Guest Web-Lecture
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Road Safety Challenges in the Digital Era
Is Digitalisation Boosting Road Safety?

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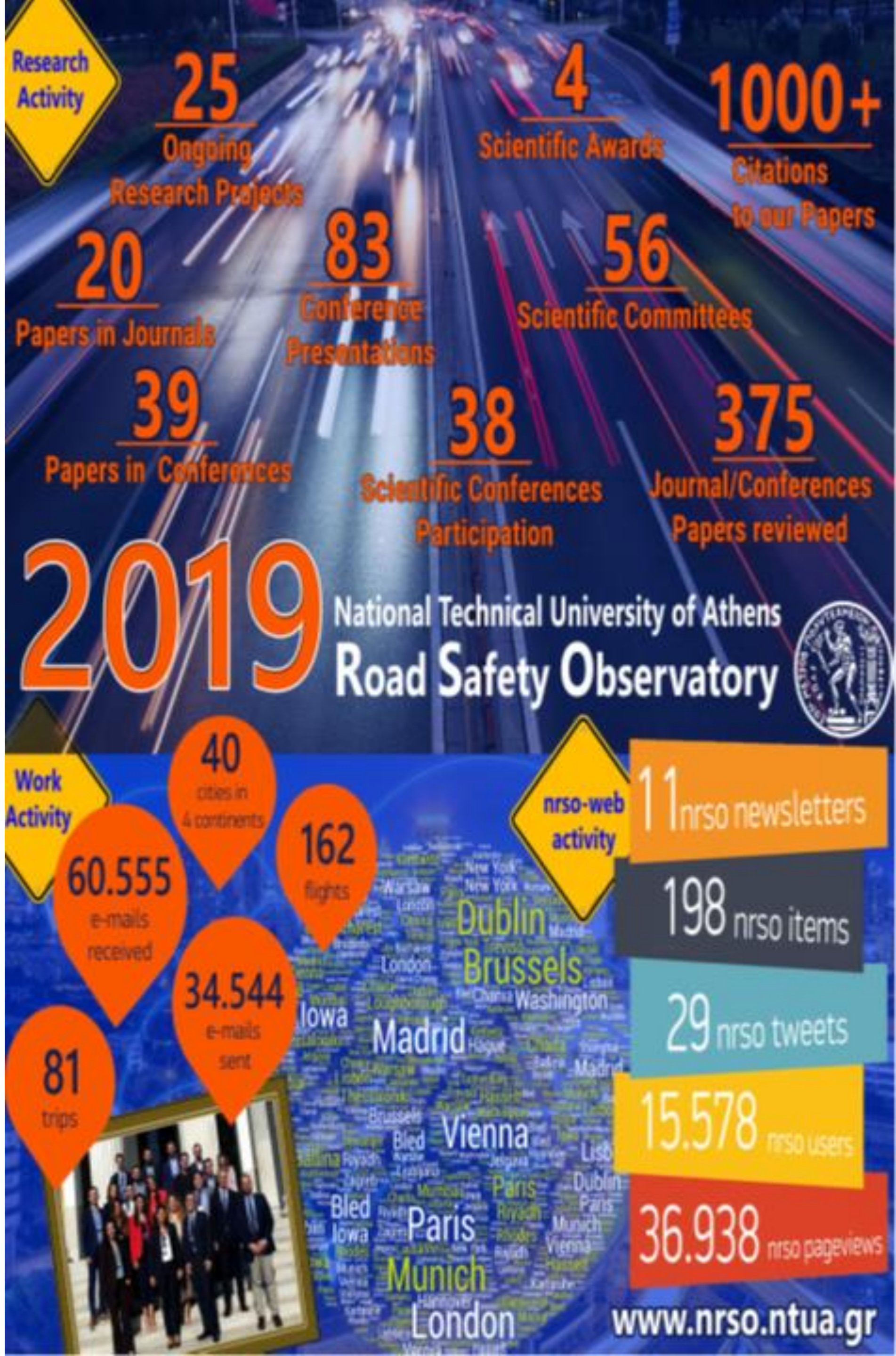
NTUA - Dpt of Transportation Planning & Engineering

NTUA Department of Transportation Planning & Engineering

- The mission of the NTUA DTPE is to educate scientists engineers and promote science in the field of transportation planning and engineering.
- The NTUA DTPE is a Research and Innovation Center of Excellence with global recognition [Ranked 9th in Europe, 39th worldwide (Shanghai Ranking's 2017), Scientific citations: 3rd in Europe, 19th worldwide (Pulse 2017), Road Safety: 2nd in Europe, 6th worldwide (AAP, 2018)].
- A Team of 60+ Scientists: 7 Internationally recognized Professors, 15 Senior Transportation Engineers and PostDoc, 25 PhD Candidates, 15 Transportation Engineers and other scientists.
- NTUA DTPE Activities in figures (since mid 80s):
  - More than 1.100 Diploma and 30 PhD Theses,
  - More than 330 road safety research projects, mostly through highly competitive procedures,
  - More than 1.100 scientific publications (> 400 in Journals), widely cited worldwide,
  - More than 150 scientific committees,
  - International collaborations: European Commission, UN/ECE, OECD/ITF, WHO, World Bank, EIB, CEDR, FEHRL, ERF, IRF, UITP, ETSC, WCTR, TRB, decades of Universities and Research Centers.

