eCoMove

Cooperative Mobility Systems and Services for Energy Efficiency

D6.1	**Requirements and motivators for private and commercial drivers**

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Abstract	The Validation and Evaluation sub-project of the eCoMove project groups a number of complementary activities including the core tasks to validate the functionality of the eCoMove system and applications, and to evaluate if the aimed reduction of 20% overall energy consumption can be achieved. Besides technical requirements a validation process also has to consider non-technical requirements of potential users of the eCoMove system which were in the focus of research for this deliverable.

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	In this document requirements of eCoMove applications are assessed trough three empirical studies. Within these studies drivers and barriers for the use of eco-driving assistant systems of private and commercial drivers within Europe could be identified for different driver types. Furthermore motivating factors for a long term use of eco-driving assistant systems could be derived.

Control sheet

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Terms and Abbrevations

Abbreviation /Term	Definition
ANOVA	analysis of variance
approx.	approximately
Chi^2-test	Chi-square test
C2X communication	Car-to-Infrastructure/Car-to-Car communication
F	F-value, test statistic of the analysis of variance
HMI	Human Machine Interface
iACC	Intelligent adaptive cruise control
iADAS	Intelligent advanced driver assistance system
iNavi	Intelligent navigation system
iTM	Intelligent traffic management
IVIS	In-vehicle information system
km/year	kilometres per year
m	Mean / average value
N	natural number
PAF	Principal Axis Factoring
p	p-value
SUV	Sport Utility Vehicle
sd	Standard deviation
TPB	Theory of Planned Behaviour
t-Test	Student's t-Test
t	t value, test statistic of t-Test
eCoSmart Driving, eCoFreight & Logistics, Validation & Evaluation, eCo Traffic Management &Control	Sub Projects of the eCoMove Project
WTP	Willingness to pay
User	Actor that is directly interacting with the eCoMove system(s)
User need	User needs are per definition entirely user oriented and are not necessarily consistent. They describe the expectation of the user to the system. The user needs are collected as part of the stakeholder needs.
User requirements	User requirements are derived from the user needs and are defined after assessing user needs first
System	Used as short term for eCoMove driver assistant systems in chapter 4. Also used to explain the interaction of eCoMove applications and components.
Analysis of variance	The analysis of variance is a collection of statistical models in which the observed

	variance in a particular variable is partitioned into components attributable to different sources of variation, it provides e.g. a statistical test of whether the means of several groups are equal or not, i.e. of whether the groups differ or not.
Chi^2-test	The Chi-square test is a statistical procedure in which the results are evaluated by reference to the chi-square distribution. It tests whether the frequency distribution of certain events observed in a sample differs from a theoretical distribution, i.e. whether events or statements were named disproportionally more or less often.
Explorative factor analysis	The explorative factor analysis is a method to extract the common information (factors) of several questionnaire items, i.e. to uncover the underlying structure of a relatively large set of items or to identify the underlying main factors / motives of the different items.
iACC	By using a radar or a laser setup the intelligent adaptive cruise control system not only allows the vehicle to slow when approaching another vehicle and to accelerate again when traffic but it also prevents the development of traffic congestions and includes environmental route information as well as information about the traffic situation.
iADAS	Intelligent advanced driver assistance systems help the driver during the driving process, e.g. the system informs about or supports the driver with eco-friendly driving strategies such as when to change gears, how to accelerate or decelerate in an optimal way.
iNavi	An intelligent navigation system includes e.g. current traffic information, eco-friendly and fuel efficient routes.
iTM	Intelligent traffic management supports eco-driving e.g. by an optimization of traffic lights or "time counts" for a red signal.
IVIS	An in-vehicle information system displays information to the driver, e.g. current fuel consumption.
N	N (natural number) is the denotation for the sample size of a statistical sample, i.e. the number of participants or the number of

	observations that constitute it.
p	The p-value is the probability of obtaining a test statistic at least as extreme as the one that was actually observed. The lower the p-value the more significant is the result in the sense of a statistical significance.
Post-hoc comparisons	The significant result of an ANOVA can be further specified by calculating post-hoc comparisons to determine which mean values differ from each other. In order to account for multiple repeated testing, the tests adjust the critical value of the test statistic. One commonly used method is the bonferroni correction
Principal axis factoring	The principal axis factoring is a method to extract factors within the explorative factor analysis. The method seeks the least number of factors which can account for the common variance (correlation) of a set of variables.
t-Test	The t-Test is any statistical hypothesis test in which the test statistic follows a Student's t distribution. A two sample location test e.g. tests whether the mean of two groups are equal or not, i.e. whether the groups differ or not
Varimax method	The varimax method is an orthogonal rotation method within the explorative factor analysis that minimizes the number of variables with high loads for each factor. The method simplifies the factor interpretation

Executive Summary

The development of eCoMove applications needs to be based on well founded definitions of requirements from the stakeholder perspective. Three empirical studies were carried out among private/non-commercial and professional/commercial drivers to determine drivers and barriers for the use of eco assistant systems and for the motivation of drivers to change their driving behaviour. The results show how eCoMove driver assistant systems can change sustainably the behaviour of commercial and non-commercial drivers into a more eco-friendly driving style.

The main issue of the first study was to analyse how to motivate commercial and non-commercial drivers to behave according defined driving strategies (2). The most important motivators were identified based on experience from related evaluations such as driver trainings. Important here were the moderating and influencing factors on drivers' motivators (e.g. unconscious / not intended behaviour due to absence of relevant information versus conscious / intended behaviour due to time pressure). Three different driver types could be identified. According to the study results a group of drivers is motivated by the factor time which means any mean to get faster trough traffic is valuable. Such drivers are rather young and tend to have a high yearly mileage. From this a second group can be distinguished which represents driver with economical driving behaviour. They check their fuel consumption frequently and drive rather small vehicles. Also their main purpose to use a car is for leisure activities. To the third group belong those drivers who are more aware of the possibility to change their driving behaviour than others. This applies especially to female drivers and those drivers using their vehicle mainly on their way to work. These results show that different strategies are necessary to change the behaviour of all drivers and convince them that the cooperative system will work beneficial for all users.

The design of an eco HMI is depended on user specific expectations towards of such systems. The study results showed that drivers found speech advices to be the most appropriate way to give information to the driver. The information should be provided visually underlined with messages which are easy to understand. Some functionality could act autonomously such as cruise control or start stop automatics but should not restrict the driver's freedom. The assessment of eco driving applications differed between groups of drivers. Older drivers prefer the HMI to give instructions when to shift gears and inform about the current driving styles economical impact. Younger drivers on the other hand are more interested in functionalities which help saving driving time. For instance traffic- and situational adaptive navigation were highly relevant for younger drivers.

Analogous to the study on the motivation of private car drivers, an analysis on motivational aspects of commercial truck drivers was of interest in the second study (3). A stated preferences study helped analysing several influencing factors in pre-, during and post-trip situations. Most drivers believe that systems for tyre pressure check and route planning will help them the most to save fuel. Anticipation or simply "looking ahead" while driving also results in an increased economical driving style because braking and acceleration becomes less erratic. The highest motivation to drive more economical would result from incentives or rewards provided to the driver which would have to be introduced slowly to sustain the positive effect.

To assess the usefulness of eco driving assistant systems on a large scale a European driver study was carried out (4). In this case the respondent rated the perceived ease of use, usefulness, the

environmental impact of driver assistant systems and the willingness to pay (WTP) for such systems. A main outcome was the identification of regional differences among European drivers. Drivers in Germany, Switzerland and Austria were more critical about the environmental impact of eco HMI than other regions. The ecological impact is perceived higher in Southern and Eastern Europe. Also the WTP for such systems is higher within these regions compared to Central Europe. A further analysis on other factors did not bare significant differences among the regions but rather light tendencies. Besides the acceptance of eco driving assistant systems the distribution of driver types in Europe was assessed according to the definitions of the other studies. The driver type indicating time as the most important motivational factor is found especially in Northern Europe and Eastern Europe. Those regions also have less environmentally conscious drivers than elsewhere in Europe according to the study.

Besides the regional analysis an assessment on the European level showed promotive factors and barriers of adopting eco driving strategies. The general perception was that the use of personal data has to be restricted to the necessary information needed, e.g. recording driving patterns. Drivers feel that the freedom of driving is not restricted using eco assistant systems and that stress can be lowered when one is guided through the traffic. Almost all solutions aiming in driving style improvement were rated useful. Commercial drivers however rated systems which included a monitoring function through the employer as critical. The results show that from a user perspective eco driving assistant systems have a positive environmental impact; either through changed driving behaviour or improved traffic flow. The WTP for eco driving assistant systems was rated very low by commercial and non-commercial drivers. The potential for future markets is foreseen is such regions where the share of environmental orientated drivers is high.

The results show that drivers do welcome assistant systems and traffic systems which help improving one’s driving style and which help to safe time and money in traffic. On the other hand such systems have to be designed in a way that they do not overstrain or hinder safe and comfortable driving and are worth to pay for. The development of an eCoMove cooperative traffic system will only work with the support of the users. Therefore the studies deliver valuable information for stakeholders in the design and implementation stages.

1. Introduction

1.1. eCoMove objectives and study approach

The concept of the eCoMove project foresees that vehicle drivers benefit from additional information which is exchanged with the traffic system using Car2X communication and which helps them to improve their driving behavior. The idea is to assist drivers in reducing unnecessary fuel consumption and to help road operators to manage traffic the most energy-efficient way. Possible causes for driver induced inefficiencies are:

- Inefficient trip planning & route choice
- Inefficient driving behaviour
- Individual motivation towards fuel efficient driving
- Low knowledge about means to reduce fuel consumption

All factors together need to be taken into account when driver assistance systems and services are developed and evaluated. In the end the driver should choose the "greenest" route, use her/his vehicle the most economical way and raise the awareness of the fuel saving potential by providing the appropriate information. Incentives such as offering advantages to drivers that spend the least fuel are useful to achieve a reduction of emissions in the overall network. Three situations can be distinguished in which the driver takes decisions and where systems can assist in reducing fuel consumption: Pre-Trip (driver creates a travel plan or receives a tailored trip plan), On-Trip (driver steers the vehicle applying individual driving habits) and Post-Trip (giving feedback to drivers about driving performance).
A complete advantage of driver assistance systems is only reached through large-scale market entry and thus a high level of user acceptance. The users have certain expectations towards such systems which are relevant to developers in early stages. In order to develop systems in a user friendly way the user and her/his motivation concerning the usage of such systems needs to be assessed first.
This document describes different studies which aim to find out what attitudes drivers have towards eco-friendly driving, and how they can be motivated and supported to drive eco-friendly, with the aim to provide the system developers with preferences about drivers and barriers for eco-friendly driving. First an overview is given on the results of the driver motivation and behaviour study. The results present typical driver types defined by different driving motives. These driver types are identified as potential eCoMove system users.
The second study involved drivers from different European countries and aimed to assess the regional acceptance for driver assistant systems which aim to reduce fuel consumption and thus CO2 emissions. A connection was drawn to the first study to find out which assistant systems are preferred by certain driver types.
The third study focused on the motivation of truck drivers in several European countries to drive eco-friendly. An analysis of European differences was conducted.

1.2. Purpose of this deliverable and relations to other SPs

Due to fact that SP applications and especially the HMI applications are still to be defined and developed the assumptions made in this deliverable are based on preliminary documentation about functionalities and purposes of eCoMove applications. Developing and testing of single applications is subject of Deliverables 3.1, 4.1 and 5.1. The user acceptance and motivation studies carried out in this deliverable shall provide a first impression on eCoMove applications in a pre-prototype stage. The results based on user perception will lead to relevant findings for the system developers in SP 3, 4 and 5.

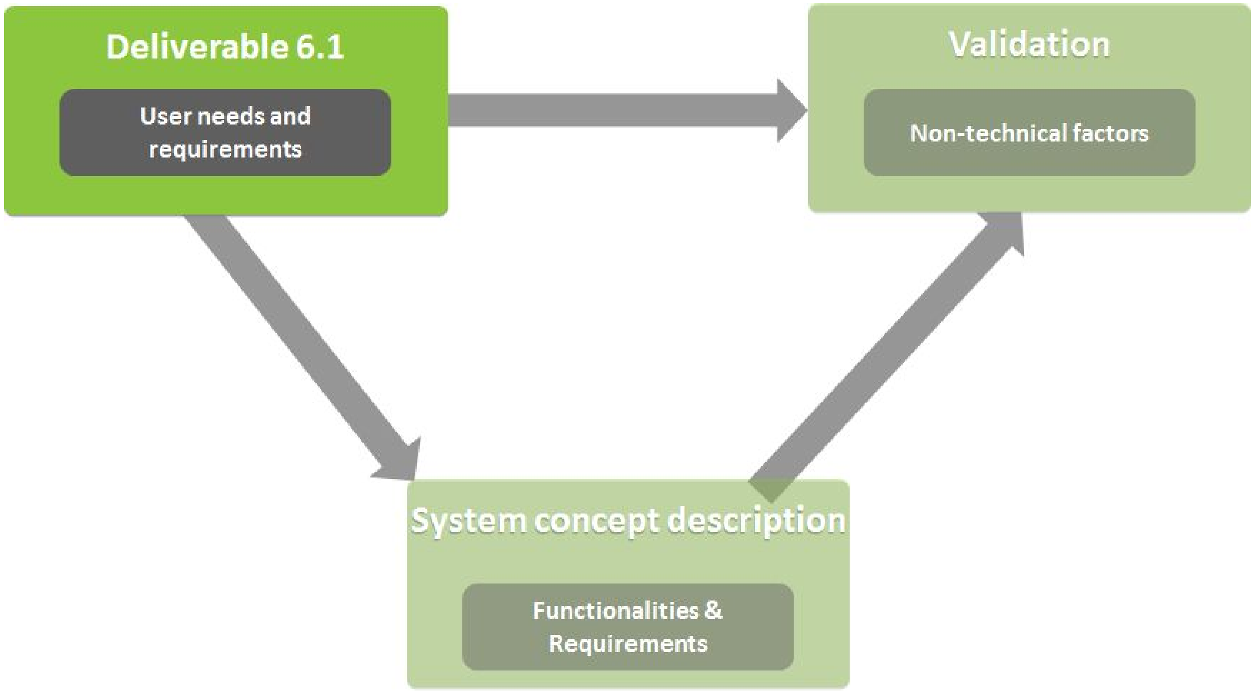


Figure 1: Deliverable results in the eCoMove context

This document delivers valuable information on user needs and requirements for sub-project3 (eCoSmart Driving), sub-project 4 (eCoFreight & Logistics) and sub-project 5 (eCoTraffic Management & Control). Furthermore, the results will be part of the validation plan as non-technical requirements for evaluating the impact of eCoMove applications in sub-project 6 (Validation & Evaluation).
Figure 2: Deliverable Structure gives an overview how this deliverable is structured:

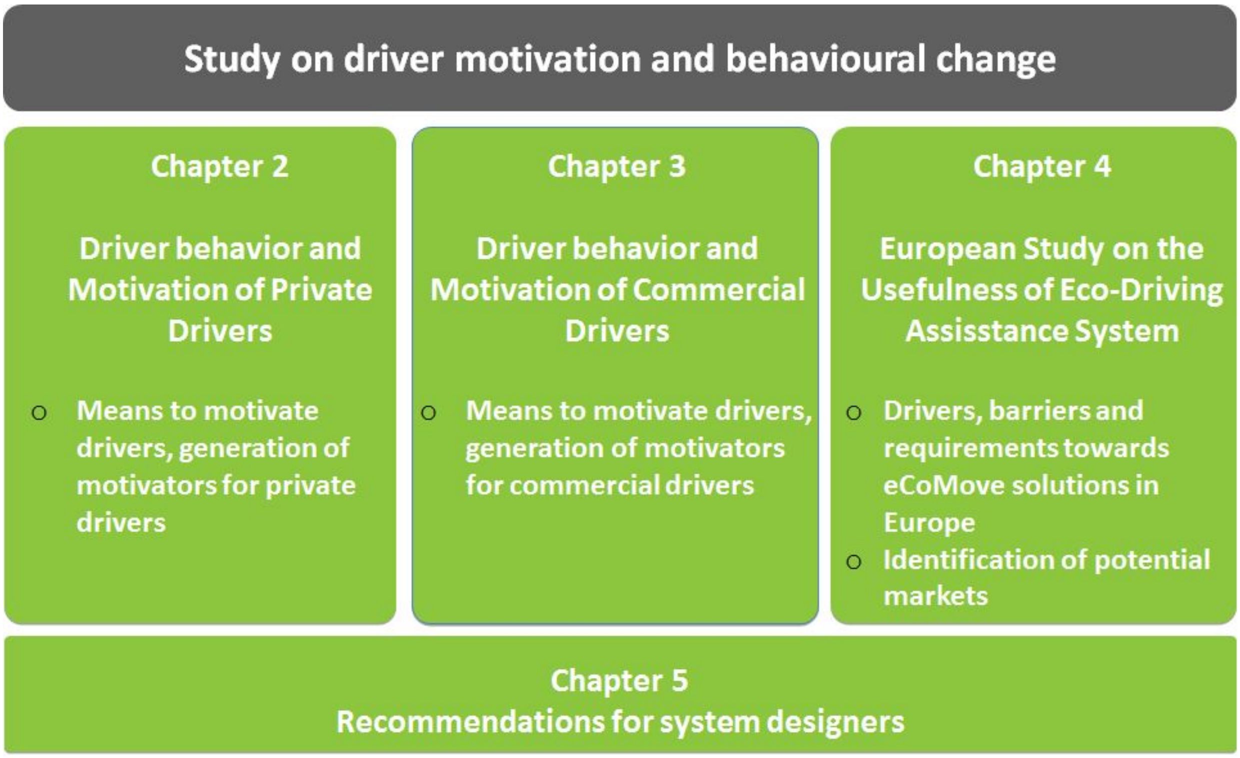


Figure 2: Deliverable Structure

The research methods used for each chapter are explained in Table 1: Research methods. Especially the sampling strategy and limitations of each method is mentioned.

