Summary:

Intelligent Transport Systems (ITS): An overview of effects on behaviour and accidents

Background

As a response to competition from the Japanese car industry, the European car industry established the PROMETHEUS-program in 1986. The main objective was then to intensify the research on high-technological systems that could promote car safety and mobility. The EU regarded this as a significant challenge for their R&D-activities and in 1988 they launched the research program DRIVE where the EU invited European research institutions for cooperation in order to solve research tasks which the EU defined as important for supporting the car industry's PROMETHEUS-program and for meeting the competition from Japanese and American car industry. High-technological systems which have been applied within the road traffic system have had different collective terms since the start in the late 1980's, as Road Transport Informatics (RTI), Advanced Telematics in Transport (ATT), Intelligent Vehicle-Highway Systems (IVHS) and finally Intelligent Transport Systems (ITS) which emerged as the agreed term around 1995. Today ITS is used as a generic term comprising a wide spectre of information-technological systems within all transport sectors, i.e. road traffic, aviation, railways and shipping industry.

New ITS-solutions in road traffic may contribute significantly to the future transport policy. In order to increase the knowledge within this wide area the Norwegian Public Roads Administration (NPRA) initiated the "ITS på veg" ("ITS on road") in 2003 as a special targeted project ('Etatsprosjekt" within the NPRA). In the present overview, some selected ITS are described specifically with respect to their effects on behaviour and accidents. The prime objective has been to map, describe and evaluate the selected ITS-solutions' safety potential in the road traffic system.

The amount of literature in the area of ITS is very large. One example can illustrate this: The 1st World Congress on ITS was held in Paris in 1994. The proceedings from this single congress comprised 6 volumes and a total of 3.400 pages. Including 2006, there has been arranged 13 World Congresses on ITS. If the number of pages from the first congress is representative, today's amount should comprise some 44.000 pages from the World Congresses alone. In addition, there are held separate continent congresses for Asia, Europe and the Americas. Further, there are articles published in scientific journals, reports from EU-projects 1989-2007, reports from research institutes and the like. It is evident that it would be impossible to review all these sources of literature within the frames of the present project. Hence, we have at first considered other summary reports and selected key information from these overviews. Secondly, we have

selected reports which have applied meta-analysis for estimating effects on accidents of given systems.

Some systems have been considered more thoroughly than other ITS-solutions as with Antilocking Brake Systems (ABS), Electronic Stability Control (ESC), Intelligent Speed Adaptation (ISA), speed cameras and Variable Message Signs (VMS). A summary of the main ITS-features has, as a starting point, been done by considering which types of evaluation that have been applied on a given IT-system as the evaluation type in itself indicates level of maturity and the degree of technological development. However, the type of evaluation may not say anything about how widespread the system is or the number of cars which are fitted with a given system. Further, a principal reservation must be clearly stated regarding the possibility that the effect of a given system may have been evaluated on a higher level of maturity than displayed here.

In the present overview, the IT-systems are grouped according to the following levels of evaluation:

- ITS where the effects on accidents are estimated by meta-analysis

- ITS where the effects on accidents are estimated by isolated accident studies

- ITS which only are evaluated with respect to effects on behaviour

- ITS where the effect on accidents are given indirectly, by surrogate and hypothetical methods

- ITS where effects on behaviour or accidents have not been evaluated

ITS where effects on accidents have been studied by meta-analysis

ADR (Accident Data Recorder/Datalogger): Two meta-analyses exist. One of these apparently with a statistical significant effect on accidents but a re-analysis done by Rune Elvik (TØI) cannot confirm the initial significant estimate.

ABS (Antilocking Brake System): Of all IT-systems considered ABS must be said to be the one which has been most comprehensively investigated with respect to its effects on accidents. Several large studies, predominantly American, exist and two different vehicle groups have been considered.

- **Effects of ABS on personal vehicles**: For this group the overall weighted average effect is a 3,5% reduction on the number of accidents, but the picture is complicated and somewhat contradictory: Accidents involving pedestrians, cyclists and animals, and accidents with a turning vehicle, are significantly reduced, while fatal accidents, collision with fixed objects, overturning accidents, and single-vehicle accidents without overturning, show statistically significant *increases* in the number of accidents. It is assumed that these increases are effects of risk compensation, as cars with ABS may be driven faster than cars without ABS, possibly also in combination with insufficient knowledge of the manner of operation of ABS. ABS has no effect on rear-end accidents.