NTUA Road Safety Observatory

- An international reference road safety information system, with most updated data and knowledge, with:
  - more than 3.000 visits per month,
  - tens of items and social media posts/tweets annually



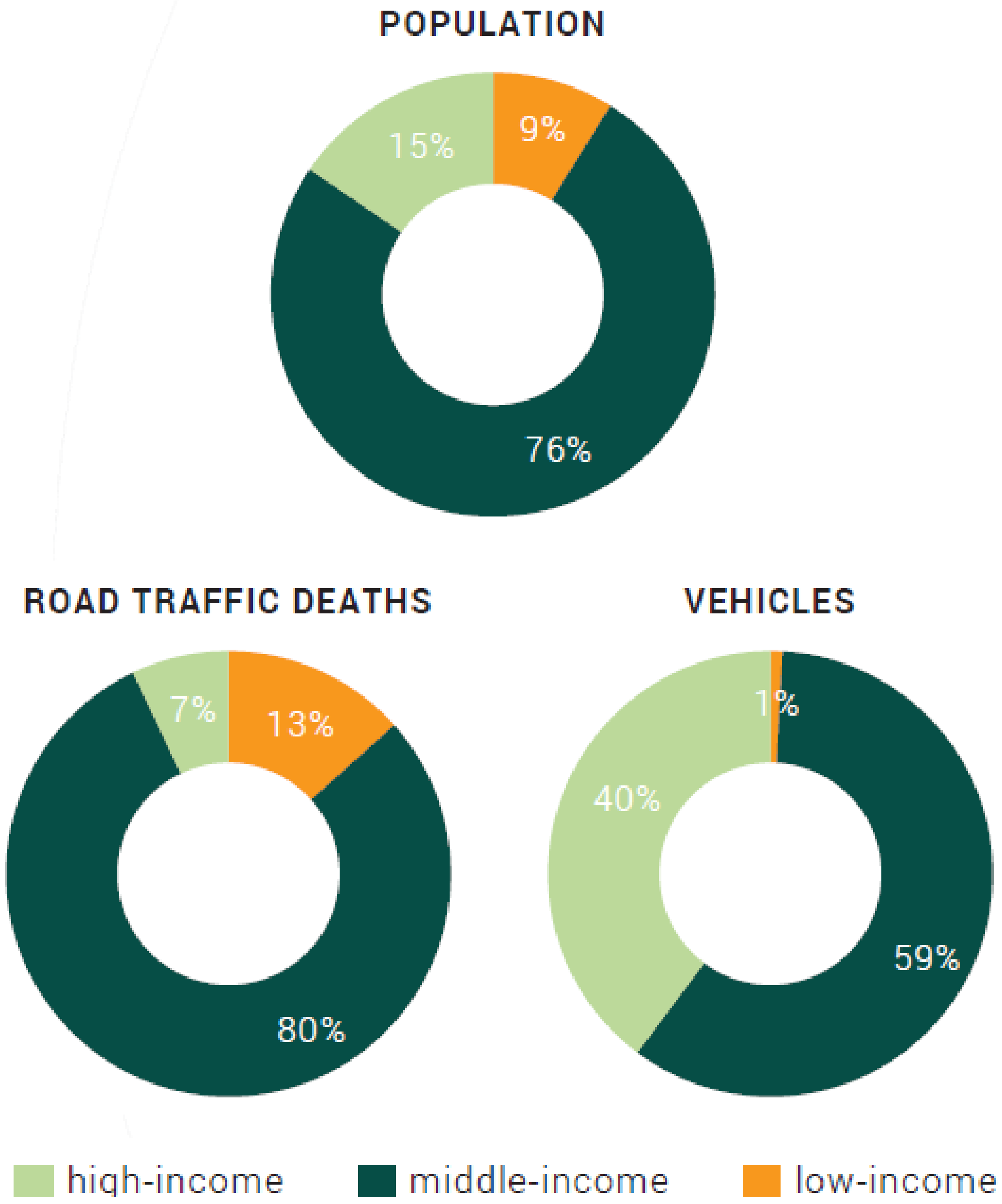
Road Safety in the World

Road Safety Worldwide

- 1.35 million road traffic deaths per year (World Health Organisation 2018).
- Road traffic injuries are:
  - the 8th leading cause of death worldwide
  - the 1st cause of death among children and young adults (5-29 years old).
- SDG 3.6 target to halve road deaths and injuries by 2020 will not be met without drastic action.
- Between 2013 and 2016 a 7% fatalities increase was observed.

