SIXTH FRAMEWORK PROGRAMME

PRIORITY 1.6.2.

Sustainable Surface Transport

506716

Policy Recommendations

Deliverable No. (use the number indicated on technical annex)		**D5.4**	
Work Package No.	**WP5**	Work Package Title	**Implementation priorities and policy recommendations**
Activity No.	**A5.5**	Activity Title	**Issue of Policy recommendations**
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Status (F: final; D: draft; RD: revised draft):		**F**	
File Name:		**IN-SAFETY_Deliverable D5.4.doc**	
Project start date and duration		**01 February 2005, 36 Months**	

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Abbreviation List

Abbreviation	Definition
ABS	Antilock braking system
ADAS	Advanced Driver Assistance Systems
AHP	analytic hierarchy process
CBA	Cost-Benefit-Analysis
CBT	Computer-Based Training
CEA	cost-effectiveness analysis
CRF	CRF Societa' Consortile per Azioni
EU	European Union
FOR	forgiving road
HMI	Human Machine Interface
IAT	Institut für Arbeitswissenschaft und Technologiemanagement
ICCS	Institute of Communications and Computer Systems
ITS	Intelligent transportation system
IVIS	In-Vehicle Information Systems
IVIS	in-vehicle information systems
MAMCA	multi-actor multi-criteria analysis
MCA	multi-criteria analysis
SER	self-explaining road
TERN	Trans-European Road Network
TMC	Traffic Management Centre
TMI	Traffic Management Information centre
TTC	Time to Collision
V2V	Vehicle to Vehicle
VMS	Variable Message Sign
VTI	Swedish National Road and Transport Research Institute
WBT	Web Based Training
WP	Work Package

Executive Summary

Policymaking on transport requires an integrated view with respect to the various alternative options, their possible consequences for transport system perfor mance, and societal conditions for implementation. The so called "adaptive policy making view", focussing upon managing the uncertainties, is adopted for IN-SAFETY.

The analysis of stakeholders' interests and motivation to act according to policy recommendations gives an overview of who is addressed:

- Legislation bodies on the EU and national level
- EU and national research funding bodies
- Public and private infrastructure owners and road operators
- Standardisation bodies
- Insurance companies

The private sector is not directly addressed with policy recommendations; nevertheless the IN-SAFETY results are of interest for them as well.

The recommendations from IN-SAFETY project are classified according to work packages results :

- Recommendations from Application Guidelines and Further Research Issues
- Recommendation on pictograms and verbal messages, horizontal and vertical signing
- Recommendations for Application Of Traffic Simulation and Risk Modelling
- Lessons learnt from Pilot Tests
- Recommendations for Application Of the Operators Manual
- Recommendations from MCA -AHP and CBA assessment of selected systems and functions

For all recommendations described in this Deliverable the objective of the policy recommendation is listed, and the basic policy action. Then, a few of the most relevant vulnerabilities are given. For each vulnerability, mitigating or hedging actio ns are given, along with the possible signposts, triggers or actions.

1 Introduction - Approach to policy recommendations[1]

According to Marchau et al (2007), policymaking on transport requires an integrated view with respect to the various alternative options, their possible consequences for transport system performance, and societal conditions for implementation. The basis for such a view has been provided by Walker (2000a). According to this view, policymaking, in essence, concerns making choices regarding a system in order to change the system outcomes in a desired way (see Figure 1). At the heart of this concept lays the system comprising the policy domain, in our case the transport system. A transport system can be defined by distinguishing its physical components (e.g. loads, vehicles, and infrastructure) and their mutual interactions. The results of these interactions (the system outputs) are called *outcomes of interest* and refer to the characteristics of the system that are considered as relevant criteria for the evaluation of policies. The *valuation of outcomes* refers to the (relative) importance given to the outcomes by crucial stakeholders, including policymakers. Two types of forces act on the system: *external forces* and *policies*. Both types of forces are developments outside the system that can affect the structure of the system (and, hence, the outcomes of interest to policymakers and other stakeholders). *External forces* refer to forces that are not controllable by the decision-maker but may influence the system significantly, i.e. exogenous influences. A *policy* is a set of actions taken to control the system, to help solve problems within it or caused by it, or to help obtain benefits from it.

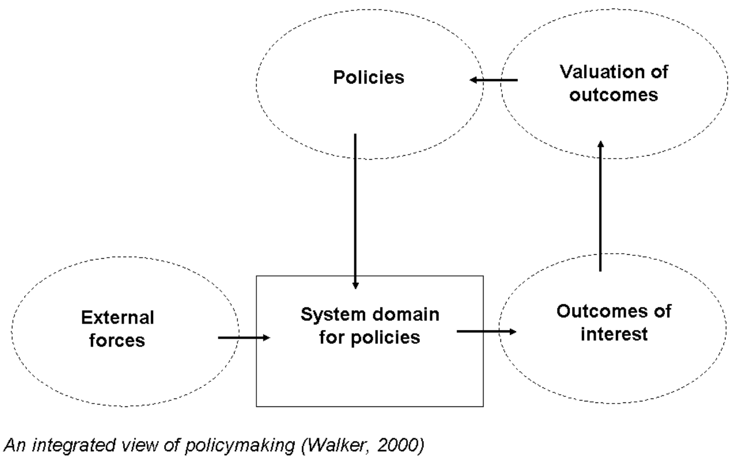

Figure 1: An integrated view of policymaking (Walker, 2000a)

Applying the framework shown in Fig. 1 to long-term transport policymaking reveals several locations where uncertainties arise. First, the external forces are uncertain, since it is difficult to

[1] The introduction is based on Marchau et al (2007)

identify which external developments will be relevant for long-term future transport system performance (e.g., changes in demography, economy, technology) and, perhaps more important, the size and direction of these changes. Second, even if there were certainty about the external developments (that is, we knew how the transport system's external world would develop), there might still be uncertainty about how the system would respond to those external developments, since the key-relationships determining transport system performance are uncertain because (some of) the interactions within the transport system are insufficiently known. Finally, the valuation of the various outcomes is uncertain. Stakeholders tend to have different opinions about the importance of future transport problems. This results in different, often conflicting, opinions regarding the various transport policies. As such, the willingness of stakeholders to accept (or reject) outcomes of transport policies is uncertain. In addition, over time, new stakeholders might emerge and/or current stakeholders might leave, and/or the opinions of the current stakeholders might change. Marchau et al (2007) therefore propose an Adaptive Policy making view. The inevitable policy changes, resulting from changes in the external forces or the transport system becoming part of a larger, recognized process and are not forced to be made repeatedly on an ad - hoc basis.