1.3. Research Methods

Study focus	Chosen Method	Sampling strategy and limitations
Driver Behaviour and Motivation of Private Drivers	Closed web based survey. Convenience sample: DLR test panel	For answering the questionnaire the participants of the DLR proband panel (n=445) were invited to a closed web survey. They received a unique link to an online-questionnaire which prevented repeated participation. As the DLR proband panel is a convenience sample, there are limitations concerning the representativeness of the sample. Thus the participants may for instance differ from the average because they are more interested in vehicles and new vehicle technologies. However, in order for gathering first impressions on the topic, the sample should be sufficiently especially since a second study with new participants has confirmed the results on driving motives of the first study. For more information see chapter 2.2.2 and chapter 2.4
Driver Behaviour and Motivation of Commercial Drivers	Interviews and hand-out questionnaires.	The survey was carried out amongst commercial truck drivers within the social and business network of SP3 and SP4 participants by means of a convenience sample. They received a link to an online-questionnaire which was available in different

		languages. Further personal interviews were carried out using a paper-and pencil version of the questionnaire. Altogether 258 truck drivers took part in the survey voluntarily. Thus the sample can not be considered as representative for the population of European truck drivers. However, in order for gathering first impressions on the topic, the sample should be sufficiently. For more information see chapter 3.4.1.
European Study on the Usefulness of Eco-Driving Assistant Systems	Standardized online questionnaire in different European countries	The aim is to collect population samples from different countries and compare the results. The sample taken in each country will not be able to represent a complete population but it will be weighted according to the motorized population of that country. The target group for this study consists of persons driving a vehicle on regular basis for private or business purposes. The dissemination channel used is an online questionnaire on automobile club webpages which should reach a high number of responses from target group persons; however using this method the overall sample size is unknown and not controllable which may result in few responses or high number of missed questions. The method with its advantages and limitations will be explained further deeply in section 4.5

Table 1: Research methods

The research methods used included an online questionnaire, target group interviews and handout questionnaires:

- A study on motivational factors for eco-driving identified the most relevant and important motivators for private car drivers. A samp1e of 192 participants participated in a closed web based survey. The results of this study are described in section 2.
- The target group of goods vehicle drivers (truck drivers) was assessed using interviews and hand-out questionnaires. To receive a broad picture about the acceptance in different regions the study was conducted in different countries. The results of this study are described in section 3.
- A private and commercial vehicle driver survey was conducted through an online questionnaire. This questionnaire was placed on automobile club homepages to reach independent target groups of car drivers. The questionnaire was offered in 12 different European countries. Further detailed explanation to this step is given in section 4. The objective here was to assess the attitudes and acceptance of European drivers towards driving with eco assistant systems. Regional markets can be identified using the information derived from the survey. The results of this study are described in section 4.

1.4. Skewed samples in studies

The sample chosen for data analysis predict to some extend a statistical skewness. Especially for small sample sizes this needs to be taken into account when making evaluations. In worst cases skewness leads to false interpretation of hypotheses, meaning that they are falsely rejected or approved. Comparing the distribution of the sample to a normal distribution leads to the conclusion if it is skewed or not. The distribution of the present studies was analysed with a histogram (plotted with the statistical software SPSS).

2. Driver Behaviour and Motivation of Private Drivers

2.1. Motivation and Background

The main objectives of the empirical studies are the identification of main eco-driving motives, moderating and influencing factors and analysis and description of how these motivators can be generated, e.g. by in-vehicle systems, applications and measures. A literature search was performed for gathering hints on driving motives and motivators for environmentally-friendly driving. Sources were English and German articles on ScienceDirect and Google Scholar. Used keywords were for example car driving motives or ecological psychology. Altogether no articles on ecological driving motives could be found. Several authors published work concerning the issue of driving motives in the nineties. The main focus of the studies was on safety relevant aspects so that there was no characterisation in terms of fuel efficient driving. Dick (2002) e.g. described a model of driving experience in his PhD-thesis. The dimensions of the model range from stimulation and relaxation to routine and disturbance. Besides other aspects he described the stimulating feeling of driving flow. The focus of other authors was the identification of motives which encourage drivers to use their vehicles. Gardner & Abraham (2008) found in a meta-analysis that cost-benefit considerations (or rather expectancy-value considerations) were especially important, e.g. shorter driving times and more flexibility. Furthermore, habits were very important particularly regarding the transfer of intentions (e.g. go to work by public transport) into actual behaviour. Other authors emphasised the role of "irrational" motives. Hiscock et al. (2002) differentiated among safety motives (e.g. robberies, accidents and bad weather conditions), autonomy motives (e.g. comfort, free choice, controllability, reliability, predictability) and prestige motives (e.g. high income, masculinity, exciting lifestyle, self-confidence). Additionally, driving pleasure (Gardner & Abraham, 2006), affection for the vehicle (Beirao & Cabral, 2007) or the feeling of freedom and independency (Steg, 2005) were mentioned as irrational motives.
Besides the identification of eco-driving related motives the second objective is to analyse how to generate driver motivation in order to support behavioural changes towards eco-friendly driving. Previous research described e.g. that there is a discrepancy between positive attitudes towards the environment and actual environmentally conscious behaviour (Gardner & Abraham, 2008). The low-cost-high-cost hypothesis (principle of rational choice) serves as a general explanation. According to this hypothesis, environmental attitudes become effective only if they are associated with low costs. Kanapin (2000) analysed the interaction between environmental behaviour and different psychological and socio-demographic variables by means of a meta-analysis. He showed that the variables internal control attributions, an individual sense of responsibility, a higher degree of education, an existing environmental knowledge and specific attitudes correlate with environmentally friendly behaviour. According to Neugebauer (2004) the so-called "Allmende-Klemme" (Tragedy of the Commons) is another explanation for the discrepancy between environmental awareness and actual behaviour. It describes the phenomenon that the individual benefit of polluting behaviour is instantly noticeable, whereas the disadvantages only become socially apparent with large time lags. Therefore a direct feedback is missing, which consequently facilitates polluting behaviour.

On the basis of the literature review the following driving motives could be found:

- Vehicle as an object of utility versus vehicle as a status symbol (e.g. Adelt, Grimmer & Stephan, 1999; Hiscock et al., 2002; Steg, 2005)
- Enjoying driving with high velocities (e.g. Dick, 2002)

- Short travel times (e.g. Beirao & Cabral, 2007; Gardner & Abraham, 2006)
- Focus on costs (e.g. Gardner & Abraham, 2006)
- Safe driving (e.g. Hiscock, 2002)
- Comfort (e.g. Gardner & Abraham, 2006; Beirao & Cabral, 2007)

Many of the motives are described and analysed within studies investigating motivational aspects of vehicle usage. Environmental attitudes and awareness as a driving motive is not identified in these studies). One explanation could be that most of the studies looked at using private vehicles versus public transportation.

Other studies focused on the prediction of environmentally conscious behaviour. Amongst others, the following aspects or predictors have been indentified:

- Habits (e.g. Gardner & Abraham, 2006; Neugebauer, 2004)
- Locus of control (Kanapin, 2000)
- Subjective norm (Neugebauer, 2004)
- Knowledge (Scheuthle & Kaiser)

Besides research on driver motives, several studies and projects concentrated on fuel efficient driving within the framework of driver trainings. Ecological knowledge is the most important precondition for the realisation of eco-friendly behaviour according to Bilharz (2004). Thus, training programs aimed at fuel efficiency have been practiced over the last years (e.g. “Ecodriven” project: http://www.ecodrive.org/Home.219.0.html; eco:Drive user program by FIAT). In the nineties, the topics of eco-friendly and fuel efficient driving have also increasingly been added to the curriculum in driver education programs. The main aspects include knowledge and facts on correct behaviour and its translation into driving skills. Characteristic examples are the emphasis on anticipatory driving as well as early gear changing. The Ecodriven project (http://www.ecodrive.org/Home.219.0.html) for example published five golden rules of fuel efficient driving, such as early gear changing, anticipating traffic flow and continuously checking tyre pressure.

Motivational factors influencing fuel efficient driving are presented in addition to the skill-based knowledge, e.g. within the framework of the EcoDrive project. These are e.g.:

- cost reduction by means of lower fuel consumption,
- more comfortable driving for the driver and the car passenger through anticipatory driving,
- less environmental pollution,
- less noise and
- driving more safely.

To summarise the literature review: Although there has been a lot of research regarding the description of driving motives, ecological aspects were not a central theme in these studies. Furthermore, the studies point out that a concept to enhance fuel efficient driving has to consider more than a transfer of knowledge and skills. Motives and habits have to be taken into account when developing countermeasures. This was already partially done especially within the framework of driver trainings but additional research is needed to develop concepts and measures for enhancing environmentally friendly driving. The eCoMove surveys aim to close this gap by identifying eco-driving motives on the one hand and to analyse how these motivators can be generated on the other hand.

The first step is conducting an online-questionnaire study to gather information about influencing factors on motivation and intentions for fuel efficient behaviour. Based on this first questionnaire study, incentives and measures will be deduced that are linked with eco-friendly driving behaviour. These incentives and measures will then be transferred in a human-machine interface (HMI) study 2. The aim of the second study will be the validation of the findings of the first questionnaire study on the one hand and getting more detailed driver feedback for the development and design of HMI concepts for the applications on the other hand. The results of both studies will be fed back to the other sub-projects.
The next chapter describes the methodology and design of questionnaire study 1.

2.2. Methodology and design of the questionnaire study 1

2.2.1. Design of the Questionnaire

The theoretical basis for the development and the design of the questionnaire in the first study is the Theory of Planned Behaviour (TPB, Ajzen, 1985, 1991). The TPB describes which factors influence the transfer of intentions into actual behaviour. The theory postulates three principal components that influence the generation of behavioural intentions which are furthermore essential for the determination whether specific behaviour is turned into action (see **Figure 3**).

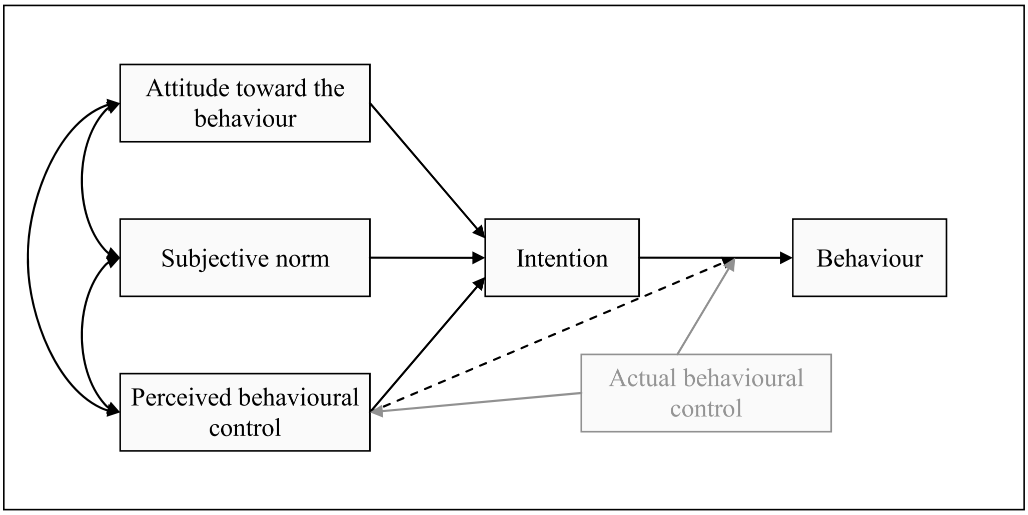


Figure 3: Theory of Planned Behaviour (Ajzen, 1985, 1991)

First of all, intentions are influenced by attitudes towards own behaviour. They are developed based on expectancies and the values that a person associates with a specific behaviour. As an example, a person can have a positive attitude towards using vehicles as a means of transportation because of expected time savings when travelling from A to B compared to public transport. This is evaluated as very important. In contrast, another person can have a critical attitude towards the usage of vehicles as the person expects high costs, e.g. due to maintenance and gas. These expectations lead to a negative evaluation and determine the attitude.
The second influencing factor regarding the development of intentions is subjective norm. According to the authors, this is the probability with which several social reference groups accept behaviour based on their own behaviour. Buying a vehicle for example could be influenced by family members, friends or colleagues and whether they are interested in buying a new car.

The third influence on the development of intentions is the so-called perceived behavioural control. It refers to how well a person uses his resources, abilities and possibilities for performing the behaviour. Relevant factors are the available knowledge, e.g. a person knows about a fast connection by public transport or perceives this as a fast connection. Additionally, the evaluation of the ease or difficulty of performing the behaviour, past experiences and anticipated difficulties are also relevant. Especially important for the third aspect is the importance of the perceived behavioural control, i.e. it does not reflect the actual, real mechanisms of behavioural control. Actual cost-benefit relations, opinions of peers or abilities and skills of performing the behaviour are irrelevant; important is the individual perception of these aspects. Perceived behavioural control does not only influence the development of intentions such as the other two aspects attitudes and subjective norm do, but it also indirectly influences the actual behaviour. Additionally, actual behavioural control mostly influences the perceived behavioural control. Actual behavioural control describes actual restrictions concerning resources, abilities and possibilities that could prevent the transfer of specific intentions into behaviour.

The development of the questionnaire and therefore the description of the questionnaire items were based on the results of the literature review and the Theory of Planned Behaviour. The aspects of eco-friendly and polluting motives and attitudes mentioned in the literature review were subsumed under the category attitudes / motives. Subjective norm included several social groups which could be relevant for a driver. Aspects that support or prevent environmentally friendly behaviour in specific situations were summarised in perceived behavioural control. For the questionnaire, 39 items were described that covered attitudes (or motives), subjective norms and perceived behavioural control (see Annex 1).

Before giving the respondents the 39 items, the first section of the questionnaire assessed demographic variables and basic driving information such as annual mileage, driving style, trip purposes, in order to analyse whether e.g. different driver groups (e.g. young versus older drivers) emphasise different eco-driving motives. The second part was comprised of the above mentioned 39 items, given in the form of statements, regarding eco-driving related attitudes, subjective norm and perceived behavioural control. Participants rated the 39 items using a five-point rating scale (1 = “strongly disagree”, 2 = “disagree”, 3 = “neither agree nor disagree”, 5 = “agree”, 5 = “strongly agree”). This was followed by the third section, which consisted of questions about existing knowledge with regard to fuel efficient driving and eco-friendly driving behaviour. At the end of the questionnaire, participants were asked to propose measures that would motivate energy efficient driving (see Annex 1 for the questionnaire).

2.2.2. Procedure and Participants

A preliminary version of the questionnaire including the 39 items regarding eco-driving related attitudes and behaviour was tested in-house with a sample of 25 participants. Although the analysis of the results and comments led to a slightly modified wording of the items, the changes were small enough that these 25 participants could be included in the analyses of the driving motive items.

The main study used the platform “www.limerservice.com“ as a distribution and data collection method. 431 members of the DLR proband panel were invited by e-mail to participate in the study. The closed web survey was used in order to enable the direct contact of participants if necessary and therefore to control data quality. The participants of the DLR proband panel

enlisted voluntarily for different studies concerning car driving, e. g. research on driver assistance systems. The members of the DLR proband panel consist of employees currently and formerly working at DLR and people who were recruited during marketing events such as open house.
The DLR proband panel is a database with different indices concerning personal data and basic driving data. The storage of the personal data is carried out anonymously. At the time the study took place there were 445 test drivers with an e-mail address (n=78 employees of the DLR) in the database. The age of these members was between 18 and 90 years (mean(m) = 40 years, standard deviation (sd) = 16 years). Of these, 26.6% were female, 73.4% were male. The average amount of time that these drivers possessed their driving license was 22 years (the longest was 61 years, the shortest was 1 year). 11% of the panel members stated to drive less than 3000 kilometres per year, 17.8% between 3.001 and 9.000, 17.2% between 9.001 and 12.000, 27.4% between 12001 and 20.000, 19.4% between 20001 and 30000, 4.8% between 30.001 and 50000 and 2.5% of the panel members with an e-mail address drive more than 50.000 kilometres per year. The participants received a unique link to the questionnaire which prevented repeated participation. The survey was anonymous and the participants did not receive any compensation.
The survey was active for one month. Within this time period the participants who did not fill out the questionnaire were given a maximum of two reminders. A total of 178 participants (41.3 % return rate) filled out the questionnaire. 10 participants failed to answer the questions regarding the driving motives and were excluded from the analyses of the driving motives. Additionally, one participant was excluded as the comments of the person indicated an unserious answering behaviour. Therefore a total of 167 web-based questionnaires were included in the analyses. As the answering format was optional and voluntary the number of individual responses may vary from analysis to analysis. Regarding the analyses of the driving motives, the 25 additional cases from the pilot study were included in the analysis.

Participants were aged between 19 and 90 years (mean (m) = 38 years, standard deviation (sd) = 16 years). 31.8% were females, 68.2% were males and they had possessed their driving license with a mean of 20 years (the longest was 58 years, the shortest was 1 year). The distribution of the annual mileage is displayed in Table 1. Approximately 60% of the participants reported an annual mileage in the medium range between 9000 and 30000 kilometres. Therefore the participants of the study did apparently not differ from the members of the DLR proband panel considering basic attributes.

Table 2: Distribution of annual driving mileage

Annual mileage	absolute frequency	percentage frequency	cumulative percentage
< 3000 km	26	13.5	13.5
3001< 9000 km	28	14.6	28.1
9001< 12000 km	39	20.3	48.4
12001< 20000 km	49	25.5	74.0
20001< 30000 km	38	19.8	93.8
30001 < 50000 km	11	5.7	99.5
> 50000 km	1	0.5	100
total	192	100	

43.3% of the participants used their vehicle 5 to 7 days per week, 23.4% 3 to 4 times a week. Only 8.3% used their vehicle only once a week and the remaining 9.8% drove 1 to 3 times per month or even less than once a month. Additionally, the participants were asked to specify the make and model of their most frequently used vehicle and the data were post-hoc classified into vehicle categories. The data show that 50% of the participants drove a medium-sized vehicle (e.g. VW Golf), 20.3% a small vehicle (e.g. Smart), 13.5% a comfort vehicle (e.g. VW Passat, 5er BMW), 5.7% an SUV and 5.2% a Van.
50.5% of the participants described their driving style as rather dynamic, 6.8% even as very dynamic. 41.1% described themselves as rather cautious and 1.6% as very cautious drivers.

