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SMART CITIES &
MOBILITY AS A SERVICE

REVIEW OF ADVANCED DRIVER ASSISTANCE SYSTEMS

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Background

- **Vehicle safety** is a key strategy to address ambitious long-term and interim goals and targets.
- New in-vehicle technologies under development have the potential to **decrease crash injury risk**.
- More **promising safety technologies** that address large road safety problems and where benefits have been demonstrated are being promoted in only a few countries or are being taken up at a lesser rate across EU countries.

Objective

The objective of the present research is to **record and categorize advanced driver assistance systems** as well as to discuss a variety of measures mainly in the European Union and worldwide that are being promoted widely as ADAS, e-Safety or active safety measures.

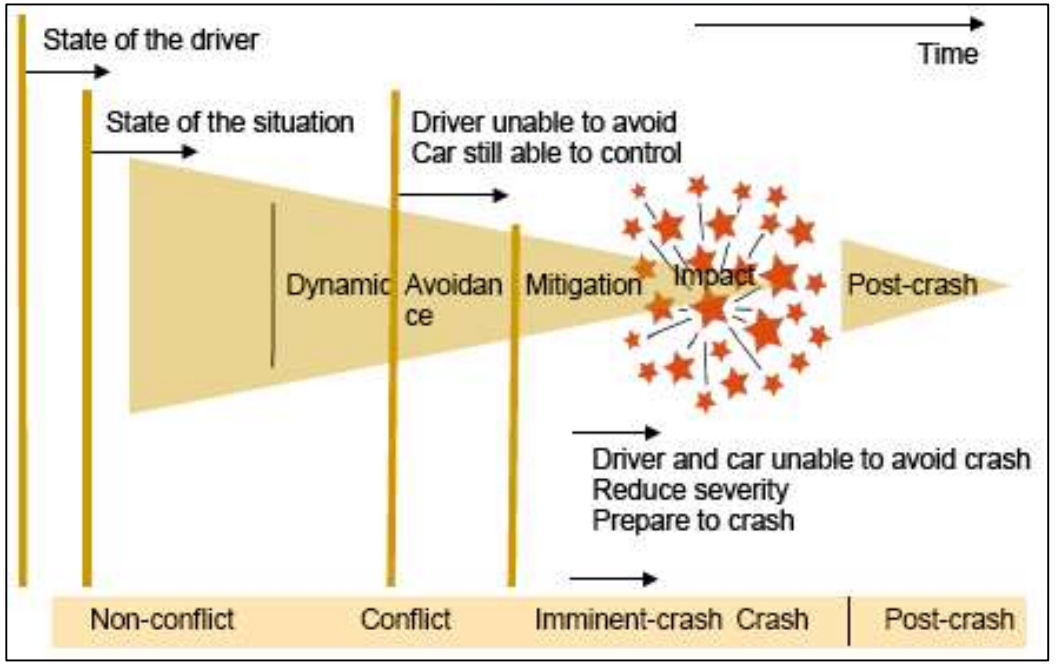
The analyses are based on Traffic Safety Synthesis on Advanced driver assistance systems (European Commission 2016, DaCoTA 2012, SafetyNet 2008) (www.erso.eu)

Vehicle Safety

- Vehicle safety comprises measures:
  - targeting at **crash avoidance** and injury prevention (primary safety)
  - targeting at the **reduction of injury** in the event of a crash (secondary safety)
  - **assisting post-impact care**, i.e. reducing the consequences of injury.