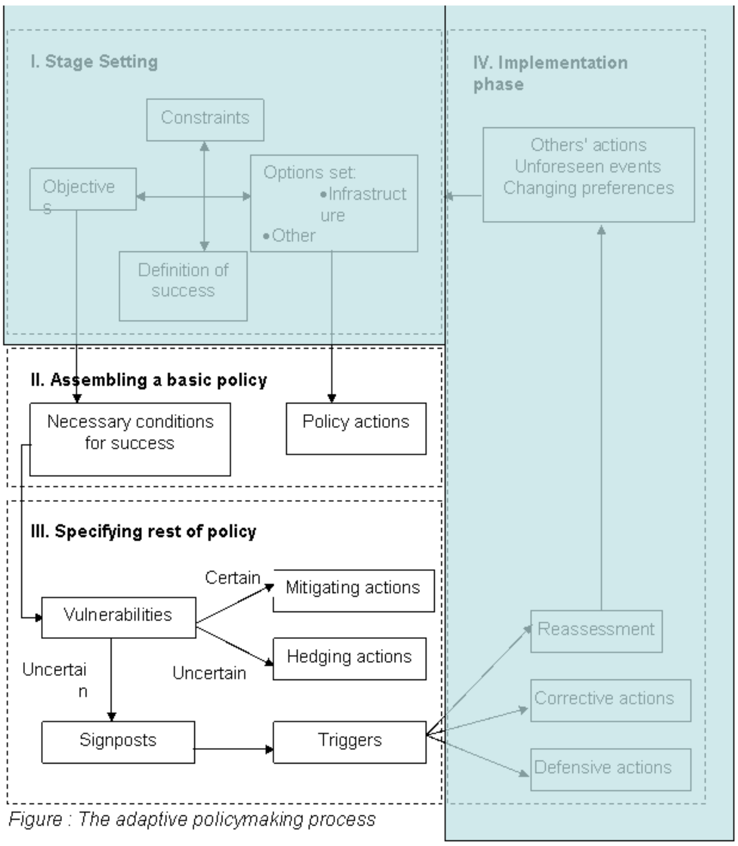

Figure 2: The adaptive policymaking process (Marchau et al, 2007)

This specification should lead to a definition of success, i.e. the specification of desirable outcomes. In the next step, a *basic policy* is assembled, consisting of the selected policy options and additional policy actions, together with an implementation plan. It involves (a) the specification of a promising policy and (b) the identification of the conditions needed for the basic policy to succeed. These conditions should support policymakers by providing an advance warning in case of failure of policy actions.

In the third step of the adaptive policymaking process, the *rest of the policy* is specified. These are the pieces that make the policy adaptive. This step is based on identifying in advance the vulnerabilities of the basic policy (the conditions or events that could make the policy fail), and specifying actions to be taken in anticipation or in response to them. This step involves (a) the identification of the vulnerabilities, (b) defining actions to be taken immediately or in the future, and (c) defining signposts that should be monitored in order to be sure that the underlying analyses remain valid, that implementation is proceeding well, and that any needed policy interventions are taken in a timely and effective manner. Vulnerabilities are possible developments that can reduce the performance of a policy up to a point where the policy is no longer successful. Actions are defined related to the type of vulnerability and when the action should be taken. Both certain and uncertain vulnerabilities can be distinguished. Certain vulnerabilities can be anticipated by implementing mitigating actions – actions taken in advance to reduce the certain adverse effects of a policy. Uncertain vulnerabilities are handled in two ways. First, by implementing hedging actions i.e. – actions taken in advance to reduce or spread the risk of possible adverse effects of a policy. Second, by specifying possible future actions. For the latter cases, signposts are defined and a monitoring system established to determine when actions are needed to guarantee the progress and success of the policy. In particular, critical values of signpost variables (triggers) are specified, beyond which actions should be implemented to ensure that a policy keeps moving the system in the right direction and at a proper speed. Note that apart from vulnerabilities to the basic policy, opportunities might also be considered in this step. Opportunities are external developments that improve the performance of a policy so that it is more successful than it would have been without these external developments. These opportunities should be monitored as well in order to take advantage of the developments and, for instance, expand the basic policy.

For IN-SAFETY the adaptive policy making view will be adopted, focussing upon managing the uncertainties. Therefore, the Policy Recommendations in all chapters described in this Deliverable will be presented according to the following schedule: First, the objective of the policy recommendation is listed, and the basic policy action. Then, a few of the most relevant vulnerabilities are given. For each vulnerability, mitigating or hedging actions are given, and the possible signposts, triggers or actions.

2 Stakeholders and their motivation

Several stakeholders have been identified who are addressees by the results and (political) recommendations of the IN-SAFETY project. First of all their motivation to act according to political recommendations to achieve more traffic safety is analysed.

Stakeholders to be addressed from the IN-SAFETY point of view are:

- Legislation bodies on the EU and national level
- EU and national research funding bodies
- Public and private infrastructure owners and road operators
- Standardisation bodies
- Insurance companies

The private sector is not directly addressed with policy recommendations; nevertheless the IN-SAFETY results are of interest for them as well.

2.1 Motivation of EU and national legislation bodies

Legislation bodies on the EU-level as well as on the national level act on certain political objectives – usually defined in political programs.

According to the WHITE PAPER "European transport policy for 2010: time to decide" by the European Commission a main political task is to achieve a sustainable transport system. The White Paper provides a statement of requirements on safer roads. Often cited from the White Paper is the following sentence: "The European Union must, over the next 10 years, pursue the ambitious goal of reducing the number of deaths on the road by half; this by way of integrated action taking account of human and technical factors and designed to make the trans-European road network a safer network."

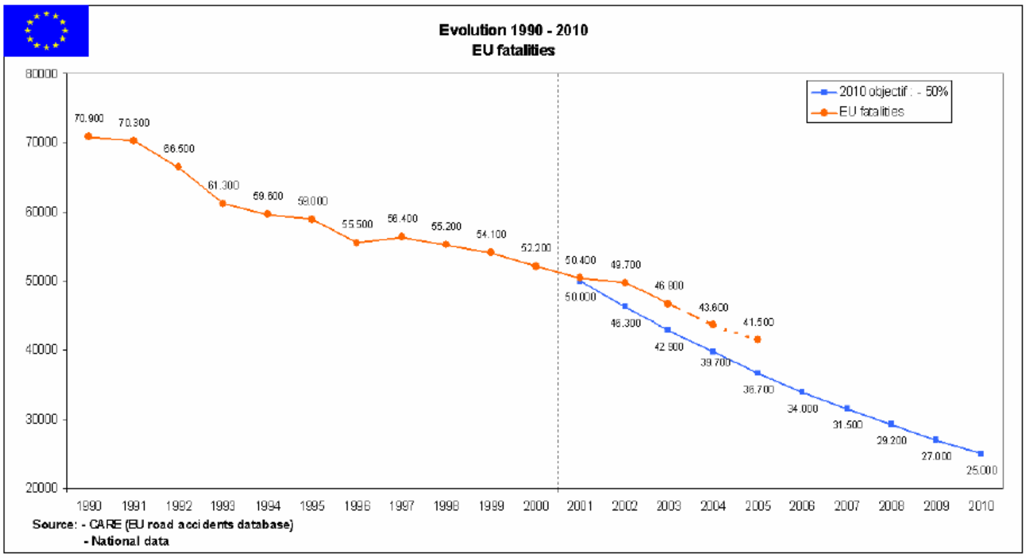

Figure 3: Achieved road traffic safety according to EU mid term review (Source: European Road Safety Action Program - Mid-term Review (COM(2006) 74 final)

In 2005 the EU published in the European Road Safety Action Programme - Mid-term Review a, graph shown in Figure 3. Indicated by the orange line is a reduced number of fatalities, but it is still above the blue line which indicates the aspired reduced number of fatalities in the EU.

As European accident statistics show, there is a high number of traffic fatalities per year and country. It is evident that each member state of the European Union considers traffic safety as a high priority political issue.

2.2 Motivation of research funding bodies

EU and national research funding bodies investigate on further research needs and co-ordinate research actions to make sure that results are statistically significant and transparent as a basis for standardisation and legislation actions. A main objective of research funding bodies is to get to know about solved and unsolved questions and missing links between the results of different research projects. They are also interested in ensuring support to their future research programs.

The main objective of research funding bodies is to gain reliable results where good decisions can be based upon. Their investments ought to be decided wisely taking into consideration the latest research results and needs.

