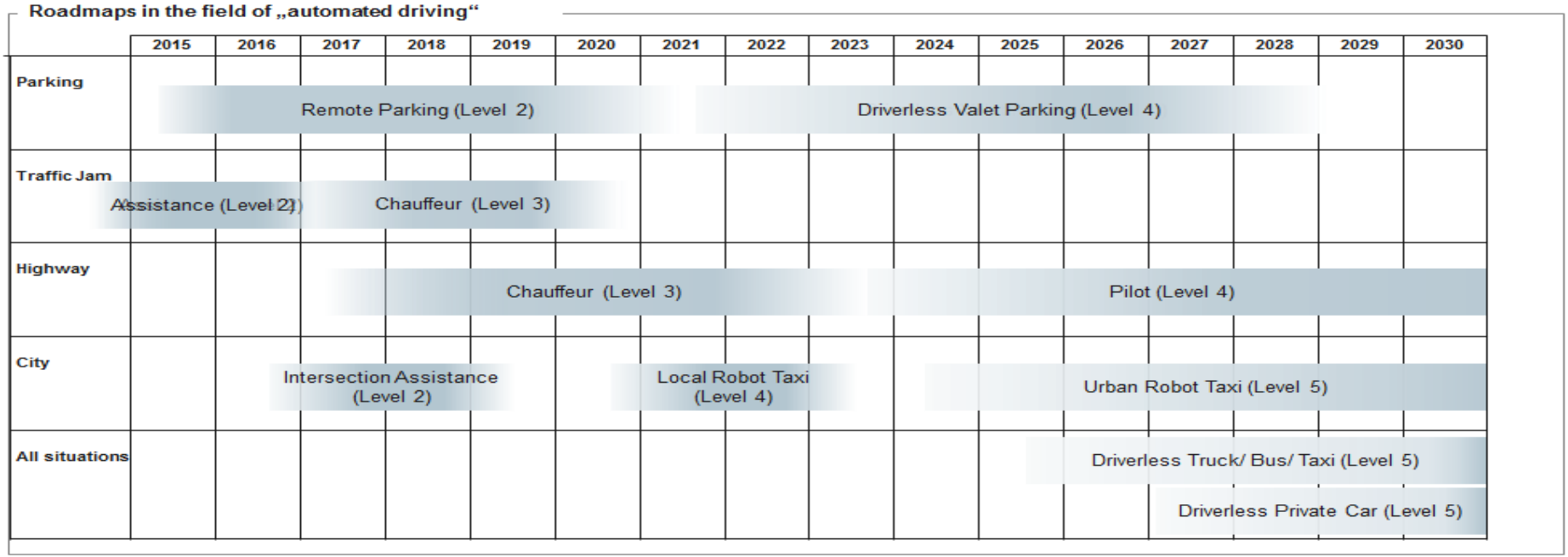
- The digital ‘revolution’
  - IoT, Smart Cities & Connected Highways
- Changing population characteristics
  - Fewer young people gaining car driving licences & proportionally more elderly people using vehicles
  - Reductions in individual vehicle ownership, car share …
- Changing vehicle fleet
  - More SUVs & light weight vehicles
  - ULEVs – more electric & hybrid vehicles
  - Advanced Driver Safety Systems (ADAS)

Connected & Autonomous Vehicles (CAVs)

Safety Efficiency Environment Mobility

Changing world: Connected and Automated Vehicles

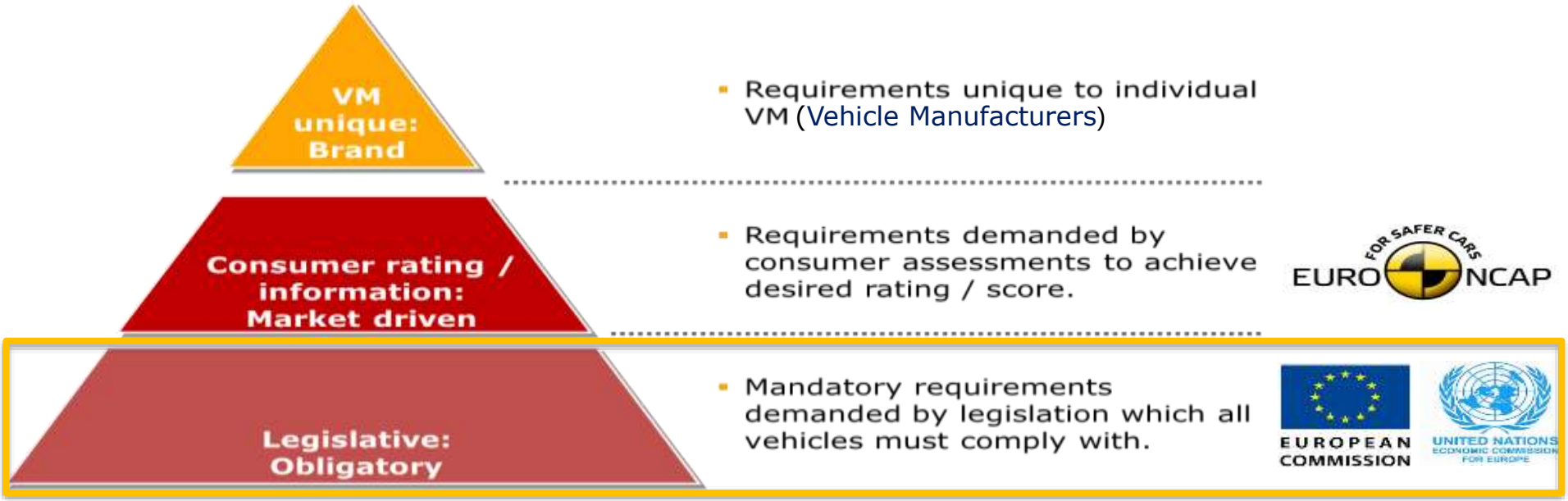
Consolidation of automated driving roadmaps