The distribution of the trip purposes is displayed in Table 2 (drivers were allowed to select more than one category).

Table 3: Frequencies of trip purpose

Trip purpose	absolute frequency	percentage frequency
drive to work	111	57.8
business trips / travelling salesman	37	19.3
shopping / errands	141	73.4
leisure activities	109	56.8
pick-up children	29	15.1
visiting friends / family	133	69.3
Others	36	18.8

More than 2/3 of all participants used their vehicle for shopping and errands (73.4%) or for visiting friends and the family (69.3). Also, driving to work (57.8%) and driving to leisure activities (56.8%) were mentioned frequently. The remaining categories of trip purpose were mentioned less often.

2.2.3. Research Questions

The objective of the questionnaire study is answering the following research questions:

1. Which main motives can be identified by analysing the answers of the respondents to the 39 statements related to eco-driving attitudes and behaviour?
2. Is there a correlation between specific driver characteristics and the occurrence of driving motives and predictors for environmental behaviour? The participants of the questionnaire can be grouped according to their answers from the part of the questionnaire concerning basic information and fuel consumption. The following driver characteristics were analysed:
    a. Drivers with a high versus a normal versus a low annual mileage
    b. Drivers with a more or less pronounced focus on fuel efficiency
    c. Drivers using small versus large (comfort vehicles, vans) vehicles
    d. Drivers having low versus high theoretical knowledge about fuel saving
    e. Drivers with a more or less pronounced focus on fuel efficiency
    f. Young versus middle-aged versus older drivers
    g. Female versus male drivers
    h. Drivers with different trip purposes
3. Which measures and applications were most frequently named by the participants and do the above mentioned driver groups prefer different kinds of measures and applications?

2.3. Results

2.3.1. Identification of eco-driving motives

The first analysis aims to describe the distribution and frequencies of the 39 items assessing motives and attitudes related to driving behaviour. As explained above, a five-point rating scale was used (1 = strongly disagree, 5 = strongly agree). The mean values of the single items range between "disagreement" of 1.48 „On routes which I well know I try to set time records" and "agreement" of 4.17 "I drive with the preferably highest gear in order to reduce my pollutant emission" (see Annex 2 for the complete results).

In order to identify the most important motives an explorative factor analysis was conducted. The explorative factor analysis is a method to extract the common information of several items, i.e. to identify the underlying main motives of the different statements. Principal axis factoring (PAF) was used as the extraction method and the factor matrix was rotated using the varimax-method [1]. This orthogonal rotation method was used because it was assumed that the items are not completely independent from each other. The used extraction criteria was the Kaiser-Gutman criteria, i.e. only factors with eigenvalues greater than one were interpreted. The rotated factor matrix is shown in Annex 3. The factor structure will be interpreted in the purpose of an explorative analysis although not all preconditions are completely given (e.g. sample size, structure stability). The explorative approach should be sufficient for determining the most important factors or motives and for analysing whether the above mentioned driving groups differ in the extent to which they emphasise these motives.

The analysis resulted in 14 factors. 8 out of the 14 factors include more than 1 variable and will be interpreted and used in the subsequent analyses (see Annex 3). The results are summarised in Table 4.

Table 4: Interpretation of the factors (only factors with more than one variable-load)

Factors	Motive / Interpretation
1	Velocity and dynamics
2	Environmental orientation / attitudes
3	Focus on low fuel consumption
4	Vehicle as an object of utility
5	Low internal locus of control concerning eco-friendly behaviour
6	Subjective norm: personal driving behaviour
7	Subjective norm: driving behaviour of relevant others
8	Subjective norm: handling of speed limits

The following factors or motives will be included in the analyses:

- Velocity and dynamics: the factor refers to a positive attitude towards a driving style associated with high velocities and dynamics. High values are linked with a positive attitude towards fast and dynamic driving.

[1] The varimax method is an orthogonal rotation method that minimizes the number of variables with high loads for each factor. The method simplifies the factor interpretation.

- Environmental orientation / attitudes: the factor is associated with a positive orientation and attitude towards eco-friendly behaviour. High values are associated with a positive orientation towards eco-friendly behaviour.
- Focus on low fuel consumption: the factor describes behavioural patterns that are linked with monitoring and reducing fuel consumption. High values are linked with an increasing focus and monitoring of personal fuel consumption.
- Vehicle as an object of utility: the factor illustrates to what extent the vehicle is seen as an object of utility. High values are linked with a stronger association of the vehicle being an object of utility.
- Low internal locus of control: The factor is related to the estimation of personal possibilities to act in an eco-friendly way. The items of this factor are worded negatively towards a low perception of possibilities which means that higher values indicate a lower internal locus of control, i.e. the agreement regarding a decreased perception of possibilities of acting eco-friendly.
- Subjective norm – personal driving behaviour: The factor describes the personal perception and importance of how others evaluate the driving style. High values are associated with a high importance of what others think about the personal driving style.
- Subjective norm – driving behaviour of others: The factor reflects the perception and evaluation of the driving behaviour of others. High values are linked with the perception that others behave eco-friendly.
- Subjective norm – handling of speed limits: The factor is associated with the perception whether others exceed speed limits and to what extent exceeding speed limits is negatively evaluated. High values are linked with an increased perception of others exceeding speed limits as well as an opinion that high velocities are not dangerous.

2.3.2. Correlation between different driver groups and motives

The following group comparisons refer to the research questions whether different driver groups differ significantly regarding their emphasis on specific eco-driving motives. Therefore statistical group comparisons will be conducted by means of one-factor analyses of variance (ANOVA) or t-Test depending on the number of subgroups, e.g. annual mileage (high versus normal versus low) by an ANOVA, gender (female versus male) by t-Tests. The detailed statistics are displayed in Annex 4. In the following chapters only the main findings will be described.

a. Comparison of drivers with a high versus normal versus low annual mileage

The participants were classified into low annual mileage drivers (< 9000 km/year), normal drivers (9000 – 20000 km/year) and high mileage drivers (> 20000 km/year) based on their statements from the demographics part of the questionnaire.

The analyses show that drivers with a reported low annual mileage are acting eco-friendly significantly more often than high annual mileage drivers. Additionally the factor "internal locus of control" regarding environmental behaviour, e.g. positively influencing the environment by using public transport, is significantly stronger for low annual mileage drivers and more distinctive compared to normal and high annual mileage drivers.

b. Comparison of drivers with a more or less pronounced focus on fuel efficiency

99 out of the 167 participants (approx. 60%) confirmed to have an in-vehicle display of the average fuel consumption in their car. 62.6% of these 99 participants reported that they check their fuel consumption regularly several times per trip, 14.1% use the information once a trip, 12.1% once per tank of gas and 11.1% less than once per tank of gas. 89.9% of the drivers said that they use the in-vehicle display as an information and control instrument, 2/3 reported they use the display as a possibility to optimise their fuel consumption.
In order to compare the answers of drivers that control their fuel consumption often versus seldom, the participants were classified into two groups. Drivers who control their consumption very often reported to check the display at least once a trip (N = 76). Drivers who control their consumption seldom were defined as those who reported to check the display once per tank of gas or even less (N = 23).
The analyses indicate that drivers who regularly check their fuel consumption, i.e. at least once a trip, also indicated an increased focus on low fuel consumption. The groups also differ in the subjective norm with regard to speed limits. Drivers who check their fuel consumption less frequently agreed more often with the statement that other drivers speed. They also rated higher velocities in urban areas as being less dangerous.

c. Comparison of drivers using different vehicle makes and models

The participants were asked about the kind of vehicle (make and model) they drive most frequently. These data were classified in vehicle categories. The frequency of the named vehicle categories is displayed in Table 5**.**

Table 5: Frequency of vehicle categories

	Frequency	Percent	Cumulative percent
Small vehicle	39	20.3	20.3
Medium-sized vehicle	96	50.0	70.3
Comfort vehicle	26	13.5	83.9
SUV	11	5.7	89.6
Van	10	5.2	94.8
Others	6	3.1	97.9
No regular use of vehicle	4	2.1	100.0

70.3% of the interviewed persons reported driving a small or medium-sized vehicle. 25% drive a comfort vehicle, SUV or van. 3% of the participants drive other cars and 2% do not regularly use a vehicle. Based on these data, two groups of drivers were classified. The first group includes drivers of small and medium-sized vehicles (small) and the second group includes drivers of comfort vehicles, SUVs and vans (large).
Drivers of small vehicles agreed more often to statements related to a higher environmental orientation than drivers of large vehicles. There were no significant differences between the two groups with regard to the other factors.

d. Comparison of drivers having different theoretical knowledge about fuel saving

The third section of the questionnaire covered five questions that tested what existing knowledge respondents had with regard to fuel efficient driving and personal eco-friendly driving behaviour. A total of 189 answered the questions, 45.5% of them answered all questions correct, 34.9% gave 4 correct answers, 13.2% three, 2.6% two and 3.6% one answer. Two groups were classified, the first having up to three correct answers (low knowledge), the second having more than four correct answers (high knowledge).
Both groups differ significantly regarding the factors “velocity and dynamics” and “vehicle as an object of utility”. Participants with a higher score, i.e. more knowledge, reported to drive faster and more dynamically than participants with less knowledge. On the other hand drivers with less knowledge more often view their vehicle as an object of utility, compared to drivers with more knowledge. The results point out that having low or non-eco-friendly attitudes and motives is not associated with a lack of knowledge about what is eco-friendly driving.

e. Comparison of motives concerning the factor age

The participants were classified into three groups concerning their age: young drivers up to 24 years old, middle aged drivers aged between 25 and 64 years and older drivers aged over 65 years.
The analyses show that young drivers report more often that they drive dynamically compared to older drivers. Additionally, younger drivers reported more often that they are environmentally oriented than the other age groups. Regarding the factor focus on fuel consumption the results indicate that the older the drivers, the more they focus on fuel consumption, i.e. fuel efficient driving becomes more relevant and dynamic and fast driving less important.

f. Comparison of motives concerning the factor sex

In total 61 female and 129 male drivers participated in the study. Female and male drivers differ significantly regarding the factors „vehicle as an object of utility“ ($t = 2.783$, <.01) and “low internal locus of control” ($t = -2.118$, $p < .05$).

The results show that female drivers view their vehicle more often as an object of utility. Additionally, they scored higher on the questions linked with a higher internal locus of control than the male drivers, which means that they agreed more often that they see possibilities of behaving eco-friendly.

g. Comparison of motives concerning different trip purposes

The aim of this comparison was to describe possible interactions between several trip purposes (e.g. drive to work, shopping / errands, picking up children) and the answers to the items of the different factors.

Participants using their vehicle to drive to work ($N = 111$) differed significantly from participants reporting not to use their car to drive to work ($N = 81$) regarding the factor “low internal locus of control” ($t = -2.604$, $p < .05$). Drivers that regularly use their vehicle for driving to work reported a higher internal locus of control than the other drivers, i.e. they think they have more possibilities to act in an eco-friendly way. The comparison of drivers who either use ($N = 37$) or do not use ($N = 155$) their vehicle for business trips shows that drivers who do not use their vehicle for business trips tended to rate the items of the factor “focus on low fuel consumption” more positively ($p = .081$). This can be interpreted in such a way that drivers using their vehicle for business trips care less about eco-friendly driving.

The question whether the participants use their vehicle for leisure activities (e.g. driving to sport clubs etc.) was positively answered by $N = 109$ participants, negatively by $N = 83$ participants. Both groups differed significantly concerning the three factors “environmental orientation”, “subjective norm regarding personal driving” and “subjective norm regarding speed limits”. Drivers that do not use their vehicle for leisure activities pay more attention to what others think about their driving style ($t = 2.845$, $p < .01$). Drivers who use their vehicle for leisure activities rate the items of the subjective norm factor regarding speed limits more positively, i.e. they agree more often with the statement that they think that other people exceed speed limits and they indicate that it makes no difference whether the general urban speed limit is 50 km/h or 60 km/h.

i. Summary of results

A summary of the results is shown in Table 6. Significant results ($p < .05$) as well as tendencies $.05 > p < .10$) are displayed in the table.

Table 6: Summary of the results

Comparison of…	Factor	F-/t-values	p	Result
High versus low annual mileage	Velocity and dynamics	F=2.914	.057	High annual mileage drivers tend to describe their driving style as faster and more dynamic.
	Environmental orientation	F=4.932	<.01	High annual mileage drivers describe themselves as less environmentally oriented.
	Low internal locus of control	F=8.752	<.001	High annual mileage drivers rate their internal locus of control as lower, i.e. they do not see possibilities of acting eco-friendly.
High versus low frequency of checking fuel consumption by means of the in-vehicle information	Focus on low fuel consumption	t=-2.228	<.05	Drivers who regularly check their fuel consumption indicate a higher focus on low fuel consumption.
	Subjective norm: handling of speed limits	t=3.534	.001	Drivers who do not regularly check their fuel consumption perceive that others exceed the speed limit more often and rate high velocities in urban areas as less dangerous.
Driving small versus big vehicles	Environmental orientation	t=3.020	<.01	Drivers of small vehicles describe themselves as more environmentally oriented.
High versus low theoretical knowledge about fuel consumption strategies	Velocity and dynamics	t=-1.504	<.05	Drivers with more theoretical knowledge describe their driving style as faster and more dynamic.
	Vehicle as object of utility	t=1.285	<.01	Drivers with less theoretical knowledge view their vehicle rather as an object of utility.
Young versus middle aged versus older drivers	Velocity and dynamics	F=3.672	<.05	Younger drivers describe their driving style as faster and more dynamic than older drivers.
	Environmental orientation	F=3.709	<.05	Younger drivers describe themselves as more environmentally oriented than middle aged and older driver.
	Focus on low fuel consumption	F=10.358	<.001	Older drivers indicate a higher focus on low fuel consumption than middle aged and young drivers.
Female versus male drivers	Vehicle as object of utility	t=2.783	<.01	Females view their vehicle rather as an object of utility.
	Low internal locus of control	t=-2.118	<.05	Males rate their internal locus of control as lower, i.e. they do not notice possibilities of acting eco-friendly.
Trip purpose – drive/not to drive to work	Low internal locus of control	t=-2.604	<.05	Drivers who regularly drive to work rate their internal locus of control as higher, i.e. they see possibilities of acting eco-friendly.
Trip purpose: drive/not to drive to leisure activities	Environmental orientation	t=2.540	<.05	Drivers who regularly drive to leisure activities describe themselves as more environmentally oriented.
	Subjective norm: personal driving behaviour	t=2.845	<.01	Drivers who regularly drive to leisure activities indicate that pay more attention to what others think about their driving style.
	Subjective norm: handling of speed limits	t=-2.070	<.05	Drivers who do not regularly drive to leisure activities perceive that others exceed the speed limit more often and rate high velocities in urban areas as less dangerous

In order to descriptively interpret the results and to get more information about the underlying motives the above mentioned results have been sorted according to the relevant factors.

Table 7: Interpretation of results depending on the underlying motives

Driver type	Focus on	Find irrelevant	Velocity / Dynamics	Environ-ment	Locus of control	Object of utility	Focus on low consumption	Support higher velocities	Social norm (own driving)
High annual mileage	Time	Environment Possibilities to change	Yes	No	Low				
Young drivers	Time	Environment Consumption	Yes	Yes			No		
High knowledge	Time	Object of utility	Yes			No			
Middle-aged, older drivers	Environment Consumption	Time	No	Yes			Yes		
High frequency of fuel checking	Consumption	Time					Yes	No	
Small vehicle users	Environment			Yes					
Trip purpose: leisure activities	Environment Social norm	Time		Yes				No	Yes
Female	Possibilities to change Object of utility				High	Yes			
Trip purpose: drive to work	Possibilities to change				High				

The interpretation of the results leads to a classification of all participants into three driver groups based on comparable main motives. The first group consists of drivers with a high annual mileage, drivers who are younger than 25 years old and drivers with a high knowledge about fuel efficient behaviour who seem to focus primarily on the time motive. Additionally, the high annual mileage drivers indicated no environmental orientation and they rated their own possibilities to behave in an eco-friendly way as very low, the younger drivers answered that they do not focus on low fuel consumption and drivers with a high knowledge about fuel efficient driving do not solely see their vehicle as an object of utility.

The second group consists of middle-aged and older drivers as well as drivers checking their fuel consumption with a high frequency and small vehicle users and drivers primarily using their cars to drive to leisure activities. They are environmentally oriented and efficient fuel consumption is another main motive. The time factor seems irrelevant, as they describe their driving behaviour as smooth and anticipatory instead of fast and dynamic and they oppose to and do not support higher velocities. The social norm in terms of the evaluation of their own driving behaviour by others is additionally relevant for drivers who primarily named driving to leisure activities as a trip purpose.

The third group includes female drivers and drivers mostly using their cars to drive to work. Both indicate a high locus of control i.e. they see possibilities to behave in an eco-friendly way. The underlying main motive can be described as an action-orientated readiness to change behaviour towards eco-friendly driving. Additionally, female drivers describe their cars as an object of utility.

Participants can be part of several groups, e.g. a driver can belong to the group of young drivers with high knowledge and additionally to the group of small vehicle users. Given that the statistical comparisons resulted in significant effects the results can be interpreted in an explorative way.

2.3.3. Identification of measures to motivate drivers towards eco-friendly driving

As described before the participants were also asked to name measures and applications that would motivate them towards eco-friendly driving. This was an open question, i.e. they did not get any examples or solutions to choose from. The commentaries of the participants were further qualitatively analysed to explore whether the main motives are associated with preferred measures and specific applications.

