

 <b>iCars Network</b>	<b>iCars Network</b>
<b>D3.1 – Inventory of impact assessment methods for intelligent vehicle systems</b>	

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<b>Abstract</b>	This deliverable provides the results of an inventory of the methods used in the impact assessment for intelligent vehicle systems. The methods are classified according to the types of impacts assessed. The deliverable includes 31 method summaries.
<b>Keyword list</b>	Impact assessment, evaluation methods, intelligent vehicle systems
<b>Nature of deliverable</b>	Report
<b>Dissemination</b>	Public

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## 1. Introduction

### 1.1. Intended audience

This document was prepared for experts who develop and assess intelligent vehicle systems (IVS). It may also be useful to anyone interested in IVS, such as researchers, developers and decision makers, as a first approach to the subject. The report is also meant for the experts participating in the expert study to compare the methods in WP3.2.

### 1.2. Structure of the document

The report includes 31 summaries of evaluation methods. A specific template was created to collect the information.

### 1.3. Objective of the document

This deliverable provides the results of an inventory of the methods used in the impact assessment for intelligent vehicle systems. The inventory is based on the expertise of the group, but also on a literature survey on the existing impact assessment studies concentrating on methodological issues. The methods are classified according to the types of impacts assessed such as driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy including costs on actor/stakeholder basis as well as the type of assessment such as desktop, laboratory, simulator, field study or use of statistics.

This document provides a first list of evaluation methods. The templates will be further developed, and the methods will be analysed and compared in WP3.2.

## 2. Templates for impact assessment of IVS

### 2.1. Socio-economy and efficiency

Description of the study	
Study reference	ADVISORS Action for Advanced Drivers Assistance and Vehicle Control System Implementation, Standardisation, Optimum Use of the Road Network and Safety
Availability of electronic version	<a href="http://www.advisors.iao.fraunhofer.de/">http://www.advisors.iao.fraunhofer.de/</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	empirical
Description of the method and its application in the study	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	socio-economy
Type of assessment (desktop, survey, lab, simulator, field, statistics)	desktop
Process/design	<b>AHP method (Analytic Hierarchy Process)</b> As a basis for a multi criteria analysis for socio-economic evaluation this method can be used for establishing criteria against which the performance of each system should be measured. In the ADVISORS-project AHP was used to consider the stakeholders' (users, society and manufacturers) objectives.
Expertise used/needed	
Result parameters / description	After giving weights to various criteria, the analysis permits to measure each system overall level of goal achievement.
Restrictions of the method	
Key references to the method and its application to ITS used in the study	Report on preliminary analysis and initial deployment program, BLADE (Business models, Legal Aspects, and DEployment), Subproject 6 of SAFESPOT INTEGRATED PROJECT, Deliverable 6.2.1

<b>Description of the study</b>	
Study reference	<p>BLADE (Business models, Legal Aspects, and Deployment), Report on preliminary analysis and initial deployment program, Subproject 6 of SAFESPOT INTEGRATED PROJECT, Deliverable 6.2.1</p> <p>E-MERGE Pan-European harmonisation of vehicle emergency call service chain</p>
Availability of electronic version	<p><a href="http://www.safespot-eu.org">www.safespot-eu.org</a></p> <p>link to an electronic version of E-MERGE not found</p>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	ex-ante
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	efficiency, socio-economy, environment
Type of assessment (desktop, survey, lab, simulator, field, statistics)	desktop
Process/design	<p><b>CBA (Cost-Benefit Analysis)</b> The welfare-economics-based CBA measures all relevant costs and benefits. The CBA can be used to assess the absolute efficiency of a measure (by monetarizing all cost and all benefits) which aims at finding whether a proposed objective is economically efficient and how efficient it is.</p>
Expertise used/needed	statistics, cost / benefit information
Result parameters / description	<p>Benefit-cost-ratio (alternatively benefit-cost-difference) Benefit-cost-ratios of more than "1" indicate that the deployment of the safety system would be in the public's interest</p>
Restrictions of the method	<ul style="list-style-type: none"> <li>- entire information on cost must be available</li> <li>- entire information on benefits must be available</li> <li>- eventually a sensitivity analysis is needed</li> </ul>
Key references to the method and its application to ITS used in the study	

<b>Description of the study</b>	
Study reference	Report on preliminary analysis and initial deployment program, BLADE (Business models, Legal Aspects, and DEployment), Subproject 6 of SAFESPOT INTEGRATED PROJECT, Deliverable 6.2.1
Availability of electronic version	www.safespot-eu.org
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	ex-ante
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	efficiency, socio-economy, environment
Type of assessment (desktop, survey, lab, simulator, field, statistics)	desktop
Process/design	<b>CEA (cost-effectiveness analysis)</b> As well as the CBA (cost-benefit analysis) the CEA assesses the alternative resource use and compares the socio-economic benefit in terms of resource savings with the system costs. In contrary to the CBA the benefits are expressed in non-monetary terms (e.g. number of saved lives)
Expertise used/needed	statistics, cost information
Result parameters / description	change of an analysed parameter depending of the spent resources
Restrictions of the method	The CEA can only ascertain the effectiveness of a measure in accomplishing a particular objective (e.g. reduce of the number of road accidents)
Key references to the method and its application to ITS used in the study	