CEDR
Conférence Européenne des Directeurs des Routes
Conference of European Directors of Roads

General Safety Regulation and Pedestrian Safety Regulation

European Union



General Safety Regulation and Pedestrian Safety Regulation

Casualty impact and cost-effectiveness evaluation for the Commission proposal on General Vehicle Safety

Objective:

To **calculate** concrete **cost-effectiveness indicators and numbers of road casualties that could be prevented at an EU-28 level** for sets of safety measures proposed by the European Commission and considered for **mandatory implementation in new vehicles.**

Study scope

Study scope

The specific scope of the study was defined as:

- **Geographic scope**: EU-28
- **Vehicle categories covered**: Cars [M1], Buses [M2&M3], Vans [N1], Trucks [N2&N3]
- **Evaluation period**: 2021–2037
- **Baseline scenario**: No further policy intervention in the transport sector, but voluntary improvements and effects of already implemented policies continue: Continued dispersion of mandatory vehicle safety measures into the legacy fleet and **continued voluntary uptake of the safety measures under consideration**.
- **Action scenario:** 17 safety technologies made mandatory according to Commission proposal.

Measure	Description	Applicable vehicle categories			
AEB-VEH	Autonomous emergency braking for vehicles (moving and stationary targets)	M1		N1	
AEB-PCD	Autonomous emergency braking for pedestrians and cyclists	M1		N1	
ALC	Alcohol interlock installation document	M1	M2&M3	N1	N2&N3
DDR-DAD	Drowsiness and attention detection	M1	M2&M3	N1	N2&N3
DDR-ADR	Advanced distraction recognition	M1	M2&M3	N1	N2&N3
EDR	Event data recorder	M1		N1	
ESS	Emergency stop signal	M1	M2&M3	N1	N2&N3
FFW-137	Full-width frontal occupant protection (current R137 configuration with Hybrid III ATDs)	M1		N1	
FFW-THO	Full-width frontal occupant protection (introduction of THOR-M ATDs and lower appropriate injury criteria thresholds to encourage adaptive restraints)	M1		N1	
HED-MGI	Adult head-to-windscreen impact (mandatory HIC limit in headform-to-glass impact tests; no mandatory A-pillar impact)	M1		N1	
ISA-VOL	Intelligent speed assistance (voluntary type system; can be overridden by driver and switched off for the rest of journey)	M1	M2&M3	N1	N2&N3
LKA-ELK	Lane keeping assist (emergency lane keeping system that intervenes only in case of an imminent threat such as leaving the road, or leaving the lane with oncoming traffic)	M1		N1	
PSI	Pole side impact occupant protection	M1		N1	
REV	Reversing camera system	M1	M2&M3	N1	N2&N3
TPM	Tyre pressure monitoring system		M2&M3	N1	N2&N3
VIS-DET	Front and side vulnerable road user detection and warning (no auto braking)		M2&M3		N2&N3
VIS-DIV	Minimum direct vision requirement (best-in-class approach)		M2&M3		N2&N3

Measure	M1	M2&M3	N1	N2&N3
AEB-VEH	B		B	
AEB-PCD	C		C	
ALC	B	B	B	B
DDR-DAD	B	B	B	B
DDR-ADR	C	C	C	C
EDR	B		B	
ESS	B	B	B	B
FFW-137	B		B	
FFW-THO	B		B	
HED-MGI	C		C	
ISA-VOL	B	B	B	B
LKA-ELK	B		B	
PSI	B		B	
REV	B	B	B	B
TPM		B	B	B
VIS-DET		B		B
VIS-DIV		D		D

Introduction dates assumed for cost-effectiveness analysis (evaluation period: 2021–2037)