Road Safety Progress

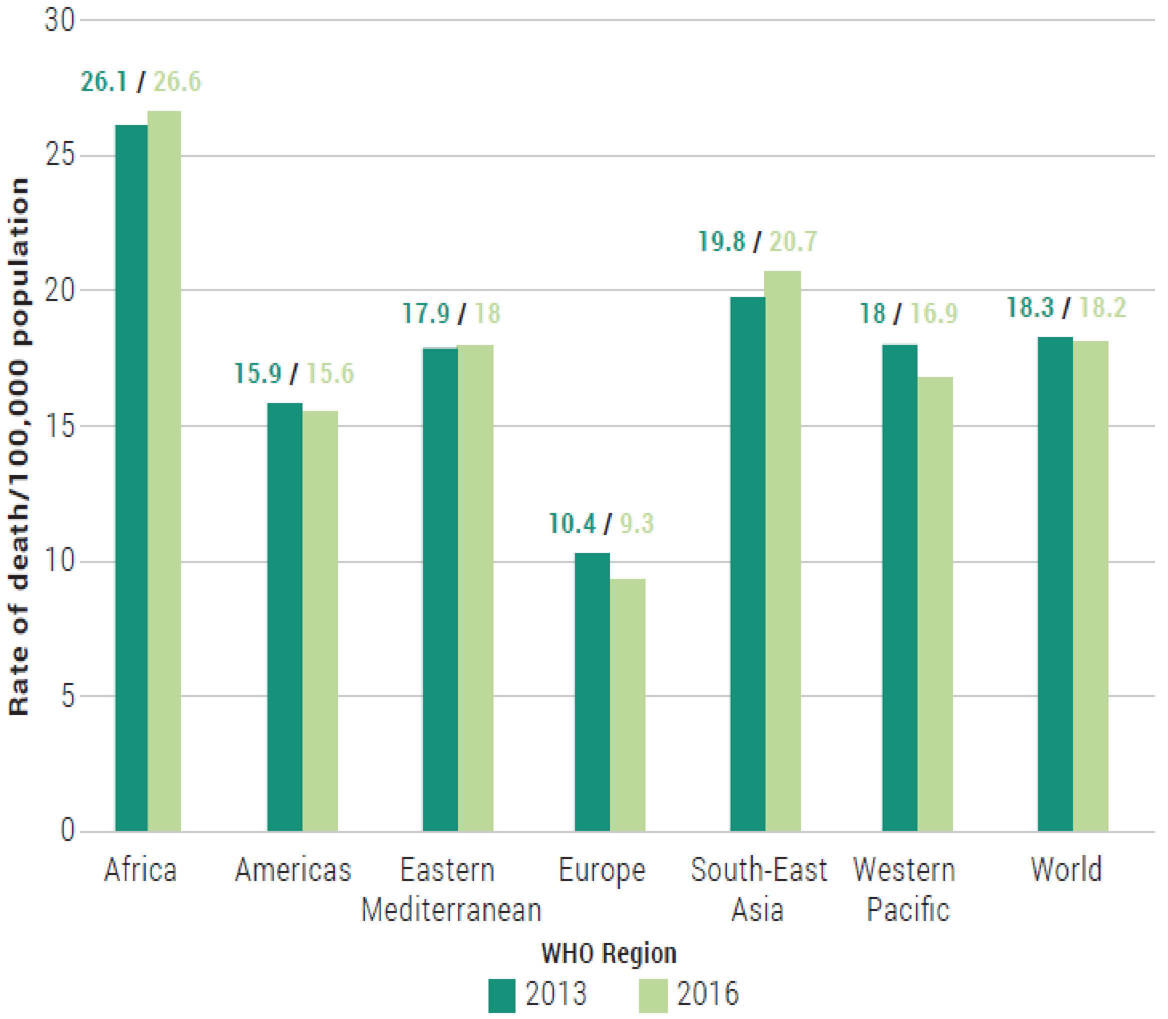
- Progress in road safety is **not uniform** across regions and income levels.
- Although only 1% of the world's motor vehicles are in **low income countries**, 13% of deaths occur in these countries.
- In **high income countries**, 40% of the world's vehicles are in traffic, but only 7% of all deaths correspond to these countries.
- The risk is **more than 3 times higher** in low-income countries than in high-income countries.
- **No reduction** in the number of road traffic deaths in any low-income country has been recorded since 2013.



Source: WHO, 2018

Road Safety in Regions

- The rates of road traffic deaths are highest in Africa (26.6/100,000 people) and South-East Asia (20.7/100,000 people).
- The rate of road traffic deaths per population generally decreases as income increases (after a certain level of motorization: ~220 vehicles per 1000 people)
- More than half of all road traffic deaths are among vulnerable road users: pedestrians & cyclists (26%) and motorcyclists (28%).



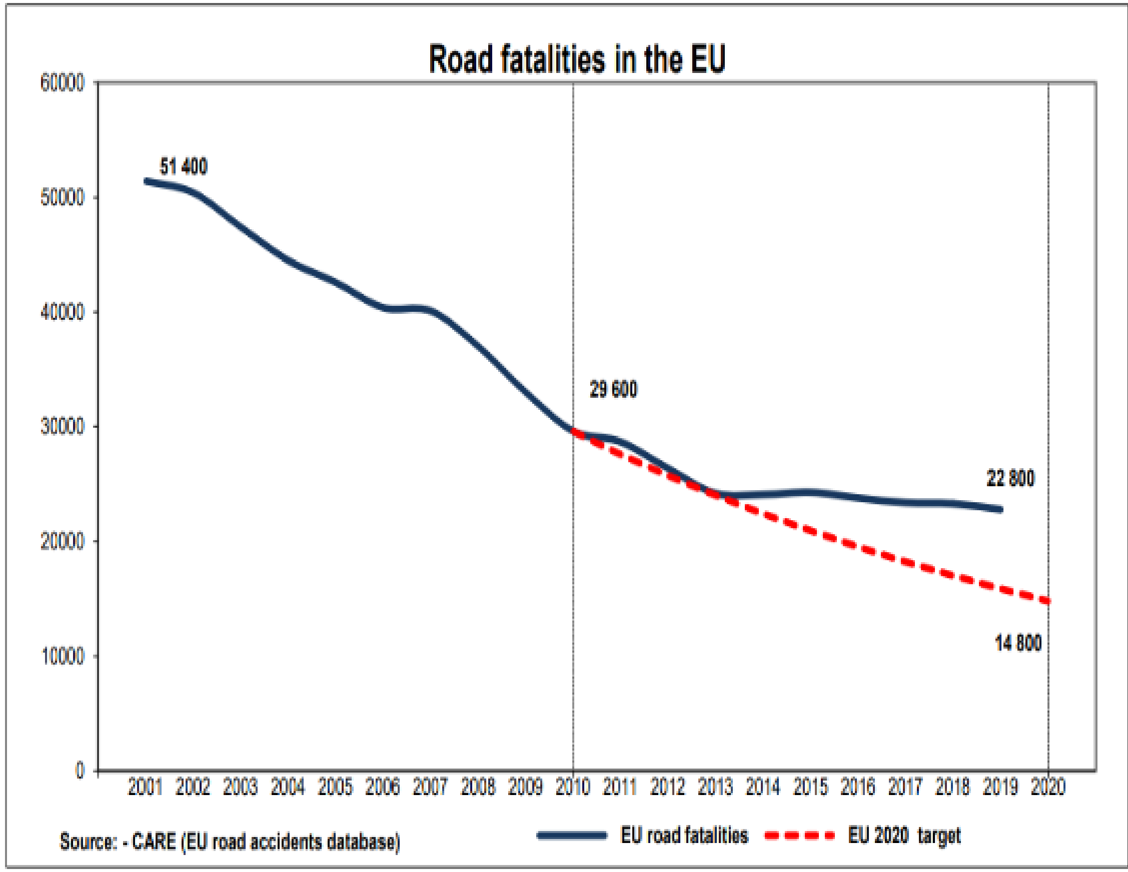
Source: WHO, 2018

UN Sustainable Development Goals

- In 2015, the United Nations General Assembly adopted a series of SDGs as part of the 2030 Agenda for Sustainable Development.
- Target 3.6: By 2020, **halve the number of global deaths and injuries** from road traffic accidents.
- Target 11.2: By 2030, provide access to **safe, affordable, accessible and sustainable transport systems for all**, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.
- In 2018, a set of **global road safety targets** has been established, together with the respective KPIs.