<b>Description of the study</b>	
Study reference	SEISS Socio-economic impact assessment of stand-alone and co-operative intelligent vehicle safety systems (IVSS) in Europe
Availability of electronic version	<a href="http://ec.europa.eu/information_society/activities/esafety/doc/call_4/final_seiss.pdf">http://ec.europa.eu/information_society/activities/esafety/doc/call_4/final_seiss.pdf</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	ex-ante
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	socio-economy
Type of assessment (desktop, survey, lab, simulator, field, statistics)	desktop
Process/design	<b>Distributional effects in macroeconomic efficiency analyses</b> For the political acceptance of systems (e.g. IVSS) and therefore for the implementation chances, the social effects possess substantial relevance. The social effects address the fact, that the costs of a measure burden certain social classes, while others benefit from the measures. In such an analysis it is examined, how the effects affect the income distribution of the user groups. It should be answered which income groups - the "rich" or the "poor" - benefit from the implementation of an examined system.
Expertise used/needed	information about effects of costs / benefits on several social groups
Result parameters / description	Distributional effects of the implementation of measures.
Restrictions of the method	The approach is only sufficient if the existing income distribution in a society is regarded to be optimal. Because that cannot be assumed, inequities in the income distribution have to be determined.
Key references to the method and its application to ITS used in the study	eIMPACT D6

<b>Description of the study</b>	
Study reference	SEISS Socio-economic impact assessment of stand-alone and co-operative intelligent vehicle safety systems (IVSS) in Europe
Availability of electronic version	<a href="http://ec.europa.eu/information_society/activities/esafety/doc/call_4/final_seiss.pdf">http://ec.europa.eu/information_society/activities/esafety/doc/call_4/final_seiss.pdf</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	ex-ante
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	socio-economy
Type of assessment (desktop, survey, lab, simulator, field, statistics)	statistics
Process/design	<p><b>FA (Financial Analysis)</b></p> <p>The Financial Analysis (FA) is a technique to measure the impacts on the financial expenditure, revenues and fiscal cash flows of the acting public institutions. The Financial Analysis can be seen as a decision tool for public institutions. The introduction of systems like IVSS for example can be supported by the public authorities in different ways, whereby the spectrum of policy intervention lies in between a hands-off approach and strong interventions. Normally the intensity of public interventions is related to the budget of the relevant public authority. Therefore, the relevant institutions need information on the income and expense coming up from policy interventions to support specific measures.</p> <p>FA and BCA together enable the proof if supporting measures are appropriate in terms of welfare. The FA gives information on the expenditure for public interventions. The CBA provides the information on the resource savings.</p>
Expertise used/needed	cost information
Result parameters / description	Impacts on budget and public expenditure
Restrictions of the method	-
Key references to the method and its application to ITS used in the study	eIMPACT D6

<b>Description of the study</b>	
Study reference	SEISS Socio-economic impact assessment of stand-alone and co-operative intelligent vehicle safety systems (IVSS) in Europe
Availability of electronic version	<a href="http://ec.europa.eu/information_society/activities/esafety/doc/call_4/final_seiss.pdf">http://ec.europa.eu/information_society/activities/esafety/doc/call_4/final_seiss.pdf</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	ex-ante
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	socio-economy
Type of assessment (desktop, survey, lab, simulator, field, statistics)	desktop
Process/design	<b>MCA (Multi-Criteria Analysis)</b> The general objective of multi-criteria analysis is to establish preferences between options by reference to an explicit set of objectives. The objectives have to be identified by the decision making institution. Furthermore, it is necessary that measurable criteria are defined to assess the extent to which the objectives have been achieved. Contrary to CBA MCA offers a number of ways of aggregating the data on individual criteria to provide indicators of the overall performance of options. Therefore, a lot of multi-criteria analysis techniques exist.
Expertise used/needed	
Result parameters / description	<ul style="list-style-type: none"> <li>- identification of one single most preferred option</li> <li>- ranking of options</li> <li>- selection of most promising options for a further assessment of the short-list</li> <li>- distinction between acceptable and unacceptable option</li> </ul>
Restrictions of the method	<ul style="list-style-type: none"> <li>- All techniques require the exercise of judgment</li> <li>- The results of the weighting process give no indication of an option adds more to welfare than it detracts</li> </ul>
Key references to the method and its application to ITS used in the study	eIMPACT D8

<b>Description of the study</b>	
Study reference	SEISS Socio-economic impact assessment of stand-alone and co-operative intelligent vehicle safety systems (IVSS) in Europe
Availability of electronic version	<a href="http://ec.europa.eu/information_society/activities/esafety/doc/call_4/final_seiss.pdf">http://ec.europa.eu/information_society/activities/esafety/doc/call_4/final_seiss.pdf</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	ex-ante
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	socio-economy
Type of assessment (desktop, survey, lab, simulator, field, statistics)	desktop
Process/design	<b>Sensitivity Analysis</b> The purpose of the sensitivity analysis is to select the “critical” variables and parameters of the assessment model. Critical variables are those whose variations, positive or negative, compared to the value used as the best estimate in the base case, have the greatest effect on the results.
Expertise used/needed	statistics
Result parameters / description	The sensitivity elasticity measures the change in one significant variable in response to a change of the results (e.g. cost-benefit ratio). The definition of the sensitivity elasticity is: $\text{SensitivityElasticity} = \frac{\text{Percentage Change of Result}}{\text{Percentage Change of Critical Variable}}$
Restrictions of the method	-
Key references to the method and its application to ITS used in the study	eIMPACT D6

<b>Description of the study</b>	
Study reference	SEISS Socio-economic impact assessment of stand-alone and co-operative intelligent vehicle safety systems (IVSS) in Europe
Availability of electronic version	<a href="http://ec.europa.eu/information_society/activities/esafety/doc/call_4/final_seiss.pdf">http://ec.europa.eu/information_society/activities/esafety/doc/call_4/final_seiss.pdf</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	ex-ante
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	socio-economy
Type of assessment (desktop, survey, lab, simulator, field, statistics)	desktop
Process/design	<b>Stakeholder Analysis</b> The benefit-cost analysis displays the social profitability only jointly for all impact components. Which kind of benefits result for the different stakeholder groups is not transparent in a conventional benefit-cost analysis. Therefore the stakeholder analysis gives a breakdown and displays the benefits as well as the costs for the different stakeholders. In case of the implementation of intelligent vehicle safety systems these are the users, the society and the manufacturers.
Expertise used/needed	statistics, cost / benefit information
Result parameters / description	Information about cost and benefits of the implementation of separate systems that occur for the different stakeholders.
Restrictions of the method	- entire information on cost must be available - entire information on benefits must be available
Key references to the method and its application to ITS used in the study	eIMPACT D6

