EasyWay VIKING 2007-2012

Overview of ITS evaluations 2007-2012

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Executive summary

The objective of this report is to provide an overview of ITS evaluations in the VIKING area (Finland, Sweden, Norway, Denmark, Lithuania, Estonia and Northern Germany) reported during EasyWay I 2007-2009 and EasyWay II 2010-2012. The report also contains results obtained outside the EasyWay programme during that period.

The overview may be used as a supporting tool for ITS decision makers and professionals to find ITS evaluation results achieved by others and to inform about what have actually been conducted in the field of ITS evaluation in the EasyWay VIKING area.

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1. Introduction

1.1 Purpose and scope of the report

The purpose of this report is to provide an overview of ITS evaluations in the EasyWay VIKING region i.e. Finland, Sweden, Norway, Denmark, Lithuania, Estonia and Northern Germany.
The report contains the latest evaluation results and reports produced during EasyWay I and II (2007-2012). The report also contains results obtained outside the EasyWay programme during that period.

The overview may be used as a supporting tool for ITS decision makers and professionals to find ITS evaluation results achieved by others and to inform about what have actually been conducted in the field of ITS evaluation in the EasyWay VIKING area.

1.2 Background and methodology

The EasyWay VIKING Evaluation Group has the purpose of cross-fertilisation, sharing of knowledge, exchange of information about the impacts, benefits and costs of ITS applications, methods of evaluating those as well as best practices of evaluation, and the group is working towards harmonisation of evaluation methods and practices. The EasyWay VIKING Evaluation Group (VEG) has earlier produced overview reports with evaluations conducted since the beginning of VIKING (i.e. 1996).

Most of the national evaluation reports are written in the national languages, but as part of the horizontal work the VEG has agreed on a common format for short English abstracts (1-2 pages) of ITS evaluations. The format is in accordance with the EasyWay template for reporting evaluation results, i.e. the abstracts do have the same headlines as are in the evaluation reports. Some of the reports are in the full EasyWay format.

Additionally, the VEG has produced a film presentation on evaluations and results from using Variable Speed Limits within the EasyWay VIKING area. The syntheses used for the film are also included in the report. Further, the VEG has produced a synthesis on travel time information services and a synthesis on co-modal information services, which also are included.

Each country representative in the VEG has had the responsibility of providing input on the national evaluations to the report.

The evaluations are categorized according to the EasyWay Activities within which they belong. Some project evaluations will always be difficult to put in a certain category because they cover several ITS services or functions, but in most cases the category is quite obvious. The dilemma mentioned will be there no matter which grouping is used.

2. Evaluation results

2.1 Activity 1.1 Traveller Information and Warning Services

2.1.1 Performance of a pre-trip road weather information service (Finland)

Description of the problem:

Adverse road weather is a major transport problem causing problems related to accessibility, safety and throughput of the transport system in Finland. Without any supportive information, road users are not capable of making the correct decisions concerning trip making, mode choice, route choice, and target speed choice nor operating their vehicle with proper caution in the prevailing conditions.

Description of the ITS project:

The road weather service is a traffic information service that provides road users with information on predicted road weather conditions, via the Internet and as part of weather forecasts broadcast on television and radio. The service collects and combines data on road weather, road maintenance and current weather, and forecasts the development of road and weather conditions based on this data for the next 24 hours.

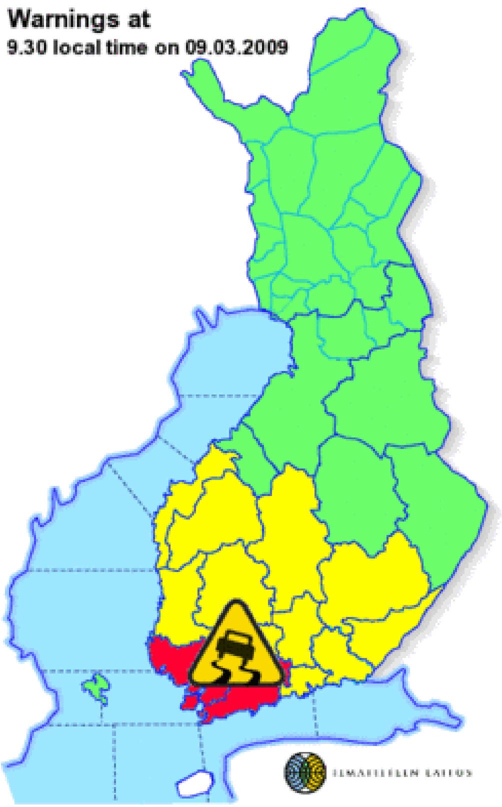


Figure: pre-trip road weather information service on TV.

Evaluation (timing, type, methods):

The study was an ex-post evaluation. The aim of the study was to determine how well the objectives of the road weather service were met. That is to say, how often the different road weather classes were predicted, how the predictions succeeded and whether the drivers were warned about the conditions on days with a markedly high accident rate. The study examined more carefully the winter seasons 2004–2007 and made a summary of the years 1997–2007 with the help of earlier studies. Hence, the assessment concentrated on the technical performance of the service.

Impact of the project (technical performance, impacts):

Based on the study the road weather service has in its ten year history succeeded in its objective to focus road weather warnings. In 1997–2007, poor road weather conditions were predicted about 27–35% of the time and hazardous conditions 2–5% of the time. This means that reference values prepared at the beginning of the service are proven to be functional and there is no need for remarkable changing the road weather classification behind them at least in the near future.

Studying accidents showed that warnings were usually successfully focused on days with a distinctly high accident rate. However, there was also days, when the road weather service has forecasted poor or hazardous road weather condition, but the amount of accidents was low. Detailed study of these days could be reasoned. In future, warnings about poor road weather conditions may increase especially in East and North Finland if the climate changes.

It is important to forecast poor road weather conditions already the previous evening. It is also important to predict the first and last slippery road conditions. During the three more detailed studied years, poor or hazardous road conditions on accident-prone days were well warned of in advance. In the studied data the most typical poor road weather condition was a low pressure and snowfall coming from West. In many cases the difficult road conditions were also caused by the very cold temperature. Predicting these conditions is especially important, since the slipperiness cased by cold temperature is especially hard to notice by the driver.

Transferability of results:

The results are applicable to all countries with advanced road weather related monitoring and information management systems as well as the institutional structures enabling this type of service to be provided as a public utility to road users.

Reference:

Niina Sihvola, Pirkko Rämä, Ilkka Juga (2008): Liikennesäätiedotuksen toteutuminen ja arviointi 2004–2007 ja yhteenveto 1997–2007. [Determining the successfulness of the road weather information service 1997–2007]. Helsinki 2008. Finnish Road Administration 15/2008. 84 p. + app. 18 p. ISSN 1457-9871, ISBN 978-952-221-067-8, TIEH 3201095.

2.1.2 User views of and reactions to road weather information (Finland)

Description of the problem:

Adverse road weather is a major transport problem causing problems related to accessibility, safety and throughput of the transport system in Finland. Without any supportive information, road users are not capable of making the correct decisions concerning trip making, mode choice, route choice, and target speed choice nor operating their vehicle with proper caution in the prevailing conditions.

Description of the ITS project:

The road weather service is a traffic information service that provides road users with information on predicted road weather conditions, via the Internet and as part of weather forecasts broadcast on television and radio. The service collects and combines data on road weather, road maintenance and current weather, and forecasts the development of road and weather conditions based on this data for the next 24 hours. The service has been in operation from 1997.

Figure: Adverse weather conditions are common in Finland.

Evaluation (timing, type, methods):

The study was an ex-post assessment. The objective was to produce information for developing the information on road weather conditions. This was done by determining how drivers experience different road weather conditions and how their impressions relate to the Road Weather Information Service forecasts, whether the drivers had received information on the road weather conditions and whether they had made any changes in their behaviour or travel plans based on this information.

The material for this study was gathered via interviews at service stations (24 %) and on the roadside (76 %). In total, slightly over 300 drivers answered. 180 of the interviews were carried out in poor or hazardous road weather conditions. Information on the speed of the drivers was available for the roadside interviews.

Impact of the project (technical performance, impacts):

The forecast class by the Road Weather Information Service was poor or hazardous during 61 % of the time the interviews took place. About 75 % of respondents rated the road weather conditions to be poor or hazardous. Snowfall was most often mentioned as a factor affecting the current road weather conditions.

The drivers’ estimations of the road surface skidding level did not correspond to the information from the road weather stations. About half of the drivers rated the road surface as very slippery or slippery and about half as non-skidding or mostly non-skidding. The opinions of the drivers did not depend on whether the road surface was skidding or non-skidding according to the road weather station.

62 % of drivers had received or looked for information on weather and road conditions before the start of their trip and/or during the trip. The most common sources of information were radio and TV. The share of information received via the Internet was notably higher than in previous studies. In the future, the drivers wished to receive information also through mobile services in addition to the traditional information sources. The information on road weather conditions corresponded well to the drivers’ own experiences. Drivers that were less experienced, had driven for a long time before the interview and were on a trip they did not do frequently, were more likely to have acquired information on weather and road conditions than other drivers.

In general, those who had looked for or received information on the current weather and road conditions rated the conditions worse, the road surface more slippery and the accident risk higher than those that had not received this information. In some of the survey locations those drivers that had received information on road weather conditions drove more slowly than other drivers.

Every fifth respondent stated that they had changed or considered changing the travel plans for their current trip because of the road weather conditions either before the trip or during the trip. The change mentioned most often was allocating more time to the trip. The road weather condition information was most often stated to lead to increasing the distance to the preceding vehicle, focusing attention to the road surface, avoiding overtaking and lowering travel speed. As the information affecting behaviour the most efficiently the drivers estimated warnings affecting main roads shown on a map on province level as well as verbal descriptions of the weather and road conditions. Also individual and focused information, e.g. information on road maintenance, was supported..

Transferability of results:

The results are applicable to all countries with advanced road weather related monitoring and information management systems as well as the institutional structures enabling this type of service to be provided as a public utility to road users.

Reference:

Niina Sihvola and Pirkko Rämä (2008): Kuljettajien käsityksiä kelistä ja kelitiedotuksesta – tienvarsihaastattelu talvikelissä [Drivers’ opinions about road weather conditions and road weather information – interviews during winter conditions]. Helsinki 2008. Finnish Road Administration 16/2008. 62 p. + app. 10 p. ISSN 1457-9871, ISBN 978-952-221-069-2, TIEH 3201096

2.1.3 New Travel Time VMS in Gothenburg (Sweden)

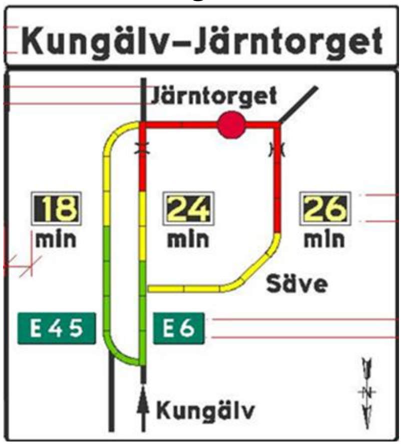
Description of the problem:
Dynamic travel time information can be presented through a number of means, such as VMS. The layout of a travel time message on a VMS board can be designed in different ways. Two new types of design has been tested. The impacts of these needed to be evaluated and compared.

Description of the ITS project:
Two alternative types of signs for presenting travel times are compared. The first type is a permanent road sign with unchanged route text and embedded LEDs showing actual travel times. This sign is called a numerical sign. The other sign type has embedded LEDs formed as a stylized map of alternative routes to specified destinations including travel times. The traffic accessibility is illustrated by different colors along the routes. This type of sign is called a graphical sign.

The main objectives of the ITS project are to:

- Compare travel time understanding and cost-effectiveness of alternative VMS signs.
- Improve traveller information quality and inform travellers about traffic disruptions.
- Make travellers choose alternative routes in congested situations.

Numerical sign



Graphical sign

Evaluation (timing, type, methods):
A user evaluation was carried out in 2011 after implementation (ex-post evaluation). The user evaluation was conducted using telephone interviews with 603 drivers. The interview consisted of both open questions and quantitative questions with alternatives to choose from. Respondents were selected from travellers on the specific roads with VMS signs through number plate recognition. Only private drivers were interviewed – not professional drivers such as taxi and truck drivers.

Impact of the project (technical performance, impacts):
The VMS signs with travel time information were noticed by the users. Nine out of ten interviewed drivers have noticed the graphical sign and six out of ten have noticed the numerical sign.

User acceptance is high, with most drivers state that VMS signs with travel time information is a good thing. Regarding the aim of the VMS signs, the most common answer from the drivers is: “To enable travellers to choose a faster route”.

The signs have had effect on user behaviour: 19-28 % of users state that they have changed behaviour because of the graphical sign and 16-19 % because of the numerical sign.

Respondents are more positive towards the graphical signs than the numerical signs. The graphical signs are perceived as more visible. A common way to use the VMS sign is to turn on the radio to find out if there is additional traffic information available.

Transferability of results:
Similar results could be expected in other European countries testing travel time information signs. The methodology with telephone interviews of drivers passing the VMS sign is also applicable to other countries. The impact of the sign is dependent on what types of signs are placed along the roads in other countries.

Reference:
Trafikverket (2011). Utvärdering av restidsskyltar. Susan Lorentzen, Frida Karlsson Trivector Information AB; Björn Carselid, Carina Claesson Trafikverket.

2.1.4 Test of new road sign with accident pictogram (Sweden)

Description of the problem:

VMS (variable message signs) are increasingly used to give the road users current information about the traffic situation and events of temporary nature on the nearby road network. In recent year several DRIPs (dynamic road information panel) have been installed, particularly in the large town areas. These have message panels for free text and incorporated variable road signs. Road signs with pictogram explaining the nature of an incident are preferred since they are independent of language and they will release text lines for supplementary information. A new road sign “obstacles due to accident” has been developed and tested in full scale.

Description of the ITS project:
The road sign “Obstruction due to accident” has been developed with a pictogram designed in accordance with international proposals within EU as well as UN. The sign was implemented in the databases for activating traffic messages on the DRIP’s in and around the two largest cities in Sweden, Stockholm and Gothenburg. It has been operational since spring 2008. During the test phase until Dec 2009 an extra frame included the

text ”accident” was incorporated at the bottom of the sign.

Evaluation (timing, type, methods):

The study was an ex-post evaluation. User attitude surveys were carried out in Stockholm 2008 and in Gothenburg 2009 (Vägverket, 2010). The survey method was post enquiries, which made it possible to show and test alternative illustrations of the design for DRIPS including the sign with accident pictogram to the respondents. Questionnaires were distributed to ~1000 persons in each of the two cities. The responders were selected through license plate registrations of passing vehicles. A total amount of ~500 answers was received in each city which means more the 1000 all together.

Impact of the project:
Only about 30% of the respondents say they have ever seen the activated sign. A reason for this might be that the sign is not particularly conspicuous and therefore not remembered. An explanation could also be that the majority of the drivers did not actually pass by a traffic information board when the road sign was activated.

A clear majority (80-90%) have a fairly accurate idea of what the sign means. This shows that the understanding of the meaning of the sign is high. A majority of the drivers claim that the accident road sign affects their driving behaviour. Most of them (75% in Stockholm and 62% in Gothenburg) raise their attention, many try to get more information and a surprisingly large proportion is trying to take an alternative route, especially in the Gothenburg study where there are access to a good alternatives.

More than 90% believe that there is a need for a separate, variable accident road signs. A similar proportion thinks it is very or quite important to use an accident pictogram which also foreign motorists can understand. The majority (67%) prefer a message design with which include the accident road sign instead of the traditional sign 'Other danger'. One of four participants stressed the need for better location information on the DRIP:s.

Transferability of results:

The results are probably applicable to all countries enabling this type of service to be provided as a public utility to road users.

Reference:
Lindkvist et al (2006) Bättre trafikinformation – Resultat av Fasan-projektet. *(Improved traffic information. Result of the Fasan project)* Vägverket Publication 2006:101. (in Swedish, no English summary).
Anders Lindkvist, Movea (2010) Utvärdering av försök med olycksvägmärke på trafikinformationstavla, Sammanfattande slutrapport, Vägverket

2.1.5 New Dynamic Road Sign Activated together with Speed Limits at Poor Air Conditions (Sweden)

Description of the problem:
Several studies have shown a correlation between high speeds and negative

environmental effects such as noise and emission. This study evaluates if information about poor air quality can help reduce speeds and thereby improve the local environment. The effect of air quality information displayed together with changed speed limits is also studied.

Description of the ITS project:
The evaluation site consists of two road sections on E6, northbound direction in the southern part of Gothenburg. There is no VMS sign on the southern road section; the sign is located 1 km ahead of the evaluation site. This means that only about appr. 50% of all drivers travelling on the first road section could read the first VMS sign since about half of the traffic approach the evaluation section from a side road. All drivers pass the second VMS sign, located between the two test sections. The first sign only displays an environmental message about poor air quality and an appeal to lower speeds, whereas the second sign also includes speed limits that are lowered from 90 km/h to 70 km/h.

Evaluation (timing, type, methods):
Two ex-post evaluations were carried out in 2010 and 2011 during two weeks each. The 2010 study included traffic speed measurements and a user evaluation survey. During the first week a message was displayed to drivers, whereas during the second week the message was given together with new displayed speed limits. The evaluation in 2011 was a follow up study to see if speed reductions would be greater during winter when there is a higher risk of poor air quality. Message combined with reduced speed limits where given in both evaluation weeks of the follow up study. The follow up study focused on speed measurements and did not include a user survey.

Impact of the project (technical performance, impacts):
Results of the user survey shows that around 70% of the respondents have seen the VMS sign. The percentage increases somewhat for the signs that include speed limits. 60% of the speed. Interestingly, more than 80% state that they will reduce their speed next time they pass such a VMS sign based on increased knowledge gained through the survey.