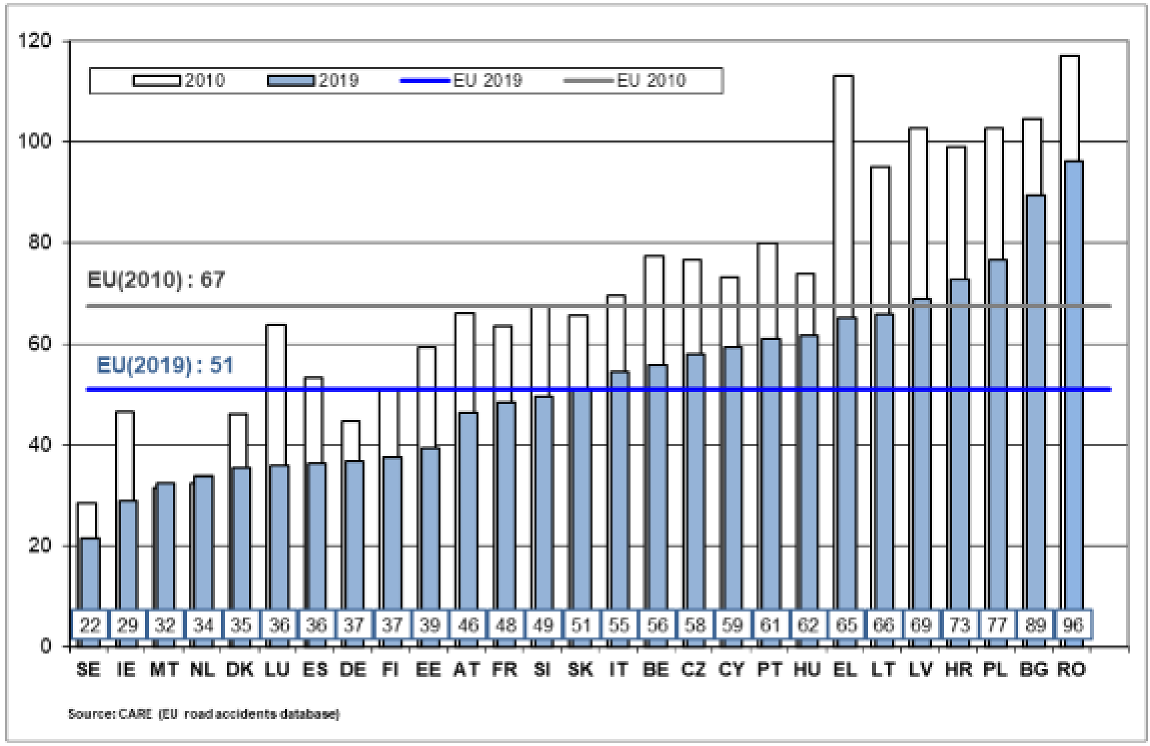
Road Fatality Trend in the European Union

- EU has made significant progress in road safety during the last two decades. However, the progress rate has lately slowed down.
- In 2019, almost 22,800 fatalities in road accidents were recorded in the EU, global leading performance with 51 fatalities per million population.
- The target of halving road accident fatalities between 2010 and 2020 is unlikely to be achieved.
- More coordinated efforts are required at all levels in order to achieve the targets set.



Fatality rates per population in the EU

- Great discrepancies in road safety performance exist among the 27 EU countries.
- In the EU, fatality rates per million population range from 22 in Sweden to 96 in Romania (51 EU average).
- Accident fatality rates show both a broad north-south divide and an east-west divide across Europe.



Current Road Safety Concepts

Evolution of Road Safety Policies

- The 4 E's of Road Safety
  - Education
  - Engineering
  - Enforcement
  - Emergency Response

- Qualitative objectives and specific priorities are set, covering the three main factors of road accidents: driver behavior, road infrastructure and vehicles.

- Long-term quantitative targets are set and the need of monitoring the road safety progress by establishing performance indicators and the preparation of a mid-term review are highlighted.