135 participants named a total of 242 measures and applications that would motivate them towards fuel efficient driving. In a first step the mentioned measures and applications have been investigated. By using the method of content analysis it was the goal to integrate the measures into different categories in order to get an overview of the described measures. The following 15 categories resulted from the analysis.

- Competing situation: driver should compete for the lowest fuel consumption
- In-vehicle information system (IVIS): informs the driver about the current fuel consumption
- Intelligent traffic management (iTM): e.g., optimisation of traffic lights, intelligent traffic lights (e.g. "time counts" for red signal)
- Public transport: optimising public transport through an increase of options or a decrease in pricing
- Recuperative engines or braking systems
- Economical engines
- Increase pricing, e.g. for fuel, insurances, or motor vehicle taxes
- Start / stop automatic
- Training
- Automatic engines
- Subsidisation of energy efficient vehicles
- Optimising construction of vehicles and techniques, e.g. alternative engines, automotive lightweight construction
- Intelligent navigation system (iNavi): including current traffic information, eco-friendly and fuel efficient routes
- Intelligent speed control or adaptive cruise control (iACC): system prevents the development of traffic congestions and includes environmental route information and information about the traffic situation
- Intelligent advanced assistance system (iADAS): system informs about or supports the driver with eco-friendly driving strategies, e.g. points to change gears at the right time, how to accelerate or decelerate in an optimal way

The frequencies of the named categories are sorted in descending order and displayed in Table 8**.**

Table 8: Frequency of named measure/application

Category	Frequency (absolute)	Frequency (in %)
iTM (intelligent traffic management)	48	19.8
IVIS (in-vehicle information system)	40	16.5
iADAS (intelligent advanced driver assistance system)	40	16.5
Increased pricing (fuel, insurance, taxes)	16	6.6
Economical engines	15	6.2
Start / stop automatic	12	5.0
Optimising construction of vehicles techniques	11	4.5
iNavi (intelligent navigation system)	10	4.1
iACC (intelligent adaptive cruise control)	10	4.1
Automatic engines	9	3.7
Public transport	8	3.3
Training	7	2.9
Recuperative engines	6	2.5
Subsidisation of energy efficient vehicles	6	2.5
Competing situation	4	1.7

The most frequently named measure/application was the intelligent traffic management (19.8%), followed by IVIS and iADAS (16.5%). Recuperative engines, subsidisation (2.5%) and the generation of a competing situation (1.7%) were mentioned less often.
The second step aimed to analyse whether the above mentioned driver groups named different categories of measures. Therefore, the frequencies of the named measures were analysed regarding the driver groups with the main motives of time, environmental orientation and action-orientated readiness to change behaviour.
The following tables show the descriptive values for the driver comments for the three most frequently named measures iTM, IVIS and iADAS (see Annex 5 regarding the other measures/applications). The basis for the analysis is the total number of the named application which is also displayed in the tables.

Table 9: Frequency of comments for each measure/application (basis: N application)

	iTM (total frequency = 48)	
	frequency (absolute)	frequency (in %)
High annual mileage drivers	21	43.8
Young drivers	6	12.5
High knowledge	**42**	**87.5**
High frequency of fuel checking	27	56.3
Small vehicles	**31**	**64.6**
Trip purpose: leisure activities	**32**	**66.7**
Female drivers	10	20.8
Trip purpose: drive to work	30	62.5

	IVIS (total frequency = 40)	
	frequency (absolute)	frequency (in %)
High annual mileage drivers	13	32.5
Young drivers	7	17.5
High knowledge	**32**	**80.0**
High frequency of fuel checking	15	37.5
Small vehicles	**23**	**57.5**
Trip purpose: leisure activities	**25**	**62.5**
Female drivers	13	32.5
Trip purpose: drive to work	22	55.0

	iADAS (total frequency = 40)	
	frequency (absolute)	frequency (in %)
High annual mileage drivers	7	17.5
Young drivers	11	27.5
High knowledge	**34**	**85.0**
High frequency of fuel checking	11	27.5
Small vehicles	**27**	**67.5**
Trip purpose: leisure activities	24	60.0
Female drivers	11	27.5
Trip purpose: drive to work	**28**	**70.0**

For each of the applications the three driver groups/types that named the application most frequently are bold. It is obvious that participants with a high knowledge had high shares in naming the most frequently named measures, as well as people using small vehicles and primarily to drive to work. This can be due to the fact, that these groups are characterised by a high number of participants ($N_{\text{high knowledge}} = 110$, $N_{\text{small vehicle}} = 92$, $N_{\text{drive to work}} = 81$) that is they represent a big portion of the participants who mentioned the measures, but it can also be due to a generally higher interest in eco friendly driving behaviour. In order to account for differences in sample sizes the descriptive statistics are again analysed for each application and separately for each driver group (see Annex 6). The most frequently named application within each of the groups are iTM, IVIS and iADAS. Female drivers additionally named increased pricing as a useful measure.

In addition to the descriptive analysis a Chi^2-test was performed to see whether the distributions of the mentioned applications and measures of the specific driver groups (i.e. within the group of high versus low annual mileage drivers) statistically differ from each other. The basis of this analysis is the total number of applications mentioned in each group (Table 10). Significant positive differences are marked by a plus, in case of a disproportionately lower frequency it is marked by a minus in parentheses.

Table 10: Frequencies of mentions, comparison within the single groups (Chi2-tests)

	High annual mileage	Young drivers	High knowledge	High frequency fuel checking	Small vehicles	Trip purpose: leisure	Female drivers	Trip purpose: drive to work
iTM	**41.7%**	**21.7%**	**27.7%**	**33.4%**	**25.0%**	**29.3%**	**24.3%**	**25.9%**
IVIS	**33.4%**	**30.4%**	**29.1%**	**24.6%**	**25.0%**	**32.0%**	**32.4%**	**27.2%**
iADAS	**16.7%**	**43.4%**	**26.3%**	**19.3%**	**27.2%**	**28.0%**	**24.3%**	**29.6%**
Increased pricing	2.8%	8.7%	9.1%	3.5%	9.9%	6.7%	**21.6% (+)**	14.8%
Eco engines	13.9%	0.0%	8.2%	10.5%	10.9%	8.0%	10.8%	12.3%
Start/stop	8.3%	17.4%	10.9%	8.8%	8.7%	12.0%	**0.0% (-)**	11.1%
Vehicle technique	2.8%	4.3%	7.3%	7.1%	5.4%	5.3%	0.0%	6.1%
iNavi	2.8%	4.3%	8.2%	10.5%	7.6%	**12.0% (+)**	5.4%	6.2%
iACC	8.3%	0.0%	4.5%	3.5%	6.5%	8.0%	10.8%	4.9%
Automatic engines	**0.0% (-)**	4.3%	6.4%	7.0%	7.6%	6.7%	**0.0% (-)**	6.2%
Public transport	2.8%	8.7%	4.5%	3.5%	7.6%	**1.3% (-)**	**10.8% (+)**	4.9%
Training	2.8%	0.0%	4.5%	8.8%	7.6%	5.3%	8.1%	6.2%
Recuperative engines	8.3%	4.3%	4.5%	7.0%	6.5%	5.3%	2.7%	4.9%
Fiscal subsidisation	2.8%	4.3%	3.6%	1.8%	3.3%	2.7%	5.4%	2.5%
Situation of competition	0.0%	8.7%	3.6%	1.8%	4.3%	4.0%	5.4%	2.5%

Table 10 shows that besides the three most frequently named measures of iTM, IVIS and iADAS, the high annual mileage drivers did not name automatic engines whereas this measure was named disproportionally more often by low annual mileage drivers. Participants who reported using their cars mostly to drive to leisure activities disproportionally more often named iNavi applications than participants with other trip purposes. On the contrary, they less frequently named public transport as a useful means of transport. Female drivers named disproportionally more often increased pricing as a useful measure as well as public transport compared to male drivers. Additionally female drivers did not mention start-stop or automatic engines as a useful measure which differed significantly from male drivers who named the measures disproportionally more often.

Figure 4 summarises the above mentioned results and displays the main motives of the driver groups and the three most frequently named measures or applications for each of the groups.

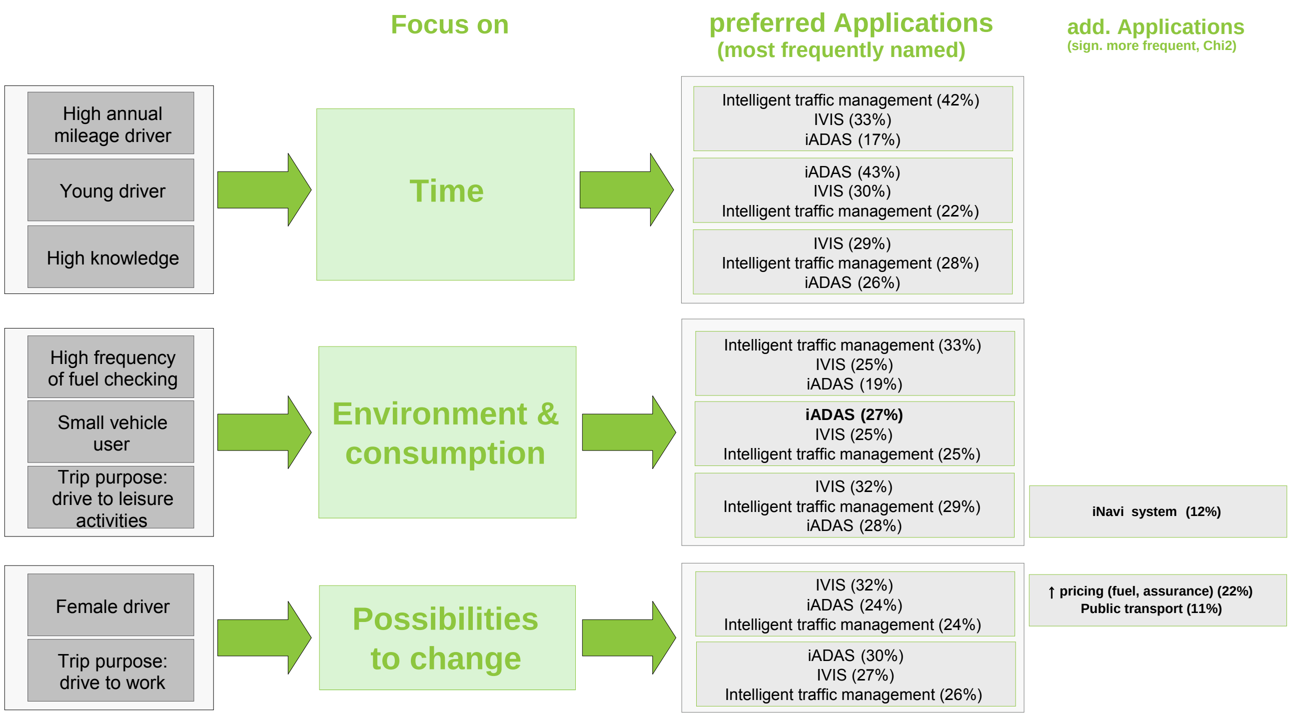


Figure 4: Applications and measures regarding the driver groups

2.4. Methodology of the HMI study

On the basis of the presented results of the online-questionnaire study, a second study was carried out, which focused on HMI aspects. The general objective of the HMI study was the validation of the results of the first questionnaire study regarding the motivators for eco-friendly driving on the one hand, and getting more detailed driver feedback through interviews for the development and design of HMI concepts for the applications on the other hand. The results of both studies will be fed back to other sub-projects.

The study consisted of five parts. In the first part, the same demographic characteristics were assessed as in the first study. Furthermore, items from the first questionnaire study which were associated with three out of four of the main motives time, environment and consumption were used in the second part (see Annex 7). Participants had to indicate their agreement on a five-point rating scale. The other main motive "possibilities to change" (see Figure 2) was not a focus in this study because it is assumed that participants with a focus on this motive have a very high level of internal control. That means they are highly motivated in avoiding car driving and using public transport. Thus their behaviour might not be as assessable with an eco-HMI as for the drivers with high scores on the time and environment motive.

In addition to these items, scenarios were used to introduce participants to the topic of eco-friendly driving and related driver assistance systems. These scenarios had been used in another study within the eCoMove project to explain application functionalities to participants (see 4.7) but they were slightly modified so that they matched the three motives that were investigated in this study. They also included a description of a driver assistance function (see Figure 5).

Scenario 1: Please imagine that you own a car with a new driver assistance system. This system receives information about waiting times at traffic lights and obstacles. Based on this information the system might recommend turning off the engine in order to optimise fuel consumption.

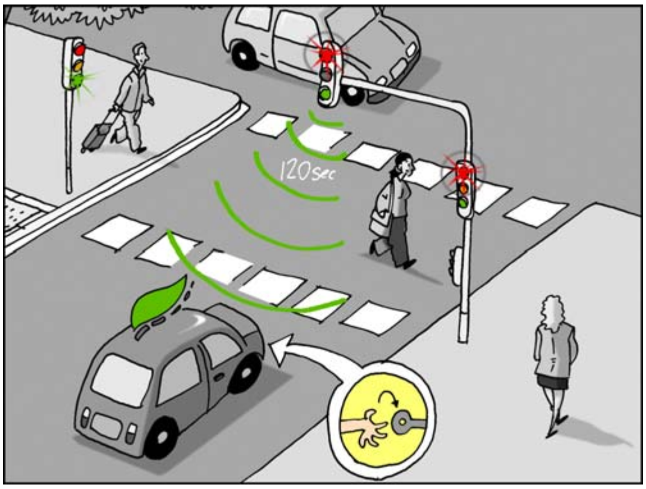


Figure 5: Consumption scenario

One scenario focused on the consumption motive (see Figure 5), another scenario on the time motive and the third scenario was associated with the environment motive (refer to Annex 8 for all scenario graphics and to Annex 7 to see how they were used in the HMI study). For each of the scenarios, participants were required to rate a series of statements on a five-point rating scale.

In part four, participants were asked to name and describe a driver assistance function which they find useful. This was an open question and was queried in an interview style which means that after an answer was given additional questions for further understanding were asked. Moreover, participants were asked to name a specific design implementation.

Afterwards, in part five, four assistance function groups which had been identified in the first study were evaluated:

- intelligent-vehicle information system (IVIS),
- intelligent-advanced driver assistance system (iADAS),
- intelligent traffic management (iTM) and
- intelligent navigation system (iNavi).

Each group was introduced by one picture and a table with several options for specific functions and HMI implementations. Participants were then asked to rate the usefulness of these options for each assistance function on a five-point scale (1 = not useful, 5 = very useful). They could additionally comment on each of the specific examples. After the participants had rated all options, the investigator asked for the reasons to enhance understanding in case of low ratings. At the very end, participants had to define the three best options for each of the driver assistance function groups.

2.4.1. Procedure

The study was conducted at DLR. Eighteen members of the DLR test driver panel participated in the study. One session took about 45-60 minutes, depending on the time spent during the questionnaire and interview phases. Participants received a compensation of 8€.

2.4.2. Participants

Of the eighteen participants, ten were male and eight were female and the average value for age was 41 years (Min: 20 years, Max: 67 years). The average value for possession of the driving license was 21 years and except for the high annual mileage category (>30000 km/year) most drivers were equally distributed between annual mileage categories (see Annex 9).

Sixty-one percent of the drivers used their car everyday, 22% three to four times a week and 17% once a week. Participants were classified based on the vehicle make and model they drive and 50% drove a small vehicle, 28 % a medium-sized vehicle and 17% a van. Their own personal driving style was rated as very dynamic by one person, rather dynamic by 61 % and rather defensive by 33% of the participants.

Most participants indicated to use their car for shopping and errands (89%), visiting friends and family (83%), leisure activities (78%) and to drive to work (56%).
Please refer to Annex 9 for the detailed values on the characterisation of the participants.

2.4.3. Results: items related to the motives time, environment and consumption

Single factor analyses of variance or t-test for independent samples were calculated for the driver groups concerning age, gender, annual mileage, trip purpose and vehicle models. In the following paragraphs only the significant ($p<.05$) or tendency effects ($.5 > p < .10$) are reported.

The items that belong to each of the factors time, environment and consumption (based on the results of study 1) were summarised by an average value. A higher value on these factors refers to a higher focus on this motive.

The first single factor analysis of variance (ANOVA) was conducted for the factor time and the driver group annual mileage. The results show no significant difference between the groups but a tendency effect ($F = 2.713$, $p = 0.099$). High annual mileage drivers tended to rate time as being more important (Mean: 3.14) compared to low annual mileage drivers (Mean: 2.80).

For the age-groups (≤ 24 years, 25-64 years, ≥ 65 years) an ANOVA was calculated and revealed a significant effect ($F=4.859$, $p< .05$). Post-hoc comparisons (bonferroni, $p<.05$) showed a difference in the ratings between the young (Mean: 3.17) and older drivers (Mean: 2.74). Older drivers had significantly lower ratings which indicate that they focused less on the time motive. Please refer to Annex 10 for all descriptive values.

Concerning the trip purpose, most participants indicated that they use their car for shopping, leisure-activities and visits. Not all people indicated that they use their car to drive to work (n=10). Therefore, a t-Test for independent samples was calculated for this aspect. Results displayed no significant differences, but a tendency effect ($t=-1.892$, $p=.077$). People who use their car to drive to work tended to emphasise the time motive more (Mean: 3.07) compared to participants that did not mention to use their car to drive to work (Mean: 2.84). Please refer to Annex 10 for all descriptive values.

Drivers were classified based on the vehicles they drive. The frequency of vehicle models in the present study was as follows: small vehicles (n=9), middle-class vehicles (n=5), van (n=3) and a missing value. There were no other models present. Therefore, participants were categorised based on their vehicle makes and models into "small vehicles" vs. "middle-class/van". A t-test for independent samples showed a significant effect for the motive environment ($t=2.471$, $p<.05$). Small vehicle drivers had significantly higher ratings (Mean: 2.96) meaning that they focus more on the environment motive compared to middle-class vehicle/van drivers (Mean: 2.17). . Descriptive values for the factor environment are shown in Annex 10.