<b>Description of the study</b>	
Study reference	Kulmala R. et al. (2008). CODIA Final study report. Deliverable 5.
Availability of electronic version	
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	ex-ante
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	socio-economy
Type of assessment (desktop, survey, lab, simulator, field, statistics)	desktop
Process/design	<b>Socio-economic assessment</b> The benefit and cost assessment methodology relies on standard discounted flow and cost benefit analysis techniques. To conclude the benefit assessment of co-operative systems there are a series of assumptions and decisions that need to hold in order to be able to yield results that are reliable, understandable and concrete.
Expertise used/needed	cost-benefit analysis, transport economics
Result parameters / description	benefits-and-costs-ratio
Restrictions of the method	-
Key references to the method and its application to ITS used in the study	

## 2.2. Environment

Description of the study	
Study reference	Kulmala R. et al. (2008). CODIA Final study report. Deliverable 5.
Availability of electronic version	
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	ex-ante
Description of the method and its application in the study	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	environment
Type of assessment (desktop, survey, lab, simulator, field, statistics)	desktop
Process/design	<p><b>Environment impact assessment</b></p> <p>Instantaneous emission models aim to provide a precise description of vehicle emission behaviour by relating emission rates to vehicle operation during a series of short time steps (often one second). The advantages of instantaneous emission models include the following:</p> <ul style="list-style-type: none"> <li>- Instantaneous emission models inherently take into account the dynamics of driving patterns, and can therefore be used to explain some of the variability in emissions associated with given average speeds.</li> <li>- Emissions can be calculated for any vehicle operating profile, and they are thus able to take advantage of the vehicle profiles produced by micro-simulation traffic models such as SISTM.</li> <li>- Instantaneous emission models allow emissions to be spatially and temporally resolved.</li> <li>- Instantaneous emission models require detailed and precise information on vehicle operation and location.</li> </ul> <p>Direct field measurements are possible but represent a logistically large exercise. However, traffic micro-simulation modelling is able to provide an appropriate level of input.</p> <p>TRL has developed a prototype Instantaneous Emissions Module (IEM) that can take the output</p>

	<p>from an instantaneous traffic model and evaluate the emissions of NO<sub>x</sub>, PM and total carbon (C). Changes to all three quantities were calculated as a result of the cooperative systems being studied.</p> <p>The module consists of:</p> <ul style="list-style-type: none"> <li>- a basic emissions module, which takes two consecutive vehicle speeds plus the time period and calculates the emissions.</li> <li>- a post processor, which takes the traffic model output and evaluates the emissions for each vehicle</li> </ul>
Expertise used/needed	environment
Result parameters / description	emissions in g per vehicle and percentage change relative to base at different equipment rates
Restrictions of the method	<p>The current emissions module contains look-up tables for light-duty vehicles up to Euro IV and heavy-duty vehicles up to Euro V, and will therefore deal with vehicles in the current period and in the near future.</p> <p>The link between emission estimates and their impact on local air quality was not directly modelled within this study.</p>
Key references to the method and its application to ITS used in the study	

### 2.3. Safety

Description of the study	
Study reference	Dang J. (2004). Preliminary results analyzing the effectiveness of electronic stability control (ESC) systems. National Highway Traffic Safety Agency, USA.
Availability of electronic version	<a href="http://www.nhtsa.dot.gov/cars/rules/regrev/evaluate/809790_files/809790.pdf">http://www.nhtsa.dot.gov/cars/rules/regrev/evaluate/809790_files/809790.pdf</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	ex-post
Description of the method and its application in the study	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	safety
Type of assessment (desktop, survey, lab, simulator, field, statistics)	desktop
Process/design	<b>Analysis of crash data</b> from currently available databases
Expertise used/needed	statistics
Result parameters / description	changes in accident rate
Restrictions of the method	-
Key references to the method and its application to ITS used in the study	

<b>Description of the study</b>	
Study reference	Lie, A. et al. (2005). The effectiveness of ESC (Electronic Stability Control) in reducing real life crashes and injuries. 19th International Technical Conference on the Enhanced Safety of Vehicles Conference (ESV), June 2005.
Availability of electronic version	<a href="http://www-nrd.nhtsa.dot.gov/pdf/nrd-01/esv/esv19/05-0135-O.pdf">http://www-nrd.nhtsa.dot.gov/pdf/nrd-01/esv/esv19/05-0135-O.pdf</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	ex-post
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	safety
Type of assessment (desktop, survey, lab, simulator, field, statistics)	desktop
Process/design	<p><b>Induced exposure</b></p> <p>In this study, induced exposure is used to estimate the exposure to crashes for cars equipped and not equipped with ESC. This is an accepted method to use in situations when it is not possible to calculate the true exposure (13, 15, 16). The method is based on the identification of at least one type of event that is not expected to be affected by ESC. For that specific case, the crash number relation between ESC and not ESC would be considered as the true exposure relation. Any deviation from the established basic distribution for crashes not affected by ESC is considered to be a result of the equipment of ESC. The method is also considered to be based on the fact that there are no other differences between cars equipped and not equipped with the system under study (ESC), or any other user related factor that would alter the expected equal distribution of events and crashes. Both these prior factors are normally complicated to fulfil and control. In the present study, not only the type of crash but also the surface condition was used to estimate possible effects.</p>
Expertise used/needed	statistics