- **Effect of ABS on SUVs/vans/pick-up trucks**: This group show a somewhat different picture than was case with the personal vehicles. For this group the overall, weighted average effect is a 7,4 % reduction on the number of accidents, while the effects on fatal accidents is somewhat larger than for personal vehicles with 10-14%. Both these estimates are statistically significant. Analogous with the group of personal cars, collisions with pedestrians, cyclists and animals are significantly reduced, here by 12%. For the remaining accident types the picture is different: Overturning accidents and accidents with fixed objects are reduced by 21% and 6%, respectively, while rear-end collisions and head-on collisions, and accidents with turning vehicles are increased by 16%, 7% and 9%, respectively. It is unclear why the effects on these last accident types differ from those with personal cars.

Speed cameras: 10 studies have evaluated the effects of speed cameras on accidents. These studies serve as base for estimating the effect by meta-analysis. The overall effect is estimated to a statistical significant reduction of 18% on the number of accidents, for personal injury accidents, accidents in urban areas, and accidents in rural areas, the reductions are 17%, 18% and 16% respectively.

Collective feedback of driving speeds: The estimated effect is 46% reduction in the number of accidents.

Variable message signs: Signs which warn of accidents reduce the number of accidents by 44%, and fog warning by 84%. Queue warning signs on motorways reduce personal injury accidents by 16%, while property-damage-only accidents are increased, also by 16%.

Collective feedback of giving way for pedestrians: No significant effect documented.

Individual feedback of driving speeds: No significant effect documented.

ITS where effects on accidents have been studied by isolated accident studies

Three studies exist which have evaluated the effect of Electronic Stability Control (ESC) on accidents. Single standing results from these studies show reductions in the number of accidents for the following accident types:

- All accidents except rear-end collisions: - 22,1 ± 21,0% (sign)
- Accidents on wet road surface: -31,8 ± 23,4% (sign)
- Single accidents with personal cars: - 35%
- Fatal accidents with personal cars: - 30%
- Fatal accidents with SUV (Sports Utility Vehicles): - 63%
- Single accidents with fatal outcome over a 3 year period in USA: - 56% (sign)
- All fatal accidents (USA): - 34% (sign)

Warning of black spots for heavy vehicles with dangerous goods: No accidents in after-period when warning heavy vehicles with certain combinations of height and weight.

ITS which are evaluated on effects on behaviour only

Automatic detection of pedestrians walking on red traffic light signal: Fewer pedestrians are walking on red (one study only).

Variable speed limit sign near a school: 7 km/h reduction in average speed

ITS where effects on accidents have been estimated by indirect or hypothetical methods

AlcoLock: This measure is only studied by considering the number of convictions for repeated dring driving.

Intelligent Speed Adaptation: The following behaviour parameters have been studied: Speed, time headways, interaction with road users, red light running, travel time, and acceptance/attitudes. Evaluation on the effect on accidents has not been done, but one estimation has been done by applying Göran Nilsson's power model.

Static/dynamic route guidance systems: No studies with evaluations on the effects on behaviour and/or accidents have been found. The only study types that have been identified are studies addressing appraisals of travel time and simulation studies regarding how many drivers that would have used an alternative route dependent on presumed proportions of drivers who actually have the system.

Traffic management – tunnels: Present studies show relatively low degree of understanding and respect for symbol signals. Some estimates regarding the effects on accidents exist, but the estimation method is not stated.

Automatic Intelligent Cruise Control (AICC): No real accident study regarding AICC have been identified. Studies which are found are from the early 1990's which only state hypothetical effects on the number of accidents.

Informative Speed Advice: One study identified. The system recognizes the shape of a sign and warns the driver, by registration of gaze fixations, if the sign is overlooked. The system has not been evaluated regarding the effect on accidents.

Maximum speed limiter: Only simulation studies with hypothetical effects are found.

Traffic information on radio/mobile phone: Only one study has been found

ITS where studies on effects on behaviour and/or accidents have not been found

- ***Pedestrian warning and activation of automatic braking:*** Only the system is described. No effects are stated

As stated above, there is innsufficient knowledge regarding effects of important ITS which may represent high accident reduction potentials. Systems where expectations of effects may be considerable, but where the evaluation is insufficient are systems which warn fatigued drivers of falling asleep at the wheel, systems which enhance night vision, and systems which warn drivers of vehicles on a crossing course.