Vehicle Technologies

- **Crash avoidance systems**, aiming to casualty reduction
- **Crash mitigation systems**, active in-vehicle systems aiming to mitigate the severity of the crash
- **Crash protection systems** , aiming to reduce injury severity during the impact phase
- **Post crash response systems**, aiming to alert and advance emergency medical system support in the event of crash
- **Integrated systems**



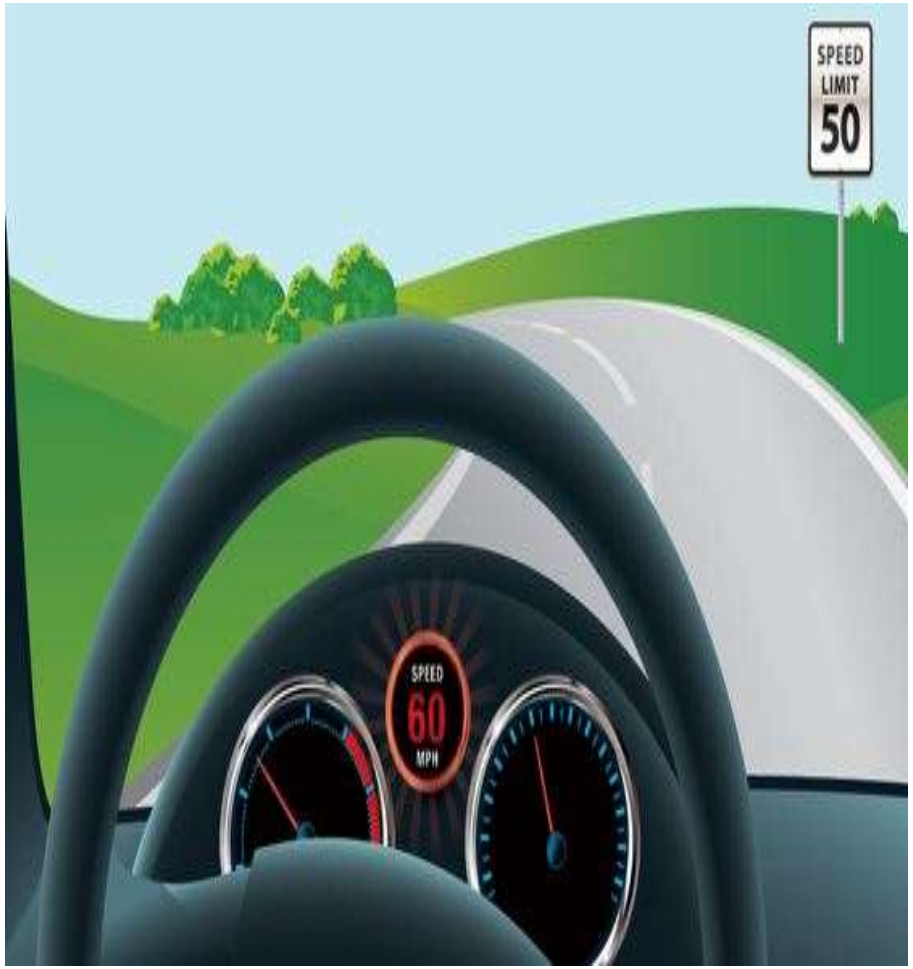
The Holistic View of Safety (Source: Swedish Transport Administration 2010)

Advanced Driver Assistance Systems (ADAS)

- ADAS are defined as **vehicle-based intelligent safety systems** which could improve road safety in terms of crash avoidance, crash severity mitigation, crash protection and post-crash phases.
- ADAS can be defined as **integrated in-vehicle or infrastructure based systems** which contribute to more than one of these crash-phases.
- Based on current knowledge about safety impacts and feasibility:
  - Safety related ADAS - safety effects known
  - Safety related ADAS - safety effects unknown

Intelligent Speed Adaptation (ISA)

- ISA **informs, warns and discourages the driver to exceed the statutory local speed limit** or other desired speed thresholds.
- **Reductions in fatalities** between 19-28%, were predicted in a market-driven scenario for voluntary systems and 26-50% for a regulated scenario (PROSPER).
- **15% reduction in hospital admissions** and 21% in fatalities in the Netherlands (Loon, van & Duynstee, 2001).
- **Benefit to costs ratios** ranged between 2,0-3,5 for the market driven scenario and 3,5-4,8 for the regulation driven scenario (Carsten & Tate, 2006).