Result parameters / description	change in accident rate
Restrictions of the method	<ul style="list-style-type: none"> <li>- dependent on a number of assumptions and critical factors</li> <li>- doubts about how the technology is picked up by consumers</li> <li>- method does not allow an analysis on the actual function of the system, and in what sequence of driving it has its potential</li> </ul>
Key references to the method and its application to ITS used in the study	<p>Evans L. Antilock brake systems and risk of different types of crashes in traffic. ESV Conf paper no 98-S2-O-12. Windsor 1998.</p> <p>Kullgren A, Lie A, Tingvall C. The effectiveness of ABS in real life crashes. ESV Conf paper no 94-S4-O-07. Munich 1994..</p>

<b>Description of the study</b>	
Study reference	Frampton R., Thomas P. (2007). Effectiveness of Electronic Stability Control Systems in Great Britain. Loughborough University.
Availability of electronic version	<a href="http://www.dft.gov.uk/pgr/roads/vehicles/vssafety/safetyresearch/esc">http://www.dft.gov.uk/pgr/roads/vehicles/vssafety/safetyresearch/esc</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	safety
Type of assessment (desktop, survey, lab, simulator, field, statistics)	desktop
Process/design	<b>Case-control method</b> based on the induced exposure method
Expertise used/needed	statistics
Result parameters / description	relative rates of crash involvement for cars with ESC under a variety of different conditions
Restrictions of the method	
Key references to the method and its application to ITS used in the study	Evans, L. (1986) 'Double paired comparison – a new method to determine how occupant characteristics affect fatality risk in traffic crashes', <i>Crash Analysis and Prevention</i> , Vol. 18, No. 3, pp.217–227.

<b>Description of the study</b>	
Study reference	Virtanen N. (2005). Automaattisen hätäviestijärjestelmän vaikutukset onnettomuustilanteessa [Impacts of an automatic emergency call system on accident consequences]. AINO-publications 14/2005.Ministry of Transport and Communications, Helsinki.
Availability of electronic version	<a href="http://www.aino.info/julkaisut/4_kuljtuki/aino14_2005.pdf">http://www.aino.info/julkaisut/4_kuljtuki/aino14_2005.pdf</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	ex-ante
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	safety
Type of assessment (desktop, survey, lab, simulator, field, statistics)	desktop
Process/design	<b>In-depth accident study</b> Studying case reports of Road Accident Investigation Teams to determine whether faster help through eCall could have saved lives
Expertise used/needed	statistics, traffic safety, medical knowledge
Result parameters / description	probable change in number of fatalities/injuries
Restrictions of the method	- whether a person's life could have been saved with faster help can only be estimated (although it was done by medical experts) -
Key references to the method and its application to ITS used in the study	

<b>Description of the study</b>	
Study reference	Aittoniemi E. (2007). Tieliikenteen tietopalveluiden vaikutusmahdollisuudet liikenneturvallisuuteen [Potential safety impacts of in-vehicle information services]. AINO-publications 46/2007. Ministry of Transport and Communications, Helsinki.
Availability of electronic version	<a href="http://www.aino.info/julkaisut/5_palvelup/aino46_2007.pdf">http://www.aino.info/julkaisut/5_palvelup/aino46_2007.pdf</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	ex-ante assessment
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	safety
Type of assessment (desktop, survey, lab, simulator, field, statistics)	desktop
Process/design	<b>Delphi study</b> The Delphi method is a popular tool for assessing different problems with the help of experts' opinions. The three main principles of the Delphi method are anonymity, iteration and feedback.
Expertise used/needed	statistics, driver behaviour, traffic safety
Result parameters / description	% or unit change in behaviour due to system/service in different conditions; % change in crash risk due to system/service
Restrictions of the method	<ul style="list-style-type: none"> <li>- the experts should represent the available knowledge pool and the relevant disciplines</li> <li>- the answers are subjective and sensitive to the formulation of questions and survey settings</li> <li>- the questions have to be tested with sufficient number of test respondents</li> <li>- the survey needs to be repeated at least once, and it takes time to have sufficiently many answers from all rounds (especially later ones)</li> </ul>
Key references to the method and its application to ITS used in the study	<p>Kamppinen, M., Kuusi, O. &amp; Söderlund, S. (2002). Tulevaisuudentutkimus - perusteet ja sovelluksia. Finnish Literature Society, Helsinki, 2002.</p> <p>Höjer, M. (1997). Telematics in Urban Transport - a Delphi Study Using Scenarios. TRITA-IP FR 97-23. Infrastructure and Planning, Royal Institute of Technology, Stockholm.</p>

<b>Description of the study</b>	
Study reference	Ohono, Shimura (2005). Results from the survey on effectiveness of electronic stability control (ESC). Press release. National Agency for Automotive Safety & Victims' Aid (NASVA) 2005/02/18.
Availability of electronic version	<a href="http://www.esafety-effects-database.org/studies/NASVA_ESC_effectiveness.pdf">http://www.esafety-effects-database.org/studies/NASVA_ESC_effectiveness.pdf</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	ex-post
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	traffic safety
Type of assessment (desktop, survey, lab, simulator, field, statistics)	desktop
Process/design	<b>Crash data study</b> Comparing accident data of cars with and without ESC
Expertise used/needed	statistics
Result parameters / description	change of accident rate
Restrictions of the method	-
Key references to the method and its application to ITS used in the study	