European research funding bodies need a good overview about all European research activities. National research funding bodies have a better overview what research results are needed to achieve national policy objectives or what innovation is needed to bring national interests forward. They also check the transferability of results on national frameworks.

2.3 Motivation of infrastructure owners and road operators

Systems that provide efficient solutions for traffic management and increase safety are interesting for public and private road operators. Fatalities cause considerable economic damage. Public road operators have to manage the impact of an accident. Their focus lies on accident prevention and managing the accidents` impact (traffic jam, resulting accidents). Many systems are proposed by research projects to avoid accidents occurrence and/or reduce accidents severity. For a decision on those investigations, proofed knowledge about costs and efficiency of safety systems is needed.

Road operators and infrastructure owners face international cross-border traffic as a new and increasing challenge. Road operators and infrastructure owner also have to discuss ITS-Systems for cross-boarder traffic. An important objective is technical compatibility but also comprehensibility for the user.

2.4 Motivation of standardisation bodies

Official standardisation bodies are at international level

- ISO (International Organization for Standardization)
- IEC (International Electrotechnical Commission)
- ITU (International Telecommunication Union)

at European level:

- CEN (European Committee for Standardization)
- CENELEC (European Committee for Electrotechnical Standardization)
- ETSI (European Telecommunication Standards Institute)

and corresponding standardisation bodies at national level.

Standardisation is important for cost efficient production, for open European wide markets and for a Europe-wide implementation of systems. Standardisation is important, not only from the economic point of view but also concerning the safety aspect.

2.5 Motivation of insurance companies

Insurance companies are addressed because they are interested in the reduction of follow-up costs of accidents. They also have a special interest in risk assessments (e.g. to calculate subscription fees or incentives).

For insurance companies, the amount of risk is less important than its predictability (Dr. W. Reisinger, Wiener Städtische Versicherung, Verkehrsrechtstag 2007-09-21, Vienna). For marketing reasons, insurance companies tend to more frequently allow discounts of various types, which refer to certain attributes of vehicle or owner. It might be considered to allow discounts for safety features of the vehicle, as it is already done e.g. for vehicles with electronic stability control (ESC). From the road safety point of view, it is quite favourable that such discounts exist in order to motivate purchasers to spend their money also on additional safety features. To enable insurance companies to calculate discounts on safety equipment on a real micro-economic basis (instead of marketing aspects), the reduced or additional risk of safety equipment has to be predictable.

3 Recommendations from Application Guidelines and Further Research Issues

3.1 Objectives

IN-SAFETY Deliverable D5.3 includes a description of guidelines and research proposals based on experience of the IN-SAFETY partners and other experts, with the aim to improve overall knowledge on the complex character of forgiving and self-explaining roads.

The result, a knowledge collection, is not only a systemisation of several national, international guidelines and research outcome from IN-SAFETY and other projects but also important for the work done in IN-SAFETY due to the content of some of the guidelines. For example the "European statement of principles on the Human Machine Interface (HMI)", a guideline for safe and efficient in-vehicle information and communication systems (HMI), are also important when preparing ITS systems for pilot test. Also a lot of existing guidelines on Variable Message Signs (VMS) are to be found on national level. The knowledge collection is helpful for other researchers with similar research tasks.

3.2 Approach

Many existing guidelines targeting the self-explanatory and forgiving nature of road environment was collected with the help of questionnaires. The questionnaires were filled out by experts from various countries. They were asked to briefly describe national guidelines and research needs on how to give roads a more forgiving and self-explaining quality, and to define gaps in knowledge and potential regulation. Also included is knowledge from a detailed literature analysis during the whole IN-SAFETY project.

On the basis of collected responses a concluding matrix of guidelines was created. Furthermore a list of needs for the future research was created.

Geographical focus has been detected for specific guidelines on the:

- International (mostly European),
- National and
- Local levels.

A very important organisation scheme was a classification in

- Infrastructure related guidelines
- Guidelines on vehicle autonomous system
- Guidelines about co-operative system (vehicle-infrastructure)

In addition a brief description to all guidelines is to be found in Deliverable D5.3.

3.3 Recommendations

The analysis of named existing guidelines in questionnaires and research results from IN-SAFETY and other projects shows further research needs. Of course research needs are not only an outcome of Deliverable D5.3, but are also based on IN-SAFETY project experiences.

In terms of information sources, for most of all ITS there are three different approaches:

- Autonomous systems: The vehicle has any information needed on board, operating system and human-machine-interface (HMI) are also based in the vehicle. Typical example: Anti-lock braking systems (ABS).
- Infrastructure-based systems: All equipment is located outside vehicles, at least an HMI is located on site, there may also be sensors at the site and control units may also be placed on site or in a traffic management centre. Typical example: variable speed signs.
- Co-operative systems: These are solutions, where both infrastructure - and vehicle-based equipment co-operates, exchange information and inform, warn or guide road users.

IN-SAFETY again revealed that for most of ITS applications there is more than one basic solution. As an example, warning a driver approaching a curve may be done by infrastructure-based equipment such as a road-side device that detects an approaching vehicle and activates a VMS in case the vehicle is assumed being too fast. On the other hand, a digital map could provide information on the radius of an oncoming curve, by considering the usual behaviour of the driver, calculating the recommended speed and warning the driver in case of exceeding the personal limit or even the physical limits of his vehicle. In a cooperative solution, an in-vehicle device could receive a speed recommendation from a road-side beacon, considering the usual behaviour of the driver and then providing warning when required.

There are various other examples where there are the generic methods of providing one specific service. Obviously, it is hardly efficient to provide one specific service in different ways. Policy decisions should be taken to select the most appropriate method for a service. Until this decision can be taken, respective research should be funded in order to determine feasibility, cost, effectiveness, efficiency, reliability, etc. of the different solutions.

To calculate those parameters more data is needed than it is available today. Development of ADAS/IVIS currently strongly considers technical feasibility and market acceptance. Still, in many cases there are only rough estimates about impact on road safety. In some cases, information about implementation is even misleading: If systems are implemented not isolated (e.g. VMS and automatic enforcement together) it is not possible to identify what one would have achieved without the other. Therefore field operational tests, large scale experiments or other research about IVIS and ADAS are needed, which are representative for Europe's population, infrastructure and vehicles.

Apart from existing systems, the technologies available today could and should be used for developing new systems, either enhancing previous ones, or dealing with new functions and preventing different kinds of dangers. Therefore migration strategies ought to be developed how to upgrade existing systems. Within IN-SAFETY, apart from the scenarios that were developed based on existing systems, two additional ones were described and rated, introducing the suggestion of new systems [see IN-SAFETY D5.3]. These were the following:

- Overtaking Assistant on roads with lane separation („Blind spot“)
- Overtaking Assistant on rural roads without lane separation

For both proposed systems the following could b e recommended:

- Further research is needed around the potential of employing innovative technologies dealing with Vehicle to Infrastructure (V2I), Infrastructure to Vehicle (I2V) as well as Vehicle to Vehicle (V2V) communication.
- Integrated HMI prioritising warnings with different risk origin is needed. Potential for integration of haptic HMI's needs to be further investigated.
- Personalisation of HMI warning strategies needs to be investigated according to drivers individual profile. In this way, specific driver groups (i.e. elderly drivers, novice drivers, etc.) may be addressed. Self-adaptive and self-learning systems, which would adapt different driving patterns should be investigated.
- Intuitive HMIs should be developed addressing all phases of overtakin g.
- More research is needed for special infrastructure segments (i.e. curves) and special visibility conditions (which may hinder the full and/or sufficient operation of vision detection systems).