2.4.4. Results concerning the driving scenarios matched to the three motives

In the consumption scenario (refer to Annex 7 and Annex 8) a system that automatically turns off the engine at traffic lights was introduced to the participants via a picture and a description. From a descriptive view (since no statistical analyses were performed) the ratings differ for the identified driver groups. For example, drivers with a medium annual mileage (9001-20000 km) rated the statement that such a system is not superfluous less positively compared to low and high annual mileage drivers (see Annex 11). Middle-aged drivers (25-64 years old) answered the statement that such a system enhances their driving behaviour more negatively whereas younger and older drivers agreed more positively on this statement (see Annex 9).

The time scenario described a system which proposes routes leading to time savings. The most obvious descriptive difference can be seen for the age group. Older drivers rated more positively that this system would enhance environmentally friendly driving and it would enhance their personal driving behaviour compared to the younger and middle-aged group (refer to Annex 11Annex 9).

The environment scenario described a system which provides information on CO_2-emissions and suggests routes based on this information. There are two descriptively identifiable differences. First of all, high annual mileage drivers agree less that such a system would support them, enhance their driving and would be desirable compared to low and medium annual mileage drivers (see Annex 9). Secondly, for the age groups, for most of the statements the older drivers rated the system more positively compared to the younger and middle-aged drivers, e.g. that the system is desirable and supports them (see Annex 9).

2.4.5. Results concerning specific options for the four systems: iVIS, iADAS, iNavi, iTM

Four types of systems were identified based on the comments and named measures in the online-questionnaire study : an in-vehicle information system that provides information about the fuel consumption (IVIS), an intelligent advanced driver assistance system (iADAS), an intelligent navigation system (iNAVI) and a system that uses traffic management (iTM). Participants received a list of system options which they had to rate according to the perceived usefulness. The two systems, iNAVI and iTM were rated very similarly by the driver groups as well as ratings from the groups vehicle model, sex and trip purpose and therefore no interpretations will be provided, please refer to Annex 12 for details.
For the IVIS options, younger and older drivers rated the options more similarly compared to the middle-aged group. From a descriptive point of view, middle-aged drivers found an auditory/visual consumption display less useful compared to the other two groups (see Annex 12). Looking at the comments that were given for this option in this group, three participants mentioned that a visual only display would be better. A similar trend was found for displaying possible kilometre (two comments related to the display as being too complex) or financial savings (two comments questioned that there are useful consequences associated with this). For the group factor annual mileage, the high annual mileage drivers rated the auditory/visual consumption display and the display of monetary savings as lower and less useful compared to the other two groups (see Annex 12).

With regard to the iADAS systems, older drivers rated the options of warnings based on optimal driving behaviour and the display of the current driving style as well as a comparison with the optimal driving style more positively compared to younger and middle-aged drivers (see Annex 12). The middle-aged drivers commented that a warning in this context is not helpful since a driver already knows his personal driving style. High annual mileage drivers rated automatic gear changing and active gas pedal as less useful compared to the low and medium annual mileage drivers. The commentaries of these drivers referred to less driving freedom and they mentioned to prefer an automatic car instead of this option.

2.4.6. Rankings of assistance options for the four systems

After rating the specific options for the four systems, participants were required to rank the best three options for each system (please refer to Annex 7 to see the lists of all system options).

Ranks were given multiple times, e.g. some participants gave the rank 3 to multiple options, therefore the numbers do not equal 54 (18 participants giving 3 ranks).

For the IVIS system, the display of the current consumption rate through colour-coding received the highest number of first place rankings (8) and also the highest number of total rankings (13). Two other light displays received three number one rankings, one was a digital light display from green to red the other one lights above the speedometer. An auditory/visual consumption display additionally received three number one rankings. A consumption display based on the driving profile received the highest number of second place rankings (6) and the second highest number of total rankings (11). Please refer to Annex 13 to see all rankings.

An iADAS system that automatically turns off the engine was ranked number one most often (6) in the category of driver assistance systems and also received the highest number of overall ratings (12). Another preferred version was displaying the optimal gear for the actual driving situation (4) and displaying the optimal time for shifting gears received the highest number of second place rankings (5). Please refer to Annex 13 for all rankings.

For the iNavi systems, a traffic- and situational adaptive navigation was ranked highest most often (7) followed by route suggestions that are based on possible savings such as time-, consumption- or emission savings (6). Please see Annex 13 for all rankings.

An iTM system that gives suggestions for optimal speed and routes was ranked highest most often (8) in that category. Second highest number one rankings received the approach of improving traffic flow by traffic lights and enhancing the communication between traffic lights (5). The highest number of second place rankings received the options of providing timely information about obstacles, rerouting and traffic flow (6). Please refer to Annex 13 for details.

2.4.7. Results of the interviews

The open ended interview responses were qualitatively analysed and summarised. First of all, responses were categorised into the four assistance function types. Intelligent driver assistance systems (iADAS) (89%) and intelligent vehicle information systems (IVIS) focusing on displaying fuel consumption (67 %) were mentioned most often. Start-stop mode is reported separately since it was specifically mentioned in 39 % of the cases, even though it is also summarised under iADAS. The same is true for synchronised traffic lights (22 %) which is included in the category iTM. Please refer to Annex 14 for details.

In a second question, participants were asked about the specific implementations of the system, e.g. which type of presentation format (e.g. visual, auditory) should be used and what level of support they would prefer. Most participants preferred that the system provides information (83%) via the visual modality (61%). About 33% explicitly stated that they do not wish any auditory signals. On the opposite, 28% of the participants mentioned that they would like to have auditory support. Please refer to Annex 14 for details.

The comments were further compared with the specific assistance options that were presented to the participants (see 2.4.5) to see whether new ideas were generated. Overall, most new ideas were iADAS functions which can be summarised as distance control, automated driving (cruise control or lane keeping), speed limits for the driver, driving recommendations (such as use the brake, turn off the engine) and anticipatory warning signals (e.g. before reaching a traffic light or a city). For the consumption display, there was one new idea for displaying current compared to optimal consumption.

Participants named a few design recommendations such as using visual blinking which increases if consumption is too high, a laughing or crying smiley for post-trip evaluation of driving performance and speech such as “higher gear” or “engine off”. One comment suggested using steering wheel vibration if the driver is speeding.

2.4.8. Conclusions

For the three motives time, environment and consumption the relevant questionnaire items from the online-survey were again used. Concerning the motive time, young drivers were again found to focus more on this motive as well as high annual mileage drivers who showed a tendency to focus on this motive which supports the findings from the online-questionnaire study. In addition, in this study the group that indicated to drive to work by car showed a tendency to also focus on the time motive. Small vehicle users were found to focus more on the environment motive which is also consistent with the findings from the questionnaire study 1 (refer to

Figure 4).

The other parts of this study focused more on the actual design of support and assistance for drivers with the underlying motives and for the specific driver groups.
It seems that older drivers rate IVIS systems that provide auditory/visual warnings more positively compared to middle-aged drivers. iADAS systems that intervene, e.g. automatic gear changing were rated less useful by middle-aged drivers and high annual mileage drivers.
For the specific system options, the rankings and commentaries provided hints for designing such assistance. For example, it might be beneficial to refrain from using auditory warnings for either IVIS or iADAS – more than 50% of the comments indicate that visual only information is preferred. Optimal gear choice and time to shift as iADAS applications received many first and second place rankings.

For future studies the following HMI-aspects it might be interesting to consider:

- General: using speech for information and recommendations, no tones;
- Specific:

- IVIS: use visual format, present simple information (e.g. no km/financial savings) e.g. coloured lights;
- iADAS: partly automated features, such as cruise control/lane keeping, turning off the engine
- Older drivers: provide information on optimal gear and time to shift as well as comparison of current and optimal driving style
- Younger drivers: assistance that focuses on time savings, e.g. traffic- and situational adaptive navigation

3. Driver Behaviour and Motivation of Commercial Drivers

3.1. Introduction

Within eCoMove, SP4 (ecoFreight & Logistics) focuses on the driving activity of people in their role as a commercial truck driver. It should be noted that a commercial truck driver is also a car driver. When work is finished, he or she gets into the privately owned car to participate in traffic as a private car driver (SP3, ecoSmart Driving, focuses on these drivers). Sub project 4 has made the choice to disregard this specific behaviour and any relations that may exist between his private and work related driving behaviour.

3.2. Literature Review

3.2.1. Motives for vehicle use

It is common for the commercial truck driver to be in an employer-employee relationship, unless he is also the owner of the company. In both cases, the commercial aspect of transportation is the main cause of vehicle use. Where a private car driver usually has alternatives to fulfil his transportation needs (e.g. public transport or bicycle) the commercial truck driver does not. It is his job to drive the truck, and therefore the part of the literature reviewed in chapter 2.1 which deals with motives for car use, is not applicable to commercial truck drivers. (This excludes the work by Gardner & Abraham (2006 & 2008), Hiscock et al. (2002), Beirao & Cabral (2007) and Steg (2005).

3.2.2. Motives for driving behaviour

Similar to private car drivers, the work by Bilharz (2004), that states ecological knowledge as the most important precondition for the realisation of eco-friendly driving behaviour, can also be applied to commercial truck drivers. The motivational factors derived from the EcoDrive project (see also section 2.1) can be applied only partly:

- ***Cost reduction by means of lowered fuel consumption*** is definitely an important topic in the commercial truck application, especially because fuel consumption of a truck is approximately 4 to 5 times higher than that of a regular car. What is different from the private car is that in most cases the commercial truck driver does not have to pay for the fuel himself, but rather the company he works for. The company will need to use incentives towards his drivers to bring across the message that it is financially attractive to reduce fuel consumption.
- ***More comfortable driving for passengers*** is hardly applicable to commercial truck drivers. Due to drive time constraint and risen operational costs, most drivers work alone unless the type of work requires two or three persons. Related to this topic is the effect of driving style on the cargo, which is more important than for private cars.
- ***Less environmental pollution*** is a topic that could be part of company values, but could also be a private motive for the driver.
- ***Less noise*** could be important for the haulage company, since a “silent” truck increases the accessibility for delivering goods in restricted areas.
- ***Driving more safely*** is an important topic for the commercial truck driver as a personal interest. It is also an important topic for the haulage company in terms of costs for person injuries, sick-leave, damages on good and trucks, insurances etc. A “safe” haulage company is also attractive to the drivers.

Other motivational factors that apply specifically to commercial truck drivers are:

- Work related factors
    - Delivery time constraint
    - Drive time limitations
- Truck related behaviour that influences driving behaviour (see section 3.3.1)

Since the work by Adelt, Grimmer and Stephan and that of Dick (2002) is focussed on private car drivers and neither is concentrated on fuel economy, the applicability towards commercial truck drivers is limited.

3.2.3. Environmental attitudes and environmentally friendly behaviour

This chapter describes reasons why most of the drivers do not use cost efficient eco-friendly behaviour although they have the theoretical background and knowledge to do so. Just as with private car drivers there is discrepancy between positive attitudes towards the environment and actual environmentally conscious behaviour. The low-cost-high-cost hypothesis (principal of rational choice) can also be applied here. According to this hypothesis, environmental attitudes become effective only if they are associated with low costs. In the situation of the commercial truck driver, his employer creates many of these “costs”. The company can determine to a great extent how easy it is for his drivers to carry out fuel efficient driving behaviour by increasing or limiting the amount of freedom a driver has in his behaviour and by offering, but also by stimulating or punishing certain behaviour.

From the work of Kanapin (2000) it can be derived that a higher degree of education correlates with environmental behaviour. Since most truck drivers have a relatively low level of education, this would make them less likely to perform this behaviour. However, the individual and social motives as described by Neugebauer (2004) confirm the influence of the company policies on the driver’s behaviour. Whereas the driver’s sense of locus of control and responsibility is closely related to the relationship he has with his employer.

Especially for the commercial truck driver it is essential whether there are conflicts between environmentally friendly behaviour and other priorities as defined in section 3.2.2. This blend of commercial and private interests determines which motives will be prioritised at the end. Thus, a commercial truck driver with distinctive environmentally conscious attitudes that exhibits environmentally friendly driving behaviour when driving in his private car can easily exhibit a less fuel efficient driving behaviour when commercially driving the truck. This happens despite of internal attribution of responsibility, because of time constraint or other factors are more important for that particular moment.

The so-called “Allmende-Klemme” (Tragedy of the Commons), which is described in section 2.1 is also applicable to the commercial truck driver to explain for the discrepancy between environmental awareness and actual behaviour.

A concept to enhance fuel efficient driving has to include more than a transfer of knowledge and skills. Motives and habits have to be taken into account when developing measures to change driver’s behaviour toward a more fuel efficient style.

3.3. Theoretical model and hypotheses

3.3.1. Model of main effects

As stated in section 3.2.2 there are many influencing factors that directly or indirectly influence fuel consumption. eCoMove as a project does not aim to overcome inefficiencies inside the combustion engine and superstructure of the vehicle, but rather to improve fuel efficient driving by influencing the driver behaviour. Therefore it is important for a driver to know what his influence is on the overall fuel consumption of the commercial vehicle. To gain insight on the self-reported knowledge of commercial vehicle drivers, a questionnaire was considered to be the most useful instrument available within the time span and resources of the project. To construct this questionnaire, SP4 partners GoGreen, (bringing experience on driver coaching) DAF and VTEC, came together and prepared questions relevant for commercial vehicle use and system development.
During the meeting, the most important aspects of driving behaviour were identified and taken into account as factors influencing fuel consumption.
For each identified factor, questions were formulated to gather insight based on self-reporting.
The absence of actual fuel consumption measurement as part of the research was taken into account, and questions were more focussed on finding correlations between the self-reported insights that truck drivers have on the different influencing factors of fuel consumption

In the aforementioned workshop with SP4 members, the following factors were recognized as having a major influence:

- Amount of horse power of the truck (HP)
- Total maintenance of the truck (M)
- The driving behaviour of the truck driver (DB)
- Traffic conditions within driver control (TrC)
- The time constraint that is laid upon the driver (TiC)
- General safety during driving (SAF)

The following factors were identified, but were regarded outside the scope of the questionnaire:

- Route choices (as directed by the back-office)
- Load conditions
- Weather conditions/seasons
- Use of in cab accessories (AC)

The use of in cab accessories was considered beyond the questionnaire's scope for two reasons.
The first reason is that it is eCoMove's main target to influence the driver behaviour in the driving situation. With other words, the aim is to influence/improve the driving behaviour, and not so much other behaviours the driver may exhibit in the non-driving situation.
The second reason is that the use of in-cab accessories differs a great deal between passenger cars and trucks. Next to the transportation functionality of both cars and trucks, a truck cabin also offers "hotel or comfort functionalities", since a portion of trucks is used to live and sleep during week days and weekends. Also, in the range of comfort functionalities, there is a very large variety of build-in (both OEM fitted and aftermarket) accessories and brought-in accessories (like iPods/notebooks/DVD players etc).

Truck drivers often do not have a clear knowledge of the actual power use of these accessories, so self-reporting cannot give insight in the influence and the great variety between drivers of in cab accessories use.
Route choice was considered out of scope because the driver has little influence on it. The dimensions (weight and size) of the commercial vehicle limit the availability of route choice for the driver. The route itself is most often directed from the back-office, because the logistic process dictates an order in which the stops need to be visited. This also applies to the load condition of the vehicle, which can only be optimised on a fleet level and not on a vehicle level, if the aim is to optimise the overall fleet use of vehicles.
Since weather conditions cannot be influenced, they also are regarded outside the scope of the questionnaire.

The driving behaviour and maintenance are directly influencing the fuel consumption. Other factors, horsepower, traffic conditions, time constraint and safety influence the driving behaviour, but not directly the fuel consumption. From these factors the following model is derived: (see Figure 6: Model of main effects).

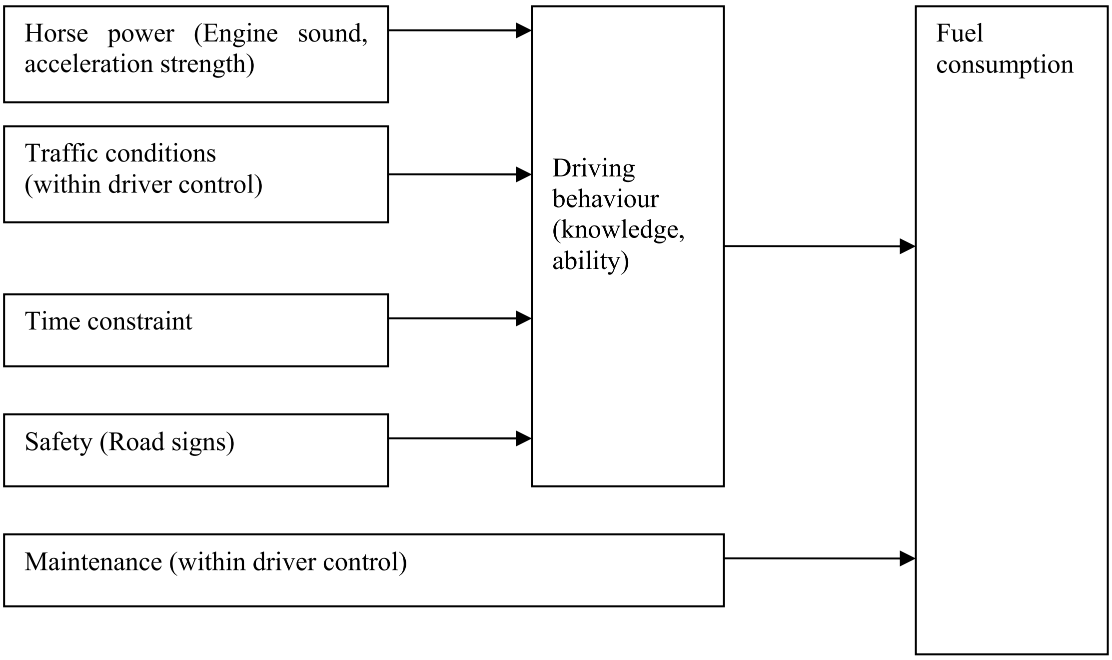


Figure 6: Model of main effects

It was assumed that asking directly for the fuel consumption in the questionnaire would result in biased result because of two factors:

- Commercial drivers are not always familiar with their own driving behaviour, because it is not fully shared with them by the company and/or they have not found the motives or means to calculate it themselves
- Commercial drivers might fear they are judged on the reported results and therefore could report more positive behaviour than what is actually achieved.