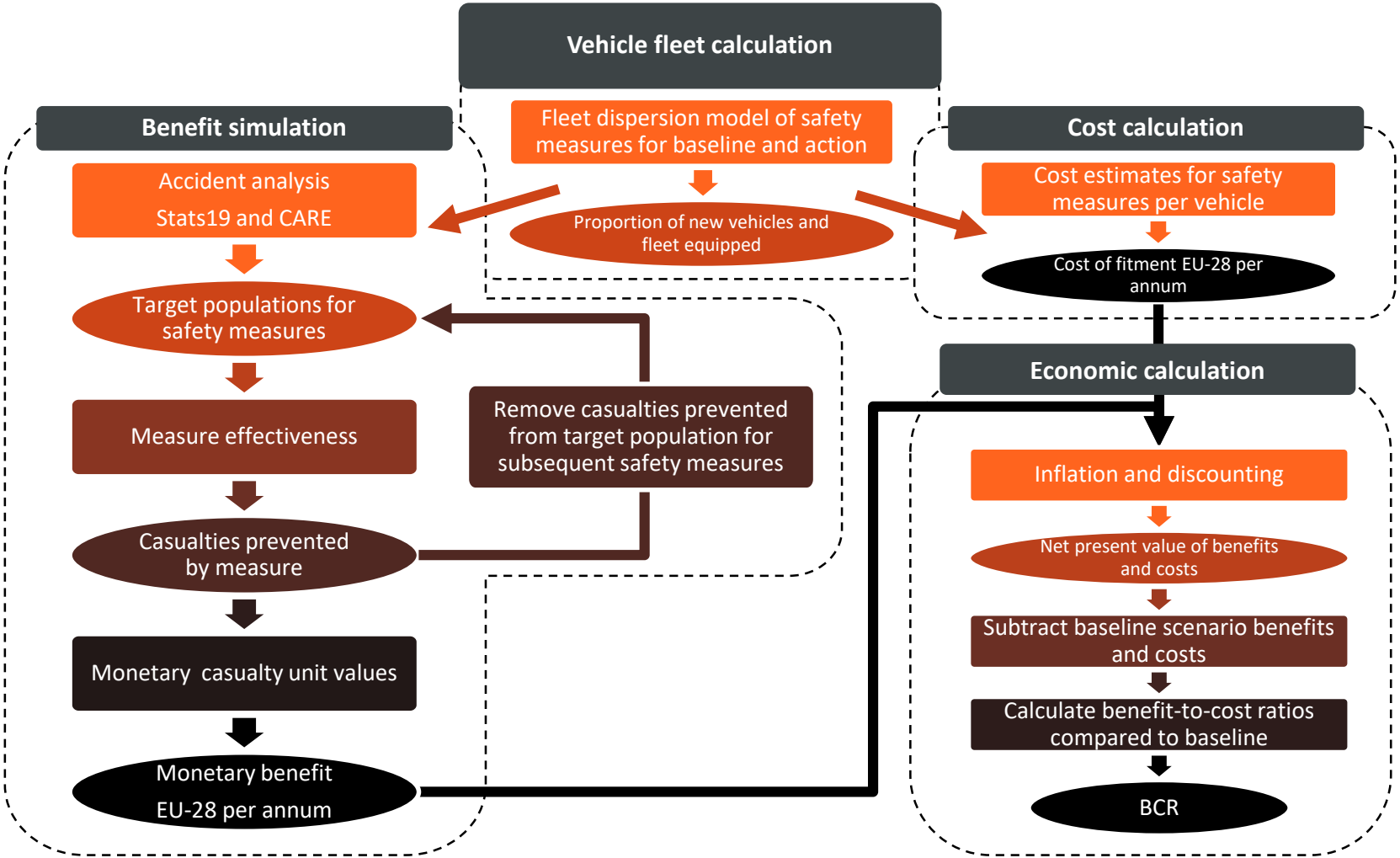
- B = 01/09/2021 new approved types, 1/09/2023 new vehicles
- C = 01/09/2023 new approved types, 1/09/2025 new vehicles
- D = 01/09/2025 new approved types, no mandatory introduction for new vehicles

Actual introduction dates might deviate (see Commission Proposal)

Study scope (cont'd)

- **Benefits considered**: Monetary values of casualties prevented (fatal, serious, slight) by safety measures
- **Costs considered**: Cost to vehicle manufacturers (OEMs) of fitment of safety measures to new vehicles
- **Treatment of uncertainty**: Interval analysis and scenario analysis
- **Results**: Benefit-to-cost ratios (BCRs) and numbers of casualties prevented. All results are **in comparison to the baseline scenario.**

Method

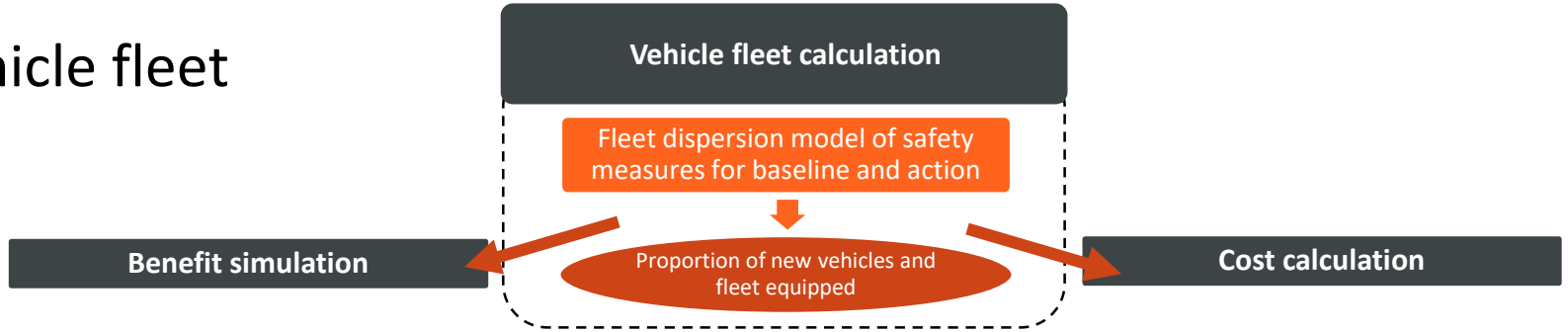

Vehicle fleet calculation
Fleet dispersion model of safety measures for baseline and action
Proportion of new vehicles and fleet equipped
Benefit simulation
Accident analysis
Stats19 and CARE
Target populations for safety measures
Measure effectiveness
Casualties prevented by measure
Monetary casualty unit values
Monetary benefit EU-28 per annum
Remove casualties prevented from target population for subsequent safety measures
Cost calculation
Cost estimates for safety measures per vehicle
Cost of fitment EU-28 per annum
Economic calculation
Inflation and discounting
Net present value of benefits and costs
Subtract baseline scenario benefits and costs
Calculate benefit-to-cost ratios compared to baseline
BCR