The Safe System Approach

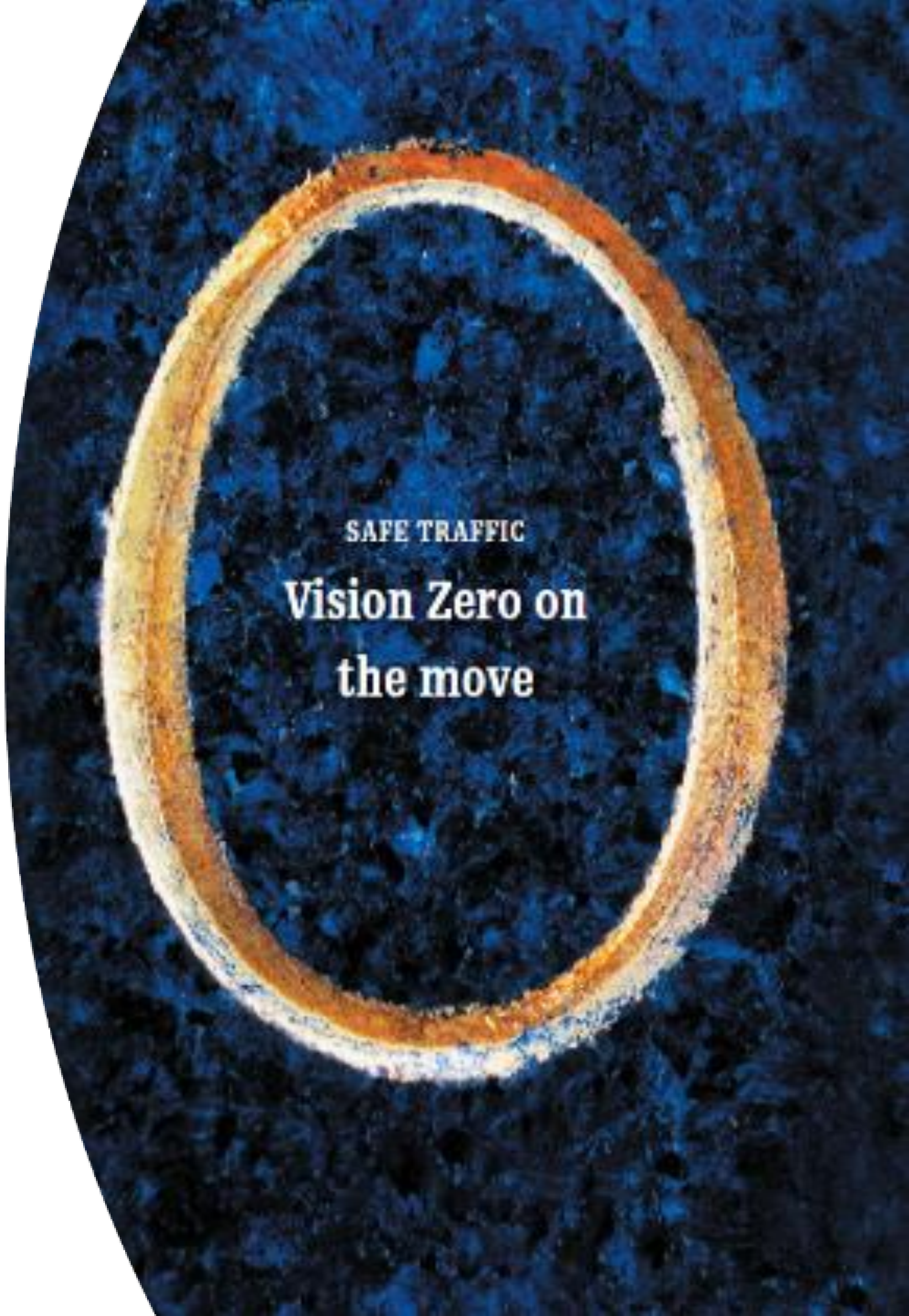
- Aims to develop a road transport system better able to accommodate human error through better management of crash energy.

- Incorporates strategies for better management of crash forces (e.g. road network improvements, speed limits).

- Safety management decision making is aligned with a broader societal decision making to meet economic goals and human and environmental health goals, and to create a safe transport environment.

The Vision Zero Concept (1/2)

- A traffic safety policy developed in Sweden (1997), expressing an ethical imperative to eliminate death and serious injury from the transport system.
- Responsibility for crashes and injuries is shared between the providers of the system and the road users.
- The road user remains responsible for following basic rules.
- The system designers and enforcers are responsible for the functioning of the system.
- When road users make errors or fail to follow the rules, the responsibility reverts to the system designers to ensure that these failings do not result in death or serious injuries.



The Vision Zero Concept (2/2)

- **Human beings make errors** and there is a critical limit beyond which survival and recovery from an injury are not possible.

- The road transport system should be able to **take account of human failings** and absorb errors in a way to avoid deaths and serious injuries. Crashes and minor injuries need to be accepted.

- The **components of the road transport system** (incl. road infrastructure, vehicles and restraint systems) must be designed so that they are **linked to each other**. The amount of energy in the system must be kept below critical limits by ensuring that speed is restricted.

EU Strategic Action Plan for Road Safety (2020-2030)

- On May 2018, the EC adopted its EU Strategic Action Plan for Road Safety with an outline of actions planned for the 2021-2030 period.
- The EU Strategic Action Plan was published as part of the 3rd mobility package, including also a revision of the directive on road infrastructure safety management and a strategy for connected and automated mobility.
- Actions within eight pillars are to be set out into a specific target time frame:
  - Enhanced road safety governance
  - Stronger financial support for road safety
  - Safe roads and roadsides
  - Safe vehicles
  - Safe road use
  - Fast and effective emergency response
  - Future-proofing road safety
  - The EU's global role: exporting road safety

Next Steps at EU level

- A new policy framework has been established in the EU for the next decade focusing on:
  - closer cooperation between all road safety actors,
  - better monitoring,
  - targeted funding.
- The transparency of procedures concerning infrastructure safety management has to be ensured and members should work towards an equal level of infrastructure safety.
- The latest technological developments on vehicle safety should be used to avoid accidents and protect pedestrians and cyclists.
- A safe transition to connected and autonomous mobility should be guaranteed, which offer potential in reducing driver errors, but also create new challenges.

Data Driven Safety Policies

Why road safety data?

- Road Safety is a typical field with high risk of **important investments not bringing results**.
- Absence of **monitoring** and accountability limits seriously road safety performance.
- Decision making in road safety management is highly dependent on appropriate and **quality data**.
- Very often we look where the data are and **not where the problems and solutions are**.

Critical Data Properties

- Crash data are meaningful only if they are combined with exposure data (crash per km driven, per traffic characteristics, per time, etc.).

- Crash causalities are revealed when crashes are correlated with safety performance indicators (behaviour, infrastructure, traffic, vehicles).

- The evaluation of safety measures effectiveness provides valuable information, necessary for matching problems with solutions.

- Analysis of high resolution data reveals hidden and critical crash properties.