Therefore, a correlation analysis aimed at actual fuel consumption was not possible without measuring actual fuel consumption, which was considered outside the scope of this study, Instead questions were asked that focus on the underlying factors that influence the driving behaviour, in order to get a coarse feeling for the relationship between these factors and the intention for fuel efficient driving behaviour.

The factor “Total maintenance of the truck” is assumed to have a direct influence on fuel consumption. Since fuel consumption itself is not measured in this study, this factor was excluded from the regression analysis.

3.3.2. Interaction effects

As a theoretical basis the Theory of planned behaviour (TPB) by Ajzen (1985, 1991) will be used. This is described in more detail in chapter 2.3.1. The theory does not deal with interaction effects between attitude, social norm and perceived control. It assumes the behavioural intention in general (or the intention to perform eco friendly driving behaviour in this specific case) is the result of an integration process over all three different types of underlying evaluations. But since we are investigating a multi-attribute concept with underlying factors that can strongly influence each other, we need to investigate interaction effects between them as well. The following table (see Figure 7: Interaction effects between underlying factors) shows where strong interaction between factors was expected (the squares marked X). The ones marked with a yellow v are already covered by the model of main effects.

	HP	DB	TrC	TiC	SAF
Horse power (HP)		*v*			
Driving behaviour (DB)			*v*	*v*	*v*
Traffic conditions (TrC)				**X**	**X**
Time constraint (TiC)					**X**
Safety (SAF)					

Figure 7: Interaction effects between underlying factors

From figure 2 the following interaction effects can be derived:

- ***Time constraint vs Safety***
- ***Traffic conditions vs Safety***
- ***Traffic conditions vs Time constraint***

3.3.3. Research questions and hypotheses

The factors identified are assessed in a questionnaire study (see appendix for the actual questionnaire) as part of this project. Each factor will be assessed using attributed attitudes, social norms and perceived behavioural control, consistent with the TPB framework. From the theoretical model with main and interaction effects, the following research question is derived;
"Is there a correlation between the factors *Horsepower*, *Traffic Conditions*, *Time Constraint* and *Safety*, the Driver's *experience as a truck driver*, *annual mileage*, *experience with driver training*, or the *size* of the *company* he works in. "

From this research question the following hypotheses are derived:

MAIN EFFECTS

Hypothesis 1: ***There is a correlation between the amount of horsepower in the truck and driving behaviour on the level of behavioural intention***

Hypothesis 2: ***There is a correlation between traffic conditions and driving behaviour on the level of behavioural intention***

Hypothesis 3: ***There is a correlation between time constraint and driving behaviour on the level of behavioural intention***

Hypothesis 4: ***There is a correlation between the safety and driving behaviour on the level of behavioural intention***

INTERACTION EFFECTS

Hypothesis 5: ***There is a correlation between the time constraint and safety on the level of behavioural intention***

Hypothesis 6: ***There is a correlation between the traffic conditions and safety on the level of behavioural intention***

Hypothesis 7: ***There is a correlation between the traffic conditions and time constraint on the level of behavioural intention***

DEMOGRAPHIC EFFECTS

To get a first estimation if different driver types can be identified, several demographic determinants are added to the study.

Hypothesis 8: ***There is a correlation between the demographic variables "experience as a truck driver", "annual mileage", "experience with driver training" and "company size" and the driving behaviour on the level of behavioural intention***

3.4. Results of the truck driver questionnaire

3.4.1. Procedure

A questionnaire was distributed using several different dissemination channels. The most efficient way of reaching a high number of target group respondents was to look for communities and networks in which truck drivers are associated or members (social networks which are used also for business contacts). Even though the sample size is increased, the usage of such distribution channels includes certain bias which needs to be recognized when analysing the data.

In Sweden three networks were chosen: 1) Yrkeförare, 2) Yrkesförarcentrum I Göteborg and 3) Yrkeschaufförer I Väst. In total the networks contain 2000 truck drivers as members discussing online and on workshops transport business matters, driver assistance issues as well as new laws and rules concerning the transport sector. The members were contacted by e-mail and asked to follow a link to the questionnaire page (platform: “limeservice.com”); those not responding in a certain time were contacted again with a reminder. The questionnaire was open for a two month time period, filled out anonymously and the participants did not receive any compensation.

Furthermore the questionnaire was placed on the eCoMove project web page in several languages: English, Dutch, German, Italian, Polish, Spanish and Swedish (http://www.ecomove-project.eu/news-events/news/truck-driver-survey/). The online questionnaire was available using the same platform as for the drivers in the Swedish networks and translated into English, German, French, Dutch, Swedish, Spanish, Polish and Italian to overcome any language barrier that might be encountered when surveying mostly monolingual truck drivers.

The same questionnaire was also filled out in personal interviews conducted by SP4 partners. In Sweden five companies offered to participate in the survey: Lundby (container delivery from ports), Regis (oil tanker trucks), Skårdal (long haul delivery of steel, garbage and shaft trucks), HML (cement trucks, heavy deliveries), Hitab (distribution and shaft trucks). Drivers were surveyed during brake time or at different truck stops outside the company site.

A total of 197 participants filled out the online questionnaire, of which 65 participants only partially filled in the answers, of which 23 were considered to be acceptable for analyses. This makes the total number of online questionnaires that are taken into analyses is 155.

During personal interviews 103 truck drivers filled in questionnaires, which could all be taken into analyses.

Therefore a total of 258 web-based and paper questionnaires were included in the analyses.

3.4.2. Participants

Participants were aged between 18 and 88 years (mean (m) = 42 years, standard deviation (sd) = 13 years, n=258). 3.5% were females, 96.5% were males and reported being experienced as a commercial truck driver with a mean of 17,5 years (the longest was 55 years, the shortest was a freshly started truck driver).

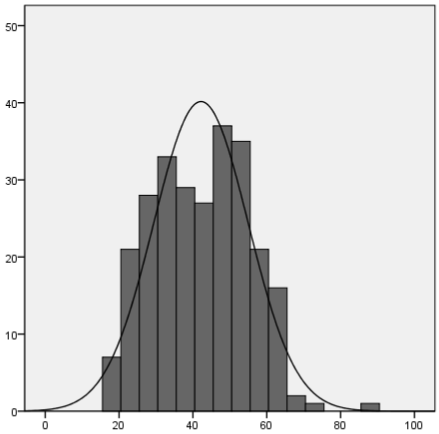


Figure 8: Distribution of age

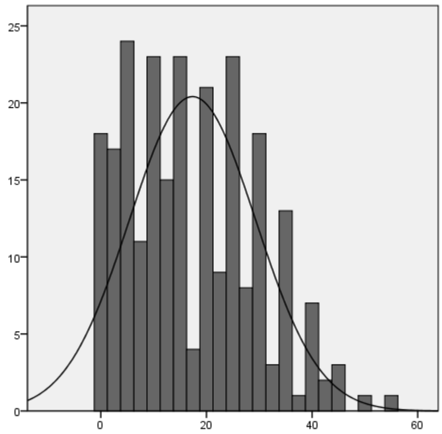


Figure 9: Distribution of driving experience

The desire was for the study to be as representative as possible for the entire population of commercial vehicle drivers. Unfortunately during the dissemination of the questionnaire it became clear that getting in touch with commercial drivers was more labour-intensive than initially foreseen. One important reason comes from the characteristic difference between commercial and private cars. Considering private cars, the user is most often also the purchases of the vehicle. In the case of commercial vehicles, these are often two separate parties. The driver is in most cases an employee of the company that bought the vehicle, making the distance between suppliers and users of commercial vehicles larger than is the case in private car users. The employer-employee relationship further complicated the willingness to comply to the questionnaire. Qualitative analyses can be useful in such matters; they can be used in such way that reasons e.g. for non-compliance are identified from responses.

Because of the fact that the Swedish SP4 participants were able to come into contact with the majority of participants, most truck drivers that participated in the study (n=256) had the Swedish nationality (see Table 11: Nationality of Driver and Company), this also applied for the reported nationality of the company they worked for (n=255) (see Table 11: Nationality of Driver and Company). Unfortunately this led to results that do not allow for comparison between countries and which are less than desired in the extend of representativeness for the entire European community.

Figure 10: Nationality of company

Nationality of driver	# of responses
Belgian	2
Danish	1
Dutch	3
Finnish	2
French	35
German	18
Icelandic	1
Polish	1
Portuguese	1
Spanish	1
Swedish	186

Swiss	1
Turkish	1
Ukrainian	2

Nationality of company	# of responses
Belgian	3
Bulgarian	1
Czech	1
Dutch	5
French	30
German	16
Luxemburgian	1
Polish	2
Spanish	2
Swedish	189
Swiss	1
Ukrainian	3

Table 11: Nationality of Driver and Company

To estimate the size of the company, participants were asked to estimate the number of trucks in the company. Figure 11 illustrates companies with truck numbers between 50 and 100 were unevenly represented in this study

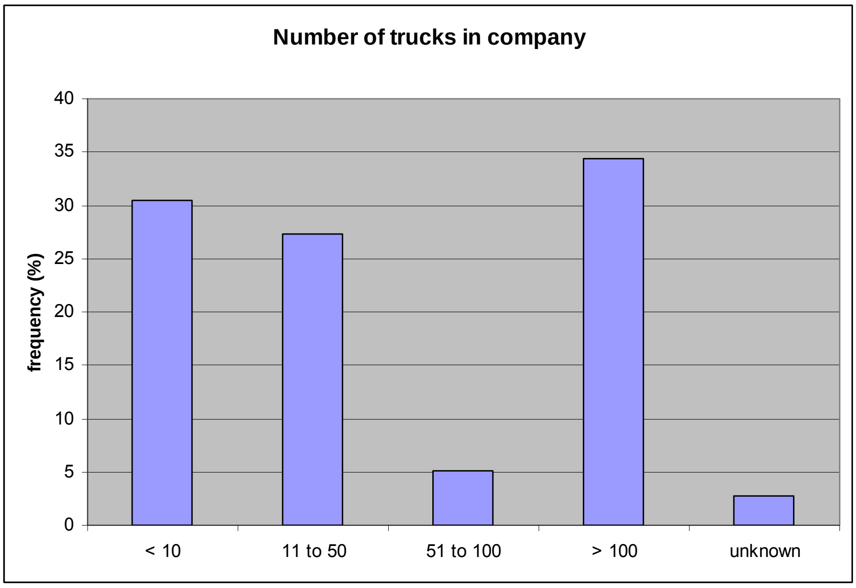


Figure 11: Number of trucks in the company

The distribution of the annual mileage is displayed in figure 8. Approximately 68% (n=257) of the participants reported an annual mileage in the range between 20.000 and 150.000 kilometres.

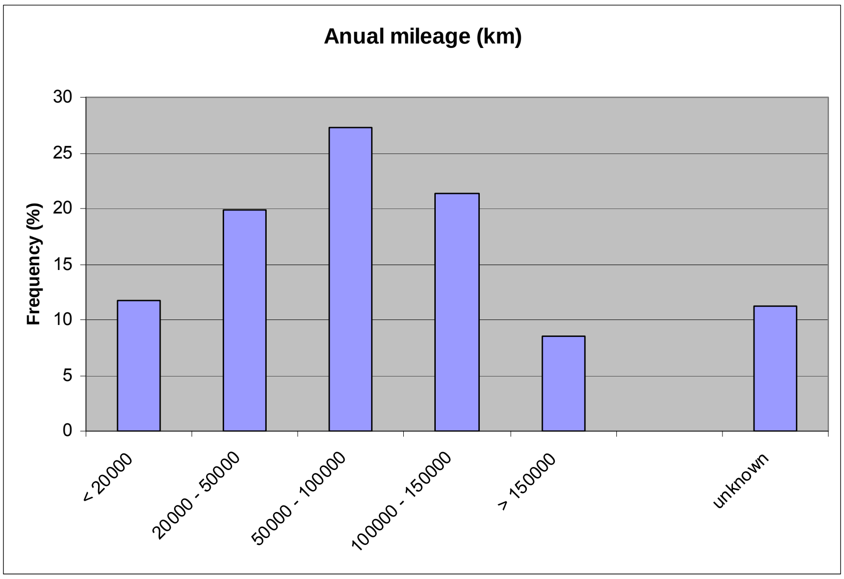


Figure 12: Distribution of annual mileage

69% (n=257) of the participants are working as a commercial truck driver for five or six days per week, 26% (n=257) during three to four days per week and only 5% (n=257) reported driving as a commercial truck driver during only one or two days per week or even less.
24% (n=244) of the participants reported working in distribution, 42% (n=244) reported working in long-distance transportation, 13% (n=244) reported working in construction and 21% (n=244) reported working in another sector.

The participants were asked to specify the brand, load capacity and production year of their most frequently used truck. From the reported production year, the truck's age was calculated. The oldest truck was reported to be 35 years; the youngest was built in the same year this study was conducted. On average the truck age was 4 years (mean (m) = 4 years, standard deviation (sd) = 4 years , n=231).

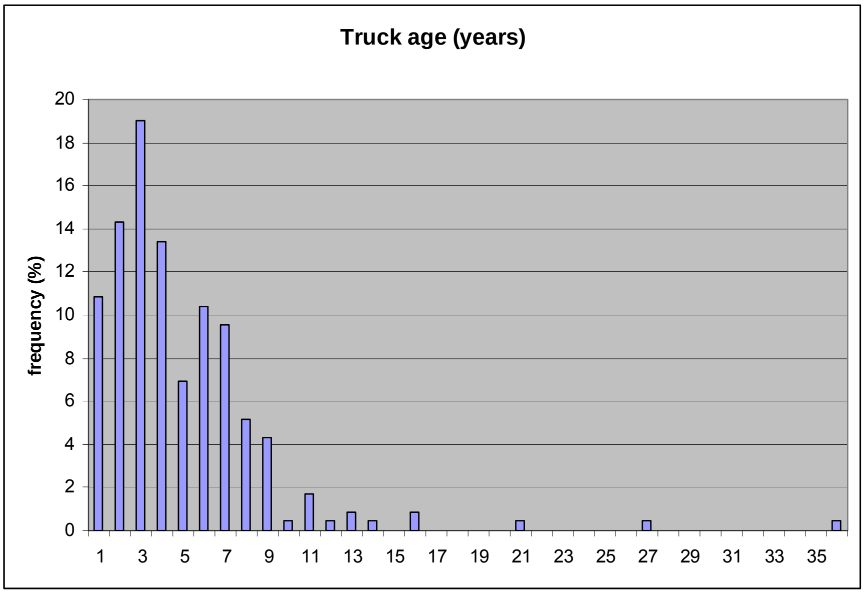


Figure 13: Distribution of truck age

Figure 13 illustrated that almost all trucks are less than 10 years old. (n=231)

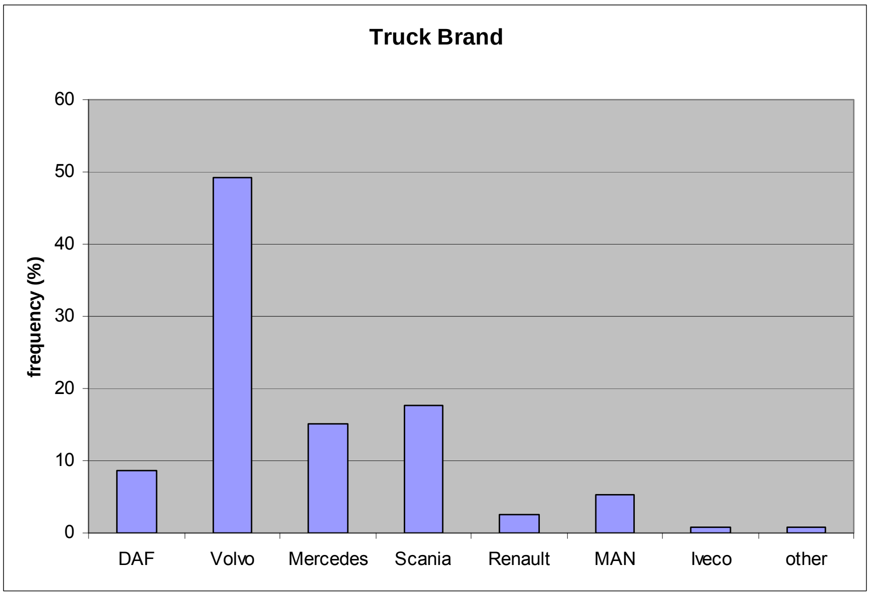


Figure 14: Distribution of truck brand

Figure 14 illustrated that almost 50% (n=244) of the participants drove a Volvo truck.