Simulation and Calculation Model

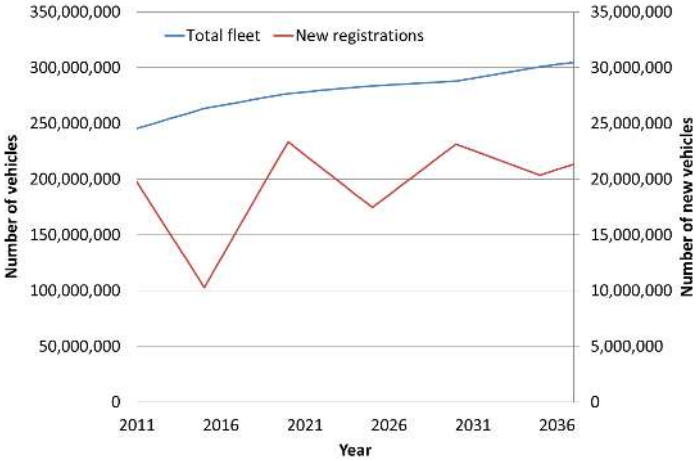
Note that the model takes into account:

- The **interactions of all measures when implemented together** (to avoid double-counting of casualties prevented by different measures)
- The **voluntary uptake of the proposed measures** expected to happen without policy intervention (baseline scenario)
- The **effects of already existing mandatory measures**, which are still dispersing into the fleet (AEBS and LDWS for trucks and buses, ESC for all categories)

Vehicle fleet

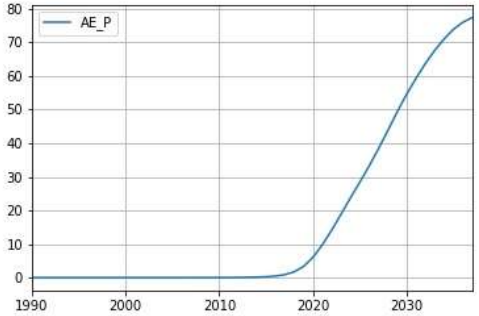


European fleet and new registrations:

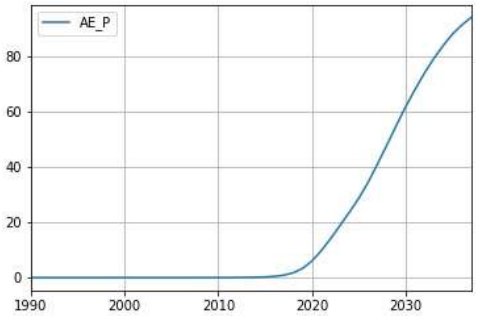


Uptake of safety measures into the fleet:

Voluntary scenario:



Mandatory scenario:



Percentage of all cars within the vehicle fleet equipped with pedestrian-capable AEB in baseline (voluntary uptake) and mandatory implementation scenario modelled

Benefits

Vehicle fleet calculation

Fleet dispersion model of safety measures for baseline and action

Proportion of new vehicles and fleet equipped

Benefit simulation

Accident analysis
Stats19 and CARE

Target populations for safety measures

Measure effectiveness

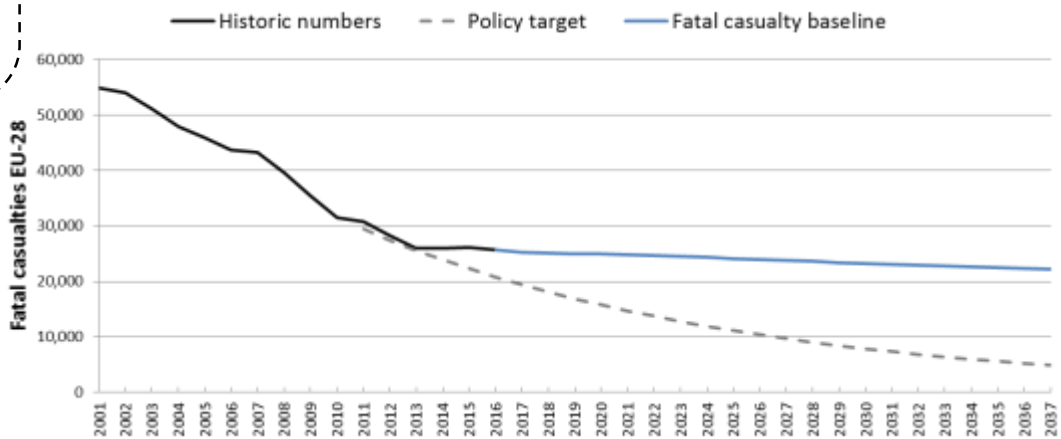
Casualties prevented by measure

Remove casualties prevented from other target populations

Monetary casualty unit values

Monetary benefit
EU-28 per annum

European road casualty baseline:



Target population estimates, EU-28 Casualty typology

Vehicle category		Collisions	Casualties (Vehicle 1)			Casualties (Vehicle 2)		
Vehicle 1	Vehicle 2		Fatal	Serious	Slight	Fatal	Serious	Slight
M1	***none***	127,635	5,405	33,198	129,912	*n/a*	*n/a*	*n/a*
M2M3	***none***	5,313	50	818	6,625	*n/a*	*n/a*	*n/a*
N1	***none***	7,475	338	1,687	7,305	*n/a*	*n/a*	*n/a*
N2N3	***none***	4,456	222	1,209	3,578	*n/a*	*n/a*	*n/a*
PTW	***none***	52,552	1,667	16,652	38,205	*n/a*	*n/a*	*n/a*
Cyclist	***none***	25,686	335	7,662	17,848	*n/a*	*n/a*	*n/a*
Other	***none***	4,301	317	1,560	3,239	*n/a*	*n/a*	*n/a*
M1	**M1**	252,173	2,900	37,283	367,874	*n/a*	*n/a*	*n/a*
M1	**M2M3**	8,986	194	808	5,254	13	580	8,823
M1	**N1**	32,931	552	3,720	30,590	111	1,320	13,459
M1	**N2N3**	23,967	1,456	4,583	22,809	35	483	3,522
M1	**PTW**	130,523	35	731	8,797	1,939	30,768	106,274
M1	**Pedestrian**	109,876	17	206	1,980	3,600	27,549	83,758
M1	**Cyclist**	103,824	7	123	1,581	1,005	16,833	86,001
M1	**Other**	13,203	331	1,469	9,247	114	1,246	5,628
.....	.....	...	...	...	...	...	...	...
.....	.....	...	...	...	...	...	...	...

Safety measure effectiveness

For each safety measure …

Casualty target population x Effectiveness value = Predicted casualty population

- **‘Avoidance’** describes a situation where casualties would remain entirely uninjured after application of the effective safety measure
- **‘Mitigation’** describes a situation where casualties would sustain injuries of a lower severity level (e.g. fatal turned to serious casualty, or serious to slight casualty)
  - An effective passive safety measure prevents the most severe injuries, or
  - An active safety measure reduces the impact speed.
- Measures have been assigned **separate values for effectiveness of avoidance and mitigation at all injury severity levels**.
- It should be noted that **effectiveness values for avoidance and mitigation are additive in this model**. ‘Mitigated’ casualties are subsequently added to the target population of the next lower injury severity level for other measures.

Safety measure effectiveness (cont'd)