Table 1: Recommendations from A pplication Guidelines and Further Research Issues

Objective: It is very important not only to push and use ITS systems as a very important instrument to improve road safety but also to evaluate them. Little is known about precise number of target accidents, synergies between several systems, costs (public authority, user , society) and a quantitative evaluation of negative and positive impact of systems.		
Pre-condition: The evaluation of ITS systems can not be done theoretical but needs the cooperation between researchers and infrastructure owners and road operators as well as the assistance of automotive industry and insurance companies. They all possess important information about costs, technical feasibility, road safety impacts and much more. It is to be clarified whether all parties are willing to open their databases under real life condition.		
Policy action: The most important research need according to IN-SAFETY is the need to gain more knowledge to evaluate ITS systems. This can be done by evalua ting existing ITS systems and evaluation processes after implementing new systems.		
Vulnerabilities	Mitigating/Hedging A ctions	Possible Signposts/ Tri ggers/Actions
Gained knowledge from project evaluations stays unpublished and therefore is useless for other researchers.	A database about evaluation results could bring the knowledge to a wider user group. The data ought to be in simplified, standardised format.	Research about structure, possible content and how to use the database is necessary. It ought to be discussed with all affected parties.

3.4 Discussion and conclusions

The decision on innovative ITS systems ought to take into consideration parameters like feasibility, cost, effectiveness, efficiency, reliability, etc. of different solutions. Some national guidelines provide methods to calculate quality and efficiency of new measures. Today lack of qualitative and quantitative data about cost and safety, environmental and traffic effects make the utilisation of methods like Cost-Benefit-Analysis difficult.

Approaches to gain more data about innovative ITS systems were discussed and analysed and suggestions for further research needs have been given within IN-SAFETY. Field operational tests, large scale experiments as well as simulation and risk analysis models can help to gain more knowledge about ITS systems. IN-SAFETY project recommend that after a decision has been taken to implement a certain system, evaluations ought to be a matter of course and evaluation processes after implementing new systems ought to be established in order to handle lacking data.

4 Recommendation on pictograms and verbal messages, horizontal and vertical signing

4.1 Objectives

In 2003 the TERN (Trans-European Road Network) covered 15 countries with 11 languages spoken plus 3 additional states which are not EU members. These countries and languages, together with 10 "new member states" with 9 official languages, were considered with the aim to derive at feasible suggestions of the cross-language and language independent display of information on VMS (Variable Message Signs) and static message boards on motorways.

4.2 Approach

The following requirements on VMS have been identified and studied in Deliverable D2.3:

- physiological requirements with regard to conspicuity and discriminability,
- cognitive requirements with regard to understanding,
- technical requirements with regard to the size and quality of the presentation of the information.

The elaborated symbols/pictograms, together with Vienna Convention traffic signs, suitable for application on VMS, static signs and in-car navigation displays meet all documented requirements. So does the complementing Latin and Greek "TERN" alphabet versions which have already been used for text elements in the renderings of the newly designed symbols/pictograms and the modified Vienna Convention traffic signs required on motorways.

Apart from verbal messages elements like place names, specific words and abbreviations have been identified as "Europeanisms", suitable for communication across language barriers.

4.3 Recommendations

Deliverable D2.3 gives a summary of recommendations on follow-up activities (e.g. Recommendation to the European Commission to amend Annex III of Council Directive 91/439/EEC: Review the viability of 0,5 visual acuity).

Table 2 summarizes recommendations from Deliverable D2.3 concerning pictograms and verbal messages, horizontal and vertical signing.

Table 2: Recommendation on pictograms and verbal messages, horizontal and vertical signing

Objective: International understandable (language independent) traffic signs/information throughout Europe are useful to make "understanding" easier for international traveller and therefore are supposed to increase traffic safety due to less misunderstandings.
Pre-condition: The need of revision of the Vienna Convention on Traffic Signs ought to be clarified. Investigations are necessary to specify the negative impact of today's situation in relation to what can be improved with harmonisation. Other positive and negative effects of harmonisation are to be taken into account beside visibility, comprehensibility before a decision

<table>
<tr><td colspan="3">on harmonisation can be taken.</td></tr>
<tr><td colspan="3">Policy action: The results of Deliverable D2.3 provide a basis for further discussions on Europe-wide harmonization of verbal message elements, traffic signs and VMS elements. It ought to be checked and decided on substitution of signs/ symbols/ pictograms or adding new signs/ pictograms/ symbols/ Europeanisms to Vienna Convention. Information systems such as in-car traffic signing and information ought to be considered as alternative to infrastructure signing elements.</td></tr>
<tr><th>Vulnerabilities</th><th>Mitigating/Hedging Actions</th><th>Possible Signposts/ Triggers/Actions</th></tr>
<tr><td>The IN-SAFETY results of D3.2 are not jet verified in real test installation.</td><td colspan="2">Initiations of pilot test and long term research is needed.</td></tr>
<tr><td>Not all Europeanisms proposed in D2.3 are likely to be harmonised, because often the English version of a word, e.g. “exit” is used instead of national wording e.g. “Ausfahrt”).

Harmonisation of wording could lead to confusion and misunderstanding. Especially the meaning of abbreviations might cause confusion (e.g. min = minimum = minute)</td><td>Europeanisms should be used wisely but could be useful in case no symbol is available to allow language independent information.

An alternative are bilingual information (analysed in D2.3). If the dimension of traffic signs and VMS allows it than bilingual information should be used (e.g. “Police / Polizei”). Symbols and pictograms are always the most language independent way to transfer information.</td><td>Although there are many guidelines and recommendations how to design warning messages, alarm sounds and so on, it is impossible to design alarm messages suitable for all drivers and for every situation. Therefore users should be able to personalize their applications, e.g. adjusting alert levels. Individual in-car traffic signing and information ought to be considered in addition to infrastructure signing elements. Further activities in this field are necessary.</td></tr>
<tr><td>In D2.3 high requirements were formulated on VMS (several colours, certain minimum dimension, lot of graphical details, animation, freely programmable). Not all today’s existing VMS are conforming to those requirements.</td><td>VMS are often used at accident blackspots. The required and detectable information may vary from point to point. The information shown on VMS can be either recommendation or mandatory (e.g. dynamic speed limit is mandatory).</td><td>Taking into consideration the necessary traffic information content and cognition requirements new VMS might became necessary. Individual in-car traffic signing and information ought to be considered in addition to infrastructure signing elements.</td></tr>
</table>

4.4 Discussion and conclusions

The results of IN-SAFETY Task A2.3 can be considered as a first step towards systematizing and harmonizing of verbal messages and traffic signs across Europe based on extensive investigations concerning visibility and comprehensibility .

Not all traffic related aspects have been analysed within this task (e.g. national legal frameworks). Therefore it stays a long way to harmonisation of traffic signs. Nevertheless the IN-SAFETY results on pictograms, signing and verbal messages are a good starting point and basis for further discussions and decisions. The authors of Deliverable D2.3 describe further recommended activities in detail.

5 Recommendations For Application Of Traffic Simulation and Risk Modelling

5.1 Objectives

Safety and Risk analysis and assessments are helpful to make decisions on safe road and vehicle systems. Simulation models are important for the analysis of existing situation of traffic system, and for the answer of the question "what would happen if...? ". Application of traffic simulation and risk modelling are used within IN-SAFETY to analyse reasons for accident blackspots or identifying gaps and imprecise regulations in standards and to evaluate and verify different alternatives of safety measures.