There is a large difference between presenting a message solely and combining the message with changed speed limits (green line). This is especially true for the first road section. One reason is that only 50% of drivers on road section 1 had the chance to see the message sign. The impact of combining message and variable speed limits is a reduction of speeds with about 9% in average for the two road sections.

Transferability of results:
Similar results might be expected in other European countries evaluating environmental messages and variable speed limits. The site on E6 in Mölndal had an existing infrastructure with VMS signs and variable speed limits, which facilitated implementation. Winter conditions did not affect the results, which increases the chances of transferability to warmer countries.

Reference:
Trafikverket 2010-08-24. Utvärdering av miljöbudskap. Peter Wessel, Inmind Scandinavia AB and Björn Carlsson, Sweco Infrastructure AB.

Trafikverket 2011-06-09. Utvärdering av miljöbudskap på VMS vinterförhållanden på E6 i Göteborg sträckan Åbro-Kallebäck. Raja Ilijason, COWI AB.

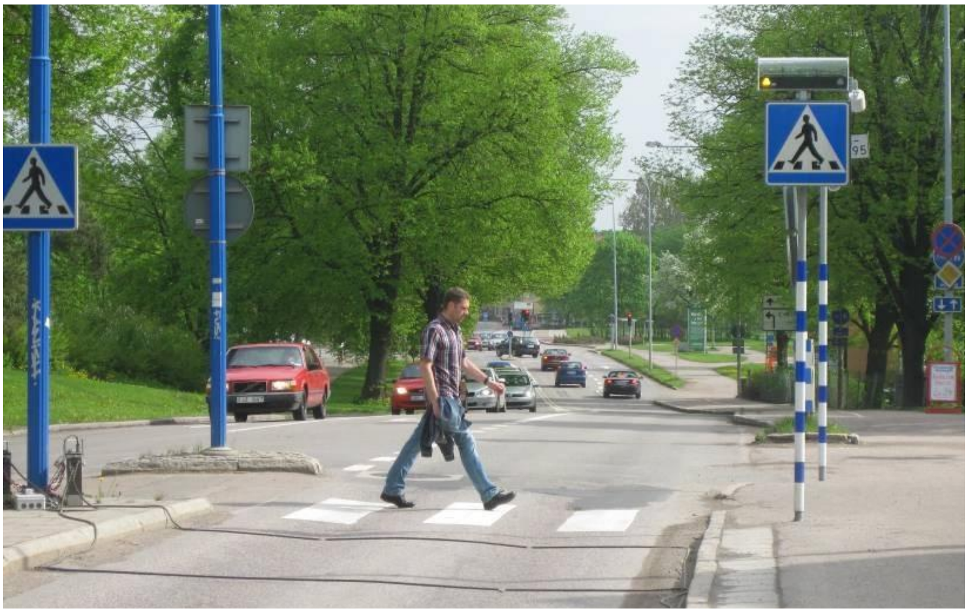
2.1.6 Evaluation of enhanced information at pedestrian crossings (Sweden)

Description of the problem:

There is a need to increase driver's attention to spots where vulnerable road users are crossing busy roads. The reason is that several accidents have occurred when drivers passing-by have not noticed pedestrians or cyclists. To get an idea of the extent of the problem, an analysis of data from the national swedish accident database (STRADA) was carried out. An extract from this database shows that over the last three years 750 accidents occurred every year at pedestrian crossings in Sweden. Thus there is a need to take actions.

Description of the ITS project:
Three sites were selected for evaluation. They were chosen based on results from the initial general accident analysis. Two of these had already FIVO equipment installed. These sites are located in Åhus and Båstad, both located in the southern province of Skåne. Reference sites without the information system were selected close to the test site. The third site was established in Linköping.

The overall objective is to show the consequences of the enhanced information system in terms of changed speed of passing vehicles and to explore the views from vulnerable road users and drivers.



Test site in Linköping

Evaluation (timing, type, methods):
The evaluation took place 2009-2010. It comprised four parts:

1. Accident analysis
2. Identifying existing information system (FIVO) and choice of test and reference sites
3. Speed measurements (test sites / reference control sites)
4. Road user Interviews

Impact of the project (technical performance, impacts):

The results show that most accidents at the crossings take place in urban areas, close to intersections where the speed limit is 50 km/h. Probably most people cross the roads at pedestrian crossings why many injuries are reported there.

For the selected sites, the results of speed measurements show a significantly lower speed (~ 2.2 km/h) when the information system was activated compared to when there is no such system.
Both pedestrians and cyclists perceive that the systems contribute to their feeling of being safe and secure. They also believe that motorists to a higher degree stop and let the pedestrians pass. Drivers feel that the system facilitate their detection of pedestrians and cyclists at the crossing point.

Transferability of results:
The possibility of obtaining a positive effect, similar to the evaluation results, depends on the preconditions on site. Good results require the driver to have good opportunities to see the enabled information system and the pedestrians.

Reference:
VTI (2010), Statens väg- och transportforskningsinstitut; Utvärdering av effekten av förstärkt information vid övergångsställe (FIVÖ); Anna Anund och Beatrice Söderström, VTI; VTI notat 16-2010

2.1.7 TeleFOT

Description of the problem:
Many intelligent transport services provided by nomadic devices are already part of the daily lives of road users, but information about their actual impacts on road safety, for example, has not previously been available.

Description of the ITS project:
TeleFOT is a large-scale collaborative project under the seventh Framework Programme, co-funded by the European Commission DG Information Society and Media within the strategic objective "ICT for Cooperative Systems". Started on 1 June 2008, TeleFOT aimed to test the impacts of driver support functions on the driving task with large fleets of test drivers in real-life driving conditions. In particular, TeleFOT assessed via Field Operational Tests (FOTs) the impacts of functions provided by aftermarket and nomadic devices, including present mature services and future interactive traffic services that will become part of driving environment systems within the next five years. Field Operational Tests developed in TeleFOT led to a comprehensive assessment of the efficiency, quality, robustness and user friendliness of in-vehicle systems, such as ICT, for smarter, safer and cleaner driving.

Evaluation (timing, type, methods):
Field Operational Tests developed in TeleFOT were aimed at a comprehensive assessment of the efficiency, quality, robustness and user friendliness of in-vehicle systems, such as ICT, for smarter, safer and cleaner driving. FOTs were organized in three test communities in Northern (Finland, Sweden), Central (Germany, UK, France) and Southern (Greece, Italy, Spain) Europe.

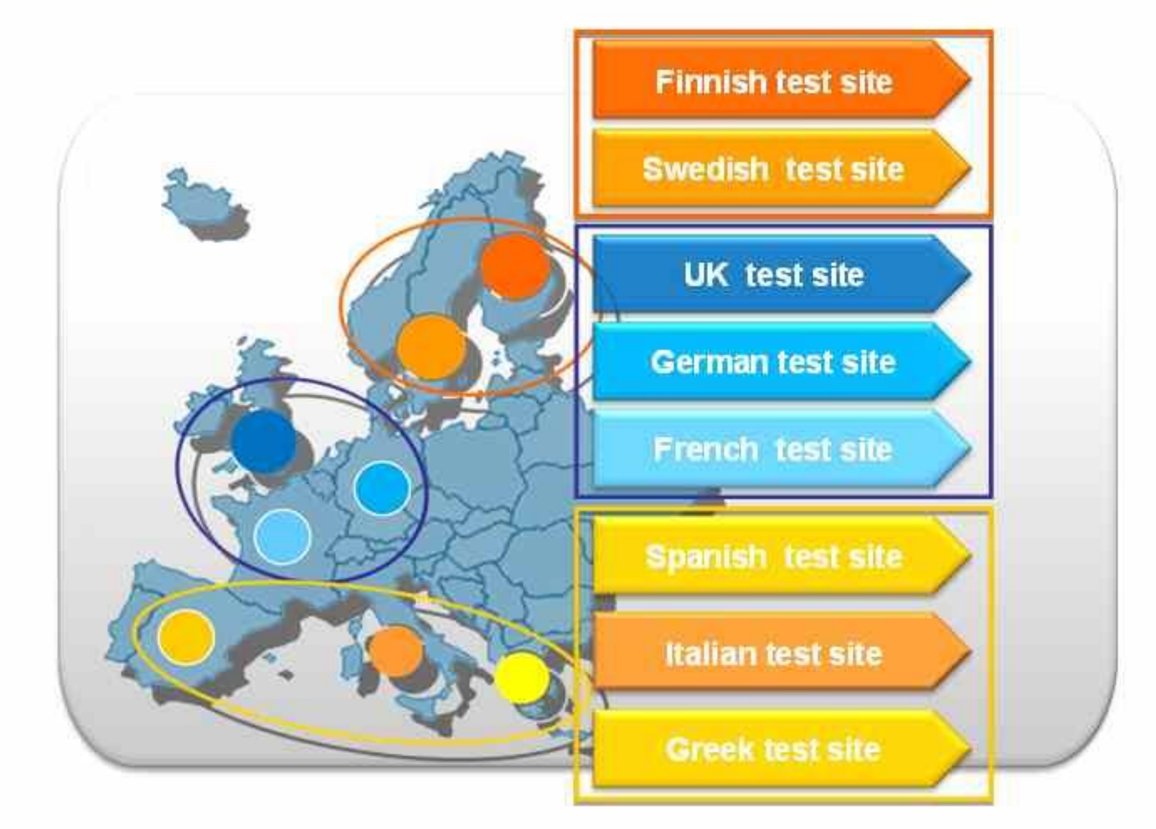


Figure 1: TeleFOT test sites

The tests were planned in two phases: first, short and long term testing were performed with a large number of vehicles. In the second phase, detailed testing with a limited number of subjects with instrumented cars was carried out. In the tests, drivers had access to smart phones and navigators and the effects of the services they provide to support driving were tested. Prior to any field operational tests, the usability and safety of the devices and services was studied carefully in laboratory conditions.

Impact of the project (technical performance, impacts):
In conclusion, navigation and traffic information had both positive implications for mobility in terms of amount of travel, travel patterns and journey quality (increased feeling of safety and comfort and decreased uncertainty and stress), and for efficiency by alleviating existing volume and by reducing driving with dangerously small headway. Traffic information had positive implications also for the environment by leading to routes with higher speed in urban areas but the environmental impacts of navigation support were small and no influence could be shown on fuel consumption and CO2 emissions. Both functions had twofold

implications for safety as expose was reduced but routes were changed to road type with higher accident risk.

Another main conclusion is that green driving support had positive implications for environment by reducing fuel consumption on average 4%. The implications for mobility and efficiency were twofold: increased both in distances and durations but also in journey quality aspects. However, the implications for safety were negative due to longer exposer and use of roads with higher accident risk.

Third conclusion is that speed information had smallest impacts of all tested function in all impact areas. Mobility was improved only by increase in journey quality. Efficiency found only secondary effects and the implications for environment were limited. No results indicated any change in safety indicators.

In conclusion, participants expectations for all of the different functions tested within TeleFOT were high but they became more negative as the FOTs progressed. By the end of the FOTs, the participants positive again about the functions.

Participants assessments of the designs of the devices were positive but there were some negative views. Acceptance of the devices changed over time – acceptance results in usage rather than vice-versa.

Transferability of results:
Results are transferable to similar driver support systems. TeleFOT provided opportunities to test the impacts of similar functions that future cooperative systems will provide after their development challenges have been solved in the coming years. In fact, aftermarket and nomadic devices provide an alternative to some important cooperative driving and ADAS functions for many years ahead.

Reference:
www.telefot.eu

2.1.8 TeleBUS: Impacts of a green driving application in city buses on fuel consumption, speeding and passenger comfort (Finland)

Description of the problem:
Road transport CO_2 emissions form an important part of greenhouse gas generated in most developed countries. The most recent figures released by the European Union in 2011 showed that road, rail and shipping transport together was responsible for 19% of total greenhouse gas emissions, with road transport contributing 82% of this share. Among the policy options to reduce these emissions is green driving or eco-driving. Reducing fuel consumption significantly by teaching drivers how to change their driving behaviour is potentially a cost-efficient way to cut energy use and hence emissions.

Description of the ITS project:
A green driving support application, or eco-driving assistance, aims to assist and encourage the driver to drive more economically i.e. fuel efficiently. Specifically,

the driver is provided with information about fuel consumption, appropriate gear selection, acceleration and speed. The fuel consumption and mileage of a bus is higher than of a passenger car. Consequently, the potential of green driving or eco-driving applications on buses is of interest. However, few impact assessment studies are reported in this field.

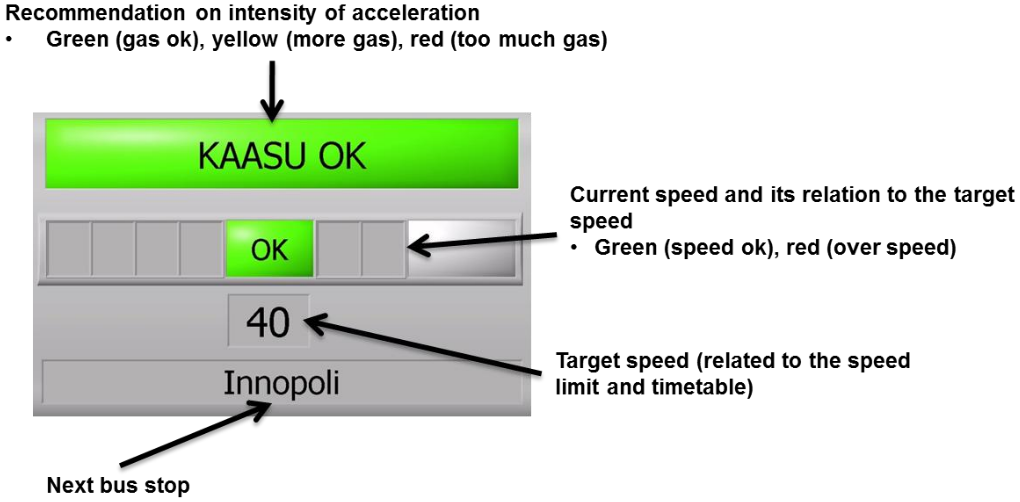


Figure: The HMI for the bus driver.

Evaluation (timing, type, methods):

The purpose of this study was to assess the impacts of a green driving application in city buses on fuel consumption, speeding and passenger comfort. Study was part of TeleFOT (www.telefot.eu) which was a 4-year EU-funded research project aiming to study, through major field experiments, the impacts of driver support functions provided by aftermarket and nomadic devices on traffic flow, road safety, environment, mobility, and drivers' perception of the services.

The study was based on data logged between June 2010 and September 2011 (16 months in total). Data included variables related to e.g. the bus itself (engine speed, fuel consumption, door status, etc.), position (speed limit, bus stops, distance driven, etc.), speed, timing (date, time, course, etc.) and information on display. Data were aggregated per run by speed limit area and the driver category (novel user, long-term user, non-user). Data were divided into three categories (peak, day-time and night-time) according to traffic situation and time of day, and by season (winter and summer). Finally, the impact assessment included data of 17,590 runs for the whole route totalling 475,000 logged kilometres.

Both within- and between-subject designs were applied for the logged data; performance with and without the application was compared within and between groups as follows:

- Impact of application use: (1) Within subjects design for comparing novel users without system before its first activation to their performance with system in treatment phase; analysis was limited to summer time only as treatment phase data of novel users existed only for summer period; and (2) Between-subjects design for comparing long-term users with system to non-users (without system) as no before phase data was available for the long-term users

- Transfer effect: (1) Within subjects design for comparing driving without system before its first activation and in treatment phase; and (2) Between-subjects design for comparing long-term users and non-users both without system

- Novelty effect: Between-subjects design for comparing long-term users and novel users both with and without system

Impact of the project (technical performance, impacts):
The main results showed that use of a green driving application reduces fuel consumption and speeding and increases passenger comfort. Specifically, novel users of the application drove more fuel efficiently in speed limit areas 30–50 km/h with up to 30.0% less fuel. For the higher speed limits the result was dependent on the traffic condition and speed limit combination. The average impact over all traffic conditions and speed limits was 8.9% reduction in fuel consumption due to green-driving application in use for the novel users.

In addition to driving more safely (speeding less) and more economically (with less fuel), passengers of drivers who used the green driving application gave statistically significantly better grades for decelerations, and the driver's service attitude in peak traffic. The same but not statistically significant tendency was found for keeping to timetables. No difference was found in daytime traffic.

In conclusion, the use of green driving support system is beneficial for safety, economic and passenger comfort even after years of use. The novel users had greater benefits of using the system than the long-term users. Thus there is a novelty effect that decreases in time. However, the long-term users had a transfer effect also when they were not using the system. Novel users did not have it so the transfer effect (although smaller than the effect of actual use of system) takes more time to develop than the four months treatment period that was included in this dataset. Therefore continuous encouragement on the use of system is recommended in addition for green driving to be included in driver training. Finally, we conclude that it would be beneficial to install a green driving application in all vehicles and to instruct all drivers to follow the recommendations given by the system, which would help maximize its benefits.

Transferability of results:
In comparison with earlier studies suggesting that education on eco-driving reduces fuel consumption by 5–10%, our results suggest lower estimate if the education is not supported by a green driving support application. It was also stated that eco-driver assistance systems could reduce road transport's CO_2 emissions in EU27 by 5–15% if the penetration of such a system and driver compliance were both 100%.This proportion appears also high when looking at the long-term user results (2.9–3.8% overall reduction in fuel consumption). However, as bus drivers do not pay for their fuel, their motivation for economic drivers may be smaller than regular drivers if no other motivation or encouragement is provided to them.

Reference:
TeleFOT (2008). Telefot project website: www.telefot.eu
Sihvola, Niina; **Innamaa**, **Satu**; Penttinen, Merja. 2012. Impacts of a green driving application in city buses. 19th ITS world congress, 22 - 26 October 2012, Vienna, Austria. ERTICO; EC; ITS

2.1.9 INTERACTION

Description of the problem:
Understanding driver interactions with In-Vehicle Technologies (IVT) was the main objective of the project INTERACTION. Amongst all the available IVT, INTERACTION decided to focus on mature technologies, i.e. technologies already available on the European market and adopted by a sizeable proportion of car drivers. The very first activity of the project was to select the IVT to investigate. After a detailed investigation, four IVT have been selected according to their availability on the European market and their associated stakes in terms of Human / Machine Interaction issues and road safety.