<b>Description of the study</b>	
Study reference	Kulmala R. et al. (2008). CODIA Final study report. Deliverable 5.  eIMPACT Deliverable D4.
Availability of electronic version	
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	ex-ante
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	safety
Type of assessment (desktop, survey, lab, simulator, field, statistics)	desktop
Process/design	<p><b>Safety impact assessment</b></p> <p>The effects of IVSS on traffic safety may appear in many, both intended and unintended ways. It is not possible to define in advance the group of accidents affected by the system, although system developers typically have as a starting point a target group of accidents for a system. Therefore, it is highly important that the analysis of IVSS covers all possible effects in a systematic manner.</p> <p>The approach used in the CODIA and eIMPACT projects is based on the system nature of transport. When one element of the system is affected, the consequences may appear in several elements and levels of the system, both immediately and in the long term, due to behavioural modification. Road safety is regarded as a multiplication of three orthogonal factors: (1) exposure, (2) risk of a collision to take place during a trip and (3) risk of a collision to result in injuries or death. The same methodology was used in the eIMPACT and PReVAL projects (Wilmink et al. 2008).</p> <p>The analyses covered the three main factors of traffic safety by nine behavioural mechanisms via which IVSS affects safety as first described in Draskóczy et al. (1998).</p> <p>The first five mechanisms are connected to the</p>

	<p>accident risk:</p> <ol style="list-style-type: none"> <li>1. Direct in-car modification of the driving task</li> <li>2. Direct influence by roadside systems</li> <li>3. Indirect modification of user behaviour</li> <li>4. Indirect modification of non-user behaviour</li> <li>5. Modification of interaction between users and non-users</li> </ol> <p>The second group deals mainly with exposure:</p> <ol style="list-style-type: none"> <li>6. Modification of road user exposure</li> <li>7. Modification of modal choice</li> <li>8. Modification of route choice</li> </ol> <p>Finally, there is the mechanism that deals with changes in accident consequences:</p> <ol style="list-style-type: none"> <li>9. Modification of accident consequences</li> </ol>
Expertise used/needed	traffic safety, driver behaviour, statistics
Result parameters / description	Potential reduction in injuries and fatalities (%) for different penetration rates and years.
Restrictions of the method	-
Key references to the method and its application to ITS used in the study	<p>Draskóczy M, Carsten O.M. J. and Kulmala R. (1998). Road Safety Guidelines. CODE Project, Telematics Application Programme, Deliverable B5.2.</p> <p>Wilmink et al. (2008). Impact assessment of Intelligent Vehicle Safety Systems. eIMPACT Deliverable D4.</p>

## 2.4. Driver behaviour

<b>Description of the study</b>	
Study reference	Mazzae E. et al. (2001). NHTSA Light Vehicle Antilock Brake System Research Program Task 7.1: Examination of ABS-Related Driver Behavioral Adaptation – License Plate Study. National Highway Traffic Safety Administration Vehicle Research and Test Center. Report no. DOT HS 809 430.
Availability of electronic version	<a href="http://www.nhtsa.dot.gov/staticfiles/DOT/NHTSA/NRD/Multimedia/PDFs/VRTC/ca/capubs/abs71.pdf">http://www.nhtsa.dot.gov/staticfiles/DOT/NHTSA/NRD/Multimedia/PDFs/VRTC/ca/capubs/abs71.pdf</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	empirical
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	driver behaviour (driving speeds)
Type of assessment (desktop, survey, lab, simulator, field, statistics)	field
Process/design	<b>Driver behaviour observation</b> Driving speeds were measured in real situations and license plates recorded in order to determine whether the brake system (ABS or not) has an influence on driving speeds.
Expertise used/needed	statistics
Result parameters / description	driving speeds, brake system used
Restrictions of the method	<ul style="list-style-type: none"> <li>- the range of driving situations in which differences in driver behaviour may be observed were not fully represented in this study (e.g. other types of roadways, other conditions)</li> <li>- data were collected under conditions that were amenable to recording data using the methods available</li> </ul>
Key references to the method and its application to ITS used in the study	

<b>Description of the study</b>	
Study reference	Tarry S., Pyne M. (2003). UK – TMC Service evaluation 1998–2001. TEMPO Secretariat.
Availability of electronic version	<a href="http://tempo.austriatech.org/fileadmin/library/72/EEG_DE04_TMC.pdf">http://tempo.austriatech.org/fileadmin/library/72/EEG_DE04_TMC.pdf</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	empirical
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	driver behaviour
Type of assessment (desktop, survey, lab, simulator, field, statistics)	field
Process/design	<b>Driver behaviour study</b> 6-month trial
Expertise used/needed	statistics, driver behaviour
Result parameters / description	% of drivers changing route/journey plans % of drivers willing to pay
Restrictions of the method	-
Key references to the method and its application to ITS used in the study	

<b>Description of the study</b>	
Study reference	I-WAY (Intelligent co-operative system in cars for road safety)  D1.2: Intelligent co-operative system in cars for road safety: State of the Art
Availability of electronic version	<a href="http://www.iway-project.eu/Deliverables.aspx">http://www.iway-project.eu/Deliverables.aspx</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	Theoretical
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	Driver behaviour, travel behaviour, traffic flow, Safety.
Type of assessment (desktop, survey, lab, simulator, field, statistics)	Desktop
Process/design	<b>State of the art</b> This research may concern several aspects beginning with the previous IST Projects already related with this problem, a commercial analysis of available solutions, best practices and research foundations, showing the already existents products and technologies in the actual market that may be integrated to this framework.
Expertise used/needed	--
Result parameters / description	This research and analysis allowed to have a global vision of the actual technologies already existent and in some case already commercial.
Restrictions of the method	-
Key references to the method and its application to ITS used in the study	-