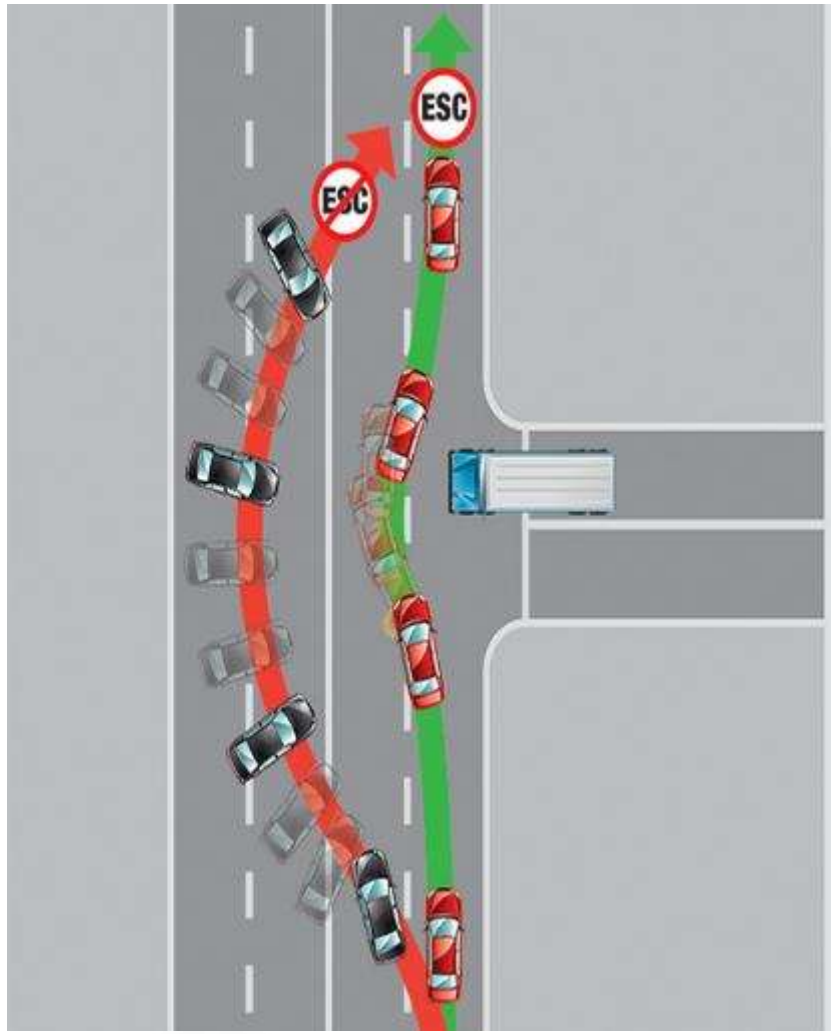


Seat-belt Reminders

- Intelligent, visual and audible devices that **detect whether seat belts are in use** and give out increasingly urgent warning signals.
- An observation study in several EU countries showed that the total **seat belt wearing rate was 97,5%** in cars with seat belt reminders, and 86% in cars without (Lie at al., 2008).
- US studies found a **7% increase in seat belt use** among drivers of cars with seat belt reminders (Williams, 2002).
- It is estimated in Sweden that reminders in all cars could contribute to a further **reduction of 20% of car occupant deaths**.
- The **benefit to cost ratio** of seat belt reminders was estimated at 6:1 after 12 years of mandatory introduction (ETSC, 2004).

Electronic Stability Control (ESC)

- ESC aims to **stabilize the vehicle and prevent skidding** under all driving conditions and situations, within physical limits, especially on wet or icy roads or in rollovers.
- A Swedish study showed that cars with ESC were **22% less likely to be involved in crashes** than those without (Tingvall, 2003).
- In Japan, ESC was found to **reduce crash involvement by 30-35%** (Aga & Okada, 2003).
- A German study indicated a **reduction in 'loss-of-control' crashes** from 21% to 12% (Breuer, 2002).
- A British research showed a **decrease of serious crashes** involving skidding (33%) and rollover (59%) (Frampton 2007).
- A US study indicated a 5% overall reduction in all impacts and a **23% reduction in passenger car fatalities** (Sivinski, 2011).
- A **Norwegian benefit to cost analysis** considered two scenarios for ESC fitment (Elvik, 2007).
  - The benefit-cost ratio was estimated to be 4 in the scenario of gradual fitment in the vehicle fleet.
  - The second scenario was ESC retrofitted on all cars of whatever age producing a benefit-cost ratio of about 0,4.