- Longitudinal control: Cruise Control (CC), Speed Limiter (SL) / Speed Alert (SA)
- Trip information: Navigation system, as a nomadic device (NS)
- Infotainment: Mobile phone, as a nomadic device (MP)

The objectives of INTERACTION were:

- • To gain a better understanding of driver interactions with IVTs
- • To focus on technologies already available on the European market
- • To identify patterns of use of these systems by European drivers in everyday life
- • To analyse their effects on driver's behaviour and skills, in normal and conflict situations;

Description of the ITS project:
Four types of IVT were studied. These were chosen to represent commonly used IVTs across
Europe. They were:
• Cruise control (CC)
• Speed limiter (SL) or Speed Alert (SA)
• Navigation system (NS)
• Mobile phone (MP)

Evaluation (timing, type, methods):
The general methodological approach designed for INTERACTION project was based on an innovative combination of well-established and new research methods: focus groups, questionnaire survey, naturalistic observations, and in-depth observations.

The purpose of this combined approach was to associate, in an only research protocol, self-reports of behaviour and opinions and observations of behaviour by collecting and analysing both qualitative and quantitative data. This comprehensive approach could also be applied to investigate differences and similarities, in terms of opinions and behaviours, at both micro and macro levels: that is at the individual and country levels.

Four methodological techniques were applied to address the project objectives:
1. Focus groups discussions of IVT use held in six countries
2. Web-based questionnaire on IVT use distributed to survey panels in nine countries
3. Naturalistic driving study of IVT use in seven countries
4. Observational driving study of IVT use in seven countries

Impact of the project/naturalistic part (technical performance, impacts):
The study indicated that the IVT systems investigated are used on a regular basis in everyday traffic. The study also showed that part of the use is in conditions that are not recommended by the manufacturer for safety reasons (Cruise Control, Navigation System). The study also revealed that participants actively operated the navigation system and the mobile phone while driving. From previous research we know that these interactions increase risk as they draw the eyes of the road and distract the driver from the driving task. Based on this, it is recommended to consider safety of interacting with these devices when developing the systems.

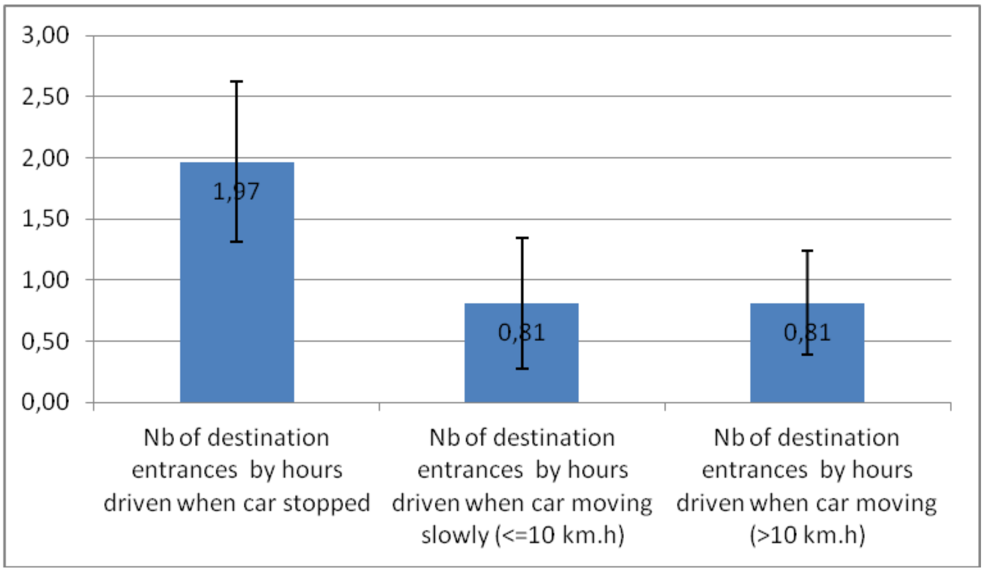


Figure: Number of destination entrances by hours driven with NS according to the speed of the car.

Also policy makers need to be aware of the risk of using these systems while driving and consider how to influence drivers behaviour by their policy.

Based on the results of this study it is recommended to further investigate the use of IVT while driving and the risks involved. To study risk, a larger sample size is required and the relation with safety critical events need to be made. To study safety effects of interactions with navigation system and mobile phone, it would be of major interest to study glance behaviour and investigate differences in glance behaviour while operating such a system or having a phone conversation compared to baseline driving behaviour.

Transferability of results:
The studies were conducted in several countries, and the cross-cultural differences were investigated.

Reference:
http://interaction-fp7.eu/index.php

2.1.10 Temporary ITS applications during major road works on motorway E22 / A1 in Northern Germany

Description of the problem:
The pavement reconstruction on the Weser Bridge between junctions Bremen-Arsten and Bremen-Hemelingen had been partly carried out in 2009 leading to severe problems in traffic flow and rising accident numbers. When the lanes in direction of Osnabrück where due for repairs in 2010 a high level of congestion was to be expected especially at peak times. Therefore, the measure focused on providing an alternative route for long distance traffic and managing inflowing traffic on the junction close to the construction site.
Although ITS measures have been in use on this motorway segment for several years, there have been serious concerns whether it would be efficient to have temporary ITS installations only for the comparatively short period of the road works. Thus a full scale external evaluation has been carried out to gauge the cost-efficiency and the socio-economic benefits derived from the application.

Description of the ITS project:
Two systems have been used: VMS-panels for a long-range re-routing of traffic and ramp metering at the motorway junction nearest to the construction site.
The temporary installation of a dynamic rerouting system and ramp metering at one junction had the main objective to increase the network efficiency during the road works and to minimise congestion.
Through the use of LED-panels at motorway interchanges around Bremen, the road users have been informed well in advance about the current traffic situation on the E22 / A1. In case of congestion an alternative route has been proposed. As this alternative route has only a limited capacity, the decision whether to display a route recommendation or not has been carried out manually by the TMC Bremen.

Evaluation (timing, type, methods):
The evaluation has been carried out during the implementation period. The temporary ITS measures have been in place during the complete road works period i.e. from 06.04.2010 to 25.06.2010.
The main focus of the evaluation was assessing whether both ITS measures had a significant impact on the network efficiency by reducing congestions. The socio-economic value of saved travel times (collective benefit) were to be compared with the costs of the measures. Both measures were assessed individually.
For the dynamic rerouting, the study area covered both the regular route (with the road works site) and the alternative route which is equal to a large share the Bremen metropolitan highway network. The ramp metering focussed on the area

affected which is the motorway between junctions Bremen-Arsten and Bremen-Hemelingen. The evaluation of the ramp metering was done by comparing the average traffic speed measured with and without the ramp metering system

Impact of the project (technical performance, impacts):
Extensive data analysis, field observations and GPS measurement runs proved travel times for trucks on the alternative route to be up to 40 minutes shorter than on the normal route. Compared to the refitting of the opposite carriageway in 2009, there was also a significant reduction in accident numbers. On the basis of traffic data it could be shown that whenever a detour recommendation was given, a significant share of traffic could be shifted to the alternative route. E.g. about 44% of truck drivers at the Stuhr interchange followed the recommendations. The cost-benefit-analysis for the temporary re-routing system included apart from traffic data socio-economical data concerning the cost of congestion and fuel consumption whereas accidents and reduced CO_2 emissions have not been included. The temporary traffic rerouting with LED-panels scored a very good cost-benefit-ratio of 6.0, which demonstrates the high benefit of the measure. This ratio equals a socio-economic benefit of 750000 € compared to costs of 125000 €. The ramp metering scored only 1.54. This is due to the fact, that during the peak hours in the morning and the afternoon the motorway was congested. The ramp metering could not change this situation and had its positive impact on traffic flow only at off-peak times.

Furthermore, it could be observed that there was a significant drop (roughly 60 %) in accident numbers compared to the refitting of the opposite lanes in 2009. However, as the accident numbers depend on multiple factors (i.e. road layout, curve angles etc.) it is not valid to compare the values from 2009 (without ITS measures) to lower values from 2010 (with ITS measures in place) because both situations are not identical. Therefore the socio-economic analysis excluded the road accidents.

Although several positive factors have not been taken into account, the positive cost-benefit-ratios prove that the supporting ITS measures worked as intended. The increased safety and efficiency are the most important factors for making it likely that ITS will be used in similar situation in the future. ITS can be an important tool in dealing with traffic problems, even if these problems are only temporary.

Transferability of results: The general knowledge that can be derived from these results is well transferable. When planning extensive road works, one should consider ITS measures for traffic management as a temporary solution as they can effectively tackle congestion and safety problems. For temporary installations, compromises can be acceptable so that e.g. the system has to work with a reduced number of inductive loops or require manual input.

Reference: Momatec (on behalf of the City of Bremen): Study of the traffic management system during the reconstruction of the pavement on the Weser Bridge (motorway A1) English Summary Report, October 2010.

The full scale evaluation report is available in German language upon request from the Bremen ministry of transport. Please contact Jan Bembennek (+49 421 316 18299, jan.bembennek@bau.bremen.de).

2.2 Activity 1.2 Services for pre-trip Travel Planning

2.2.1 Multi-modal Traveller Information Service, Trafikken.dk/ Hovedstaden (Denmark)

Description of the problem:
The multi-modal traveller information portal www.trafikken.dk/Hovedstaden covers the Greater Copenhagen Area. It provides relevant real-time information for *all* transport modes gathered on one portal.
The service is covering a problem area where motorways (TERN) are passing by a large metropolitan area.

Description of the ITS project:
The objective is to provide travellers with a complete overview of the status of the transport system, i.e. all relevant information on current situation for all transport modes. Furthermore, the objective is to improve the mobility by shifting journeys from private car to public transport or bikes, and to increase the number of combined trips where private car and public transport are combined (Park and Ride).
The Greater Copenhagen service is merging public transport information systems already existing and the road traffic information on the national portal www.trafikken.dk. It also includes updated information for cyclists. The service can be seen at www.trafikken.dk/Hovedstaden.
The service covering Greater Copenhagen is one of several similar Internet based Multi-modal Traveller information services covering problem areas where motorways (TERN) are passing by large cities.

Evaluation (timing, type, methods):
The service was launched to the public in March 2007.
Different ex-post evaluations have been conducted:

- Web statistics were/are generated continuously
- 3 user surveys on the web site have been conducted in June 2007, November 2007 and April 2008
- Traveller awareness of the service: Two times 1.000 telephone interviews have been conducted, the first time in October 2007 and the second time in May 2008
- Interviews by telephone of radio stations in November 2008

Impact of the project (technical performance, impacts):
Technical performance: The web site has a very good technical performance with almost no system failures. The web site had some errors in the beginning though, but it has been very stable since then.

The results for each of the success criteria are summarised below:

Success criteria	Result of evaluation

20 % of the target group should be aware of the site after one year	32 % after one year and two months
500.000 visits on the web site the first year	261.000 visits the first year
80 % of the users are "very satisfied" or "satisfied" with the site	81 % (in the last survey)
80 % of the users find the information "very relevant" or "relevant"	95 % (in the last survey)
10 % of the users have changed behaviour at least once due to information on the site	72 % have changed route, 63 % have changed time, 66 % have changed mode at least once
3 % of the car drivers among the users have changed travel mode at least once from their private car to public transport, bike or park-and-ride due to information on the site	4-5 % of the private car drivers have changed to another mode at least once

The results are overwhelmingly positive with respect to the success criteria for behavioural changes. The users are willing to change their behaviour and they do so to a much larger degree than expected.
All success criteria, except number of visits, have been fulfilled. Although the number of visits is considerably lower than the target, the information provided on the site is widely disseminated through other channels than the Internet, e.g. radio stations use the web site for traffic announcements. Furthermore the site is used by the TV-station TV2 News etc.

Transferability of results:

The results are difficult to transfer to other regions, because they depend to a large extent on local factors such as attractiveness, availability, frequency, price etc. of public transport and as well on car ownership, car use and the associated costs.

Reference:

- Trafikken.dk/Hovedstaden, Resultater af brugerundersøgelse på Web, April 2008. *L Dörge, C von Huth, N Wellendorf, M Kjøller*
- Trafikken.dk/Hovedstaden, Statistik for antal besøg, Oktober 2008. *L Dörge, C von Huth, N Wellendorf, M Kjøller*
- Trafikken.dk/Hovedstaden, Resultater af kendskabsanalyse, Maj-Juni 2008. *L Dörge, C von Huth, N Wellendorf, M Kjøller*
- Trafikken.dk/Hovedstaden, Udbredelse af informationen på sitet, November 2008. *L Dörge, C von Huth, N Wellendorf, M Kjøller*

2.2.2 Evaluation of bilrejseplanen.dk (Denmark)

Description of the problem:
Bilrejseplanen.dk (Car route planner) is a co-modal planner comparing travel between origins and destinations (A to B).

The co-modal planner includes the following travel mode possibilities:

- Walk/cycle from origin to bus/train, use a number of busses and trains, walk/cycle to destination
- Use car from origin to destination
- Use car from origin to P/R location, use a number of busses and trains, walk/cycle to destination

Included in all trips can be ferries, which are included with their real time schedules.
Included in all car trips are delays due to congestion based on historical data.

Description of the ITS project:
With the main purpose to motivate car drivers to consider using public transport, the Danish Road Directorate (DRD) and Rejseplanen have developed a co-modal travel planner. When a car driver searches for a route in the co-modal planner he will be presented for the public transportation (PT) alternative and if relevant even a route combining car and public transport (park and ride). All the car routes are based on realistic travel times, which mean rush hours are included. The planner's suggested routes are compared on travel time, costs and environmental impact.

In setting up a co-modal planner, the main challenge is getting the data. In Denmark the two most difficult data sets to gather is high quality PT travel plans and car travel times including delays due to congestion, are available. Fortunately, gathering these data was already undertaken by Rejseplanen and DRD. Rejseplanen has undertaken the work with PT travel plans and have collected and integrated all data into one fully functioning PT travel planner (see Rejseplanen.dk). DRD has used probe vehicles with GPS to calculate travel times for cars on all major roads. Currently the DRD has data that reflect congestion down to ½ hour intervals in rush hours based on an average weekday, but it is expected that this resolution will be even better in the future.
Most car route planners today include ferries by simply considering a ferry to be a fixed delay on the trip, which makes sense as the current car route planners do not need to take departure time into consideration. With a congestion aware travel planner the departure time becomes important as travel times varies during the day and therefore, the travel schedule of the ferry should be included. Ferry schedules as data format are comparable to PT transport. This leads to a very complicated planning algorithm as many different types of travel can be involved in the end.

Evaluation (timing, type, methods):

Autumn 2009:	Beta version opens
April 2010:	Full operation
Autumn 2010:	Added traffic information
November 2010:	Evaluation
Spring 2012:	Reorganized to let Rejseplanen take main responsibility
June 2012:	Evaluation report (this abstract is based on the report)

Evaluation was carried out by questionnaires on the website and interviews of car drivers. The data collection was carried out in the period from 22nd June to 4th November 2010.
The interviews of car drivers were undertaken as telephone interviews, where a selection criterion was that the respondent should be an active car driver.

Impact of the project (technical performance, impacts):
The system has been running very stable in the whole operational period. Down time has been very limited (few hours) and the response time of the system is very high.
Traffic flow: The results show a net effect of 5 % of the users shifting from car transport to public transport one or several times. 1/3 of the users have changed travel time due to use of Bilrejseplanen, which is a very positive result regarding more efficient use of the transport network.
Safety: With 5 % of the users periodically shifting from car transport to public transport there is a positive effect on safety, since the fatality risks are considerably lower for public transport than for the private car.
Environment: With 5 % of the users periodically shifting from car transport to public transport there is a positive effect on the environment.
Other key results: A significant service improvement has been achieved with integration of P&R, real time ferry tables and realistic travel times.

The capital cost is estimated to 200.000 €.
The annual operating cost is estimated to 100.000 €

The low capital and operating costs is due to that most of the systems and data were already developed in other projects, so the co-modal planner project only had to fund the marginal extra costs.
Rejseplanen had already a very complete public transport planner running and had both map function and routing function included. DRD had already calculated the travel times with congestion. So the job was actually to extend the planner to handle car trips and P&R trips, which were possible at a reasonable cost.

Transferability of results:
Co-modal planners are being developed all over Europe. As Bilrejseplanen was one of the first comodal planners to be available for the general public the results are very important for a better understanding of the impact of comodal planners. The results gained from the evaluation of Bilrejseplanen is of a very general nature and can be transferred and compared to other co-modal planners in other countries in Europe. To facilitate the comparison the detailed questions and answers is provided in the report.

Reference: Vejdirektoratet: *EasyWay: Evaluation of Bilrejseplanen.dk*, Draft version, Date: 20th June 2012. (Report is on EasyWay web)

2.3 Activity 2.2 Dynamic traffic and network management

2.3.1 Traffic management and information on highway E18 (Finland)

Description of the problem:

The road E18 is passing through the Helsinki area and some of its sections often suffer from incidents making travel and goods transport unpredictable. There was a clear need to improve the predictability of travelling and hauling as well as to prevent incidents and to mitigate the effects of the incidents.

Description of the ITS project:

A variable traffic management system was taken into use on highway 1 or E18 between Ring III and Lohja in January 2007. The system includes variable speed limit signs, variable roadside and overhead warning and information signs, weather stations, automated traffic measurement points and traffic cameras. The purpose of the system is to regulate vehicle speeds according to traffic and weather conditions using variable speed limits and provide road users with information on traffic incidents.