Description of the study	
Study reference	TAC SafeCar Project  On-Road Evaluation of Intelligent Speed Adaptation, Following Distance Warning and Seatbelt Reminder Systems: Full Report
Availability of electronic version	<a href="http://www.monash.edu/muarc/reports/muarc253.html">http://www.monash.edu/muarc/reports/muarc253.html</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	Empirical
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	Driver behaviour, efficiency, environment and safety.
Type of assessment (desktop, survey, lab, simulator, field, statistics)	Field test
Process/design	<p><b>Impact assessment</b></p> <p>Involved the deployment and on-road evaluation of four ITS technologies equipped to 15 Ford passenger cars. The four technologies were: Intelligent Speed Adaptation (ISA); Following Distance Warning (FDW); Seatbelt Reminder (SBR) and Reverse Collision Warning (RCW). Each SafeCar was also equipped with Daytime Running Lights.</p> <p>The PKE model for the estimation of fuel consumption and vehicle greenhouse emissions.</p> <p>The Power Model developed by Nilsson (2004) was employed to estimate the reductions expected in injury and fatal crashes based on the decreases in mean speed observed when the ISA system was active.</p> <p>Cost of injury to unrestrained occupants was determined by using cost and injury data from the Bureau of Transport and Regional Economics (BTRE; 2001)</p> <p>Cost savings associated with seatbelt wearing were calculated by using HARM, which quantifies injury costs from road trauma.</p> <p>Questionnaires to acquire subjective data.</p>
Expertise used/needed	--

<p>Result parameters / description</p>	<p><b>INTELLIGENT SPEED ADAPTATION</b></p> <ul style="list-style-type: none"> <li>- Mean Speed</li> <li>- Percentile of Speed</li> <li>- Maximum Speed per Trip</li> <li>- Median Speed</li> <li>- Standard Deviation of Speed</li> <li>- Percentage of time spent above the speed limit</li> <li>- Mean Travel Time</li> <li>- Risky Driving Episodes</li> <li>- Proportion of Time and Distance Spent in Each Speed Zone</li> </ul> <p><b>FOLLOWING DISTANCE WARNING</b></p> <ul style="list-style-type: none"> <li>- Mean Time Headway</li> <li>- Percentage of Driving Time in Time Headway Categories</li> <li>- Standard Deviation of Time Headway</li> <li>- Average Minimum Time Headway Reached per Trip</li> <li>- Number and Duration of FDW Auditory Warnings</li> </ul> <p><b>SEAT BELT REMINDER SYSTEM</b></p> <ul style="list-style-type: none"> <li>- Percentage of Trips Taken While Unbuckled</li> <li>- Percentage of Total Driving Distance Spent Unbuckled</li> <li>- Percentage of Total Driving Distance Spent Unbuckled – Driver Characteristics</li> <li>- Mean Time Taken to Buckle in Response to the Stage 1 SBR Warning</li> <li>- Occupant Responses to the Stage 1 and 2 SBR Warnings</li> <li>- Average Speeds Reached Before Buckling Up</li> <li>- Time Spent Unbuckled when Travelling at Dangerous Speeds</li> </ul> <p><b>FUEL CONSUMPTION AND EMISSION VOLUMES</b></p> <p><b>CRASH REDUCTION BENEFITS OF SAFECAR SYSTEMS</b></p> <ul style="list-style-type: none"> <li>- Intelligent Speed Adaptation – Crash Reduction Estimates</li> <li>- Following Distance Warning – Estimated Rear-end Crash Reductions</li> <li>- Seatbelt Reminder System – Estimated Cost Savings</li> </ul> <p><b>ACCEPTABILITY</b></p> <ul style="list-style-type: none"> <li>- Key Systems: FDW and ISA Analyses</li> <li>- Background Systems: SBR and RCW</li> <li>- Intelligent Speed Adaptation</li> <li>- Following Distance Warning</li> <li>- Seat Belt Reminder</li> <li>- Reverse Collision Warning</li> </ul> <p><b>WORKLOAD</b></p> <ul style="list-style-type: none"> <li>- Intelligent Speed Adaptation</li> <li>- Following Distance Warning</li> <li>- Seat Belt Reminder</li> <li>- Reverse Collision Warning</li> </ul> <p><b>ATTITUDES AND OTHER FACTORS</b></p>
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	<ul style="list-style-type: none"><li>- Driver behaviour</li><li>- Awareness of road safety issues</li><li>- Attitudes to driving behaviours</li><li>- Attitudes to ITS</li></ul>
Restrictions of the method	--
Key references to the method and its application to ITS used in the study	Intelligent Transport Systems; Intelligent Speed Adaptation; Following Distance Warning; Seat Belt Reminder; Acceptability; Intelligent Vehicles; Road Safety; Advanced Driver Assistance Systems

<b>Description of the study</b>	
Study reference	PREVENT RESPONSE 3: D11.2 Code of Practice for the Design and Evaluation of ADAS
Availability of electronic version	<a href="http://www.prevent-ip.org/en/public_documents/deliverables/">http://www.prevent-ip.org/en/public_documents/deliverables/</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	Theoretical/empirical
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	driver behaviour, safety, environment.
Type of assessment (desktop, survey, lab, simulator, field, statistics)	Desktop.
Process/design	<b>Code of practice (CoP)</b> To structure the various inputs and give a guideline for the application of the available recommendations, checklists and method descriptions, a generic product development process and a flowchart for the recommended working steps regarding controllability have been introduced within the CoP. A validation phase was used to check the comprehensibility and consistency of the CoP as well as the technical feasibility of the recommendations.
Expertise used/needed	Experts from the fields of system development, human-machine interaction, system verification, system safety and product analysis.
Result parameters / description	The Code of Practice (CoP) comprises a suitable ADAS (Advanced Driver Assistance System) description concept including ADAS specific requirements for system development. It summarises best practices and proposes methods for risk assessment and controllability evaluation.
Restrictions of the method	--
Key references to the method and its application to ITS used in the study	--