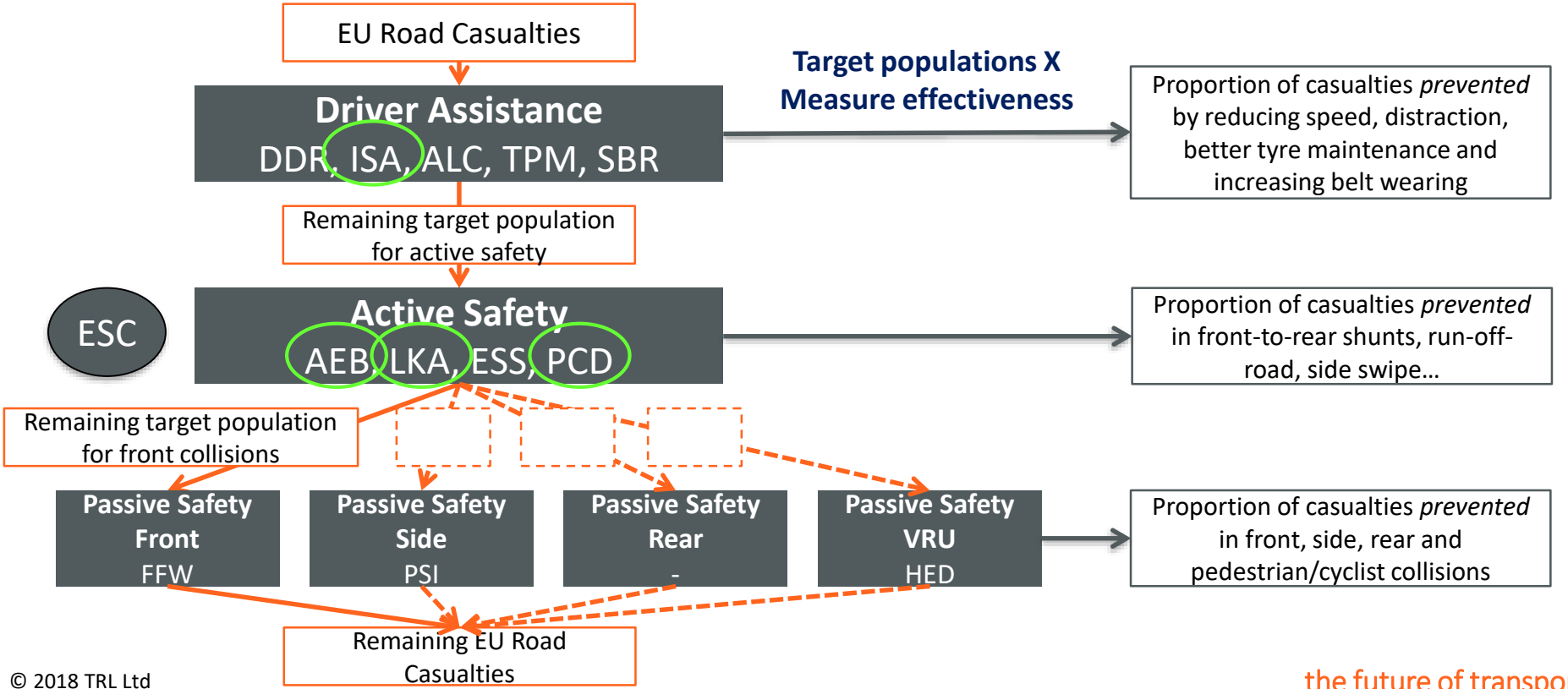
For each safety measure …

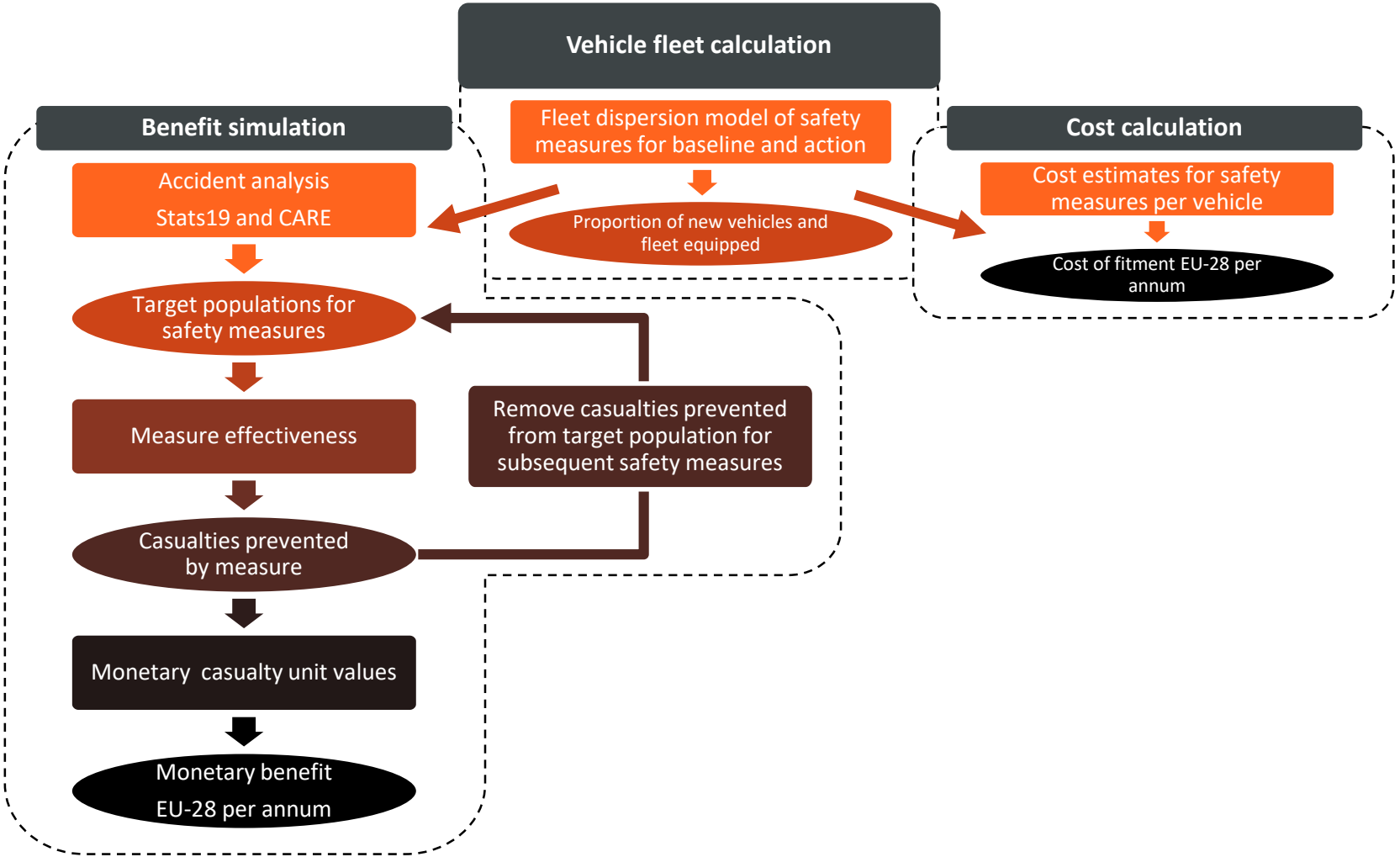
- The **effectiveness values were based on evidence** - extracted from research studies and stakeholder input
- Where no values could be identified and **no stakeholder input was provided**, a road safety expert panel **determined best estimates from the available evidence**
- For the interval and scenario analysis, **effectiveness values were assigned a confidence level** (high or low depending on the quality of the source) and the best estimates were varied as follows in order to determine the upper and lower estimates:
  - **Plus/minus 10% for high confidence estimates**

    (for example, a value of 40% would be varied ±4 percentage points, i.e. 36% to 44%)
  - **Plus/minus 20% for low confidence estimates**

Avoidance of double-counting of casualties prevented

Clustering Levels – Example for Cars




Vehicle fleet calculation
Benefit simulation
Fleet dispersion model of safety measures for baseline and action
Cost calculation
Accident analysis
Stats19 and CARE
Proportion of new vehicles and fleet equipped
Cost estimates for safety measures per vehicle
Cost of fitment EU-28 per annum
Target populations for safety measures
Measure effectiveness
Remove casualties prevented from target population for subsequent safety measures
Casualties prevented by measure
Monetary casualty unit values
Monetary benefit EU-28 per annum