Evaluation (timing, type, methods):

The study was an ex-post evaluation of the system made within a year of the implementation of the system. The purpose of the evaluation study was to determine the impact of the system on driving behaviour and traffic safety on one hand, and the attitude of road users toward the new system and its messages on the other hand. At the same time it developed methods suitable for impact studies.

The material which was used in the project, consisted of traffic studies, information produced by the system, Finnra's traffic center's bulletins, and questionnaires directed to road users. Source material was gathered both before and after the system was taken into use.

Impact of the project (technical performance, impacts):

Based on this study, the traffic management system has had a minor impact on driving behavior. The study could not detect considerable changes in the average speed of traffic, but there has been less divergence in speeds during rush hours, which improves traffic fluency and safety. Road users notice the variable signs and react to them, but the effect weakens already after a kilometer. Based on a comparison of accidents, the system has not had any considerable effects on traffic safety or the number of accidents on the section of highway. The system's impact on safety is most evident during rush hour, when the flow of traffic adapts its speed to the traffic situation better than before. The short duration of the study had some effect on the results concerning driving behaviour and road safety.

The study also examined the impact of information on speeds during bad weather and speed control arranged by the police. Speeds were clearly lower during speed control when motorists were informed of the control, although some drivers still clearly exceeded the speed limit. Some road users felt that informing about bad weather was unnecessary, as the weather can be gauged otherwise. On the other hand, road users were especially statisfied with the adverse weather information received via the VMS.

For the most part, road users had a positive attitude toward the traffic management system, yet there is room for improvement. The understandability of the system suffers from the two types of messages given by the signs. On one hand they command and on the other hand they guide and inform. According to road users, the system has only a minor impact on their driving behaviour. Information given by the signs should always be correct and up-to-date so that road users' confidence in the system is preserved. The road users hoped that information on accidents and incidents should be given more in advance than done now in order to enable route changes.

Transferability of results:

Compared to other metropolitan areas in Europe, the Helsinki region suffers from less congestion and more from severe weather problems, but as such the results are probably transferable. However, there were very few quantitative results to be transferred.

Reference:

Jukka Ristikartano, Lotta-Maija Seppänen, Kalle Toiskallio (2008): Telematiikan vaikutustutkimus valtatien 1 välillä Lohja-Kehä III [Impact study of telematics on route 1 between Lohja and Ring III]. Helsinki 2008. Finnish Road Administration, Central Administration. Finnra reports, 66 p. + app. 30 p. ISSN 1459-1553, ISBN 978-952-221-072-2, TIEH 3201097-v.

2.3.2 Cooperation of variable speed limits and automatic speed enforcement (ex-ante) (Finland)

Description of the problem:

In Finland it is not possible to build variable speed limits and automatic speed enforcement on the same road section because the systems are not cooperating and therefore the information about the current speed limit is not transferred to the speed enforcement camera. The amount of both variable speed limits signs and automatic speed enforcement cameras is increasing in Finland and it has already been recognized on several road sections where the use of both systems (on the same road) would be necessary. In the Nordic countries, there is no experience of how to use both variable speed limits and automatic speed enforcement on the same road sections.

Description of the ITS project:

The purpose of the project was to evaluate the cooperation of variable speed limits and automatic speed control. The principle of the co-operation of variable speed limits and automatic speed enforcement was to change the speed limit value in the camera after the previous variable speed limit has changed. Important technical issues were the data transfer rate, effective detection of possible technical problems during the operation and management of the interface between the two organizations (Finnish Road Administration and Police). Technical issues were excluded.

Evaluation (timing, type, methods):

The study was an ex-ante assessment which evaluated the functioning of the implementation in practice. The site for the study was outlined to be an intersection with variable speed limits a few kilometres away from the nearest automatically controlled road section. Both the technical performance and the effects of the system on traffic flow were assessed.

Impact of the project (technical performance, impacts):

It was assessed that the cooperation of variable speed limits and automatic speed enforcement would be most beneficial on road sections where drivers should drive slowly (according to the lowered speed limit) because of safety or throughput reasons for example in bad weather conditions or at an intersection with high traffic volumes.

It was also assessed that when installing cameras it is important to ensure that the driver has a chance to see the previous variable speed limit sign before passing the speed enforcement camera. For example, there should not exist a possible stopping place, like a resting area, between the variable speed limit sign and the speed enforcement camera.

It was assumed that the benefits of the cooperation of variable speed limits and the automatic speed enforcement (compared to either one of these systems alone) could be significant for the traffic safety on the road where otherwise would exist only variable speed limits. In bad road weather or traffic situations, the speed limits should be low and the automatic speed enforcement could strengthen the following of the speed limit. The results of the cooperation could be greater than of either of the systems alone. For example, if the speed limit is lowered 20 km/h and consequently the mean speed reduces 4-8 km/h, the consequence could be 10 km/h with both systems working together.

It was assessed that on a road section, where the use of variable speed limits could be justified based on adverse weather, road or traffic conditions, the use of both variable speed limits and automatic speed enforcement could cause significant improvement in traffic safety compared to having variable speed limits alone.

Transferability of results:

These results can likely be applied to other road sections with similar systems.

Reference:

Finnish Road Administration. Vaihtuvien nopeusrajoitusten ja nopeuksien automaattivalvonnan yhteistoiminta (Cooperation of variable speed limits and automatic speed control): Helsinki 2007. Finnish Road Administration. 23 p.

2.3.3 Effect of intensified automatic speed control and decreased tolerance on traffic safety (Finland)

Description of the problem:

There is an automatic speed control area on main road 51 between Kirkkonummi and Karjaa in Southern Finland. Prior to the automatic speed control system, 25-41% of drivers exceeded the 100 km/h speed limit and 1.4-1.8% exceeded it by more than 20 km/h. As an effect of the automatic speed control system, drivers lowered their average speed and the proportion of over speeding descended. However, the effect moderated in the course of time.

Description of the ITS project:

In September 2007, intensified automatic speed control was tested on the road section on main road 51. In intensified control, controlled hours were strongly increased, all speeding incidents were reacted to and the public was extensively informed about the control. The current survey examined the effect of intensified control on traffic behaviour, on the number of violations to process and on the workload of the police.

Evaluation (timing, type, methods):

In the survey, the operating time of speed control cameras was increased and the police interference threshold was lowered in a way that all the drivers driving over speed (i.e. due to technical reasons over 3 km/h over speed) were contacted for fines or reprimand. The public was informed about this. The survey was conducted on main road 51 on a 43-km-long two-lane road section. The speed limit was 60-100 km/h depending on the location. The trial period was September 2007. The speeds of the trial period were compared with the speeds of the previous month.

Impact of the project (technical performance, impacts):

As a result of the intensified control and the lowered penal threshold, the average speed of the traffic decreased 3–4 km/h at various measurement points. Later, speeds slightly increased; the long-term effect is thus estimated to be 2–3 km/h. During the survey, the share of both major (more than 20 km/h) and minor speeding dropped to half, and at some measuring points to a third. The traffic speed distribution became narrower, and the distance between vehicles grew slightly. The share of drivers driving fairly slowly or very slowly (more than 10 km/h below the speeding limit) increased a little, but the numbers were still so low that they should have no significant effect on the general fluency of the traffic.

During the intensified control experiment, the cameras picked up 3.4% of the traffic volume as speeding, compared to approximately 10% at other times. 0.4% of the traffic volume drove at a significant (more than 10km/h) over speed, the normal share being approximately 3%. Based on the observed change in average speeds it was estimated that in addition to the effect of previous automatic speed control, intensified automatic control decreases the number of accidents leading to personal injury by approximately 7%, and the number of lethal accidents by 13%.

The intensified control of a 43 km road section required the work of 4–6 people. If it were assumed that the results of the survey could be applied as such to the entire road network currently under automatic control, the intensified automatic control would save tax payers approximately EUR 13 million, including savings from fewer accidents. This calculation does not include the annual income of more than EUR 40 million from fines resulting from intensified control since, in a socioeconomic sense, fines are not considered a saving but an income transfer.

Transferability of results:

The results are likely transferable in their direction of impact. The magnitude of the impacts will depend greatly on the police enforcement practices applied in the first place.

Reference:

Mikko Malmivuo and Riikka Rajamäki. Tehostetun kameravalvonnan ja puuttumiskynnyksen alentamisen vaikutus turvallisuuteen (Effect of intensified automatic speed control and decreased tolerance on traffic safety): Helsinki 2008. Ministry of Transport and Communications. LINTU Reports 1/2008, 61 p. ISBN 978-952-201-760-4 (printed version) 978-952-201-761-1 (electronic version).

2.3.4 TRIM Queue Warning, Vejle N (Denmark)

Description of the problem:
TRIM Queue was an automatic queue warning system, which served to warn motorists of possible queue further up the motorway to avoid rear end collisions etc. in the widest possible way.
The reasons for establishing the system was a very high frequency of rear end collisions in the area around Vejle Fjord bridge (frequency of 1,7-1,8 rear end collisions pr. km. pr. year 1999-2003 for both Vejle Fjord and Lillebælt bridges).
The TRIM queue system was established on motorway E45/M60 north of the city Vejle during 2005-2006, and covered the stretch from exit 60 (km. 112.385) to Vejle Fjord Bridge (km. 109.670), equivalent to a distance of approx. 3 km. The

system covered traffic in both directions on the motorway which in both directions (at the time) consisted of two lanes and a hard shoulder with a speed limit on 110 km/h. The system was discontinued in 2009.

Description of the ITS project:
TRIM Queue was an automatic queue warning system, which served to warn motorists of possible queue further up the road to avoid rear end collisions etc. in the widest possible way. The motorists were warned by the use of variable LED signs showing the symbol A20 (Warning sign “Risk of Queue”) when queues were detected. Queues were detected by the use of radar detectors placed alongside the road.

Evaluation (timing, type, methods):
The original evaluation was carried out from September to November 2007. During the writing of this report a decision regarding a larger change of the road stretch covered (including extra lanes etc.) was taken in July 2009. As a consequence of this decision the TRIM queue system was shut down in august 2009.
The first evaluation was carried out after approx. one year of use, and comprised two components:

- A technical examination regarding the technical functionality of the TRIM Queue system
- A user survey regarding the motorists’ opinion and use of TRIM Queue.

The examination and the survey were carried out separately, and attention was paid not to overlap them. The results of the examination and survey have been summarized in the present Note.
In continuation of the original evaluation report from January 2008 accident statistics from 2001 to 2008 has been retrieved from relevant databases and analyzed in November 2009.

Impact of the project (technical performance, impacts):
To evaluate the systems influence on traffic safety data regarding accidents were analyzed in November 2009. The data used were accident data from 2001-2005 and 2007-2008. Data from 2006 was excluded to eliminate effects of the construction work on the site. Data was retrieved for km 109,5 – 112,5 (covering TRIM Queue), and reference data was retrieved for km 99-105 and 115-125.
For the period before TRIM Queue was initiated (2001-2005) there was a total of 9,8 accidents per year from km 109,5-112,5 and 28,8 accidents per year for the reference stretch.
For the period After TRIM Queue was initiated (2007-2008) there vas a total of 10,5 accidents per year from km 109,5-112,5 and 31,5 accidents per year for the reference stretch
Looking at the absolute numbers, the improvement of traffic safety for the stretch covered by TRIM Queue would therefore appear to have worsen by 7,1%, but if one were to expect the same development in the number of accident for km 109,5-112,5 as for the reference stretch covering km 99-105 and 115-125, a total of 10,7 accidents pr. year could have been expected, which leads to a calculated improvement on 2%

The same calculation has been done for different kind of accidents, the results are listed below.

	2001-2005	2007-2008	improvement	Cal. improvement
Total number of accidents pr. year for the area covered by TRIM Queue	9,8	10,5	-7,1%	2,0%
Accidents involving multiple vehicles travelling in the same direction pr. Year for the area covered by TRIM Queue	7,0	6,5	7,1%	26,6%
Rear end collisions pr. Year for the area covered by TRIM Queue	5,2	4,5	13,5%	49,1%
Injured pr. year for the area covered by TRIM Queue	3,2	0,5	84,4%	75,9%

As can be seen from the above, TRIM Queue had a very positive influence on traffic safety, even though one should have in mind that the above calculations are based on a short period of data collection after TRIM Queue was initiated (i.e. 2 years), and thus a very low number of accidents, which means that the values have a considerable degree of statistic uncertainty.

On the background of the technical studies it were concluded that TRIM Queue were more or less working according to plan, even though technical malfunctions had been observed which, in respect of the systems' credibility towards the motorists, should be corrected. The most important malfunctions concerned the unprovoked switch off/on of the variable signs, the less important flaw concerned signs that briefly increased light intensity.
On the background of the initial study carried out in 2007 it was concluded that the system to a considerable extent fulfilled the purpose of increased traffic safety. For instance 75% of the respondents thought that the variable signs had a positive effect on traffic safety, and approx. 80% thought that the system contributed to raising the attention of the motorists. This first impression was further supported by the accident statistic analyzed in November 2009.

In continuation of the first evaluation report from January 2008, the Danish Road Directorate repaired the technical flaws discovered through the evaluation, and supplemented TRIM Queue with variable messege signs that could be used to warn motorists about queues at an earlier stage than TRIM Queue allows. Two such signs were put into use in June 2008 at exit 58 and 59 southbound, where the problems with queues were assessed to be worst, and further two signs are currently under construction at the pull-in at Skærup and at exit 61 northbound (at km 99,515 and 116,620), despite the discontinuation of TRIM Queue.
The supplementary variable message signs are thought as a kind of pre-warning about queue ahead. The variable messege signs are text signs, which can be used to display the distance to the queue ahead, and to display other kinds of traffic information.

Transferability of results:
The TRIM queue system didn't involve any specially developed components or functionalities and could therefore be considered a "standard" system, and the

stretch covered by TRIM Queue was normal motorway, even though the stretch covered included small hills and wasn't completely straight which affected sight conditions (see part 1.1).
On this background there is no obvious reason indicating that the results achieved with TRIM Queue couldn't be transferred to other similar road stretches with similar traffic conditions, even though it should be taken into account that driver behaviour varies from country to country and thereby affects the results.

Reference:
TRIM Queue EasyWay Evaluation Report, November 2009, version 1.0 (Anders Bak Sørensen, The Road Directorate, Denmark)

2.3.5 ITS in the Aalborg area, User surveys (Denmark)

Description of the problem:
Upgrading and extending the existing Motorway Control System in order to achieve improved traffic safety, improved traffic flow and a high quality of traveller information.
The ITS system covers approximately 11 km motorway which is a section of E45 passing the city of Aalborg and including the Limfjord motorway Tunnel.
The motorway is a main transport corridor in Jutland, from Norway and Sweden (via ferry links) to Southern Denmark and Germany. The motorway carries substantial regional and local traffic also.
In addition a new web-based traveller information service has been launched and evaluated.

Description of the ITS project:
The system or rather systems were implemented in the 80´s and 90´s. But in 2010-2011 the ITS system was upgraded and extended. The existing signs was changed to new and improved signs. Variable message signs were added enabling information on incidents, queue warning, other warnings and travel time information. The ITS system was also extended to cover more motorway sections. At the same time, the Road Directorate launched a new web-based traveller information service with different applications: Dynamic traffic status map (green, yellow, red), Travel time calculator, playing of user defined historic time intervals (e.g. traffic situation last Monday from 7 to 9). In addition to these functions the user is also able to choose to see current road works and current active traffic messages on the dynamic map, e.g. queue warnings, weather warnings, event information etc. The Traveller Information Service covers the motorway as well as other major routes through and around the city of Aalborg.

The upgraded Motorway Control System covers appr. 11 km in total (different sections in each direction, i.e. sections leading towards the tunnel are equipped).

The overall system comprises detection, IT system, variable speed limit signs and variable message signs with queue warnings and other warnings (e.g. incidents), while travel times are shown when no severe messages are relevant.

Evaluation (timing, type, methods):
Current status of the project (December 2012):
Upgraded ITS system in operation (incl. all new functions): Mid-October 2011
Evaluation: Several evaluations planned in 2012 and 2013. This report (December

2012) is the first report on the evaluations in relation to user surveys.

Impact of the project (technical performance, impacts):
The user surveys reported did not evaluate the impacts on traffic flow, safety or environment – but they evaluated ***the perception of the users*** with regard to these issues.

The overall success criterion was stated before the surveys:
70 % of the road users are satisfied with the ITS system (both traffic control and traffic information).

Results from post card survey: Number of respondents: 1089 persons.
82 % of the respondents have stated that they are “satisfied” or “very satisfied” with the variable signs. Only 4 % have stated that they are “unsatisfied” or “very unsatisfied”. Hence the overall target (minimum 70 % satisfied) was achieved.
81 % of the respondents find that the variable signs have a positive impact on traffic safety.
42 % of the respondents find that the variable signs have a positive impact on traffic flow.
The survey did not contain questions on the environmental impacts.
The specific results in relation to travel times on the VMS are not as positive as the general results:
57 % find the reliability of the travel time information to be “high” or “very high”, but 7 % find it to be “low” or “very low”. Only 44 % find that the travel time information is “useful” or “very useful”, while as many as 25 % find that the information is not useful.
The report suggests a number of factors that might influence the perception of the usefulness of the travel time information.

The report contains further results from a web-based questionnaire also. Number of respondents: 485 persons.

Transferability of results:
The results are about user acceptance, user satisfaction and user behaviour. Therefore local traffic conditions and other local characteristics and circumstances as well as culture are factors influencing the results.

The detailed results are not transferable to other sites, since they depend to a large extent on the local factors, but the overall result in relation to the motorway control system with variable speed limits, warnings and other information seems to be transferable, i.e. user satisfaction is high with this type of ITS system on sensitive motorway sections and the users find that the ITS systems is improving traffic flow and especially traffic safety.

Reference: Vejdirektoratet: *EasyWay Evaluation Report. ITS in the Aalborg Area, Denmark – User surveys.* Draft version. December 2012. ID: VIK27.