<b>Description of the study</b>	
Study reference	HUMANIST Deliverable 5 of Task Force C (Draft Version) Intermediate reviews of knowledge on Human Centred Design applied to IVIS and ADAS
Availability of electronic version	<a href="http://www.noehumanist.org/">http://www.noehumanist.org/</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	Theoretical
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	driver Behaviour, environment, safety.
Type of assessment (desktop, survey, lab, simulator, field, statistics)	Desktop
Process/design	<b>User behaviour modelling</b> Two important “tools” have been used: - the theoretical framework provided by Joint Cognitive model of Driver-Vehicle-Environment - A description of User (Human) Centred Design approach.
Expertise used/needed	-
Result parameters / description	Complete Review of the following methods: - Observation, focus groups, checklist and expert evaluations, and interview methods. - Haste Method - The occlusion method for assessing visual demands and interruptability of IVIS tasks. - Assessment tools for ADAS acceptance by USERS At the end of the document is included a point of conclusions and recommendations.
Restrictions of the method	-
Key references to the method and its application to ITS used in the study	-

<b>Description of the study</b>	
Study reference	AIDE (Adaptative Integrated Driver-Vehicle InterfacE)  D1.2.1 Behavioural effects of driver assistance systems and road situations
Availability of electronic version	<a href="http://www.aide-eu.org/res_sp1.html">http://www.aide-eu.org/res_sp1.html</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	Theoretical
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	driver behaviour, safety, environment.
Type of assessment (desktop, survey, lab, simulator, field, statistics)	Desktop
Process/design	<b>State of the art</b>
Expertise used/needed	--
Result parameters / description	Deliverable identifying the main types of problems that arise in the study of the behavioural adaptation induced by different driver support systems.
Restrictions of the method	
Key references to the method and its application to ITS used in the study	-

<b>Description of the study</b>	
Study reference	AIDE (Adaptative Integrated Driver-Vehicle InterfacE) D1.1.1 Review of existing tools and methods
Availability of electronic version	<a href="http://www.aide-eu.org/res_sp2.html">http://www.aide-eu.org/res_sp2.html</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	Theoretical
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	driver behaviour, safety and environment.
Type of assessment (desktop, survey, lab, simulator, field, statistics)	Desktop
Process/design	<p><b>State of the art</b></p> <p>The following methods are reviewed:</p> <p>Usability techniques</p> <ul style="list-style-type: none"> <li>- Functional Behaviour</li> <li>- Comprehensibility and User Errors / Problems by Observation</li> <li>- Interviews</li> <li>- Questionnaires</li> <li>- HMI Task Performance by Observation and Verbal Measures - - Observation of HMI-Task Performance (Speed and Errors)</li> <li>- Open-structure interview</li> <li>- Driving Quality Scale</li> <li>- Usability Scale</li> <li>- Driving Quality questionnaire</li> <li>- Ranking</li> <li>- Analytical Observation</li> <li>- Performance Compared with baselines</li> <li>- Error Numbers</li> <li>- Semi-structured Interviews</li> </ul> <p>Acceptance Techniques</p> <ul style="list-style-type: none"> <li>- Willingness to pay via verbal report</li> <li>- Surveys</li> <li>- Questionnaires</li> <li>- Standardized Questionnaire</li> <li>- Willingness to Pay</li> <li>- Willingness to Purchase</li> <li>- Semantic Differential</li> <li>- Ranking</li> </ul>

	<ul style="list-style-type: none"> <li>- A Priori / A Posteriori Questionnaire</li> <li>- Interviews</li> <li>- User Satisfaction</li> <li>- Differential Scale</li> </ul> <p>Subjective Workload Techniques</p> <ul style="list-style-type: none"> <li>- RSME</li> <li>- Average of DQS</li> <li>- Questionnaire</li> <li>- NASA-TLX</li> <li>- RSME</li> <li>- Lateral Position</li> <li>- Number/Duration of Glance</li> <li>- Perceived Distraction</li> <li>- SD of Lane Position</li> <li>- Line Crossing Rate</li> <li>- Speed Loss</li> <li>- PSA-TLX</li> <li>- DALI</li> </ul>
Expertise used/needed	--
Result parameters / description	COMPLETE State of the art of the methodologies used to evaluate IVIS and ADAS applications
Restrictions of the method	--
Key references to the method and its application to ITS used in the study	--

<b>Description of the study</b>	
Study reference	Biding T., Lind G. (2002). Intelligent Speed Adaptation (ISA), Results of large-scale trials in Borlänge, Lidköping, Lund and Umeå during the period 1999-2002. Swedish National Road Administration, publication Publication 2002:89 E.
Availability of electronic version	<a href="http://publikationswebbutik.vv.se/upload/3570/2002_100_E_lund_results_of_the_isa_trial.pdf">http://publikationswebbutik.vv.se/upload/3570/2002_100_E_lund_results_of_the_isa_trial.pdf</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	empirical
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	driver behaviour, safety
Type of assessment (desktop, survey, lab, simulator, field, statistics)	field
Process/design	<p><b>ISA trial</b></p> <p>Umeå, Borlänge, Lund and Lidköping make up the trial towns in the large-scale Intelligent Speed Adaptation (ISA) trial. The practical trial period ran over an eighteen-month period from August 2000 to December 2001.</p> <p>Different systems and technical solutions were tested at the different trial sites. In Umeå a warning system (warning ISA) was tested where the driver received a warning signal (audio and visual) when the legal speed limit was exceeded.</p> <p>In Borlänge a system was tested that with audio and visual warnings for breaches of the speed limit and in addition a display informed the driver about the existing speed limit on the road in question (informative ISA).</p> <p>In Lund a system was tested that supported the driver's speed adaptation through an "active accelerator", which means when the driver has reached the legal speed limit a counter pressure is applied to the accelerator. A display was also used in Lund to show the legal speed limit. This system is called active accelerator or abbreviated active gas. In Lidköping both informative and active gas were tested.</p>

	<p>In total approximately 5000 trial vehicles were included in the ISA trial. The majority, about 4000, have been based in Umeå. The remainder were distributed between Borlänge, Lund and Lidköping. Different functions have been tested in different towns:</p>
Expertise used/needed	traffic safety
Result parameters / description	effect on injury accidents, average speeds and average travel times
Restrictions of the method	-
Key references to the method and its application to ITS used in the study	