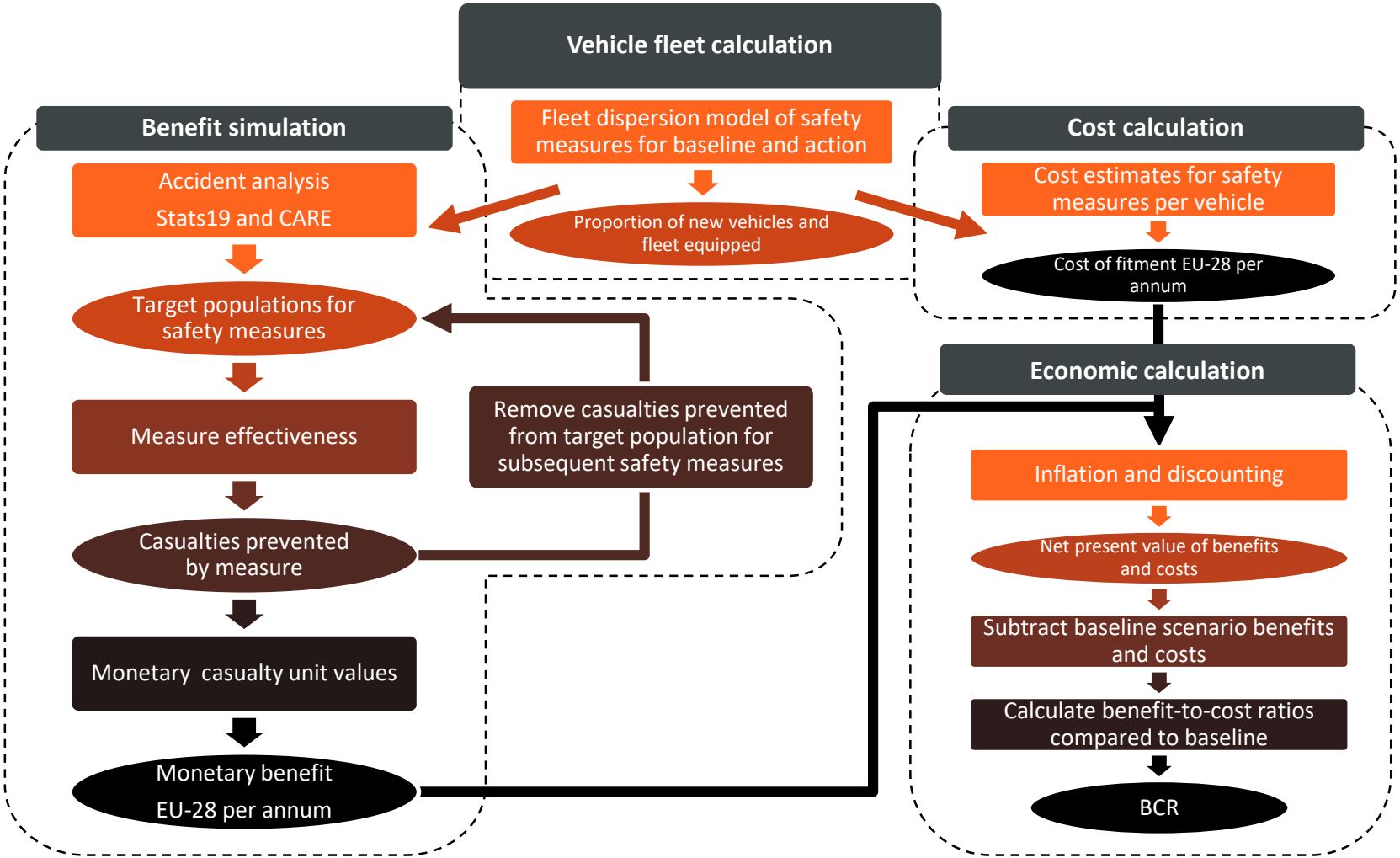
Monetisation of casualties prevented & safety measure costs

Benefit valuation:

Casualty severity	Social unit value
Fatality prevented	€1,870,000
Serious casualty prevented	€243,100
Slight casualty prevented	€18,700

Cost valuation:

Initial OEM cost per vehicle for full set of measures	
Cars (M1)	€516
Buses (M2&M3)	€970
Vans (N1)	€521
Trucks (N2&N3)	€1,013


Vehicle fleet calculation
Fleet dispersion model of safety measures for baseline and action
Proportion of new vehicles and fleet equipped
Benefit simulation
Accident analysis
Stats19 and CARE
Target populations for safety measures
Measure effectiveness
Casualties prevented by measure
Monetary casualty unit values
Monetary benefit EU-28 per annum
Remove casualties prevented from target population for subsequent safety measures
Cost calculation
Cost estimates for safety measures per vehicle
Cost of fitment EU-28 per annum
Economic calculation
Inflation and discounting
Net present value of benefits and costs
Subtract baseline scenario benefits and costs
Calculate benefit-to-cost ratios compared to baseline
BCR

Economic Calculation

Simulation and Calculation model included ….

- Discounting of costs and benefits
  - A ‘social discount rate’ is applied to reflect the fact that **benefits and costs further ahead in the future are valued lower than present benefits and costs**
- Inflation of monetary values
- Sensitivity analysis
- To quantify the range uncertainty around the best estimate BCR values, two sensitivity analysis techniques common in cost-benefit evaluations were applied (Bickel, et al., 2006a): **Interval analysis and Scenario analysis** - impact of additional safety measures on vehicle prices and sales numbers