2.3.6 Traffic management at road works, Evaluation of variable speed limits at the Holbæk Motorway, M11 (Denmark)

Description of the problem:
During construction along the east/west between Copenhagen and Roskilde, the Danish Road Directorate (DRD) has implemented a system of variable speed limits to prevent a decrease in the motorway's traffic handling capability during construction, as well as to protect contractor personnel working along the motorway. The Holbæk motorway is among the important motorway connections leading to/from Copenhagen and the western suburbs (and Zealand as a whole) carrying approximately 55,000 vehicles a day, is heavily congested during rush hours due to the many commuters travelling to/from Copenhagen. Thus, the DRD are currently widening and improving the motorway, hence the need for the variable speed limits during construction.

Description of the ITS project:
To keep traffic flowing safely at an acceptable speed while also protecting contractor personnel during the construction phase.
The variable speed limit system consists of pairs of variable message signs placed along 4 kilometres of motorway near Roskilde. The speed limits are manually operated by personnel at the traffic management centre (T.I.C.). The speed limit is usually 80 km/h rather than 110 km/h (speed limit prior to construction).

Evaluation (timing, type, methods):
The evaluation has been carried out during end 2009 and early 2010 and comprises traffic data for a period of time before and after the implementation of the variable speed limits. Data includes GPS-based travel time data (approximately one year) as well as user surveys (questionnaire survey among motorists and interviews of contractor personnel).
The purpose of the evaluation was to estimate the impacts of the ITS project on driving speeds, as well as to evaluate user acceptance (both motorists and contractor personnel).

Impact of the project (technical performance, impacts):
The evaluation indicates that the ITS project has caused the average speed to drop by approximately 10-20 km/h during daytime (at times with no congestion) depending on the (variable) speed limit.
When it comes to user acceptance the questionnaire survey carried out among motorists show that the variable speed limits are widely accepted and appreciated. 75 % of the approximately 850 respondents believe that traffic flow has improved as a consequence of the ITS project. Furthermore, 80 % believe that the project has led to an improvement of the traffic safety conditions. However, more variation in the speed limits is requested (depending on the traffic conditions).

On the other hand, the contractor personnel does not feel any safer with the ITS project than without the project (focus is more on safety via barricades etc.).

Transferability of results:
The evaluation results are most likely transferrable to other project sites, although, as is often the case with such projects, one should note that the general

driving behaviour in the country/region of implementation is of critical importance for transferability of results.

Reference: Vejdirektoratet: *EasyWay Evaluation Summary, Variable Speed Limits at Holbækmotorvejen.* November 2010.

2.3.7 Traffic controlled variable speed limits (Sweden)

Description of the problem:
Although the number of people killed and injured in road traffic is comparably low in Sweden (471 killed in road traffic 2007[1]) this number is still not considered acceptable, and there is a constant ambition to decrease it to the greatest possible extent. Variable Speed Limits (VSL) could be one conceivable means to this end.

The overall problem behind the VSL initiative is the very poor compliance with speed limits in Sweden, and the negative effect this has on road safety and traffic throughput. Speed limits that are perceived as well measured, with regard to road standard and traffic conditions, have a higher likelihood of being met with respect than limits that seems overly cautious. With VSL there is a possibility to prescribe mandatory speed limits that adapt to traffic conditions, with decreasing speed limits in dense traffic while still maintaining higher allowed speeds when conditions are good.

Description of the ITS project:
Trials with VSL for different applications were carried out by the Swedish Road Administration in 2003 - 2008. The overall objective is to show if VSL can contribute to better speed adaptation in a cost-efficient way. The test sites were selected to show how VSL could achieve this objective in risky situations. The focus was therefore to gain knowledge about:

- The impact on road safety, accessibility and the environment
- Changes in behaviour, attitudes and acceptance
- Appropriate technology and organization
- Economic considerations, including the socio-economic benefit

The speed limit is temporary adjusted downwards on major roads when traffic becomes dense and queue is building up.

Evaluation (timing, type, methods):
Core objectives for the evaluation were to assess how traffic controlled VSL contributed to

- Speed adaptation and throughput
- Reduction of rear-end accidents
- User attitudes

Secondary effects on accessibility, environment, cost-benefit and road safety were also in the scope of the evaluation in order to get a comprehensive view of the trial.

[1] Vägtrafikskador 2007, SIKA - Swedish Institute for Transport and Communications Analysis 2008:27

There are technical equipment at the trial sites to collect traffic data (foremost flow, speed and density) and to control the VSL system. All VSL activities are logged and analysed together with traffic data. On multi-lane roads the VSL signs are mounted on gantries above each lane. There are also sites where the signs are located at the road side.

Impact of the project:
The overall results can be summarised in short:

Safety
Results from floating car measurements indicate that sudden breaking manoeuvres at low speeds have become less common. A follow-up for Mölndal after two years of operation shows that the accident ratio, that is the number of accidents per million vehicle kilometres, has been reduced by 20 % for VSL as well as MCS. The statistical basis however is too small to permit definite conclusions.

Efficiency
By using VSL the speed is dropping more slowly. A harmonized flow is obtained on a higher average speed level. Traffic throughput also increases marginally. Time consumption on the E6 sections was reduced by 5-15 %.

Environment
The carbon dioxide emissions and the petrol consumption for the Mölndal and the Tingstadstunneln sections have increased slightly as a result of the raised speeds. This is also the case for Ölandsbron while the environmental impacts on Norrtäljevägen seem to be marginal.

User acceptance
A majority of drivers show a positive attitude to traffic controlled VSL. The drivers at the Mölndal section do not comprehend the difference between the variable road signs with a red ring (regulatory speeds) and without a ring (recommended speeds). Fairly many drivers admit that their respect for speed limits has improved following the launch of variable speed limits.

Transferability of results:

Variable speed limits seem to be an effective means for handling congestion and growing queues especially where the speeds tend to suddenly fall dramatically. This is especially valid on busy arterials with recurring capacity and traffic safety problems. Sections that are curvy, hilly and have road passages breaking the sight line could be suitable candidates for VSL.

Reference:
Lindkvist A, Movea (editor) (2008a) Variabel hastighet. Trafikstyrd väg. *Variable speed limits. Traffic controlled roads*. Vägverket Publ 2008:98
Lindkvist A, Movea (editor) (2008b) Variabel hastighet – en lysande idé. *Variable speed limits – a bright idea*. (in Swedish with English summary) Vägverket Publ 2008:77.

2.3.8 Time Controlled Variable Speed Signs in Gothenburg (Sweden)

Description of the problem:
The effect of the time controlled variable speed signs are evaluated in order to understand if traffic safety have improved, traffic flow throughput increased and average speed reduced.

Description of the ITS project:
The site is located on E6 north of Gothenburg in Sweden. The speed limit is 110 km/h for cars and 90 km/h for trucks. During peak hours trucks are only allowed to drive in the rightmost lane. Nine time controlled variable speed signs have been deplayed since 2008. These signs are activated during weekday peak hours (southbound 6.00-9.00 AM and northbound 3.00-7.00 PM). During these times they show 90 km/h. Posted speeds are mandatory.

Evaluation (timing, type, methods):
The reported evaluation is of before-after type. Speeds and flows were measured in 2008 before implementation of the speed signs and in 2009 after the start-up of variable speed limits on the evaluated road section.

Impact of the project (technical performance, impacts):
Traffic flow did not increase as much as expected when time controlled speed signs were implemented. The reason is that the road section was at capacity limit and average speed was already below 90 km/h during peak hours already before implementation of the new speed signs. The system recovers however faster with the new speed signs. The report recommends that flow needs to be decreased or capacity increased for the road section to work properly. Capacity could be increased by building an extra lane. To conclude, time controlled variable speed limits has not had any negative impacts on the road section in question, but did not increase capacity. The signs do however give a signal to drivers to increase their attention, which could be a reason for the fewer accidents.

Transferability of results:
Similar results could be expected in other European countries implementing time controlled variable speed signs. There is no reason to believe that the main conclusion that variable speed limits has little impact on road sections which are at capacity limit should be any different in other countries. Reliability of flow and speed measurements could however increase in countries where weather conditions do not differ so much from year to year as in Sweden.

Reference:
Trafikverket (2010). Utvärdering av tidsstyrda hastigheter, Klareberg-Rödbo, Göteborgs kommun, Västra Götalands län. Johan Larsson och Anna Jägemalm, Tyréns AB, Björn Carselid, Trafikverket.
Carlsson (2010). Tidstyrning E6 Göteborg sträckan Klareberg-Rödbo. Arne Carlsson, VTI. Trafikverket Intern PM, 2010

2.3.9 Environmentally adjusted speed on E18 (Sweden)

Description of the problem:
Along the busiest roads in Stockholm, established standards (EQS – environmental quality standard) of particle levels are frequently exceeded. A study revealed that several schools and kindergartens in the county are located in areas where levels are above or close to the standards. In addition to measures aimed at reducing traffic volume and the share of studded tires, there are only a few measures that are effective in reducing particle pollutant concentration. Such a measure with some potential is to reduce the average speed along the roads.

Description of the ITS project:
The trial section includes part of the E18 north of Stockholm, between junctions Danderyd Hospital and junction Danderyd Church, in both directions. Variable speed limits are applied in the southbound direction of this road section. The trial equipment included four stations for measuring emissions and meteorological data and two stations for measuring traffic data.

Some topics covered in the study are:
- Relationship between vehicle speed and traffic contribution to particle concentrations
- What can environmentally adjusted speed limits mean for the total particle concentrations?
- What is the impact from traffic on climate and noise?

Evaluation (timing, type, methods):
Data collection took place according to plan during two periods between March and May 2009 and December 2009 and May 2010. Except for flow and speed measurement and emission/meteorological data collection, counts were made of vehicles using studded tires. Supplementary data from other road stretches in the region were used for comparison.

Some questions for the evaluation are:
- What are the variations in traffic flow and vehicle speed?
- What are the monthly variations in road temperatures and precipitation?
- What is the share of vehicles using studded tires?
- What are the daily variations of PM_{10} and NO_x
- What is the predicted relationship between vehicle speed and PM_{10}-level?
- How can environmentally adjusted speed limits influence PM_{10} concentration?

Impact of the project (technical performance, impacts):
The results are in line with the outcome from several earlier studies. When using studded tires, road wear increase. In addition to the speed the wear is dependent on type of road surface, type of studs and whether the road surface is dry or damp.
Analysis of measurements from E18 and the reference road sections in Stockholm shows that vehicle flow is the single most important factor affecting PM_{10}

(particulate matter; include particles with diameters <10 µm) levels.

- The emission factors for PM_{10} were found to be similar and significant in all three measured road sections, which show that the correlations are reliable.
- Speed reduction also reduces the mean concentration of PM_{10} - for example – a 10 km/h reduction in average speed would decrease the concentration by around 13%.
- To reduce the number of days with levels above 50 $\mu g/m^3$, from 49 during the measurement period to fewer than 35 (EQS - environmental quality standard), the average speed had to be reduced by slightly more than 20 km/h (if only speed is used as a tool for change of pollution levels).
- If the average speed during the daytime (06-18) would be reduced by 5, 10 or 20 km/h - this would mean 4, 8 and 12 fewer days with concentrations of PM_{10} above the limit 50 $\mu g/m^3$ (EQS).

Transferability of results:
The possibility of obtaining a positive effect, similar to the evaluation results, depends on the preconditions on site. This study applies for roads with studded tires. The road types studied are highways with speeds in the range of 50 – 100 km/h. The methodology used is applicable at other sites, irrespective of road, tire and vehicle conditions.

Reference:
Trafikverket (2011), Trafikverket; Miljöanpassad hastighet på E18, Danderyds kommun, Stockholms län, Publ 2011:042; Christer Johansson SLB-analys, Lars-Olof Landerfors, Lars Dahlbom, Hanna Eklöf Trafikverket

2.3.10 Travel time and bridge-opening information using VMS north of Gothenburg (Sweden)

Description of the problem:
Variable message signs (VMS) are commonly used on roadways to give travellers information about special events, warn of traffic congestion, accidents, incidents, roadwork zones, speed limits on a specific highway segment or give dynamic information on e.g. road conditions or travel times.

The purpose of the signs is to convey updated information to travellers in order to enhance effectiveness in the traffic system, give higher value to road users, and avoid possible worsening of critical situations (accidents, congestions etc).

One type of information that can be conveyed by the VMS are travel times and bridge-opening information, giving the driver support in the decision making process of choosing route.

Description of the ITS project:
The Swedish Road Administration has located VMS at entering roads to the city of Gothenburg. Some of these signs show projected travel times for two different routes (E6 or E45) arriving at the same destination while other signs show

projected time to specific destinations on a defined route (time to travel from the position of the VMS to Ullevi- and the Åbrointersection).

The task of the evaluation study has been to assess to what extent commuters passing the VMS has noticed the information and the information has been useful to them.

Evaluation (timing, type, methods):
The study has been carried out using focus groups with commuters who are exposed to the VMS. The commuters have been divided in to two groups coming from two different suburbs north of the city that are commuting down to destinations in central and south-central Gothenburg.

Impact of the project (technical performance, impacts):
The result of the focus groups shows that:

- all of the focus group participants has noticed the travel-time information
- only a few have noticed the bridge-opening information
- the information has been easy to understand
- the relevance of the information is high, routes and destinations are easy to relate to and recognise for all the participants
- participants have doubts of the accuracy in the forecasts
- higher understanding and faith in the accuracy would lead to extended use
- the information has rather small direct impact, to prompt a change of route e.g. participants wanted a time difference of at least 10 minutes
- the participants wished to see VMS of this type on more places and for different routes
- Participants didn't want too much information but were interested also in information about accidents and about reasons for unexpected congestion
- There was a wish to get information from many different channels; directly in to the car navigator, on the radio and on the internet page of the Road Administration

Transferability of results:

The results are applicable to all countries. The result that a time difference of 10 minutes is necessary to change route confirms earlier results from other countries.

Reference:

Vägverket Väst (2007) Rapport Digitala skyltar, Vägverket_Vast_707_digitala_skyltar_rapport_071228_ML.pdf (*Report focus groups VMS*, in Swedish, no English abstract)

2.3.11 Technical evaluation of section-based automatic speed enforcement (Norway)

Description of the problem:

It was already in 2002, during the development of digital cameras for automatic speed enforcement (ASE), a plan for implementation of a section-based system for ASE in Norway. By measuring the average speed over a distance the drivers will adapt their speed to the actual speed limit over the whole distance, and not just slow down when passing the speed enforcement camera.

Description of the ITS project:

The test implementation was established on a 2,8 km section of E6 north of Lillehammer in Norway, in southbound direction towards Lillehammer. The posted speed limit is 80 km/h, and there are no exits between measurement point A and B.

The core of the concept is:

- Taking picture of every single vehicle in measurement point A. Licence plate and/or axle distance and axle load is registered automatically. The information is temporarily stored and the automatic identification is transmitted to point B
- The same automatic identification and photo of all vehicles are collected in point B. Synchronised time for the equipment in A and B
- By matching the registrations it is possible to calculate the travel time and average speed from point A to B
- If calculated speed exceeds the posted speed limit, all information is stored for enforcement. If calculated speed is below posted speed limit all information about vehicle and driver is deleted

In measurement points A and B pictures of high quality should be taken in order to verify that it is the same driver and vehicle. It must be possible to identify the driver, and also identify that it is the same driver, in the images from both measurement points

Evaluation (timing, type, methods):

Section-based ASE raised technical and legal questions, and especially issues related to protection of privacy. It was decided to focus on the technical performance of the systems only, and no enforcement was carried out during the test period. Therefore, only a technical evaluation was carried out, and the main focus was on:

- Does the ALPR system work properly?
- How many vehicles can be identified?
- Does errors occur in the identification process?
- What is the experience with the IR flash?

Impact of the project (technical performance, impacts):

<u>Licence plate recognition</u>

ALPR is an important part of section based ASE. The quality of the OCR software is essential with regards to identification of vehicles and matching of identified vehicles in two or more measurement points. The number of mismatched vehicles will influence the quality and operating cost for the system.

NPRA have evaluated the OCR software. 118093 vehicles passed by A and B in the actual period of two months. Approximately 93% of the vehicles were matched in point A and B by using OCR, axle distance and axle load. 91 % of the vehicles were matched only by using OCR. 3260 vehicles drove faster than the posted speed limit, and 0,67 % (22 veh.) of these were wrongly matched. These few mismatched vehicles would have been sorted out and handled manually, by comparing images from A and B, if the system were in operation.

Development of invisible flash

The requirements for image quality and resolution are the same for section based ASE as for conventional, cross section ASE. The main difference is the number of pictures that has to be taken without maintenance or shifting of the equipment. This requires a flash that lasts significantly longer than ordinary flashes used for ASE, and it was therefore developed a special IR-flash for the purpose.

The IR-flashes was tested during a period of ¾ of a year, and was in operation for 80 % of the test period. Each flash was in use more than 500.000 times, without any change in brightness or stability. A regular flash with visible light has to be changed after approximately 4-5000 pictures.

Transferability of results:

The results are applicable to all countries that use automatic speed enforcement in general, and section-based automatic speed enforcement in special.

Reference:

Terje Giæver, Arild Ragnøy, Trine M. Stene, Fridulf Sagberg (2007): Evaluering av Nullvisjonsprosjektet på Lillehammer, Delrapport 1: Samlet evaluering av alle vegtiltakene. [Evaluation of the Vision Zero-project at Lillehammer]. June 2007. SINTEF Technology and Society. 58 p. + app. 6 p. ISBN 978-82-14-04142-2.

2.3.12 Evaluation of public transport measures in Trondheim (Norway)

Description of the problem:
The Norwegian city of Trondheim, with a population of 175.000, introduced Real Time Passenger Information (RTPI) on 200 buses and 27 bus stops throughout the greater city area in February 2011. At the same time, bus signal priority was introduced in some 50 junctions with traffic signals.