Simulation can help to measure the impact of the implementation of ITS-systems, their effects (e.g. important for CBA and accident risk analysis) and to compare alternative measures for a certain problem. Since traffic safety depends on numerous factors (e.g. human behaviour, infrastructure, legal factors etc.) they all have to be integrated into the analysis.

5.2 Approach

Several traffic simulation models were analysed in IN-SAFETY. They can be divided in two groups: microscopic and macroscopic simulation models. The models contain state-of-the-art approaches for simulation of traffic at various stages: from the macroscopic view on networks and the traffic streams on the links down to microscopic approach with the focus on the individual driver and the vehicle. A description of the models, their parameter and methods can be found in Deliverable D3.1.

The existing models were analysed and additional safety relevant parameters (such as time –to–collision), adaptive objective function, new safety indicators (such as the shape of the headway distribution) were integrated. Sample applications within IN-SAFETY show the potential of the models for safety analyses.

Furthermore existing risk analysis methodology has been further developed in D3.2. The so called Darmstadt Risk Analysis Method (DRAM)) describes the cause-and-effect chain of critical situations taking into account the uncertainties of the system (especially human behaviour). DRAM is able to analyse complex systems with uncertainty and non-linear relations. The analysis may be done qualitative, quantitative and in a mixed form. A tool called Darmstadt Risk Analysis Tool (DRAT) is provided. DRAT is principally not limited to a certain number of dimensions and elements and so restricted only by available computer memory and calculation time, allowing the model to evolve as needed. Additionally two scenarios are analysed within IN-SAFETY: „approaching a sharp bend" and „lane changing manoeuvres".

5.3 Recommendations

Simulation and risk analysis models can help to solve questions without implementation of a system in reality. This can help to save money and time as well as to evaluate possible alternative measures. It ought to be kept in mind that for a certain problem an appropriate model is needed (sometimes adaptations of existing simulation and risk analysis models are necessary) as well as a reliable data input and parameters.

It is necessary to analyse the long-term effect of new infrastructure, regulations and accessories with all-embracing risk analysis methods which are able to integrate the effects of human behaviour and habits. A new endangerment regarding ADAS systems may arise after the first safety successes have become apparent : if such systems are useful and effective but not reliable, new risks may arise if the user is trusting the system but the system fails and the user has no chance to remark the failure in time. It is difficult to integrate these complex effects in a simulation model in a reliable way, especially it is little known about parameters and their values.

It seems useful to build an overall covering model of the road system as most of the behavioural aspects are cross-linked throughout the system. The modelling process may be started at different points, letting the different parts gradually grow together. The model may temporarily b ranch if reliable knowledge is not yet available within certain sections. But always, the goal should be to integrate all road related knowledge into one model (and its adjacent database of knowledge). Such a model could be used to enable and simplify the process of problem analysis, discussion of variants and assessment of political recommendations.

In-Safety successfully shows first steps and solutions in the direction of "an overall aspects covering model" but there are still open issues. Models will al ways be a simplified picture of the real world.

Table 3: Recommendations For Application Of Traffic Simulation and Risk Modelling

Objective: IN-SAFETY shows that the use of simulation models and risk analysis tools can help to model the ITS system impact both on traffic conditions and on road safety. The analysis of traffic safety problems with the help of risk analysis models can help to systematically find improvements and knowledge how to avoid safety problems.		
Pre-condition: An urgent need for all safety analysis based on traffic simulation is research on the relation between actual accident risks and the derived safety indicators. Today, researchers assume that a change in the indicators correspond to a change in accident ri sks. Reliable parameters, data input for model calibration as well as a detailed description of scenarios and alternatives, which are to be analysed, are important for reliable results of simulation and risk analysis models. Cost-intensive model calibration need to be done to gain reliable results, but on the long-term the use of models is often less expensive than real life test and the only way of coming to results.		
Policy action: The use of simulation and risk analysis models as described in Deliverables D3.1. and D3.2 in addition to conventional methods to calculate efficiency of certain measure/system is recommended. IN-SAFETY shows a wide variety of use cases of simulation and risk analysis models and their advantages.		
Vulnerabilities	Mitigating/Hedging Actions	Possible Signposts/ Triggers/Actions
Simulation models, both micro and macro, as well as risk analysis tools can only produce reliable and	A questionnaire survey shows the different weights the main factors affecting route choice from the drivers point of view: travel-time, distance and safety level. Other possibilities to gain data input is using results from pilot studies (e.g Swedish pilot is	

realistic results if they are calibrated using realistic and representative data.	used as input for so called "RuTSim model"). The development of a worldwide database of knowledge also helps to collect necessary data from several projects. Precondition here is to promote cooperation between projects, establish common procedures, to interact between the researchers and this database.

5.4 Discussion and conclusions

To make use of simulation models it is important to find the right model for the current problem. Very often simulation models are developed for a certain question, situation or premises. With the right parameter values and data input the results of simulations are very helpful to take decisions on a certain ITS system, conflicting measures or other alternatives.

New ITS systems are supposed to influence the driving behaviour (e.g. in terms of distance choice and also by shorter reaction times). In simulation and risk analysis models the corresponding parameters ought to indicate the effects of ITS systems on overall and individual safety. Today, one can only assume that a change in the indicators could correspond to a change in accident risks in the same direction. Therefore an urgent need for all safety analysis based on traffic simulation is research on the relation between actual accident risks and the derived safety indicators. The calculation is also complicated by driver assistance systems that possibly change this relationship between indicators and accident risks. For example, if vehicles are equipped with reliable and fail safe driver assistance systems that reduce reaction times then shorter TTCs could be accepted without any increase in accident risks.

With the restricted sample sizes of critical situations or accidents in reality, analysis often runs into statistical problems. Microscopic traffic simulation models create traffic flow as sum of movements of individual vehicles – just like in reality. In micro-simulation the sample size is normally only restricted by practical limitations, like run-time, but is generally larger than real-life observations. Furthermore, it is possible to extract safety relevant parameters which indicate a safety level on a larger sample size and therefore are statistically more significant. Given such surrogate parameters, micro-simulation can better estimate safety effects than other methods relying on a small number of real-world safety-critical data provided that the input data and behaviour modelling are realistic.

As seen in D3.2 "Road risk analysis tools" there is a risk analysis tool available which allows to work with a huge amount of data and to integrate human behaviour into the analysis. It is not necessary to reduce data to more or less arbitrary characteristic values, which normally over - or underestimate risk systematically. The possibility for quantitative description and evaluation principally allows any desired precision. The precision is only dependent on the availability and the gathering of data. In fact, the traditional methods may be integrated into this methodology.

IN-SAFETY recommendation is that for the future more additional modelled scenarios (e.g. tunnel sections) should be added, to expand the scope of the modelled scenarios and to refine them increasingly. Increased attention should be given to international and interdisciplinary work as well as on quality of input data and parameters.

6 Lessons learnt from Pilot Tests

6.1 Objectives

The Pilots have primarily examined the effectiveness and usability of the selected implementation scenarios and concepts of WP1 (forgiving roads environments) and WP2 (self-explanatory road environments). The results have also been used in order to improve simulation models, risks analysis tools and training schemes of WP3 (road safety assessment). These tests used road infrastructure elements and test vehicles equipped with ADAS and IVIS functions, as well as IN-SAFETY services and applications as defined and developed in WP1 and WP 2.