Note: *Impact of additional safety measures on vehicle prices and sales numbers*

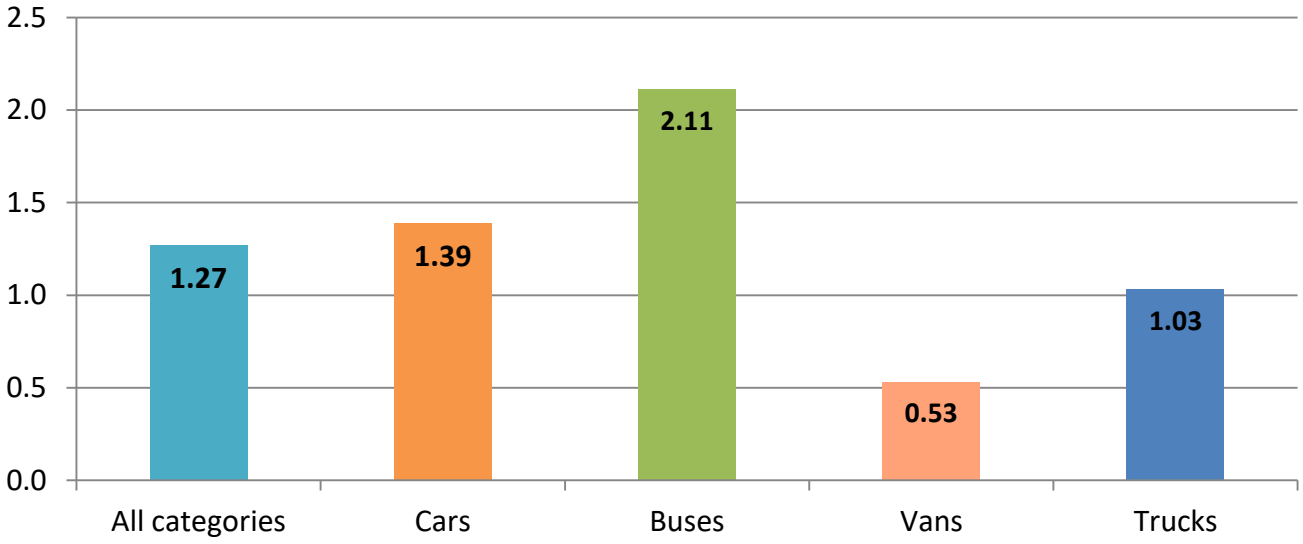
- ***Cars have become cheaper in real terms in every year of the last reported decade****, despite this being a period in which technical development to meet new and* ***more demanding environmental and safety standards increased***

Key results

Key Results

Cost-effectiveness

Benefit-to-cost ratios (BCR) of the Commission Proposal



Values greater than 1 indicate that the benefits are greater than the costs

Years: 2021–2037

EU-28

Compared to the baseline scenario

Key Results

Number of casualties prevented by safety measures split by vehicle categories over the evaluation period 2021–2037 across EU-28 compared to the baseline scenario

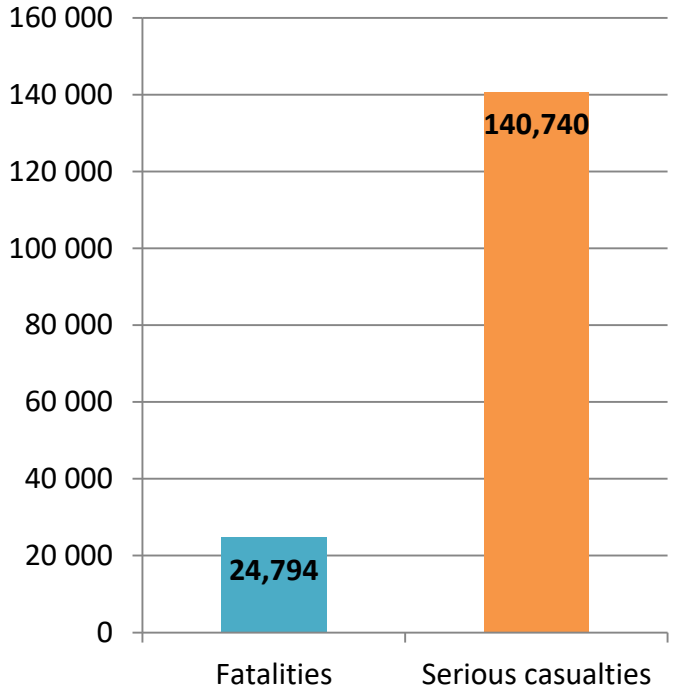
	Cars	Buses	Vans	Trucks
Fatalities prevented	21,337	227	1,283	1,947
Serious casualties prevented	126,390	2,410	6,917	5,023
Slight casualties prevented	470,747	8,174	23,486	13,274

Key Results

Casualties prevented

Total sum; years 2021–2037; EU-28; compared to the baseline scenario

	All categories
Fatalities prevented	24,794
Serious casualties prevented	140,740
Slight casualties prevented	515,681



Conclusions

Conclusions

The Commission proposal on General Vehicle Safety:

- An ambitious proposal to reduce the number of deaths and injuries on EU roads – Savings of almost **25,000 fatalities and 140,000 serious casualties** over a 16-year period
- Cost-effective – **Benefits to society exceed the costs** with a BCR of 1.27
- Substantial increase in consumer vehicle prices ***not*** expected in the medium and long term
- Technologically advanced – helping the **EU Industry to remain competitive** with regard to the **challenges of developing automated vehicles**, because it includes measures such as **Advanced Driver Distraction Recognition, Intelligent Speed Assistance** and **Vulnerable Road User Detection**.

Richard Cuerden, TRL Academy Director
Email: rcuerden@trl.co.uk
Twitter: @rcuerden_trl

Crowthorne House | Nine Mile Ride | Wokingham |Berkshire | RG40 3GA | UK

THE FUTURE OF TRANSPORT

Thank you