<b>Description of the study</b>	
Study reference	Hjälmdahl, M. (2004). In-vehicle speed adaptation. On the effectiveness of a voluntary system (Doctoral dissertation). Lund University Dissertations. Lund, Sweden: Department of Technology and Society.
Availability of electronic version	<a href="http://www.lub.lu.se/luft/diss/tec_747/tec_747_kappa.pdf">http://www.lub.lu.se/luft/diss/tec_747/tec_747_kappa.pdf</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	empirical
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	driver behaviour, safety
Type of assessment (desktop, survey, lab, simulator, field, statistics)	field
Process/design	<p><b>ISA Study</b></p> <p>All 284 test drivers in Lund had an active accelerator pedal (AAP) installed in their own vehicles and they first drove with it for one month without it being activated, this to register data of their normal driving behaviour. They then drove for a period varying from five to eleven months with the system activated. Data was registered in the vehicles and collected from the test drivers throughout the project but it was analysed for three specific periods: the month before activating the system, the first month of use and the last month of use (after five to eleven months of using the system). Control measurements were also carried out in the field.</p>
Expertise used/needed	
Result parameters / description	effect on injury accidents and average speeds
Restrictions of the method	
Key references to the method and its application to ITS used in the study	

## 2.5. Mobility

<b>Description of the study</b>	
Study reference	eIMPACT
Availability of electronic version	D4 (not yet online)
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	ex-ante
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	mobility
Type of assessment (desktop, survey, lab, simulator, field, statistics)	desktop
Process/design	<b>Penetration assessment</b> Estimation of penetration rates (passenger cars, goods vehicles), using information on current fleet composition and mileage, as well as information on the year of market introduction and the (expected) market acceptance of systems.
Expertise used/needed	traffic engineering, travel behaviour
Result parameters / description	Penetration rates of different ITS applications in the future
Restrictions of the method	-
Key references to the method and its application to ITS used in the study	the estimated penetration rates have also been used in the CODIA project

## 2.6. Traffic flow

Description of the study	
Study reference	eIMPACT
Availability of electronic version	D4 (not yet online)
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	ex-ante
Description of the method and its application in the study	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	traffic flow
Type of assessment (desktop, survey, lab, simulator, field, statistics)	desktop
Process/design	<p><b>Traffic simulation</b></p> <p>The assessment of traffic impacts. The analysis distinguishes between direct and indirect effects:</p> <ul style="list-style-type: none"> <li>- direct traffic effects on the traffic flow, e.g. changes in speeds and headways (analysed using micro-simulation)</li> <li>- indirect traffic effects in terms of reduced congestion, due to avoided accidents with fatalities and injuries.</li> </ul>
Expertise used/needed	driver behaviour, traffic flow theory, statistics
Result parameters / description	change in average speeds, headways and travel times
Restrictions of the method	-
Key references to the method and its application to ITS used in the study	

<b>Description of the study</b>	
Study reference	Kulmala R. et al. (2008). CODIA Final study report. Deliverable 5.
Availability of electronic version	
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	ex-ante
<b>Description of the method and its application in the study</b>	
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	traffic flow
Type of assessment (desktop, survey, lab, simulator, field, statistics)	desktop
Process/design	<p><b>Traffic impact assessment</b></p> <p>The traffic impact assessment carried out an evaluation of the co-operative systems in terms of the effect on journey times at different system penetration rates. The impact assessment was carried out by micro-simulation modelling. There were 8 systems to be evaluated:</p> <ul style="list-style-type: none"> <li>- 3 speed adaptation systems (congestion, poor weather, accident)</li> <li>- 1 reversible lane system</li> <li>- 3 local danger warning systems (congestion, poor weather, accident)</li> <li>- 1 post crash warning system</li> </ul> <p>Except for the reversible lane system, eight different penetration rates were evaluated; these represent the current situation (0%), high and low predicted values for the years 2015, 2020 and 2030, and a year further into the future when the penetration will be 100%. For the reversible lane system, it was assumed that both equipped and non-equipped drivers will be able to use the system and that the decision by a highway operator to switch the lanes does not depend on the penetration rate.</p>
Expertise used/needed	traffic modelling
Result parameters / description	change in average journey times and speeds
Restrictions of the method	-

Key references to the method and its application to ITS used in the study	
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<b>Description of the study</b>	
Study reference	NETWORK EFFECTS OF INTELLIGENT SPEED ADAPTATION SYSTEMS
Availability of electronic version	<a href="http://eprints.whiterose.ac.uk/2489/">http://eprints.whiterose.ac.uk/2489/</a>
Orientation of the study (theoretical/empirical/ex-ante/ex-post/..)	Theoretical/Empirical.
Focus (driver behaviour, travel behaviour, traffic flow, efficiency, safety, environment, mobility, socio-economy)	Traffic flow, safety.
Type of assessment (desktop, survey, lab, simulator, field, statistics)	Lab/field
Process/design	<p><b>Traffic microsimulation</b></p> <p>This paper describes the developments made to enhance a traffic microsimulation model (DRACULA) in order to represent ISA implemented across a network and their impact on the networks. The simulation modelling of the control system is carried out on a real-world urban network (Sweden, the Netherlands, Spain and the UK), and the impacts on traffic congestion, speed distribution and the environment assessed.</p>
Expertise used/needed	-
Result parameters / description	<ul style="list-style-type: none"> <li>- Network total travel time;</li> <li>- Fuel consumption;</li> <li>- Total emissions for pollutants CO, NOx, and HC</li> <li>- Total vehicle-hours spent over a range of speeds (at 5km/hr intervals) for each of the speed limit zones.</li> </ul>
Restrictions of the method	
Key references to the method and its application to ITS used in the study	Intelligent speed adaptation, driver support systems, dynamic network modelling, microsimulation, congestion.