RTPI was implemented to reduce bus dwell time at bus stops and to increase passenger satisfaction on public transport in Trondheim. SPOT and bus priority was implemented to reduce bus delay at signalized intersections and to reduce total bus travel times.

Description of the ITS project:
Two separate systems were evaluated;

I) RTPI on bus stops and on-board buses
II) SPOT and bus priority at signalized intersections.

The main objective of the evaluation was to test if some initial hypotheses made at the time of decision to implement the system held. These assumptions were:
RTPI will:

- Reduce bus dwell time
- Reduce passengers waiting time

- Increase passenger satisfaction
- Increase the total number of passengers

SPOT and Bus signal priority will:

- Reduce total bus travel time
- Reduce bus delays at signals
- Not cause considerable delay for car traffic
- Not cause considerable delay for pedestrians and bicyclists

Evaluation (timing, type, methods):
The evaluation was done from December 2010 until April 2011. And the methods used were before/after-study and user survey/interviews.

A web-based questionnaire was carried out from 3-13 of May 2011. A total of 1221 persons responded, and 1066 of these were in the target group and completing the questionnaire. The evaluation was limited to the city of Trondheim, for bus lines where both passenger information and bus priority systems were implemented.

Impact of the project (technical performance, impacts):
The RTPI system contributes to a reduction of passenger waiting time at bus stops and increased customer satisfaction. The system has probably not contributed to a reduction of bus dwell time at bus stops or an increased number of passengers. Based on the assumptions made, RTPI has a net socio-economic benefit of 18:1.

The evaluation of SPOT and bus priority reveals a great benefit, primarily for car traffic, of implementing SPOT. Implementation of bus priority has limited benefit for the bus travel times, while it contributes to a significant increase in travel times for the car traffic. There is some uncertainty with respect to the results from the evaluation of the SPOT/bus priority system due to a short registration period.

Transferability of results:
The observed impacts of such implementations will vary depending on the similarities of the site, prerequisites and conditions. The methodology is transferable, but be aware of the mentioned uncertainties in this evaluation.

Reference:
SINTEF. *Evaluering av enkelte kollektivtrafikktiltak i Trondheim vinteren 2011. Innføring av sanntidsinformasjon og nytt signalstyringssystem med bussprioritering.* Unn Karin Thorenfeldt, Dag Bertelsen, Liv Øvstedal. SINTEF report no: A20460.

2.3.13 Motorway A2 (Corridor E 30) Appraisal and additional Assessment of the Benefits of a Line Control System (Germany)

Description of the problem
Corridor A2 (E30) forms an important long distance corridor connecting Eastern Europe with Western Europe. A 2 is a motorway with high traffic loads and in particular a high share of HGV. This share exceeds 20%, sometimes reaches 30% and is increasing more during the recent years. This motorway suffered a high and increasing accident rate. And, often HGV are involved in these accidents. To improve the traffic situation and safety motorway control systems have been implemented earlier on most stretches of the motorway.

The motorway section addressed is a part of this A2, a 6-lane motorway located in Niedersachsen close to Braunschweig. The section has a length of 33,900 km and is located from km 169,80 to 203,7. For the section assessed in the appraisal a general speed limit of 120 km/h was introduced as temporary solution. Furthermore an overtaking ban for HGV is discussed.

Description of the ITS project:
Line Control Systems control the motorway traffic depending on the actual traffic situation by speed limits, HGV overtaking bans, congestion and accident warnings etc). As result the traffic flow is expected to become more stabilised with the consequence of less congestion and in particular reduced accidents.

A line control system is planned on the section addressed in order to carry out an traffic-dependent speed limit and to get the opportunity to instruct the overtaking ban for HGV only during the times when it is necessary.

The line control system comprises all necessary components: Gantries, VMS, monitoring stations, data transfer facilities and sub control centre for the system.

Evaluation (timing, type, methods):
An appraisal has been carried out during 2006 (Cost-Benefits Analsysis). An additional ex-ante-evaluation is carried out during 2009.

The evaluation (ex-ante evaluation) shall assess whether a dynamic line control system is advantageous compared to a static speed limit and static HGV overtaking ban. A further assesment (ex-ante-evaluation) shall provide more detailed information on the benefits

Impact of the project (technical performance, impacts):
The appraisal showed positive results. The benefit-cost ratio is 6.1 whereby a ratio which exceeds 1 recommends the implementation of the system. Thus the implementation is highly recommended. The further ex-ante-evaluation is still ongoing.

Transferability of results:
The results should most possibly applicable to all countries with similar problems

References: Errichtung einer Streckenbeeinflussungsanlage auf der A2 im Bereich zwischen AS Lehrte-Ost und AK Braunschweig-Nord, vereinfachter RE-Entwurf für eine Betriebserrichtung, Juli 2008 (Appraisal/Cost-Benefit-Analysis)

Untersuchung zur Ermittlung des erzielbaren Verbesserungspotentials durch eine SBA auf der A2 zwischen der AS Lehrte-Ost und dem AK Braunschweig-Nord.(additional Ex-Ante-Evaluation, Interim Report).

2.4 Activity 4.1 Deployment of monitoring infrastructure

2.4.1 Link speed monitoring feasibility study (Sweden)

Description of the problem:
Average link speed monitoring (ASM) is used in many European countries, among others in the Netherlands, UK, Germany, Italy for fair and efficient enforcement of excessive speeds. The possibilities with average speed monitoring its to further improve traffic safety, reduce the number of fatalities and severely injured, and to reduce environmental impact from road traffic through more homogenous speeds and reduced average speed.

Description of the ITS project:
The task of the feasibility study has been to shed light upon the possibilities to use automatic average speed monitoring as an extension of the current spot speed system in the framework of the existing legislation. The feasibility report was intended to be used as a basis for a possible Swedish test of link speed monitoring in Sweden. Due mainly to the fear for integrity problems, the decision was not to recommend average speed monitoring for use in Sweden.

Evaluation (timing, type, methods):
The feasibility study has been carried out with the following activities:

- Literature study, Interviews, Study visits
- Workshops within the areas technical solutions, legislation, impacts and HMI
- Attitude survey using focus groups
- Analysis and compilation of gathered documents and facts

The feasibility study has been going on between February 2008 and October 2008.

Impact of the project (technical performance, impacts):
The result of the feasibility study shows that ASM:

- Is technically feasible as a further development of the current spot speed enforcement system.
- Has a substantially higher demand for correct measurement and synchronisation of time.
- Is juridically feasible. Strong arguments in the form of documented social benefits are however necessary.
- Is possible to establish based on the same criteria as spot speed enforcement. The distance between two measurement points should however be limited to less than 3 km (this distance is chosen to exclude objections concerning change of drivers).
- Gives a more homogenous traffic rhythm and reduces average speed more than on a corresponding spot speed enforced link. Has given a reduction of killed or severely injured (KSI) of 50% or more in England and Holland. With Swedish legislation the impact is estimated to ca 37 %.

– Most road users find a link speed enforcement system to be more fair than the current spot speed enforcement system. Measurement of average speeds will lead to less ”time serving”, meaning that drivers slow down at a camera spot and then drive faster between them.
– There is a risk that link monitoring is not accepted to the same extent as spot monitoring as there is an evident risk of a negative debate concerning the personal integrity.

Transferability of results:

The results are applicable to all countries with rules for driver recognition as a pre-condition for law enforcement and high sensitivity for integrity aspects.

Reference:

Rikspolisstyrelsen, Vägverket (2008) Förstudierapport. Förutsättningar för automatisk medelhastighetsmätning av fordon på Väg. (*Link speed monitoring feasibility study*) STRÄCK-ATK. (in Swedish, no English abstract)

2.4.2 Evaluation of the pilot on traffic monitoring using floating phone data (Germany)

Description of the problem:
Information on the traffic situation, congestion, incidents etc. is very important for informing the drivers and for traffic management purposes. Besides the classical means for traffic monitoring (loops, radar etc.) also the use of the mobile phone network (i.e. “floating phone data”) could be an option for improving the traffic monitoring, generally or for specific purposes.

Description of the ITS project:
The project investigated as a pilot the use of floating phone data for traffic monitoring purposes on a 30 km long motorway section (motorway A2, between Access Point Veltheim and Access Point Lauenau) in Northern Germany. This section also includes a road works section with traffic disruptions in particular for HGV. The motorway A2 is characterised by dense traffic and in particular a high share of HGV. The section is equipped with loops and additional some radar detection systems have been implemented so that sufficient traffic-related data could be obtained as basis for the comparison with the data gathered by floating phone data.

Evaluation (timing, type, methods):
The aim of the evaluation was to assess whether floating phone data could be used for traffic monitoring, and for what purposes. The evaluation was carried out as a comparison of the data gathered by floating phone data with the data gathered by the conventional monitoring stations (loops and radar).

Impact of the project (technical performance, impacts):
The comparison shows general good congruence between the conventional data and the data gathered by floating phone data, in particular if traffic is moving. In this case also a good distinction between passenger cars and HGV was possible.

The system showed not so good results in the case of congestion or very slow traffic, in particular a distinction between passenger cars and HGV is not possible. As result are floating phone data generally suitable to show the traffic situation. Disruptions of the traffic are detected. However, due to some inaccuracies should the system not be used for traffic management purposes, i.e. for the controlling of line control systems.

Besides this, floating phone data are assessed as being suitable for
- Road monitoring in areas where up to now monitoring is not carried out
- As temporarily measure for traffic monitoring, i.e. in connection with road works
- As additional data source for RDS-TMC
- As additional source for data for travel times to be used for network control and traffic management.

Transferability of results:
These results may be transferred to other road sections with similar traffic conditions (i.e. motorways). However, the details of the study should be taken into account.
It has to be mentioned that technical progress is very fast in this area. Today some of the disadvantages which have been found during the evaluation are no longer the case. In particular the exact location has been improved and thus also the inaccuracies are decreased.

Reference:
NLStBV Niedersachsen/SSP Consult – Beratende Ingenieure GmbH: Evaluation des Pilotversuchs zur Verkehrsdatenerfassung mittels Mobilfunktechnik (Floating Phone Data): Hamburg 2009. 227 p.

2.4.3 Validation of Bluetooth based travel time data (Finland)

Description of the problem:
Anonymous travel time information can be provided with the means of data provided by Bluetooth. Bluetooth based travel time monitoring was piloted in Helsinki.

Description of the ITS project:
The purpose of this study was to validate the quality and quantity of Bluetooth based travel time data by comparing it to camera based travel time data and loop based traffic volume data.

Evaluation (timing, type, methods):
The validation was based on a 4032 m long Bluetooth travel time monitoring link on Road 51 in Helsinki equipped with Bitcarrier system. Corresponding camera based travel time link was shorter (total length 1732 m). The western ends of these links were very close to each other (approximately 30 meters away). However, as camera based link was shorter it had to be scaled up to match the Bluetooth link. Scaling was done in proportion of the link lengths (4032/1732). Nevertheless, as there are no exit or entrance ramps between the eastern ends of

the links, the travel times should present same vehicles. However, non-homogenous traffic situation may cause error to the results if only congested or fluent part of link is measured and the measurement is scaled up to represent the whole link. Traffic volume information used in the validation was from Hanasaari loop detectors, on western side of the travel time links.

The raw Bluetooth travel time data was one-minute averages that included number of Bluetooth devices (separated to vehicles, phones and other) for which travel time could be measured in addition to average travel times and travel speeds. Five-minute averages were calculated for each minute based on these total numbers of devices and average travel times. Bluetooth based travel time data was from period September 11–25, 2012.

Camera based travel times were based on 5-minute median travel times estimated for every minute. Data was from same dates as Bluetooth-based data. Loop data was one-hour traffic volumes for the same dates.

Impact of the project (technical performance, impacts):
The main results showed that the quality of Bluetooth based travel time data was acceptable from traffic management point of view. It included more variation (standard deviation 9.0–17.0 s) than camera based travel time data (standard deviation 4.8–5.1 s). However, the smaller sample size explained this at least partly as the sample size was in Bluetooth system 30.0–38.2% of the sample size in the camera system.

Transferability of results:
Results can be transferred to other multilane main roads in urban environment.

Reference:
Innamaa, Satu (2012). Validation of Bluetooth based travel time data. Research report : VTT-R-07613-12 (http://www.vtt.fi/inf/julkaisut/muut/2012/VTT-R-07613-12), VTT, Espoo. 6 p.

2.4.4 Floating mobile data pilot in the Helsinki Metropolitan Area - Validation of travel time data (Finland)

Description of the problem:
The floating mobile data (FMD) pilot aimed to provide anonymous travel time information from data provided by mobile phones. Cellular source obtained from teleoperators was further processed by the FMD provider before input into FMDDigiTraffic, the real-time data interface and time traffic flow status application of the Finnish Transport Agency (FTA). The links were predefined by FTA and divided from a traffic management point of view, i.e. aiming at links with homogenous traffic.

Description of the ITS project:
The main purpose of the pilot was to validate the quality of FMD by comparing it with camera-based travel time data. Also the usability of data was assessed from a traffic management point of view and some principles were tested. A current FTA travel time camera system was used as a reference system for pilot links that overlapped the current system. Measurements were complemented with a high

quality camera and software developed for number plate recognition on links outside the current travel time system.

Evaluation (timing, type, methods):

The FMD system was piloted in the western part of Espoo in Finland (Figure 2). The pilot consisted of 36 links including main road links, lower class roads and main streets, and turning links. On Road 51 there were links based on location area update in addition to links based on cell handover. All other links were based on cell handover.

Figure 2. Pilot links in Espoo, see Appendix A for individual link maps

FMD measurement was based on at least two time stamps related to cell handover or location area update of mobile phones together with corresponding locations. In the pilot, 2G to 2G handovers of active phone calls from two teleoperators were included for all links. Over some links, location area updates of all phones from one teleoperator were used, too. Given that these two teleoperators account for roughly 60% of the mobile subscriber market share in Finland, and that a portion of mobile traffic is 3G, it is estimated that the pilot result represents roughly 20%–25% of overall available mobile phone data.

FMD observation is an estimate of the FTA link travel time based on one or several measurements of a single mobile phone made on the FTA link. A measurement or several measurements of a single mobile phone were generalised as one observation to represent the FTA link travel time based on relative measurement link lengths of free flow travel time (assumed to correspond to the speed limits) in different parts of the FTA link.

Pilot data were collected during May 14–31, 2012, except for links on ramps and Röyläntie where data were valid from May 23. Reference data were collected with the current FTA travel time camera system or VTT travel time cameras.

The FTA travel time camera system was used as reference data for links on Ring road I, Ring road II, Road 1 and Road 51. Individual travel time observations and median travel times were used from these pilot links. Reference data were from the same period as FMD pilot data collected 24 hours per day. Pilot links on Road 51 and Ring II did not match FTA camera travel time links, and for these links reference travel times were estimated linearly based on the proportion of free flow travel time on partial links.

The VTT travel time camera system consists of two high class licence plate cameras and software developed at VTT that automatically produces travel time observations. This system was used to measure reference data for lower class roads and main streets. The weather was clear on all these dates and the cameras were functioning well. Data collection lasted one day per link per direction, starting around 6:30 a.m. and lasting approximately 11–12 hours. Only one direction was monitored per time. Monitoring covered one or two lanes per direction. This corresponded to all lanes except for Kalevalantie eastbound, where only the two lanes meeting Ring I East (North) were included. Cameras were located at each end of the FMD links.

The results were analysed for FMD quality and usability. In addition, the principles set for FMD were assessed. The following indicators were calculated for the FMD quality analysis:

- Median travel time for 5-minute periods
- Number of observations per 5-minute period, for a 24 hour period and 7–21 hours
- Standard deviation of observations, in daytime traffic (10–14 hours)
- Deviation in mean travel time (difference between FMD median travel time and the median in reference data)

Data quality analysis included

- Scatter plots of medians and individual observations
- Comparisons of sample sizes
- Temporal coverage (proportion of time with median)
- Variation
- Error distribution (deviation in mean and median values, cumulative error curves)
- Confidence intervals
- Performance on ramps
- Performance in a snowstorm

The usability study for the FMD system covered the user interface, user interaction with the system, and the suitability and usefulness of the system for user tasks. It included the overall analysis of the system and detailed analysis of various functions, listing of the most critical issues, and a generic proposal for potential improvements and their priority.

The usability of FMD itself as a source of information was evaluated after four weeks of online piloting at the traffic management centre (TMC) of FTA. TMC manager Mika Jaatinen was interviewed after this trial period.

Some principles were also verified. This included the calculation method for the median and the performance of the quality indicator. In addition, the need to filter out observations from a parallel road or by multiple cell phones in a car or bus were assessed. Lastly, the required sample size was determined.

Impact of the project (technical performance, impacts):

The main conclusion was that for traffic management operations, monitoring of cell handovers of active 2G phone calls alone does not produce a high enough number of observations. Consequently, it is recommended that the selected FMD technology should be such that it is able to monitor a larger proportion of mobile phones per aggregation period per link. Independence of active phone calls would help to cover also night time traffic as well as smaller roads and main streets. The rule of thumb verified by the theoretical sample size requirement is to have at least 10 observations per aggregation period, preferably 20.

Another main conclusion was that the estimation of median travel time (or any other aggregated value for the whole link) should be developed further. Obviously, although traffic-wise homogeneous links were targeted, traffic on many links is dynamic in both space and time. Consequently, it is recommended that the traffic flow status estimate be based on part-observations, and that the weight of different zones of a travel time link be balanced rather than letting full observations emphasized on a fluent part of the link bias the estimate. Hence, part-observations on the congested section of the travel time link would get more weight in the observations.

The use of a location area update border increased the sample size and, consequently, reduced the error of the aggregated travel time estimate. The implication was therefore that use of technologies able to monitor a large proportion of mobile phones should be favoured. Unfortunately, the use of location areas is not feasible everywhere due to their large size.