EU Key Performance Indicators

Indicative list of KPIs aimed to be collected and monitored at EU level within the next decade:

- Speeding
- Driving under the influence of alcohol and/or drugs
- Seat-belt and child restraint systems use
- Helmet use
- Driver distraction
- Vehicle fleet performance
- Road infrastructure performance
- Post-crash care system performance

Road Safety Observatories

- ERSO, European Road Safety Observatory
- OISEVI, Ibero-American Observatory
- African Road Safety Observatory
- IRTAD, ITF Road Traffic and Accident Group
- Dacota, EC Project – Knowledge Centre
- NRSO – NTUA Road Safety Observatory

Road Safety Decision Support Systems

- [SafeFITS, UNECE-Global Road Safety Model]()
- [SafetyCube, EU Road Safety DSS]()
- [iRAP, Road Safety ToolKit]()
- [PRACT, CEDR]()
- [PIARC, WRA Road Safety Manual]()
- [US NHTSA/FHWA CMF Clearinghouse]()
- [AustRoads Road Safety Engineering Toolkit]()

Road Safety in the Digital Era

Big Data for Road Safety (1/2)

- **Smartphones Data**
  - Sensor Based Data (e.g. Google Maps, Here, Waze, etc.)
  - Cellular Network Data
- **Vehicle On-Board Diagnostics Data**
  (e.g. BMW, Mercedes-Benz, Volvo, etc.)
- **Data from Cameras**
  - Inside and outside on the vehicle
  - On the road (cities, operators)
- **Data from Car Sharing Services**
  (e.g. Uber, Lyft, BlaBlaCar, etc.)
- **Data from Bike Sharing Services**
  (e.g. 8D Technologies, Mobike. Etc.)
- **Social Media Data**
  (e.g. Facebook, Instagram, Twitter, etc.)

Big Data for Road Safety (2/2)

- **Government Agencies' Sensor Data**
  (e.g. Public Transport and Local Authorities, Road Operators, etc.)

- **Private Agencies' Sensor Data**
  (e.g. INRIX, Waycare, etc.)

- **Travel Cards Data**
  (e.g. Oyster card, Opal card, etc.)

- **Weather Data**
  (e.g. AccuWeather, ClimaCell, etc.)

- **Census Data**
  (e.g. National and local surveys and statistics, etc.)

Telematics

- A range of telematics solutions already exist for:
  - fleet management,
  - usage-based insurance,
  - eco-driving and
  - safe driving coaching.
- Smartphones are becoming increasingly popular in those applications.
- Limiting barriers are gradually being eliminated:
  - Mobile phone technology
  - Cost of:
    - In-vehicle data recording systems (e.g. OBD)
    - Data plans
    - Cloud computing
  - Penetration rate of smartphones and social networks
- Current technological advances make it substantially easier for experts to collect and exploit data easier and more accurately through mobile phones.

Driver Performance Telematics Feedback

- Feedback to the driver through the Driver Performance Telematics (vehicle or smartphone)

- Real time feedback
  + avoid distraction
  - produce distraction

- Safety performance star rating
  + engage in the long term
  + great motivation to improve driving behaviour
  + identification of need for re-training
  - demotivation in case of non progress
  - demotivation when non favorable comparison with peers

- The feedback loop should be optimized.

VRU Data Crowdsourcing

- Cyclists and Pedestrians report:
  - safety problems (roads, behavior)
  - exposure (routes, traffic, etc.)
  - crash data (with injuries, material damage only)
  - infrastructure star rating
- Neither uniform nor systematic reporting practices though
- Feedback on network safety performance
  - useful for the cyclists
  - useful for the decision makers (all levels)
  - useful for services and businesses

Infrastructure Data

- **Automatic data collection** along the road network through:
  - instrumented floating vehicles
  - smartphones reporting information (hard braking, poor road surfaces, speed).
- **Active safety systems**
  - ABS for anti-lock braking,
  - ESP for electronic stability control and
  - AEB for autonomous emergency braking.
- **Street imagery** can support the assessment of road safety performance (star-rating for roads).
- **Drones and satellites** could complement the range of data.
- **Cooperative ITS (C-ITS)** technology could enable vehicles not only to broadcast their position, but also to report on the system performance in real time.

Critical / Open Issues (1/2)

- Punishment Vs Positive Feedback (Incentives)
- Regulatory and Voluntary Data
- Secure anonymisation might increase penetration (e.g. blockchain)
- Ownership of data
- Exploitation of data (charging schemes)
- Sharing of safety data (EU legislation)

Critical / Open Issues (2/2)

- **Harmonisation and compatibility** of:
  - data
  - metrics
  - data collection methodologies
  - data processing methodologies

- Define proper and properly the **KPIs**
- **Clean** properly the data
- **Linking** KPIs with respective interventions

- Define **safety policy focus** (behavior, VRUs, infrastructure, traffic)

- Control **in-vehicle distraction** devices

Road Safety and Automation

What is it all about?

- In the past decade, autonomous vehicles (AVs), connected vehicles (CVs) and relative technology have been in the spotlight.
- Intensely researched by both academia and industry.
- Interest spurred by computational advances, both in processing power (CPUs) and methodology (Neural Networks).
- Competition and breakthroughs from the involvement of non-traditional automotive industry players (Tesla, Google, etc.).

Traffic Safety Key Questions

- Will there be an impressive reduction in accidents when full automation is reached?
- Could vehicles be freely repurposed when there is no need for human hands-on driving?
- What do we have to change from the current state to reach safe automation?
- Where does the fault or liability lie in the event of an accident?
- What will happen during the transition phase - human drivers sharing the road with autonomous vehicles?