6.2 Approach

The IN-SAFETY Pilots sites are the following:

- Italy (Turin) - field tests (CRF)
- Sweden (Linköping) - simulator tests (VTI)
- Germany (Stuttgart) - field tests (IAT)
- Greece (Athens) - field tests (ICCS)

The aim of the IN-SAFETY Pilots was to determine the users' acceptance against the introduced IN-SAFETY cooperative solutions, as well as to perform a detailed assessment of their foreseen impacts. The evaluation of the effects of some of the selected scenarios of forgiving and self-explaining roads has been done in four different pilots realized in four selected regions, but also in an advanced moving base driving simulator in Sweden.

The results of pilots were analysed and structured in correspondence to the topics: technical verification, impact assessment, user acceptance, socio-economic, guidelines. Deliverable D4.2 provides a summary over all pilots and results.

6.3 Recommendations

The overall IN-SAFETY pilot results showed that all applications were seen as more useful than the baseline defined as normal driving without the IN-SAFETY systems. In some cases with low usefulness scores there was often a reduced technical performance of the system involved. The pilots have illustrated that there is an impact in several of the IN-SAFETY scenarios.

The Swedish Pilot with a School bus ahead warning on-board system shows a decreasing speed while the bus was approaching in comparison to a reference scenario without the system. The average passing speed was about 60 km/h which is far too high to avoid severe accidents. Even in this simulation environment drivers do not react properly on such a warning. Research needs to address the question of long term reaction and how to motivate drivers to act safely. Therefore large field operational test would also help to collect missing practical experience and data especially how drivers react in long term.

A state-of-the-art Lane Departure Warning system has been investigated in a German field experiment with a subjective assessment. Empirical results from 17 test subjects who drove more than 5000 km show that lane departure warnings were generally well accepted. Driving with the Lane Departure Warning system tends to reduce the number of lane departures and also educates drivers to use the indicators more often and earlier when changing lanes. However, the differences were not big enough to be statistically significant.

Table 4: Lessons learnt from Pilot Tests

<table>
<tr><td colspan="3">Objective: Gain statistically significant results and long term assessments about safety effects, driver behaviour, market penetration, business models and technical feasibility/reliability is very important for further decisions on implementation of ADAS .</td></tr>
<tr><td colspan="3">Pre-condition: The definition of a set of systems/technologies to be tested and the test design (parameters, alternatives, testing method, representative sample of participants) is important to prepare field operational test .</td></tr>
<tr><td colspan="3">Policy action: It is recommended to do necessary field operational test and long term assessments with statistically significant number of tests and subjects .</td></tr>
<tr><td>Vulnerabilities</td><td>Mitigating/Hedging Actions</td><td>Possible Signposts/ Triggers/Actions</td></tr>
<tr><td>Field operational test take a long time (several years). It might happen that new important questions arise and that others are less important than it has been predicted before the test started .</td><td rowspan="2">Both vulnerabilities should be addressed in the field operational test design from the very beginning. The development of a set of scenarios what might happen during test period, could help to estimate the described risk (risk management) .</td><td rowspan="2">Pre-test studies and a compilation of methodologies, knowledge and experiences from previous projects can help to avoid problems occurring during the field operational test but also help to identify missing solutions/ methods.</td></tr>
<tr><td>Different causes might lead to the case that not all questions can be answered in field operational tests.</td></tr>
</table>

6.4 Discussion and conclusions

Since empirical data from pilot tests are very important for the socio -economic evaluation they play an important role in research projects. Data collected in the pilots are also used as input for the improvement and tests of the simulation models in WP 3. The r esults from the pilots do not only provide direct evaluation results but also guidelines for future applications and implementations of IN-SAFETY systems.

The four IN-SAFETY pilot tests were discussed in terms of effectiveness, usability and acceptance. Another important issue is the technical reliability of the systems since this will most surely be an important factor when evaluating the drivers' opinions. Not all possible technical solutions could be tested during the test period, so no final recommendation on technical performance of the systems exists.

The impact assessment of a selection of the IN-SAFETY scenarios shows a tendency towards positive impacts on safety . It ought to be kept in mind that no long term data are available and that test persons tend to behave different in test situations than normally. Therefore long term assessments are recommended in further research projects.

User acceptance is studied with the help of the questionnaires described in D4.1. The results show a dependency between acceptance and technical performance. Lower rating could therefore be due to technical problems.

Although the IN-SAFETY pilots have run successfully further in-depth research is needed to gain statistically significant results and long term assessments ab out safety effects, driver behaviour, probable user acceptance, necessary market penetration, business models and technical feasibility/reliability.

7 Recommendations for Application of the Operators Manual

7.1 Objectives

A survey carried out within the framework of the IN-SAFETY project has shown that none of the interviewed operator companies had an official training scheme on innovative ITS systems for their staff (operators), so current trainings usually focuses on handling skills for the management/ information system used. Typically, today's training is on the job, using a stepwise approach from just watching experienced operators to working self dependently in times of difficult traffic conditions. None of these training schemes included a reasonable share of general knowledge about traffic management, in-vehicle information systems (IVIS) or advanced driver assistance systems (ADAS).

The research project IN-SAFETY aims at using intelligent, intuitive and cost-efficient combinations of new technologies and traditional infrastructure best practice applications, in order to enhance the forgiving and self-explanatory nature of roads. The implementation of new Intelligent Transport Systems and Services (ITS) applications will strongly depend on the operators of Traffic Management and Traffic Information Centres which are competent for implementation and operation of these systems.

Currently, ITS are developed very rapidly. Both in-car devices and infrastructure based systems are implemented throughout Europe. The aim of most of the systems is to support the driver with information and/or adequate warning. The systems use several different ways to communicate to and with the driver. Too many systems therefore may easily lead to an information overflow, specifically if information is presented which the driver does not or not actually need. In IN-SAFETY new methods to support the driver with information he/she actually needs and to elaborate optimal ways of presenting such messages are developed and summarized in an "operators' training manual".

The training handbook is dedicated to all TMI (Traffic Management Information centre) and TMC (Traffic Management Centre) operators (e.g. highway and tunnel operators, traffic surveillance centres, traffic information by mass media as radio and internet, urban traffic management and surveillance, etc.), to their staff and to the management as well. Main categories of users are road operators (Urban/ Rural/ Highway/ Ring road), area operators (TMI/ TMC-Urban/ Rural/ Integrated), specific infrastructure operators (tunnel/ bridge/ other) and generic.

7.2 Approach

The training is primarily dedicated to technicians responsible for the development and incorporation of ITS systems on the high level road network and operators which control the systems. The training includes information on installation, use and maintenance of state-of-the-art technology.

Computer-Based Training (CBT) uses the computer for training and instruction. CBT programs are called "courseware" and provide interactive training sessions for all disciplines. CBT was originally introduced on Laserdiscs, then CD-ROMs and, later, online. CBT courseware is typically developed with authoring languages that are designed to create interactive question/answer sessions. Web Based Training (WBT) is disseminated over the internet and provides added value through up-to-datedness and networking. IN-SAFETY's "operators' training manual" is available as web based training.

7.3 Recommendations

Similar procedures for traffic management should be applied and rules should be implemented according to common standards on TERN. Harmonised training for TMI/TMC operators throughout Europe lays a basis for approaching this goal without having to harmonise all the official procedures. It may be assumed that decisions taken by different operators that are based on equal information and education are likely to be similar and therefore familiar and understandable for driver from the home country as well as from any other origin.

The IN-SAFETY consortium proposes an "Operators' Training Manual" as a first step towards convergence of operators' training, which has (according to the goals of the IN-SAFETY project) a particular focus on ADAS and IVIS. This manual may serve as a basis for developing a curriculum for operators, which on the long run should be provided to all staff providing public information and traffic management.