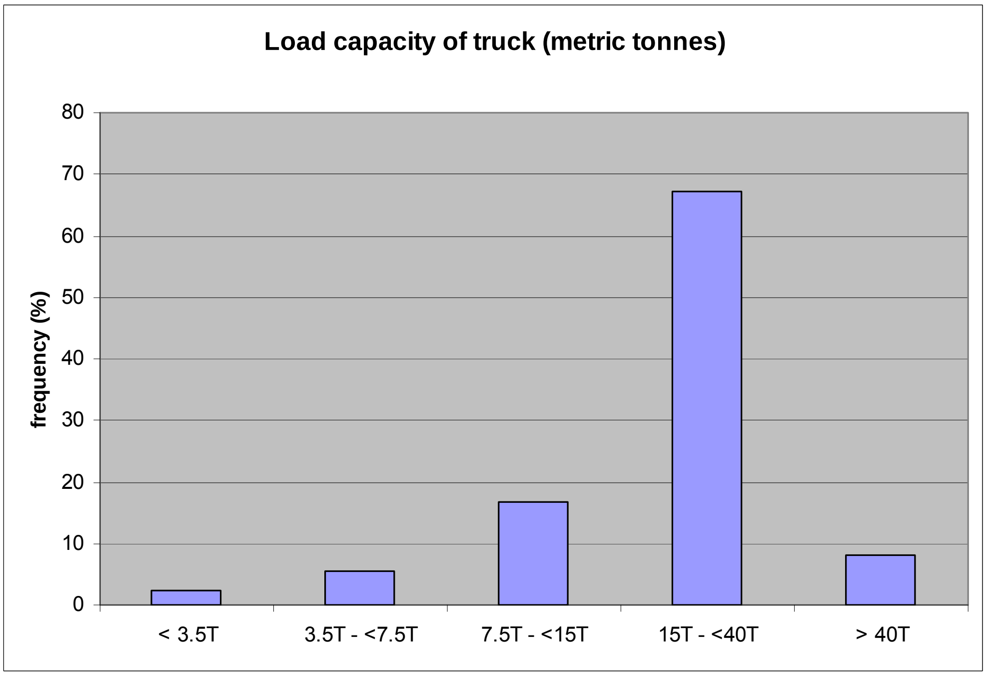


Figure 15: Distribution of load capacity

Figure 15 illustrated that approximately 67% (n=257) of the participants drove a truck with a loading capacity between 15 and 40 tons.

3.4.3. Descriptive analysis of driver's knowledge

To serve as a reference for further analyses, participants were asked for their general knowledge on driver training and fuel efficient driving. Participants were asked whether they had undergone training in the field of economic driving before. 58 % (n=228) reported having experience with this type of training. Figure 16 illustrates the different types of reported experienced driver training (n=133).

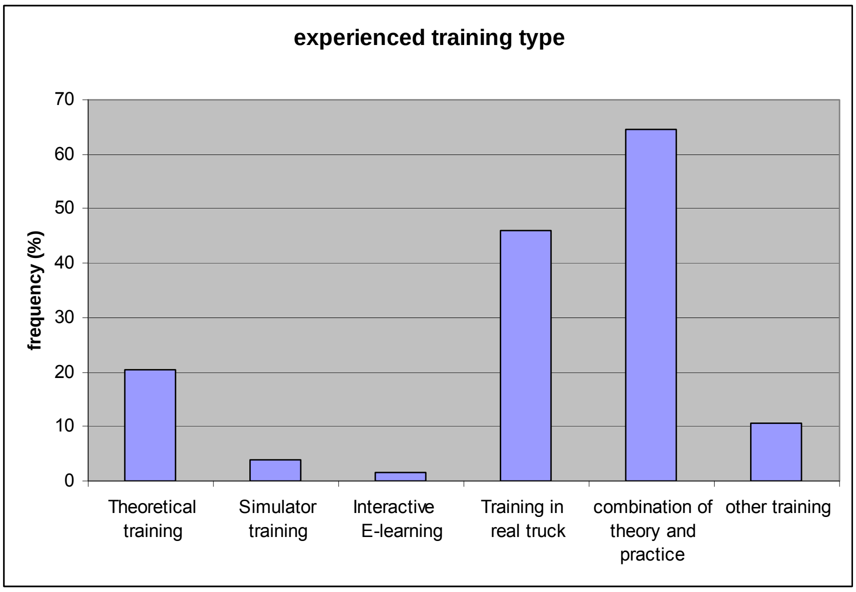


Figure 16: Reported types of driver training

Participants were asked to estimate the potential fuel saving they would be able to achieve by using a more fuel efficient driving style. Figure 17 illustrates an average of almost 13 % fuel saving, but also shows that there is a large spread in estimated fuel saving potential amongst drivers (standard deviation (sd) = 13 % saving)

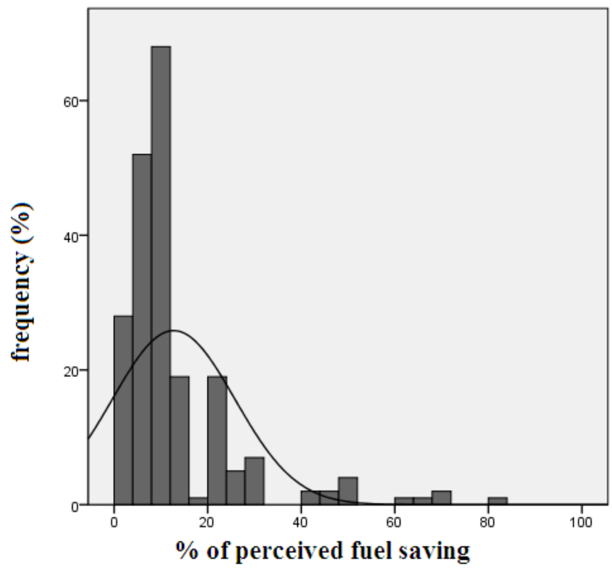


Figure 17: Reported potential fuel saving

Participants were asked to select three pre-trip actions that are most influential on fuel efficient driving. Figure 18 illustrates that checking tyre pressure and pre-trip route planning are mentioned most often.

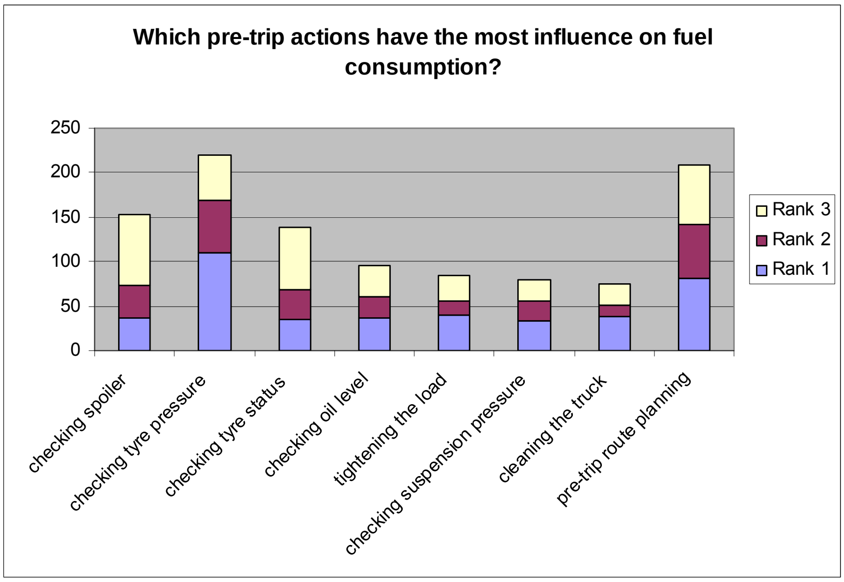


Figure 18: Pre-trip actions

Participants were asked to select three on-trip actions that are most influential on fuel efficient driving Figure 19 illustrates that looking ahead, or an anticipatory driving style is mentioned most often.

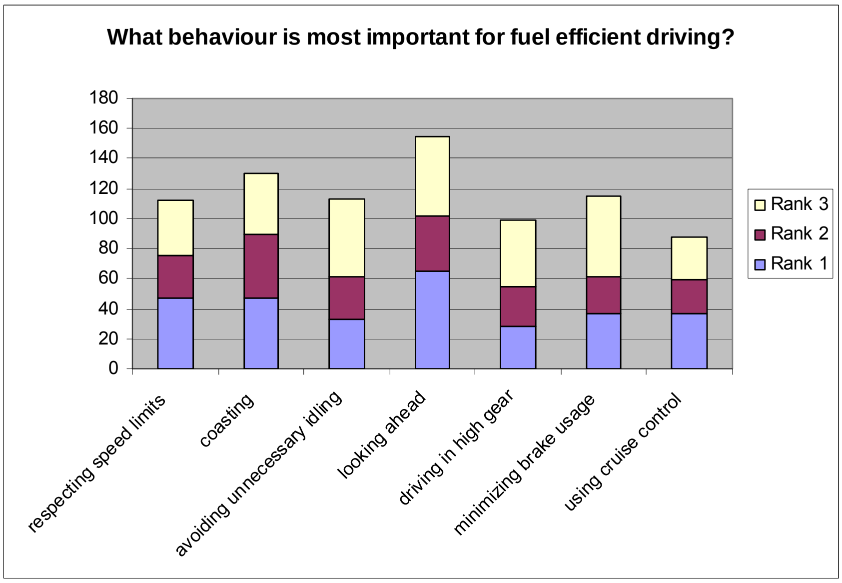


Figure 19: Driving behaviour

Participants were asked to select three sources of information that are required to achieve a better fuel efficiency. Figure 20 illustrates that information on fuel efficient driving and instructions on how to apply this knowledge were mentioned most often.

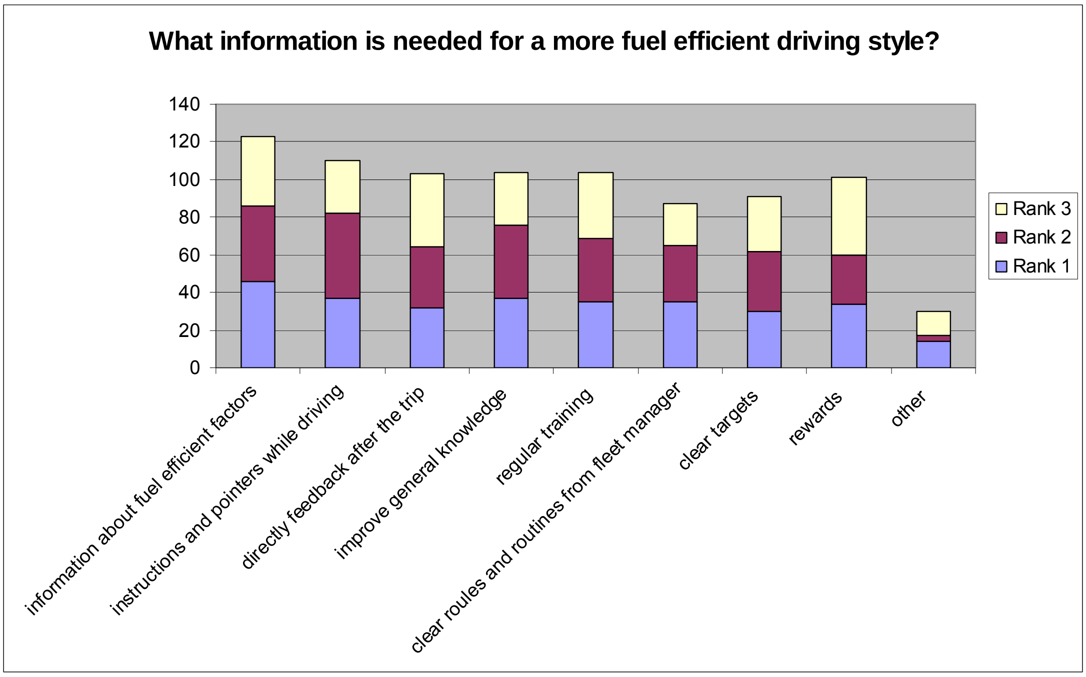


Figure 20: Information needed for fuel efficient driving

Participants were asked to select three motivational factors that are required to achieve a better fuel efficiency. Figure 21 illustrates that the reward is considered by the driver to be the best motivation. This does not mean it is actually the best motivation, as studies have shown that rewarding often has a very short period of effectiveness and that rewards need to increase in size over time to maintain the desired effect.

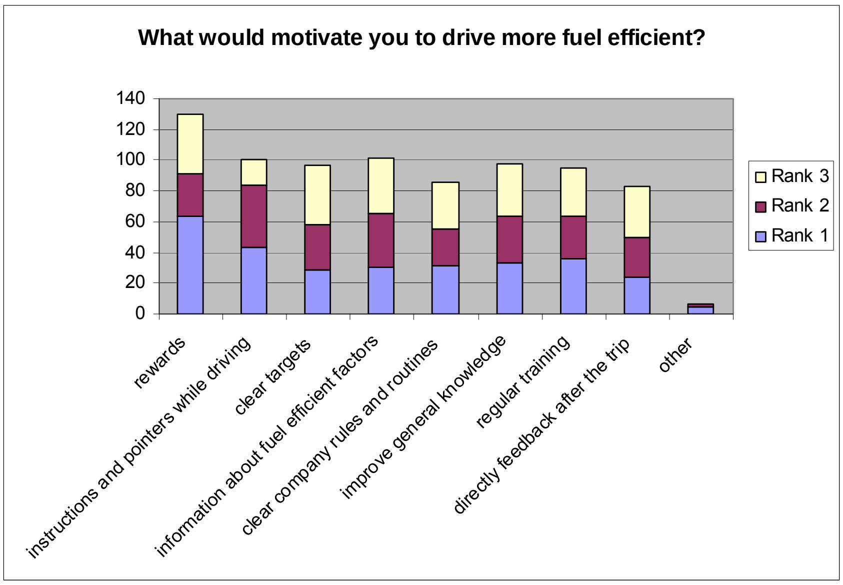


Figure 21: Motivational factors for fuel efficient driving

3.4.4. Correlation analysis of main effects

To asses the relationship between factors on the level of behavioural intention, the conversion was made from individual questions (see appendix for questionnaire) towards constructed variables. Due to the fact that a combination of binominal questions (yes/no) and questions with a 5 point Likert scale (from fully agree to fully disagree) were used, a factor analysis could not be performed to find underlying factors. Instead the conversion is based on the assumption of predefined factors and builds on the theory of planned behaviour. For most factors the questionnaire included questions that focus on Attitude-belief (Ab), Attitude-evaluation (Ae), Subjective Norm-belief (SNb), Subjective Norm-motivation (SNm), and perceived control (PC). The Theory of planned behaviour proposes a model which was adapted for this analysis. Since no questions in the questionnaire dealt with the Behavioural intention (BI), a regression analysis to calculate the model was impossible. Instead the conversion was based on the following model which is derived from the generic "Theory of planned behaviour" model:

BI = (Ab*Ae) + (SNb*SNm) + (5*PC)

The correction factor 5 for the PC was introduced to compensate the fact that for perceived control only combined questions were included which embody both the *belief* and *access to factors* components from the theory.
All questions were converted to a scale between 1 and 5. When a category of questions missed for a particular factor it was replaced by the average value of 1 and 5 which is the only rational choice to make if no other information is available.

Hypothesis 1 assumes a correlation between the amount of Horse Power and the Driving Behaviour. A regression analysis was performed with Horse Power as independent variable and Driver Behaviour as dependent variable. The results show a significant correlation (F=5,01, p=0,026) but the predictive value of Horse Power on the Driver Behaviour is poor (R-squared=1,5%). Figure 22 shows a scatter plot for driving behaviour and the amount of horsepower, which illustrates the poor correlation between them.

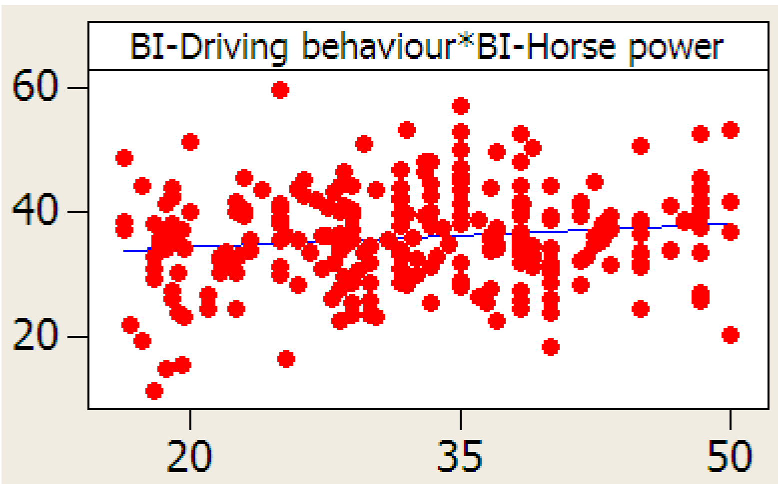


Figure 22: Scatter plot for Horse Power and Driving Behaviour

Hypothesis 2 assumes a correlation between the Traffic Conditions and the Driving Behaviour. A regression analysis was performed with Traffic Conditions as independent variable and Driver Behaviour as dependent variable. The results show a significant correlation (F=18,91, p=0,000) but the predictive value of Traffic Conditions on the driver behaviour is poor (R-squared=6,5%). Figure 23 shows a scatter plot for driving behaviour and traffic conditions, which illustrates the poor correlation between them.

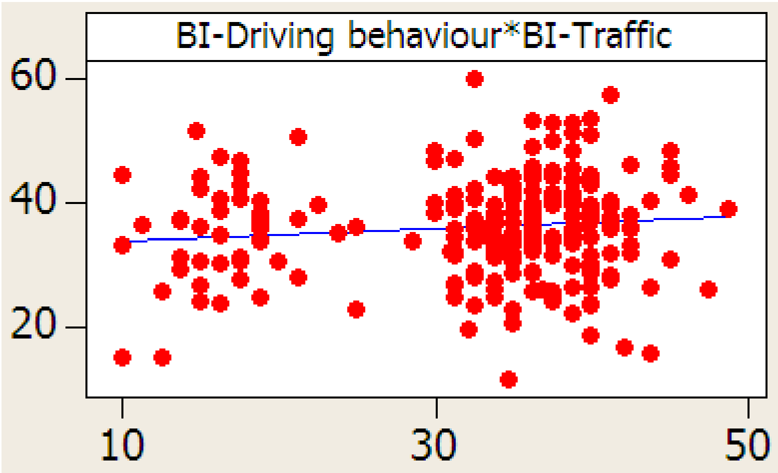


Figure 23: Scatter plot for Traffic Conditions and Driving Behaviour

Hypothesis 3 assumes a correlation between the Time Constraint and the Driving Behaviour. A regression analysis was performed with Time Constraint as independent variable and Driver Behaviour as dependent variable. The results show a non-significant correlation (F=1,53, p=0,217) also the predictive value of Time Constraint on the driver behaviour is poor (R-squared=0,2%). Figure 24 shows a scatter plot for driving behaviour and time constraint, which illustrates the poor correlation between them.