Advanced Driver Assistance Systems

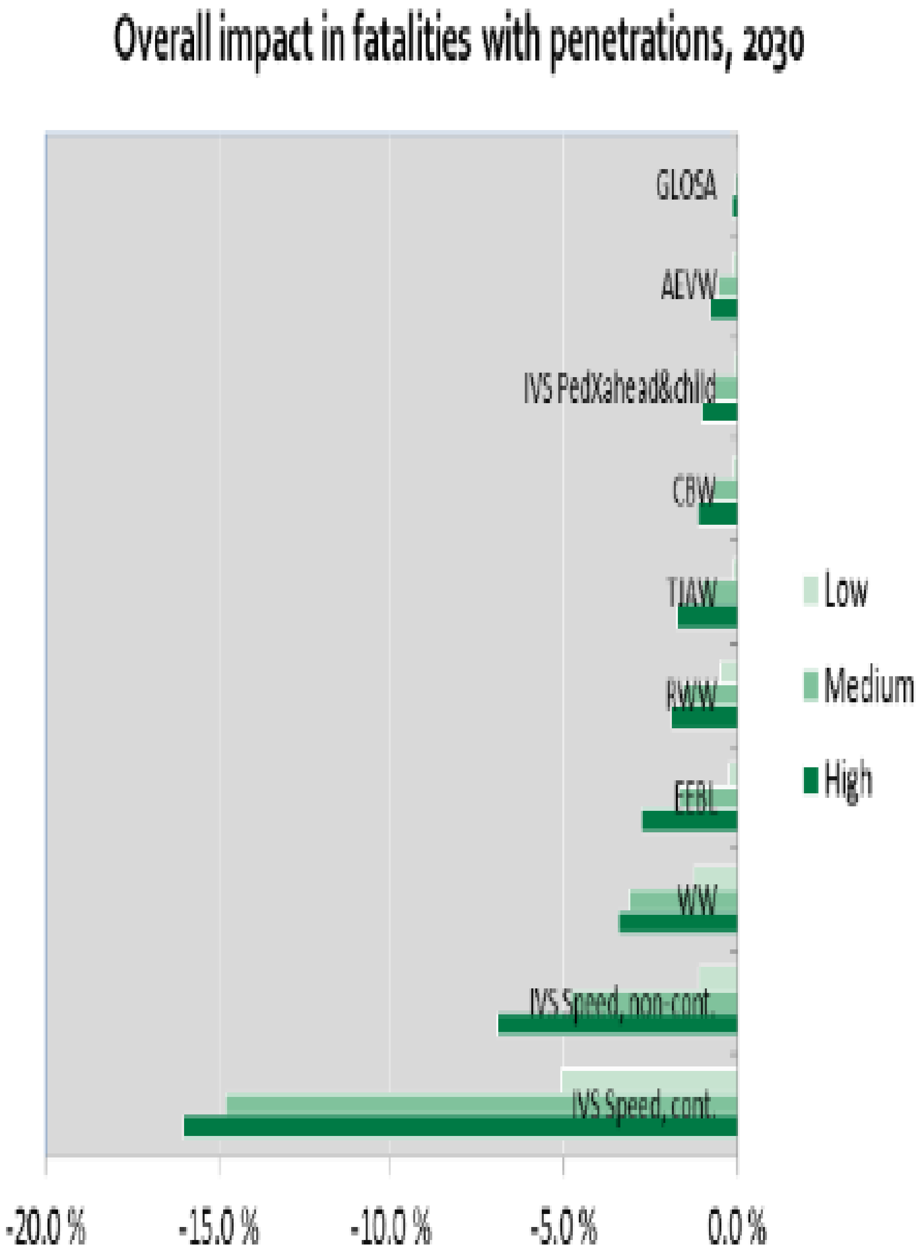
- Several ADAS already in use:
  - Cruise control
  - Electronic stability control
  - Lane keeping/departure warning systems
  - Adaptive Cruise Control, Intelligent Speed Adaptation, Autonomous Emergency Braking & Collision Warning systems

- Two approaches:
  - 'Sensor-based' technology: Focus on devices to observe the road environment
  - 'Connectivity-based' technology: Communicate in real-time with road environment
  - Convergence is desirable for optimal road safety

Category / Domain	System / Mechanism
Perception - Information	Surround view
	Parking assist
Collision avoidance	Collision warning – avoidance
	Cross traffic warning
	Autonomous emergency braking
	Pedestrian detection
Navigation control	Intelligent speed adaptation
	Lane departure warning
	Adaptive cruise control
	Traffic sign recognition
Safety augmentation	Seatbelt reminders
	Electronic stability control
	Alcohol interlock systems
Post-crash aid	E-call
	In-vehicle event data recorders