The movement of people and goods across Europe is increasingly hindered by congestion and accidents on the road. Goal is the deployment of intelligent transport systems (ITS) to combat these problems and move us towards efficient and safe management of the trans-European transport network.

Potential problems vary from region to region, with some items common to many areas. For instance, queuing to pay manually for use of motorways, bridges and tunnels causes delays and increases the risk of accidents no matter where you are. Other problems include vehicle breakdowns and other incidents that can cause major traffic disruptions at busy times as well as traffic congestion in and around urban areas. In areas of heavy traffic around cities and congested regions uncertainty about journey times is a key issue for drivers. In addition, seasonal traffic causes disruptions on motorways, with the difficulty of international travellers unable to understand traffic information in the local language. Drivers may be faced with different information in each country, which can be a problem for lorry drivers as well as those on holiday.

The "operators' training manual" describes a variety of reasons to use ITS systems. It can be seen as a decision guidance on ITS systems and it is supposed to support improving the service quality by giving background information both for the regular business (strengthening the basis of decision making) and for improvement of existing or development of new services.

Table 5: Recommendations For Application Of the Operators Manual

<table>
<tr><td colspan="3">Objective: Intelligent Transport Systems and Services (ITS) can save lives, time and money as well as reduce threats to our environment and create new business opportunities.</td></tr>
<tr><td colspan="3">Pre-condition: ITS already has a presence in everyone’s day-to-day mobile activities, for example active support systems such as vision enhancement, lane-keeping assistance and collision warning systems but also collective ITS systems such as coordinated traffic control, ramp metering, variable message signs, and traffic and incident detection systems.

There is much qualitative knowledge about the benefits and positive impact of ITS systems. It is to be seen as a pre-condition to quantitative proof positive and of course also negative (long term) effects of ITS on drivers behaviour, environment, traffic efficiency and road safety. Qualitative results are also important to fall decisions on a rational basis like Cost-Benefit-Analysis.</td></tr>
<tr><td colspan="3">Policy action: The broader, appropriate use of ITS systems is recommended.</td></tr>
<tr><td>Vulnerabilities</td><td>Mitigating/Hedging Actions</td><td>Possible Signposts/ Triggers/Actions</td></tr>
<tr><td>This handbook shall support improving the service quality by giving background information. It does not give any recommendation for training on the use of existing traffic management hard- and software systems.</td><td colspan="2">Training based on this manual does not replace any part of existing training procedures; it is meant to accomplish the education of new staff and may be implemented as a part of retraining for existing staff.</td></tr>
<tr><td>ITS systems are developing very rapidly. The handbook might not include all ITS systems.</td><td colspan="2">The quality of a handbook depends on continuous updates.</td></tr>
</table>

7.4 Discussion and conclusions

The “operators’ training manual” was updated several times during the project, but ought to be updated after the end of the IN-SAFETY projects as well. It covered a wide overview on today’s ITS systems and ITS systems under development. Information on installation, use and maintenance of state of the art technology are included. The handbook could be a decision guidance on innovative ITS.

Apart from a necessary harmonisation of operators' qualification throughout Europe, the IN-SAFETY operators training manual and training tool offer immediate benefits to operator companies. In order to provide the best service at the lowest cost, to improve safety and to encourage further development, road owners and operators will be interested to improve qualification of their staff. This additional knowledge is necessary and useful

- to improve their quality of service under regular traffic conditions, which for private (commercial) road operators also means to improve the attractiveness of their roads;

- to improve performance of their staff in everyday business;
- to improve management and/or information performance in exceptional situations;
- to improve further development of their road management ha rdware and processes;
- to improve international co -operation and implementation of best practice solutions

Moreover, apart from the strictly educative point of view, the IN -SAFETY Operators' Manual is useful also as an everyday consulting tool in higher lev el decision making procedures, in terms of providing an overview of existing ITS applications and a quick and easy way to find telematic solutions to identified problems. Of course this would be the first step and the Manual does not aim to provide all the necessary details one would need to implement any of the suggested measures. The application examples however could be an indicator of the impact of each application in similar cases.

8 Recommendations from MCA-AHP and CBA assessment of selected systems and functions

8.1 Objectives

A main objective for societal CBA (*socio*-economic analysis) is to identify those projects/measures/scenarios that will increase aggregate economic welfare as measured in monetary terms. Societal interest is in that case an aggregation of individual interests. The money measure is given from projects net benefits (total benefits – total costs) or the benefit cost ratio (total benefits divided by total costs).

The objective of the MCA-AHP (multi-criteria analysis (MCA) – analytic hierarchy process (AHP)) approach is to obtain a prioritisation for a number of scenarios contributing to the creation of a more forgiving road and self-explaining road environment. In order to assess not only the policy or societal priorities regarding these scenarios, but to assess also their implementation potential, an analysis needed to be performed for each relevant stakeholder, namely society, users and manufacturers. The objective of the IN-SAFETY project is to focus on the societal point of view, since this represents the general interest, and should be taken as a starting base for policy purposes. The two other points view, namely those of the users (demand side) and manufacturers (supply side), were considered important from an implementation perspective.

The aim of the MCA-AHP approach is broader than that of a strict cost-effectiveness analysis (CEA) or cost-benefit analysis (CBA), since in the MCA approach the contribution of the scenarios is assessed not only in terms of safety effects, but also in terms of a much larger number of policy objectives, including inter alia, driver comfort, travel time duration, network efficiency, environmental effects, liability risk, etc.

8.2 Approach

Ideally, a CBA should include all possible benefits and costs expected to result from the scenario implementation. However, in many cases all effects are not easily quantified and/or not easily monetised. In IN-SAFETY CBA only safety effects (on expected injuries/fatalities) were included, while other potential effects (on time use, environment, etc) were omitted from the calculations. Thus, the CBA is partial. There are also large uncertainties related to the estimated safety effects (that are based on an “error-based approach” which possibly yields maximum potentials) and the estimated costs (that may change a lot if the market expands). However, even if the analyses in Deliverable D5.2 are tagged to one country, they should rather be regarded as example studies. The analyses are not intended for detailed policy analysis for the selected country, even if the national injury/fatality data applied will influence on the resulting estimates.

The approach followed in order to obtain the prioritisation of scenarios is that a multi-actor MCA (MAMCA) methodology was applied. The MAMCA is a specific methodology within the entire MCA methodology. It is a methodology which makes it possible to obtain a prioritisation in terms of what each stakeholder considered relevant. In this application of MAMCA, three specific stakeholders were identified, namely society, users and manufacturers.

8.3 Recommendations

Table 6: Recommendations from MCA-AHP and CBA assessment of selected systems and functions

<table>
<tr><td colspan="3">Objective: In preparation of the Cost-Benefit-Analysis today's databases on accidents were analysed and it became clear that knowledge about target accidents and benefits of a system is not yet satisfying. To achieve reliable CBA-results as a basis for policy recommendations and actions better databases on effects and cost of ITS-systems are needed.</td></tr>
<tr><td colspan="3">Pre-condition: More research on innovative ITS-systems, especially co-operative systems is to be seen as a pre-condition. Without detailed knowledge about system architectures, technology solutions and business models it is impossible to assess costs.</td></tr>
<tr><td colspan="3">Policy action: In European countries accident statistics show different structures, different interpretations of collected data as well as different amount of data. Therefore European and national legislation bodies ought to encourage national road authorities to develop needed databases on a common European level (better standard). A result might even be a guideline for the structure of national accident statistics.