All links must cover at least two but preferably more handover zones to produce data. Balancing the number of these zones in all parts of link is important – especially in locations with large cells. This was seen with ramp links where merging traffic could not be monitored if handover zones on the link covered only one of the intersecting main roads. Although the links should be determined to represent homogeneous traffic flow, a recommendation is to fine-tune the link division to guarantee balanced measurements also from the point of view of the cellular network(s).

The main implication related to ad hoc service was that the precision of ad hoc links was not high enough. It does not have to be as high as for static links but high enough to make validation of the data possible. Thus the recommendation is to improve it. Another recommendation is to increase the number of observations in ad hoc service to suffice for real time operations based on 5-minute medians.

Although the quality indicator somewhat reflected the reliability of observation, it was not reliable enough to really pinpoint the highest quality observations. The recommendation is to proceed in developing the indicator.

Transferability of results:
Results can be transferred to other urban areas.

Reference:
Innamaa, Satu; Hätälä, Esko (2012). Floating mobile data pilot in the Helsinki Metropolitan Area - Validation of travel time data. VTT Technology : 51, VTT, Espoo (http://www.vtt.fi/inf/pdf/technology/2012/T51.pdf). 51 p. + app. 76 p.

2.5 Activity 4.3 Establishing information exchange

2.5.1 Comparison of the accuracy of friction testers (Finland)

Description of the problem:

Winter maintenance has a major part in road keeping expenditures in Finland. One of the most important detail in driving conditions in wintertime is the friction between the tire of a car and road pavement. Road Administration is following annually the quality of driving conditions in wintertime by measuring the friction level of pavements during the four months winter maintenance period. The most used method to measure the friction level is the C-trip-ц friction tester. The friction is measured in every 2 km section length by braking the car which is equipped with the friction tester. Friction measurements are done usually during the four winter months, December, January, February, and March.

The measurement system consists of fourteen friction measurement devices (= car + friction tester + driver). Although the measurement system is tested and calibrated annually before the winter period and during the measurement period in every month the quality of measurements is not as good as is expected. This measurement method has some disadvantages and there have been several projects to find replacement for it.

Description of the ITS project:

In this project a comparison between four different measurement devices has been conducted. Three additional measurement devices were tested against the current measurement method. The measurement devices were Gripman tester by AL-Engineering Oy, Traction Wacher One by Fosstech AS in Vestfold Norway, and DSC111 by Vaisala Oyj in Finland.

The first goal was to test the repeatability of each device. There was also an option to look how the winter conditions would affect to the repeatability but it showed up quite difficult to find suitable winter conditions during this winter in Southern Finland.

Evaluation (timing, type, methods):

The repeatability of each device was tested by making two runs on a test road network with 36 km of roads in the same day. The repeatability of a device was estimated by looking the scatter plots of the pair of runs, correlation of those runs, the standard deviation of the difference of both runs, and the average of the difference of the runs.

The other goal was to look how well the results of each device fit against each other. This goal was a combination of testing between the trueness and reproducibility of measurements. First the other devices were compared with TWO and then with Gripman. This comparison was made using data of a relatively large amount of friction measurements totalling to 500 km roads.

Impact of the project (technical performance, impacts):

As would be expected the average values of differences were small, between 0.001-0.008. Standard deviations of differences of two runs were between 0.01-0.098 depending on the device and the averaging interval. The main indicator of the repeatability was the standard deviation of differences. The TWO device had the best repeatability especially when the results were averaged in a longer period.

Ctrip-method gives in average lower values than TWO or Gripman. The range of friction values varied between 0.2 and 0.55. There is also quite high linearity error so that the difference is high negative in the area of low friction and high positive in the area of high friction values. Gripman is closer to Ctrip than TWO.

Gripman fits to TWO a little bit better but there is also high linearity error. Gripman gives values maximum of 0.8 and TWO gives up to 1.0. DSC and TWO gives friction values in a similar scale but there is lots of variation between them. There were probably interaction between TWO and DSC so that the wheels of TWO lifted some snow circulation in the area of DSC sensors and this had a negative effect to the results.

Transferability of results:

The results are likely applicable to all countries with advanced road weather related monitoring as well as the institutional structures enabling road weather information service to be provided as a public utility to road users.

Reference:

Virtala Pertti. Kitkamittareiden mittaustarkkuuden vertailu (Comparison of the accuracy of friction testers): Helsinki 2008. Finnish Road Administration, Kaakkois-Suomi region. Finnra reports, 76 p. ISSN 1457-991X, TIEH 4000626.

2.6 Other evaluations

2.6.1 2DECIDE

Description of the problem:
One of the most important ITS (Intelligent Transport Systems and Services) deployment-related challenges is to facilitate decision making based on best available knowledge on the feasibility, impacts, user acceptance and profitability of different ITS solutions in relation to the problems of the decision maker. As lack of easy and efficient access to such ITS knowledge during decision making is recognised as a key factor for slow deployment of ITS and low willingness to invest on ITS especially in the road operator and public sector, a single entry

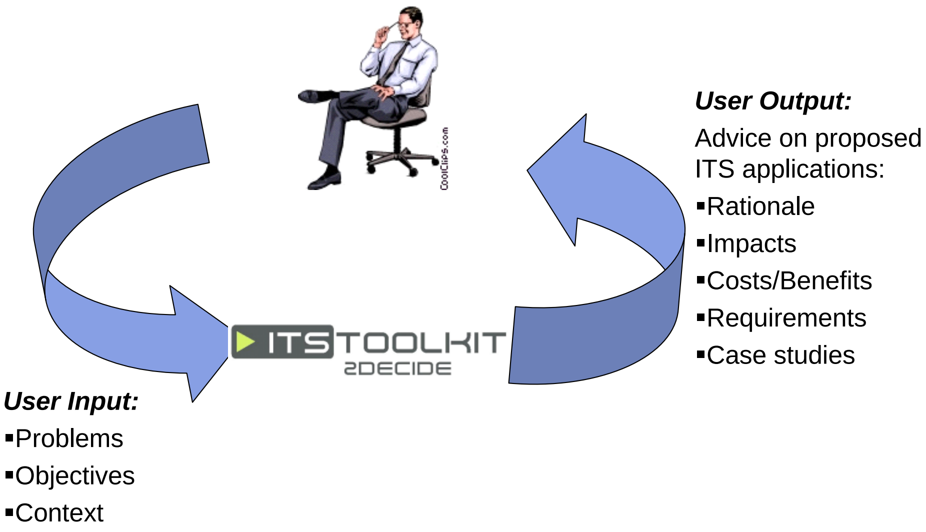
approach for a new ITS toolkit for better decision making seems like an appropriate solution.

This was also identified in the European ITS Action Plan, which identified such a toolkit as one of its key actions. The ambition of the 2DECIDE project, co-funded by the European Commission, is to support both EU ITS policy goals as well as national European ITS deployments strategies to gain the utmost benefit of ITS deployment and the related investments for a sustainable road and public transportation system.

The principal objectives of the ITS Toolkit developed by 2DECIDE have been defined as responses to the key issues as outlined in the ITS Action plan:

- to support decision making processes
- to enable easy accessibility to existing knowledge
- to support EU ITS policy goals as well as national ITS deployments strategies
- to gain the utmost benefit of ITS deployment and the related investments for a sustainable road and public transportation system

Description of the ITS project:
The project started in October 2009 and ended in November 2011. The work was broken down into four major steps. At first the specification of the web tool and the user needs analysis, followed by the collection of available evaluation results from all over Europe. Steps 3 and 4 were the assessment of the collected results and the design of the search mechanism and finally the technical realisation of the web based ITS Toolkit and its validation with a group of test users.



Evaluation (timing, type, methods):
2DECIDE-project did not evaluate impacts of any single ITS implementation project, but collected, analysed, and combined existing evaluation studies into the toolkit. The development included several steps, also user needs and stakeholder

analysis as explained in the following chapters.

User Needs and stakeholder analysis

The first activity aimed to identify user groups and their needs in respect to Intelligent Transport Systems (ITS) in general, and the proposed Toolkit in particular. Specifically, this entailed defining user groups, building a stakeholder group and undertaking a series of questionnaires and interviews in order to profile needs, experiences and the views of potential users on various aspects of the proposed ITS Toolkit.

Impact of the project (technical performance, impacts):

Decreasing traffic congestion was the most common single policy goal for which respondents had actually been involved in deploying ITS. This was followed by enhancing safety and improving user friendliness, information or accessibility. Many respondents have also deployed ITS for environmental reasons, but to a limited extent, suggesting that in many cases this is a secondary goal.

Stakeholders reported problems or insufficient information in several areas, most notably on costs and benefits, and insufficient information on different experiences or evaluations elsewhere. Lack of impartial information (e.g. most information comes from suppliers trying to sell their own product), legal obstacles or lack of political acceptance or awareness of ITS, and lack of public acceptance were also cited as problems by most respondents, but mostly as less severe or occasional problems.

Transferability of results:

The evaluation studies included into the toolkit were carefully selected to be reliable, and valid to the problems in question. In addition, the usage of inference engine, and hence utilizing the information and input from the studies that are partly relevant in the situation the user is searching the information for, also improves the quality of the toolkit output. Hence, the results given by the toolkit are highly transferable. Of course, as the systems evolve, the studies in the toolkit should be continuously updated to refer the current ITS in use.

If compared to the other existing ITS evaluation databases (like RITA (US), Dft ITS toolkit (UK), etc), the 2DECIDE ITS toolkit has the following advantages:

- 2DECIDE contains a database with ITS evaluations studies and case studies from the whole of Europe, while existing toolkits mainly provide studies for one specific country, or one specific region. 2DECIDE provides a single access point to all these ITS studies in Europe.
- 2DECIDE provides ITS decision makers in Europe at all levels: local, regional, national and European, the possibility to quickly find relevant material for taking decisions about ITS investments.
- 2DECIDE not only provides a summary of the contents of selected studies, but in addition provides an estimation of the most likely impacts, based on the available studies in the database.
- 2DECIDE uses relevance tables, which makes it possible to find more relevant studies than the ones completely matching the user’s input.

- Even if no studies are found for a specific ITS service searched by a user, 2DECIDE always provides best practice deployment guidelines and typical impacts.
- If no values for the primary indicators are available, 2DECIDE can use the available secondary indicators to estimate value categories for these primary indicators.
- The 2DECIDE toolkit HMI is not only available in English, but also in German, French and Italian.

It should be stressed that the level and type of outputs of the 2DECIDE toolkit do not eliminate the need for detailed level assessment, planning and design required to be done prior to deployment of an ITS service and application.

The Toolkit has been tested and validated by European users coming from both the public and private sectors. A high degree of satisfaction with the interface and performance of Toolkit was reported. Results of the validation tests, resulting refinements and options for future maintenance of the Toolkit are reported in other papers

Reference:
2DECIDE-toolkit is available in: www.its-toolkit.eu

2.6.2 Potential of ICT-Enabled Solutions to Reduce CO2 Emissions from Road Transport (Finland)

Description of the problem:
The main objective of this study was to determine the potential of various transportation related ICT-enabled solutions in reducing CO_2 emissions, first in selected target areas and finally on a global scale. More specifically, the goal was to identify the relative importance of various ICT solutions in reducing CO_2 emissions. This goal can also be seen as a prerequisite enabling e.g. ICT stakeholders to direct their efforts in areas where the positive impact on reducing greenhouse gas (GHG) emissions can be maximized.

Description of the ITS project:
This study only included collecting and combining public available data to calculate and estimate the potential of various ICT applications on CO2 emissions from road transport. The ICT-enabled application areas pre-selected for analysis were ridesharing, carpooling, public transport, car sharing, eco-driving, and intelligent parking guidance. An extensive model, data, and literature search was conducted for each area. In addition, several experts in the area of transport emissions were interviewed to validate the created models and calculated results.

Evaluation (timing, type, methods):
First, a comprehensive search of existing models, data and literature was performed. One of the main findings was the lack of either publicly available CO_2 calculation models or comprehensive data covering all the selected target areas. Therefore, a new model needed to be formed separately for each of the

application areas, and the data used in the calculations was in many cases either extrapolated or generalized. In addition, the uptake rates for each of the application areas were assumptions at this phase, based on expert interviews and selected to see how much the CO_2-abatement potential would be with different uptake rates.

The generic variables utilized in all the models were average CO_2 emissions per vehicle km (by vehicle type), number of trips, and annual mileage per person (by purpose and by different modes), population in each of the selected geographical areas (urban and rural separately), and occupancy rate for private cars. Of the generic variables, the current population in different areas and the forecasts for population growth for the years 2015 and 2020 were available via World Bank databases. For the other variables, the data was best available in the EU, US, UK, and Finland, and therefore that data was used quite extensively in the models.

Calculation logic for each application area
For *ridesharing and carpooling*, the CO_2 abatement potential was based on the assumption that the occupancy rate of cars will increase, and hence the driven mileage per person will decrease. Therefore, the CO_2 abatement was calculated as a function of average CO_2 emissions per km by private car, occupancy rate of private cars, an average trip length by private car, total population in each target area, reduced car trips per person per year through ridesharing, ridesharing uptake and percentage of commuting/non-commuting trips. In addition, ridesharing and carpooling uptake increase due to ICT was estimated for each target area and year. The calculations included different potential and uptake for urban and rural areas. Finally, the global abatement potential due to ICT-enabled ridesharing and carpooling was calculated.

For *public transport*, calculation of the CO_2 abatement potential was based on the potential modal shift from private cars to public transport, and hence the decreased mileage driven by private cars. This shift was assumed to take place in urban areas only. The total emissions due to private cars was calculated as a function of average CO_2 emissions per km by private car, occupancy rate of private cars, average trip length by private car, annual trips per person, percentage of daily trips by private motorized modes and total population in the target area. The total CO_2 abatement potential was calculated as a function of the reduction potential of the modal shift, uptake rate of the ICT solution, and the total emissions of private cars and public transportation in the target areas.

For *car sharing*, the calculation of CO_2 abatement potential was based on two mechanisms. First, car-sharing members drive less on average than those who have a car in their possession. In addition, car-sharing club cars are on average newer and less polluting than the car fleet in the respective area in general. Therefore, the CO_2 abatement potential was calculated as a function of average CO_2 emissions of a club car compared to an average private car, private car kilometres, and private car kilometres reduced due to a shared car (per member in a car club), car sharing uptake with and without ICT solutions, and average annual mileage driven in each area. The ICT application was assumed to have higher impact in urban than in rural areas.

The CO_2 abatement potential for *eco-driving* applications was based on two separate impact mechanisms: to affect driving style by real-time guidance (eco-driving) and to guide traffic onto less congested routes (dynamic navigation). The CO_2 abatement potential for eco-driving was calculated as a function of the reduction potential of adopting eco-driving behaviour compared to normal driving behaviour, uptake rate and the total emissions of private cars in the target markets.

For *parking*, the abatement potential was calculated as estimated reduction in the driven mileage when searching for an available parking space.

Impact of the project (technical performance, impacts):
With the assumed uptake rates and available data for the target areas, the CO_2 abatement potential was calculated to be highest for eco-driving (more than 4%), and public transport (more than 3%) of the global CO_2 emissions from the transportation sector by 2020 (**Figure 1**). Car sharing was estimated to have a potential of almost 2%, and ridesharing 1% by 2020. The potential of carpooling was less than 0.5% and the potential of parking even less than that, and therefore not included in Figures 1 and 2.

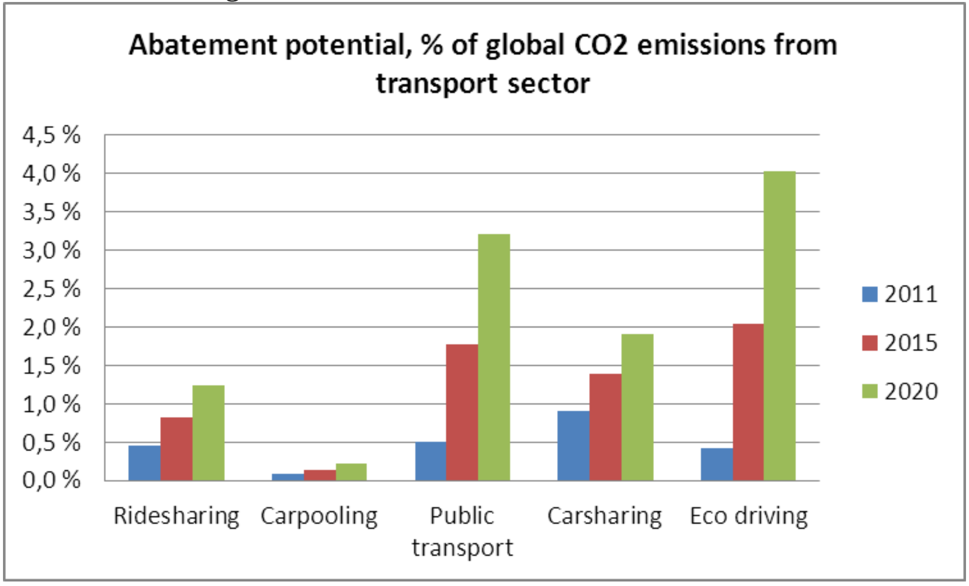


Figure 1. Abatement potential of each application area, calculated as a percentage of global CO_2 emissions from the transport sector.

If the CO_2 abatement potential is considered as a share of CO_2 emissions from road transport only (**Figure 2**), the respective percentages are naturally higher, being 9% for eco-driving, over 7% for public transport and 3 to 4% for ride sharing and car sharing.