Connected Vehicles and Road Safety

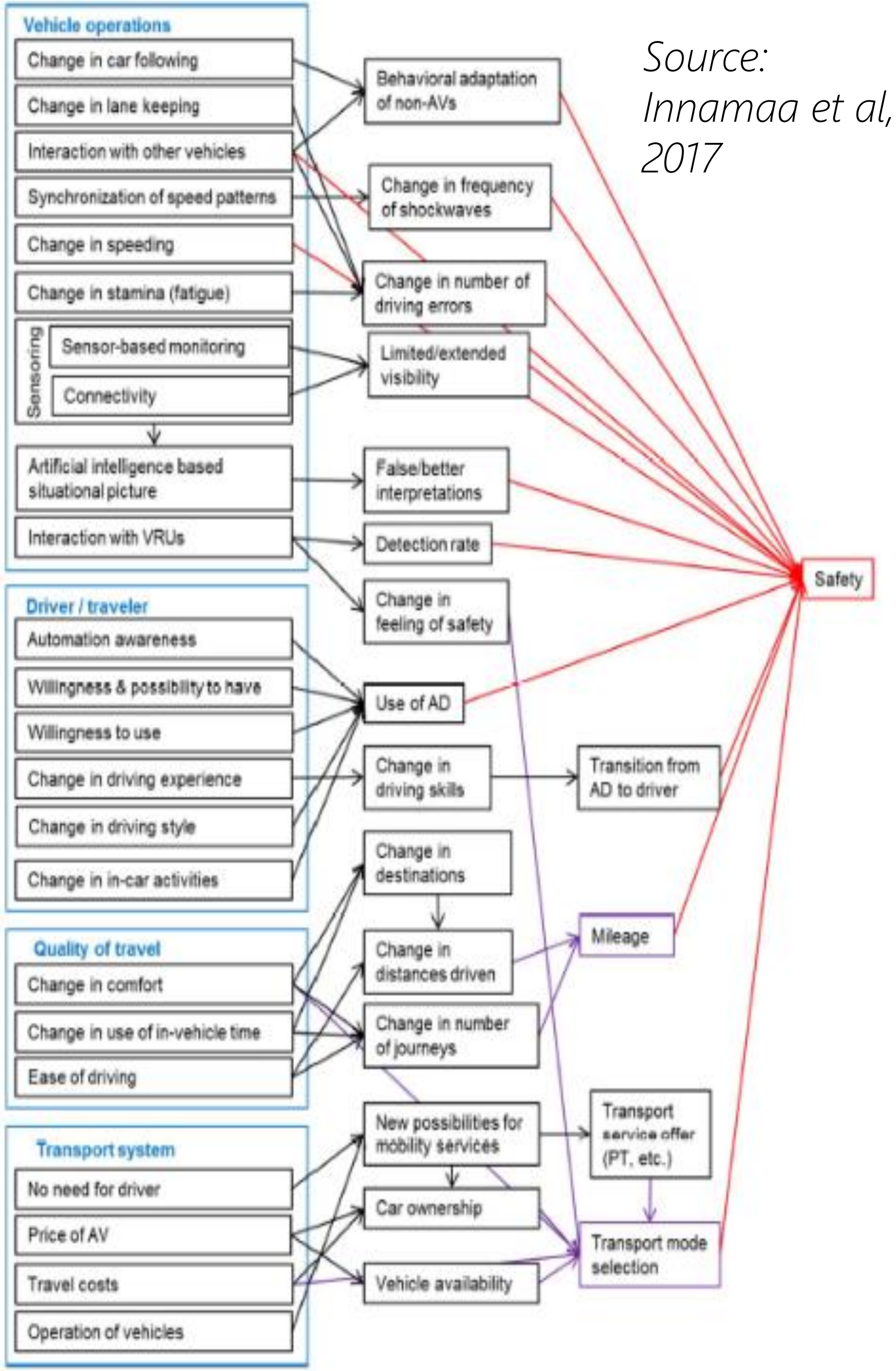
- **Crash avoidance technologies** have considerable potential for preventing crashes of all severities.
- **Lane keeping/departure** warning systems show similar but smaller effects.
- Cooperative Intelligent Transport Systems have been assessed from Field Tests in **EU, USA, Australia and Japan.**
- **Autonomous Emergency Braking** systems were effective in preventing 38%-44% of rear-end collisions.
- **Intelligent Speed Adaptation** reductions in fatalities estimated between 19-28%.
- All effects highly dependent on **penetration rate and exposure parameters** (e.g. see right).



Source: Malone, 2014

AV Impacts on Road Safety (1/2)

- Too **complex impacts** to describe casually!
- For **AV penetration rates** of 10%, 50% and 90%, Fagnant and Kockelman (2015) project 1.100, 9.600 and 21.700 lives saved/year (for USA).
- **Behavioural adaptations** for human drivers as well from AV interaction
- Personal driving styles will be suppressed (perhaps '**manufacturer styles**'?)
- Best case scenario:
  a virtuous circle of increased safety-trust-safety
  - Currently many unknown parameters



Source: Innamaa et al, 2017

AV Impacts on Road Safety (2/2)

- **Behavioural adaptation more imminent with CVs**
  - Positive effects (e.g. increased speed reductions and sign compliance rates in Japan with C-ITS)
  - Must tackle rebound effects (driver overreliance on a system and not paying attention)

- Need to anticipate **unconventional road user behaviour.**
  (e.g. Wheelchair users, School zones, Skateboarders)

- Implementation issues:
  - Temporal and spatial headways will be **minimized**
  - **Gradual increased exposure** from increased demand.
  - **New non-driver AV users** (children, elderly, etc.)
  - **Infrastructure adaptation** probable

CATS open issues

Connected and Automated Transport Systems face a series of open issues, among others:

- Legislation issues
- Economic impacts
- Transition phases
- Mobility as a Service transformations
- Ethical Issues
- Cybersecurity issues

Concluding Remarks

Overall Key Remarks

- Speed is highly misunderstood by all.
- Vulnerable road users are not accommodated.
- Logically inconsistent statement of safe system approach everywhere.
- Unrealistic expectations of technology (especially of automated vehicles).
- Too much data, too little usage.

Road Safety Policy Perspectives

- Focus on the **key road accident risk factors**:
  - Speed, Speed and Speed
  - Drink and Drive
  - Distracted Driving
  - Not use of seat belt and helmet

- Adapt **urban mobility management** to accommodate and balance current and future mobility and safety needs of the vulnerable road users (pedestrians, cyclists, motorcyclists): Reduce Speed everywhere.

- Develop strong **road safety culture** of the Authorities and the Stakeholders (safe system approach) and the whole population.

Road Safety Technology Perspectives (1/2)

- Technology can be the new road safety driver, through:
  - Public private partnerships
  - Clear problem analyses (well defined objectives)
  - Systematic effectiveness monitoring

- Great need for:
  - more data and knowledge
  - better exploitation of current and future data
  - broader geographical coverage

- Data focus on:
  - more accurate road accident data (LMIC Counties)
  - exposure data and performance indicators
  - measures and policies effectiveness evaluation

Road Safety Technology Perspectives (2/2)

- Digitalization opens great new data possibilities for:
  - road user support and guidance
  - evidence based public and private road safety decision making at all levels

- New great potential for seamless data driven procedures from safety problems identification to selection and implementation of optimal solutions.

- New increased net present value of road safety data, available for (real-time) early problem detection and prompt and customized decision support.

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