Research projects dealing with rather technical details of cooperative systems are needed. On the other hand, since the cooperative systems depend on infrastructure and vehicle systems, public authorities have to play a leading role in a partnership with private sector. Those questions are to be discussed on round tables with all affected parties. Round tables need initialisation, preferably by national road authorities!</td></tr>
<tr><td>Vulnerabilities</td><td>Mitigating/Hedging Actions</td><td>Possible Signposts/ Triggers/Actions</td></tr>
<tr><td>Necessary data are not collectable (due to high cost of detailed accident analysis)</td><td colspan="2">Expert group ought to decide on obligatory core information with respect of performable actions (done by police) at accident side</td></tr>
<tr><td>CBA in IN-SAFETY shows high dependency of cost of scenarios, especially cooperative systems reach low CB ratios.</td><td colspan="2">When developing cooperative systems other use cases ought to be integrated. In case that road-side beacons, etc. can be used for more than one use case CB ratios became better. Those use cases ought to be considered in the project (e.g. standardisation of interfaces, communication protocols).</td></tr>
<tr><td>IN-SAFETY describes possible business models which are not to be seen as finalised. They are more a basis for discussions with all affected parties.</td><td>The discussion on business models ought to be done in parallel to technical developments. Without common decision on business models co-operative systems won't work. Taking international transport into consideration the discussion might be initialised on EU level.</td><td>The stakeholders controversial rankings of scenarios was shown in Deliverable D5.3. It is therefore necessary to clarify different standpoints of Stakeholders and develop several business models alternatives, discuss dis-/ advantages.</td></tr>
</table>

8.4 Discussion and conclusions

The CBA results of IN-SAFETY project can be seen only as indicators by the authorities because of too many undetermined parameters. The tendency shows that vehicle equipments for the scenarios are now being introduced to the market, driven by market forces. This process may lead to considerable changes for a new societal economic assessment within some few years. The cost of vehicle systems represents the lion's share of total costs. If many new cars will have the necessary systems as standard, the item costs will most probably decrease substantially (in relative terms). A future CBA will then be based on a new reference situation with some share of vehicles having the necessary equipment and lower costs of equipping new cars of the marks in the car park that do not have the systems as standard. This would reduce the costs of implementing such scenarios.

On the other hand, since the scenarios are primarily cooperative systems between infrastructure and vehicles, the authorities have a role to play in a partnership, as indicated from the business modelling.

The final prioritisation of selected scenarios shows a high discrepancy among stakeholder priorities due to risks associated with reliability and open technical questions. More research on innovative ITS is therefore needed. It is also recommended to include more experts in the discussion about scenario prioritisation.

9 Conclusions

IN-SAFETY project describes innovative ITS solutions to contribute to a more forgiving and self-explaining road environment. On the basis of today's knowledge, databases, project experiences and pilot test the systems were evaluated. Their high safety potential was shown in practical tests and cost-benefit-analysis. Especially a clever combination of some ITS solutions allow an efficient implementation and success in road safety.

In-depth analysis and field operational testing are needed to answer open questions, however, deriving from the enormous cost for such efforts, the samples are normally rather small and extrapolation to whole of the European fleet and driver population is rather imprecise. As a consequence, the improvement of official national traffic accident records should be supported and international databases should be extended accordingly. Furthermore IN-SAFETY shows the potential of simulation and model based analysis to reduce costs for evaluation and decision process.

The IN-SAFETY project recommends that databases, which are operated by vehicle manufacturers, could also be used to provide data for this purpose.

- insurance companies might introduce ITS solutions which themselves collect data for estimating the particular risk of one vehicle (e.g. mileage) in order to use this data for calculating the premiums. Benefits might be given by the insurance companies to motivate drivers to accept such new solutions, which at the same time promote other very useful ITS (as UNIQA does with its "SafeLine" program promoting e-Call and car finder);
- insurance companies should collect and provide data for analysis by road safety experts (with a focus on property-damage-only accidents);
- specific ITS features of the vehicle should be included in police reports on injury accidents;
- alternatively, in-depth accident analysis should be carried out;
- such research should be funded by the relevant bodies.

The overall problem of lacking data can be addressed with more co-operations between stakeholders. With their help not only a wider data base on positive and negative impacts of systems can be established but also organisational and operational issues of innovative ITS systems can be discussed. It cannot be expected that all questions concerning cost and effectiveness, technical details or organisational issues can be solved within a research project. European legislation bodies ought to raise awareness of open questions and bring parties like national road authorities, industrial partners, automobile clubs etc. together ("round table principle"). IN-SAFETY shows solutions to go further towards forgiving and self-explaining road with the help of intelligent infrastructure and ITS solutions.

10 References

Anund, A., Tapani, A., Kircher, A., Hagenmeyer, L., Boutsikaki, N., Bekiaris, E., Vatakis, A., Spandidis, P., Kalogirou, K., Liberto, C., Raimondi, M., Damini, S., Wiethoff, M. & Benz, T. 2008. "Pilot results consolidation." Deliverable D4.2, C.N. 506716, IN-SAFETY project, January 2008.

Anund, A., Benz, T., Gaitanidou, E., Spyropoulou, I., Toffolo, S. (2008) "Improved Micro and Macro Simulation Models" Deliverable D3.1, C.N. 506716, IN -SAFETY project, January 2008.

Bald, J. St., Stumpf, K., Wallrabenstein, T., Le Thu Huyen (2008) „Road Risk Analysis tools" Deliverable D3.2, C.N. 506716, IN -SAFETY project, January 2008.

De Brucker, K. & Wiethoff, M. (Eds.) 2006. "Implementation scenarios and concepts towards self -explaining roads." Deliverable D2.1, C.N. 506716, IN-SAFETY project, October 2006.

Erke A., Veisten, K., Elvik, R., Macharis, C., Verbeke, A., De Brucker, K., Wiethoff, M., Bekiaris, A., Anund, A., Winkelbauer, M. (2008), "Cost-benefit analysis and cost-effectiveness analysis", Deliverable D5.2 C.N. 506716, IN-SAFETY project, January 2008

Macharis, C., Verbeke, A. & De Brucker, K. (2008), "Implementation scenarios and further research priorities regarding forgiving and self -explaining roads." Deliverable D5.3, C.N. 506716, IN-SAFETY project, January 2008.

Marchau, V.A.W.J., W. Walker, G.A. van Wee (2007) Innovative Long -term Transport Policymaking: From Predict and Act to Monitor and Adapt.

Sulzmann, Frank (2008) "Best practice guide on horizontal, vertical and telematic signing", Deliverable (D5.1), C.N. 506716, IN -SAFETY project, January 2008.

Walker, W.E. (2000a) Policy Analysis: A Systematic Approach to Supporting Policymaking in the Public Sector, Journal of Multi -Criteria Decision Analysis, 9(1 -3), 11-27.

Walker, W.E. (2000b) Uncertainty the Challenge for Policy Analysis in the 21st Century, Inaugural Speech, Delft University of Technology, Delft.

Walker, W.E., Rahman, S.A., and Cave, J. (2001) Adaptive policies, policy analysis, and policymaking, European Journal of Operation al Research, 128(2), 282 -289.

Wiethoff, M., Marchau, V.A.W.J., de Waard, D., Walta, L., Brookhuis, K.A., Macharis, C., Lotz, C., Wenzel, G., Ferrari, E., Lu, M. & Damiani, S. 2006. "Implementation scenarios and concepts towards forgiving roads." Deliverable D1.1, C.N. 506716, IN-SAFETY project, October 2006.