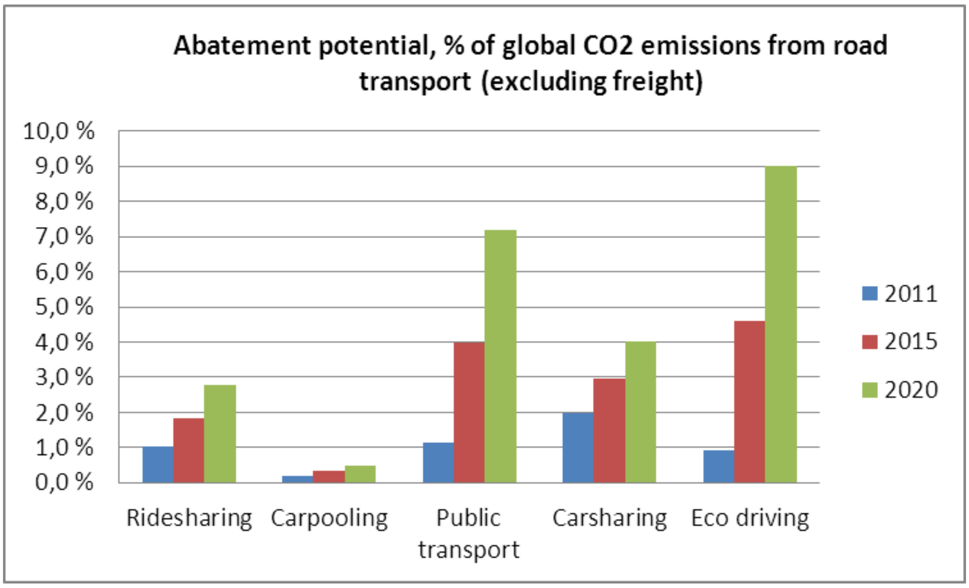


Figure 2. Abatement potential of each application area, calculated as a percentage of global CO_2 emissions from road transport, excluding freight transport.

Transferability of results:

The calculated abatement potentials of each application area were compared with earlier studies and both the magnitude of the effect and the order of the applications (with the relevant assumptions) seem to be well in line with earlier findings.

Reference:

Penttinen, **Merja**; Paloheimo Harri; Landau, Tiina; Lees, Patrick; Chen, Yu. 2012. Potential of ICT-Enabled Solutions to Reduce CO2 Emissions from Road Transport. Proceedings of 19th World Congress on Intelligent Transport Systems. ERTICO.19th ITS World Congress, Vienna, Austria, 22 - 26 oct. 2012

3. Syntheses of Variable Speed Limits results

The EasyWay VIKING evaluation group has made three syntheses of Variable Speed Limits results obtained in the EasyWay VIKING area.

1. Evaluation synthesis – Traffic controlled variable speed limits on motorways
2. Evaluation synthesis - Variable speed limits at intersections
3. Evaluation synthesis - Weather-related variable speed limits

3.1 Traffic controlled variable speed limits on motorways

The goal of traffic controlled variable speed limits on motorways in the EasyWay VIKING region is primarily to improve traffic flow and safety.

Traffic controlled variable speed limits aim to affect the speed of the traffic flow so that *speeds and their variation* are on an optimal level in relation to the current traffic conditions. The system considers that relative speeds between vehicles and between traffic in different lanes are important safety related factors on motorways.

The systems are based on real-time data from automatic traffic monitoring and sometimes also incident detection systems. The speed limit displayed is changed according to pre-set speed limit values.

Results from the EasyWay VIKING area show:

- Road user acceptance of Variable Speed Limits (VSL) is very high throughout the region
- In Sweden traffic controlled VSL gives a smoother flow and less sudden braking in traffic tailbacks. On one stretch of road a high safety improvement has been obtained, whereas the effects are limited on another stretch.
- In Germany, the Motorway Control System (MCS) concept includes VSL as a major part, together with overtaking bans and congestion warnings etc. The Motorway Control System on A1 Bremen has decreased the number of accidents by 20 % taking the increased traffic into account. Due to the accident decrease also a reduction of congestion (reduction of time losses) has been obtained. After an aggregation of gantry signs as well as a system extension a further decrease of the number of accidents by more than 15 % has been obtained and accidents with personal injury have decreased even by about 30 %. The cost-benefit ratio for the MCS A1 Bremen has been estimated to be very high, about 6 (taking increased traffic into account).
- In Denmark, during extensive road works at the Motorring 3 around Copenhagen, VSL were used together with variable message signs with warnings and information messages. Indications from accident analyses show that the number of accidents with personal injuries has decreased – in fact the number has almost been halved, but the result should be taken

with care, since the before situation is very much different from the situation during the extensive road works and hence really difficult to compare.

- The early Finnish results show increased speed variation in some cases and could not show any concrete benefits. The results indicate the importance of appropriately functioning VSL control systems and the connected monitoring systems.
- Speed harmonisation, i.e. making speeds more homogeneous, seems to have positive effects on safety as well as on flow in all countries, but more evaluations as well as development of control principles are required.

Experiences may be summarised in the following factors and conditions to obtain positive effects of traffic controlled VSL:

- motorways or multi-carriageway roads with high traffic intensity
- road stretches with a normal speed of 90 km/h or higher
- road stretches with relatively high flows and recurrent bottleneck problems
- road stretches with a large number of accidents and rear-end crashes
- road stretches with frequently recurrent dramatic speed reductions

In Norway and Germany, trials with environmental controlled variable speed limits are being conducted at the moment, but no evaluation results are available yet.

3.2 Variable speed limits at intersections

Variable speed limits (VSL) have been tested at intersections in Denmark, Finland and Sweden. Different types of technical equipment were installed at the various test sites. Sensors in the roadway register the number of vehicles, speed and the time at which they drive past. Movement detectors are used to register pedestrians. At some sites the road is also being monitored by video cameras. Data from this equipment is usually processed automatically. The speed limit displayed can be changed based on pre-set limit values. Variable message signs display the speed limit using white, luminous digits and a red, luminous circle on a dark background. The investment cost for this solution is typically 0.1-0.2 million Euro per intersection.

The systems function well and better than expected. Results from Finland and Sweden show that the system affects more vehicles on the main road than expected. With 20% secondary traffic, activation typically affects 30-50% of the vehicles on the main road.

Results from Denmark and Sweden show that drivers comply better with variable speed limits than with local static speed limits. After the implementation of the

VSL, the average vehicle speeds decreased by up to 17 km/h (E22, Sweden) on interurban roads and up to 13 km/h (Gladsaxe, Denmark) in urban areas. Typical results are 8-16 km/h reduction with a reduced speed limit of 20 km/h, 4-8 km/h for a 10 km/h lower speed limit, 0-4 km/h reduction for an unchanged speed limit.

There is a weak tendency that the effect will be reduced according to the limit, keeping the percentage reduction unchanged. Tests in Denmark in urban areas with lower speed limits in school areas support this hypothesis. Also the fastest drivers (85-percentile) reduce their speed in the same magnitude as the average value for all vehicles. The majority of road users are positive to VSL. Those turning from the side road onto the primary road, a manoeuvre considered problematic prior to the implementation of VSL, are most positive.

The number of accidents at the intersections studied for individual years is still too small for statistical analysis. The safety effects are instead estimated from speed differences using the traditional power model. In the Swedish trial this resulted in a probable 30-40% reduction, which is supported by first statistical results. After 2.5 years of implementation one of the first Danish VSL intersections show a remarkable reduction from 2.6 acc. per year down to 0.4 acc. per year.

The overall conclusion is that VSL contributes to better road safety at certain rural intersections at the expense of a few seconds increase in travel time for drivers on the primary road. With some careful reservation, these results should be possible to transfer to other sites with similar traffic conditions.

- Variable speed limits is most beneficial when the traffic volume on the primary road is 10 000 vehicles/day or more with traffic on the side road(s) accounting for about 20-30% of this. VSL can also be motivated where the traffic volume on the primary road is lower but where visibility is restricted.
- If the traffic on the side road is less (< ca 10%) a dynamic warning sign is preferable (road sign ”crossing traffic” as a VMS). The same criteria should be applied for using this sign as for the variable speed limit sign.
- If the traffic volume on the side road is greater (> ca 40%), a fixed, local speed limit should be considered.

Based on the conditions mentioned above, VSL systems are able to compete with traditional measures; i.e., grade-separated intersections or roundabouts based on current design guidelines. The advantage of VSL is the lower cost involved in relation to either of these physical measures as well as less disturbance of the traffic flow in the case of roundabouts. The benefit-cost ratio estimates of these systems have varied in the implementations in the Nordic countries between 1 and 4.

3.3 Weather-related variable speed limits

Weather related variable speed limits aim to affect the speed of the traffic flow so that speeds and their variation are on the level required by the prevailing road weather conditions. The system is based on real-time data from automatic road weather stations and roadside cameras as well as current weather forecasts and observations made by maintenance personnel.

Results from Finland and Sweden show that drivers comply better with variable speed limits than static speed limits. This means that the variation of speeds is reduced to some extent.

On poor weather and road surface conditions, drivers lower their speeds by 2-5 km/h more than they would on the basis of the conditions alone. The effects are larger, when the adverse conditions are not so easy to detect. In very poor conditions, the drivers have decreased their speeds by more than 10 km/h. In good conditions, when the speed limits are increased, drivers increase their speed by 2-5 km/h.

Accident studies indicate that high-quality systems with elaborate control systems decrease injury accident risks. Such systems improve traffic safety even though they are also used to improve the fluency of traffic flow. The variable speed limit systems have decreased the injury accident risk by ca 10 % in the winter period. Outside the winter period, there was a circa 6 % decrease in injury accident risk.

The positive effects are based three factors. First, the system requires the efficient recognition of hazardous weather and road conditions. Second, variable slippery road signs should be used to support the variable speed limit system. Third, the highest speed limits should only be used moderately. This highlights the importance of the high quality of the variable speed limit system. Previous research has shown that the lowest speed limits available in the speed limit signs are very seldom used when manually controlled. Consequently, it is critical to automatically monitor and efficiently recognise hazardous conditions and provide road users with the information and the relevant speed limits.

The evaluation results apply to motorways, dual carriageway roads and two-lane highways with frequent road weather problems. The benefit-cost ratio estimates of these systems have varied in the Finnish and Swedish implementations between 1 and 2.

3.4 Film about the results of using Variable Speed Limits

The importance of evaluating the impacts of the various Variable Speed Limit applications is a key issue. Any road authority who is considering establishing a VSL system seeks the results and experiences from other similar applications in the region. Sharing our knowledge in the field gives us all better solutions.

To present our results to a wider audience within EasyWay and to promote thorough evaluation of such applications elsewhere, the EasyWay VIKING Evaluation Group has made a film about the results, which was launched at the ITS World Congress in Stockholm in September 2009.

The film is available to the public and may be downloaded from:

http://www.ew-viking.com/index.php?option=com_docman&task=cat_view&gid=93&Itemid=70

4. Syntheses of Travel Time and Co-Modal Information Services

4.1 Introduction

Impacts of two EasyWay core services for traveller information, travel time services and co-modal services were analysed by the VEG in 2012. The objective of the study was firstly to find out how many ex-post evaluations have been conducted for the two selected EasyWay core services; travel time information services and co-modal information services. Secondly, the conducted synthesis was targeted at finding out the impacts of the implemented services. Thirdly, the synthesis study was to assess the quality and reliability of each study individually and finally make overall assessment of the impacts of both of the services and recommendations for future studies.

4.2 Method

VEG analysed, i.e. made syntheses of two selected EasyWay core services for traveller information:

1. travel time information services
2. co-modal information services

Travel time information services were services showing the drivers measured or predicted travel times in either one main corridor or in a limited network area. Travel times were collected either by road-side monitoring systems or as floating car or mobile data. The predicted travel times were based in historical data, including some real-time adjustments. The information was provided to the drivers mainly by road-side variable message signs (VMS). The co-modal services were services including both private and public modes.

The syntheses were based on evaluations from the EasyWay area, especially the EasyWay VIKING area. For both of the selected core services, the synthesis included analysis of all the **ex-post** evaluations from Europe that VEG came across for. The relevant studies were searched in both European databases, e.g. 2DECIDE [1] and EasyWay evaluation database [2] but also in national evaluation study databases. Not all the studies had ever been published in English, and hence each partner summarized the findings of his/her national studies into English. The context, facts, objectives, methodology, and the main results were presented for each study in a form of Excel tables to facilitate the comparison of the various studies. For each study, the following details were included into the tables:

- description of the problem, i.e. what was the ITS project targeted at, what kind of network was included, any specific geographical issues targeted,
- description of the ITS implementation: objectives, systems and technologies applied, implementation and maintenance cost (if available),
- evaluation e.g. timing and type of the evaluation, objectives and research questions, methods used, technical performance, impacts found, reliability,

research questions addressed, overall assessment, transferability of the results.

Furthermore, the VEG group analysed the quality, reliability and transferability of each of the studies. Finally, an overall assessment of the evaluation results per core service was conducted.

4.3 Results

Travel time services

Impacts

Impacts were analysed based on 17 ex-post evaluation studies. In general, better network distribution of traffic flow was reported due to travel time information services. If the diversion rate, i.e. proportion of time taken alternative route due to travel time information given, was either measured or estimated based on the drivers' self-reporting, it typically varied between 5% up to 25%, depending on at least three factors: the length of the delays, the drivers' visibility or self-assessment of the situation, and the drivers' familiarity of the road network and the alternative routes. Three of the analysed studies on VMS impacts reported on similar driver diversion rates of about 25 % in case of long delays on the main route. Unfortunately, the cost information was lacking from most of the studies, and no comparative conclusions of the cost-efficiency were able to be drawn.

Performance

The technical performance of the systems, especially the monitoring part, was also evaluated. Conclusion was that at the time (typically early 2000's) the studies were conducted, the travel time predictions based on historical data were typically of too low quality without any real-time travel time monitoring. Current real-time travel time measurement and estimation systems work in a satisfactory manner, but there are serious problems with their feasibility as a large-scale solution as a whole: Systems utilising licence plate recognition suffer from inadequate performance in adverse weather and glaring sun, FCD systems from either high communication costs (if ordinary cars are equipped) or low and uneven network coverage (if only taxis or other fleets are used), and floating cellular network data from overpricing by telecom operators. The current and future development of the monitoring systems is innovatively combining the data from various sources even GPS, and taking into account the strengths and weaknesses of various data sources.

User acceptance

Some general results regarding acceptance of travel time services showed encouraging results. The drivers typically (80% or more of the respondents) appreciated highly the travel time services, and believed that those are useful for them. Up to 40% of the drivers use the information actively and change their travel timing and route choice if the additional delay on the ordinary route is considerable longer than normal. The existence of alternative routes is critical for the possibilities of taking advantage of the travel time information.

Co-modal information services

Overall, even if many co-modal information services existed already, especially in the larger metropolitan areas, EasyWay was really lacking the results of ex-post impact evaluation studies of co-modal (including both private and public modes) traveller information services. The analysis of impacts in the synthesis is based on only five found ex-post evaluation studies. In general, most of the studies only included results of user satisfaction. A few studies also included some self-reported changes in traveling behaviour in general.

The results of the few studies are, however, encouraging with high user acceptances and recommendations for continuation of the service. One of the analysed service also managed to get users to change their behaviour (change time/route/mode) to a large degree. This confirms that users are willing to change their travel behaviour, but drawing this conclusion one must remember that the users of these sites (co-modal information services) most likely often have several transport options to choose from - otherwise they might use dedicated sites on their transport mode (e.g. solely public transport sites, car planners etc.).

4.4 Conclusion

For travel time information services, there were already quite a few ex-post evaluation studies available. Those were not always reported in English or added into the European databases [1, 2], but were available in the national databases. For co-modal information services, the number of the ex-post evaluation studies was very low. The group only found five studies to base the synthesis of. Hence, the synthesis concerning co-modal information services was in much more generic level than the one for travel time information services.

In general, some of the analysed evaluation studies had too short evaluation period or too few respondents (web based interviews or post card). In addition some evaluations were not focusing on studied services, e.g. travel times only. Another problem was that presented results were typically valid for the specific sites only. Certain user acceptance and user behaviour data could be used for comparison, but one must be aware of the exact focus of the reports, and the context and environment of the implemented system.

For travel time services, most of the conclusions in the synthesis were based on the drivers' self-reported behaviour. Hence, it can be stated that there is a need for more detailed studies of driver reactions and actual behaviour to given travel times displayed as single message and in combination with traffic information. In addition, most of the systems were only VMS's showing latest measured travel times. Can we expect the similar impacts in the future when more real-time and predicted travel-time data is available - and is brought into the vehicles? Are the impacts of VMS and in-vehicle systems expected to be similar?

In addition, VEG group raised also some concerns to the methodology of the evaluations concerning travel time services. It is important that the impacts of the systems are evaluated when the so called novelty effect is gone. Furthermore, sometimes the performance of the system is adapted and thus the impacts are also affected. Thus the effects of a system should be evaluated when these effects had already past (i.e. novelty effect gone, users are familiar with system and performance is optimised). In addition, firstly it may be challenging to distinguish the effect of the service/system from the effect of the (visible) congestion on the main road. Second, the analysed studies did not include the systems providing the travel time information already before the trip. Finally, the impacts of the in-vehicle systems were not included in the analysed studies.

The lesson learned by performing the synthesis was that this kind of comparative meta-analysis is very valuable in understanding the impacts and benefits of ITS and in particular the transferability of those results. In addition, the working method that was used enabled the group to utilize and compare various national studies not available in English, and in any international databases.

4.5 Recommendations

As concluded, the number of the available ex-post evaluation studies for some of the traveller information systems was still low. This was especially true for the co-modal information services. In addition, even if there were quite a few studies available for travel time services, most of the available results were based on drivers' self-reporting only. In addition, the implementation and maintenance cost information of the systems is missing from almost all of the studies.

Therefore, we recommend that the ex-post evaluations are conducted for all the new ITS services targeted at changing driver and traveller behaviour. The studies should include also estimates of the cost and benefit of the systems – and also comment on the transferability of the results. The best way to get visibility to the results is to publish those (also) in English, either as an article or a conference paper, or to summarize the most important results into one of the existing databases [1, 2].

4.6 References

1. 2DECIDE toolkit. http://www.its-toolkit.eu/2decide//node/44
2. EasyWay evaluation database. http://www.easyway-its.eu/document-center/open/444/
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