Alcohol Interlock Systems

- Alcohol interlock systems **prevent driving with excess alcohol** by requiring the driver to blow into an in-car breathalyser before starting the ignition.
- They are **40 to 95% more effective** in preventing drink-driving recidivism than traditional measures (ICADTS, 2001; SUPREME, 2007).
- A literature review (UK Department for Transport, 2004) showed a **recidivism reduction of about 28-65%** in the period where the alcohol interlock is installed.
- Swedish companies report that fitting alcohol interlocks prevented excess alcohol amongst **commercial drivers**.
- The results of **cost benefit analyses** for implementing alcohol interlocks for drivers caught twice with a BAC between 0,5g/l and 1,3g/l and for drivers caught with a BAC above 1,3g/l vary between 0,7 and 4,5 in several European countries (Vlakveld et al., IMMORTAL, 2005).

In-vehicle event data recorders

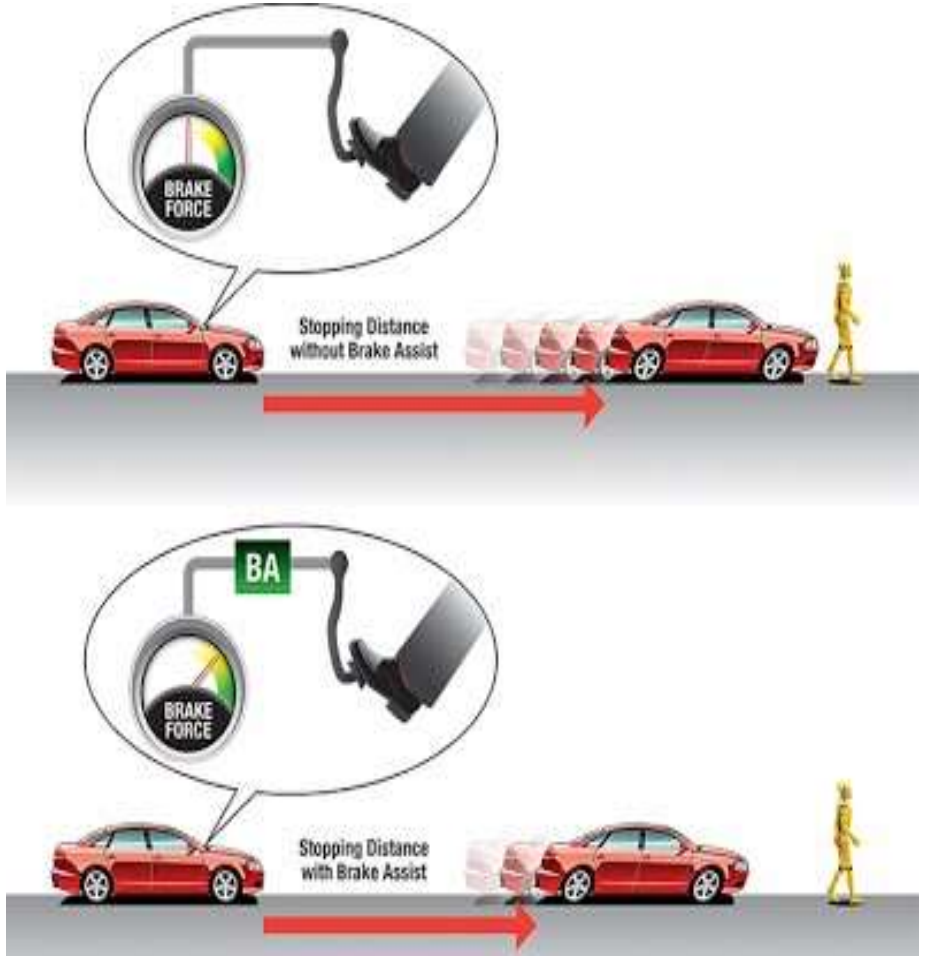
- A **valuable research tool** to monitor or validate new safety technology, to establish human tolerance limits and to record impact speeds
- **Two types** are currently used: crash data recorders and journey data recorders.
- Crash data recorders fitted to trucks and vans lead to an average **reduction of 20% in crashes** and damage (Wouters & Bos, 2000).
- A study for the Netherlands estimated the **benefits and cost ratios** of journey data recorders as 20:1 (Langeveld & Schoon, 2004).

Anti-lock braking systems (ABS)

- ABS aim to **prevent skidding** where loss of steering and control result from locked wheels when braking hard.
- **ABS in cars** give a relatively small, but statistically significant reduction in the number of crashes.
- There are statistically significant **decreases in collisions with pedestrians/ cyclists/ animals** and collisions involving turning vehicles.
- ABS brakes in cars do not appear to have any effect on **rear-end collisions**.
- One study indicates that ABS in cars may not contribute to crash prevention at all (Cummings & Grossman, 2007).
- A German study concludes that in **93% of cases where the motorcyclist fell of the vehicles**, ABS would have avoided the crash or at least reduced the severity of the accident (Winkelbauer, 2006).
- Induced exposure analysis showed that the **overall effectiveness of ABS in motorcycles** was 38% for all injury crashes and 48% for severe and fatal crashes.

Emergency Brake Assist

- Emergency Brake Assist aims to **address the problem of insufficient pressure being applied to the brake** by drivers in emergency situations.
- In marketing material, Daimler Chrysler indicate that for a car braking at 100km/h, Emergency Brake Assist can **reduce the normal stopping distance by 45%**.
- There is **no standard method to assess the safety performance** of these devices, which makes it difficult to estimate their potential benefits.
- A Swedish study of real-world pedestrian crashes found that the isolated effects of Emergency Brake Assist on pedestrian safety **were not significant enough** (Strandroth et al., 2011).



Collision Avoidance Systems

- The usefulness in addressing high-risk crash scenarios typical of most European roads as well as their feasibility **has yet to be determined**.
- Very large estimates of the safety potential of such systems have been claimed following **laboratory studies**.
- The range of technical and behavioural issues involved in many of the concepts **require full on-road assessment**.

eCall

- These systems aim to **reduce the time between the occurrence of the crash and the provision of medical services**, and thus, to reduce the consequences of injury.
- A **prospective Finnish study** estimated a reduce between 4-8% of road deaths and 5-10% of motor vehicle occupant deaths (Virtanen et al., 2006).
- The overall impact of the system which involves additional players **has not been evaluated**.
- The **American estimation** for the decrease in traffic accident fatalities based on field studies was smaller (2–3%) than in this study.
- The EC believes that a **pan-European eCall** is estimated to potentially save up to 2.500 fatalities annually (Bouler, 2005).
- The **benefits to cost ratios** of eCall in Finland have been found to be in the range of 0,5 (min estimate) to 2:3 (max estimate).

Conclusions

- Vehicle safety plays a **key role in the protection of all road users** and in the achievement of long term goals and targets.
- New in-vehicle technologies have the potential to **decrease crash injury risk**.
- However, they may also increase it through introducing new driver distraction and inadvertent behavioral change.
- While research has attempted to **record and classify ADAS by their impacts**, various problems need to be addressed in the assessment of both existing and new systems.
- It is not possible to predict **eventual casualty reduction** on the basis of experimental studies, field trials or simulators for most new systems.
- Naturalistic driving studies and the establishment of a **European in-depth crash injury database** are required to evaluate current measures and identify future problems and solutions.

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