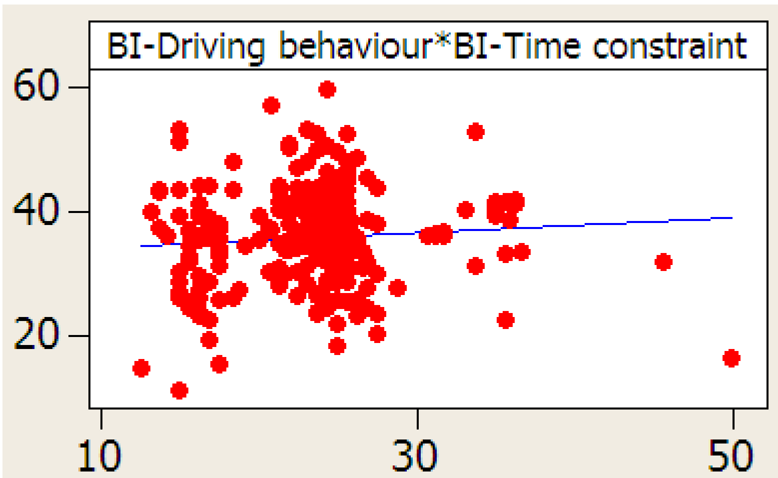


Figure 24: Scatter plot for Time Constraint and Driving Behaviour

Hypothesis 4 assumes a correlation between the Safety and the Driving Behaviour. A regression analysis was performed with Safety as independent variable and Driver Behaviour as dependent variable. The results show a non-significant correlation (F=3,14, p=0,078) also the predictive value of Safety on the driver behaviour is poor (R-squared=0,8%). Figure 25 shows a scatter plot for driving behaviour and safety, which illustrates the poor correlation between them.

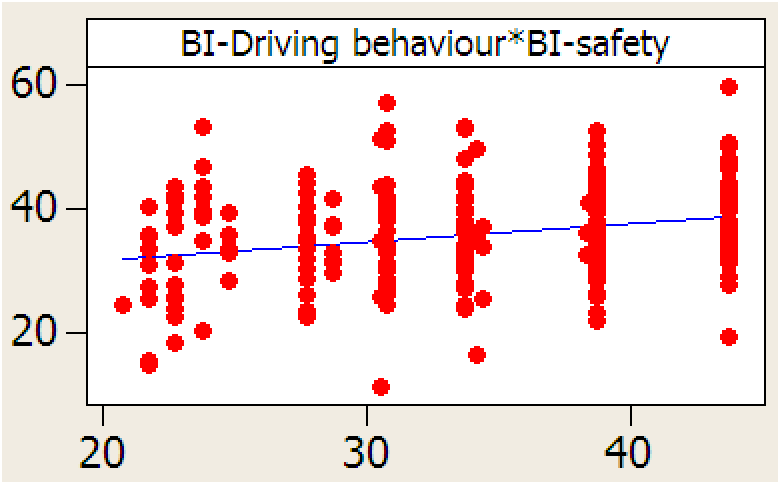


Figure 25: Scatter plot for Safety and Driving Behaviour

A regression analysis was performed with Horse Power, Traffic Conditions, Time Constraint and Safety as independent variables and Driver Behaviour as dependent variable. The results show a significant overall correlation (F=6,1, p=0,000), which is raised by the factor Safety (T=4,06, P=0,000) and deteriorates due to factors Horse Power (T=1,17, P=0,244), Time Constraint (T=0,68, P=0,497) and Traffic Conditions (T=1,44, P=0,150). The predictive value of all factors on the driver behaviour is poor (R-squared=7,4%).

3.4.5. Correlation analysis of interaction effects

Hypothesis 5 assumes a correlation between Time Constraint and Safety. A regression analysis was performed with Time Constraint as independent variable and Safety as dependent variable. The results show a non-significant correlation (F=1,01, p=0,316) also the predictive value of Time Constraint on the Safety is poor (R-squared=0,0%). Figure 22 shows a scatter plot for time constraint and safety, which illustrates the poor correlation between them.

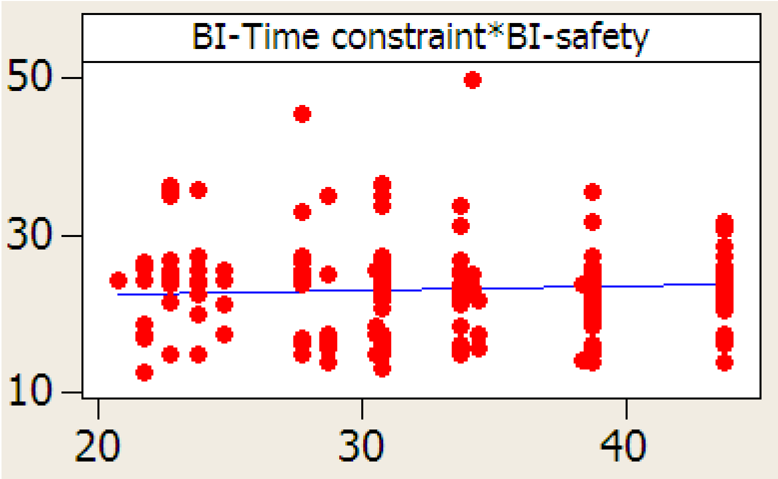


Figure 26: Scatter plot for Time Constraint and Safety

Hypothesis 6 assumes a correlation between Traffic Conditions and Safety. A regression analysis was performed with Traffic Conditions as independent variable and Safety as dependent variable. The results show a non-significant correlation (F=0,14, p=0,708) also the predictive value of Traffic Conditions on the Safety is poor (R-squared=0,0%). Figure 27 shows a scatter plot for traffic conditions and safety, which illustrates the poor correlation between them.

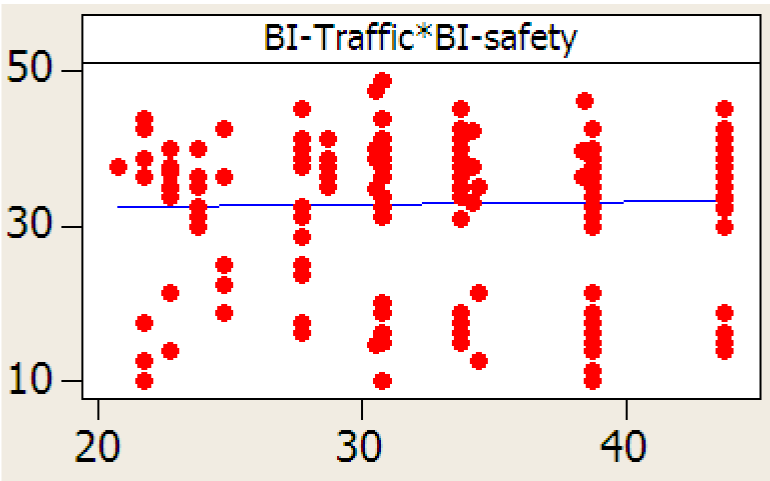


Figure 27: Scatter plot for Traffic Conditions and Safety

Hypothesis 7 assumes a correlation between Traffic Conditions and Time Constraint. A regression analysis was performed with Traffic Conditions as independent variable and Time Constraint as dependent variable. The results show a non-significant correlation (F=0,07, p=0,797) also the predictive value of Traffic Conditions on the Time Constraint is poor (R-squared=0,0%). Figure 28 shows a scatter plot for traffic conditions and time constraint, which illustrates the poor correlation between them.

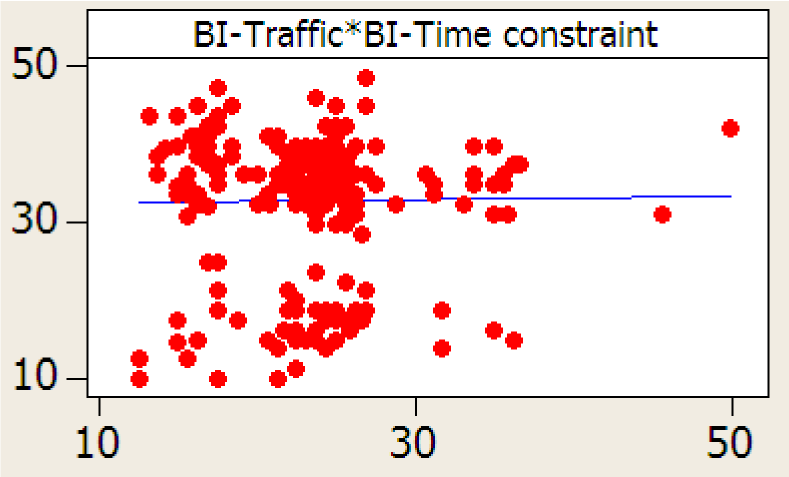


Figure 28: Scatter plot for Traffic Conditions and Time constraint

3.4.6. Correlation analysis of demographic effects

Hypothesis 8 assumes a correlation between demographic variables "experience as a truck driver", "annual mileage", "experience with driver training" and "company size" and the Driving Behaviour. A regression analysis was performed with "experience as a truck driver", "annual mileage", "experience with driver training" and "company size" as independent variable and Driving Behaviour as dependent variable. The results show a non-significant correlation ($F=1,40$, $p=0,234$) and all independent variables have non-significant correlations with driving behaviour. Also the predictive value of the demographic variables on Driving Behaviour is poor (R-squared=0,8%).

3.4.7. Qualitative results from the questionnaire

From the outcome of the questionnaire study several qualitative results can also be derived. For instance, 80 % of the participants already actively monitor their fuel consumption, meaning this is an important topic in the use of commercial vehicles. From the drivers that participated in the study, 60 % have some kind of technical device that helps them to do so, others will use more traditional ways to keep track. An important target group for fuel consumption reduction is the 20 % that reported not monitoring their consumption.

An interesting result is, although 80% of the drivers keep track of their consumption and report it to the company; only 48 % of the drivers get regular feedback from their company on their performance. Apparently there exist companies that keep track of the fuel consumption but do not share the results with their drivers. In order for a driver to improve its driving behaviour, it is important he receives feedback on his behaviour.

Overall, drivers seem to be very aware about the cause and severity of fuel consumption influences. Unfortunately 17 % of the drivers think that more brake usage doesn't increase the fuel consumption. When asked if driving in a more fuel efficient way would lead to decreasing goods damage, 50% of respondents agreed on this statement. Also 28 % believe that accelerations on full throttle will not increase the consumption.

Almost all the participants think it is important to deliver on time and feel that congestion increases the fuel consumption. They are also, correctly, agreeing that it is hard to make up for lost time by driving faster. Furthermore most of them believe that pre-trip route planning can save a lot of fuel.

Almost 50 % of the drivers think it would be easy to change their behaviour to a more fuel-efficient driving style, but the time issue is hard to solve. Drivers think that there are three driving behaviour's that influences the consumption most: an anticipating driving style where the driver looks ahead, coasting and respecting the speed limits. 60 % of the drivers believe it is part of their profession to drive in a fuel efficient way.

The most important pre-trip actions that influence the fuel consumption were found out to be: checking the tire pressure and route planning.

3.4.8. Conclusions

Only very few significant correlations, with poor predictive values, were found in the analysis of the questionnaire. There was an indication that Horse Power and Driving Behaviour are correlated. Safety also seems to be correlated with Driving Behaviour. Other than that no significant correlations could be discovered. Future analyses could be aimed at finding correlations on a question level instead of using the constructed behavioural intentions. It was not possible to construct a predictive model from the data due to the poor predictive values. This may be due to the fact that a factor analysis could not be performed on the chosen questionnaire form. Based on these results without doing any additional analysis, the preliminary conclusion is that all the hypotheses are rejected.

However, the approach bears potential to detect relationships between driver behaviour and influencing factors. A few improvements would raise the expressiveness of the study. For similar future studies it is recommended, that all underlying subfactors (see the theory of planned behaviour) for each factor are represented in the questionnaire by separate questions. Also all questions in the questionnaire should be in the form of a 5-point Likert scale to enable a factor analysis to confirm that for each question it actually belongs to the assumed factor. Questions in the questionnaire regarding behavioural intention, which enables a more profound construction of the Behavioural Intentions from other questions, should be included.

The more interesting results in this study came from the qualitative analysis.
From the questionnaire we can see that the drivers need assistance to drive more fuel efficient and that this help is needed the pre-trip phase, during the trip and after the trip.
In the pre-trip phase, route planning and support in checking the vehicle status (e.g. tire pressure) without losing a lot of time is desired.
On-trip the drivers can be helped with planning and anticipating actions. Since these matters are knowledge based, education about “eco-driving” can provide a solution here.
After the trip they need help with self-monitoring actions so they can get feedback on how their fuel consumption is developing. A potential solution for this problem is to provide a supportive backend system and help for the drivers to self-monitor the consumption.

4. European Study on the Usefulness of Eco-Driving Assistant Systems

4.1. Introduction

Many reasons have led to a fast development of driver assistant systems in recent years. The most commonly discussed need for such systems is to improve traffic safety and avoid unnecessary traffic accidents. But also the economical aspect is a promotive factor for new assistant systems (purchase price vs. maintenance costs). Further the customer's opinion on additional driving comfort influences the buying decision. More and more drivers are aware of the increasing negative effect of traffic on the environment. Such motives play a growing role when developing new assistant systems (Brookhuis, K., de Waard, D. and Janssen, W. 2001).
Today energy efficiency is in the focus of various research activities and industry developments. According to Reis, S. et al. (2000) emissions from road vehicles in Europe are expected to fall markedly in response to planned and probable control measures across the European Union (EU). However he states, the traffic sector will still be a significant contributor to both emissions and air pollution in the near future. Hickman et. al (2010) argues that transport is a major user of carbon-based fuels, and it is increasingly being highlighted as the sector which contributes least to CO2 emission reduction targets.
On the one hand, environmental changes have made people think about the need for changes. On the other hand the technological progress bares the chance to develop solutions such as driver assistant systems for lowering emissions in the transport sector. Nevertheless, technology has to be conforming to the average user's ability to actually use it, her or his acceptance (does it have an advantage for me?) and meet the willingness to pay for it.

4.2. Literature Review

Energy efficiency is currently the subject of numerous developments and innovations brought up by the automotive industry. But few driver assistant systems have been developed and found their way into the market to help drivers improve their skills and thus reduce fuel consumption. The user is confronted with an increasing amount of information provided by in-car assistant systems. Therefore strategies are necessary to develop new applications in a way that users are aware of its impact and see that it meets their needs and requirements. The aspect of influencing driving behavior towards increased fuel efficiency or reduced emissions has been the starting point for many user orientated studies. For instance Ford (2008) had success when introducing a driver coaching with assistance of a professional trainer who introduced means to drive more economical. A large-scale training with around 800 participants showed instant efficiency increase and a high acceptance mentioned by users.
Ablassmeier, Poitschke and Rigol (2006) state that the growing amount of information in cars makes the development of new strategies to cope with this amount of information for drivers necessary. New technologies such as voice control can provide possibilities to handle the complexity of the system. Brookhuis et.al (2008) mentions that novel driver support systems face a faltering implementation. Some of the systems are not yet fully developed, i.e. not sufficiently tested to functionality, safety, reliability and acceptance; others are not yet introduced because of uncertainty about liability effects or cost-effectiveness, and potential unwanted behavioural effects.
Brookhuis et.al (2008) states that before the actual marketing, research on user needs or marketing indispensable, but also studies on acceptance and certainly safety effects are necessary, even after implementation. Consumer acceptance is dependent on the attitude with

respect to system safety and validity (does the system function as it should) and benefit (is there a positive cost-benefit balance), but also on the attitudes with respect to norms and on perceived control. It is also stated that the acceptance of Intelligent Transport Systems (ITS) is vital for the successful implementation of such systems. Dillon, A. et al. (1996) defines the user acceptance as the demonstrable willingness within a user group to employ information technology for the task it is designed to support. There are research approaches to explain the technology acceptance as such.

The lack of user acceptance is a significant impediment to the success of new information systems and therefore important to be studied before developing driver assistant systems. In fact, user acceptance has been viewed as the pivotal factor in determining the success or failure of any information system project. Acceptance theory seeks to extend the traditional model of user-centred design espoused in usability engineering approaches from questions of interface improvements towards predictions of likely usage (Dillon, A. et al. (1996)).

An early assessment of user acceptance in the development of ICT applied in traffic can give advantages on both cost and effort as Meschtscherjakov, A. et al. (2009) states. The Technology Acceptance Model (TAM) created by Davis (Davis, F. (1989)) assesses the perceived usefulness as the extent to which the individual believe that using a system will enhance his or her job performance. Further the perceived ease of use is the extent to which an individual believes using a system will be free of effort. Surveys explained in Davis, F. (1989) were investigated to find out which factors have to be included when assessing the impact of driver assistant systems. For instance Man et al. concluded from a similar study on eco driver assistance systems that information on monetary savings, fuel consumption and environmental impact are highly relevant for drivers (Man et. al. 2010).
Davis and Vankatesh showed that the TAM is a reliable and valid tool to predict actual usage behaviour. The method of user questionnaires should be used as early as possible in the development stage (Meschtscherjakov, A. et al. (2009)). The approach explained here included the most important factors for the assessment of technical acceptance.

Experiences from the last years show that increasing fuel prices within Europe motivates buyers to keep track about fuel expenses and buy cars with comparably lower fuel consumption, choose a lower vehicle segment and/or invest in vehicle systems which help them do so. Car manufactures have responded to this trend and set the focus either on influencing the driver’s practice (showing the saving potential) or the cars drivability (fully automated in-car applications).

The upcoming section explains different driver assistant systems with fuel saving functionalities. They represent state of the art eco driving assistant solutions for keeping track on fuel consumption and research projects on driver assistance including the aspect of fuel efficiency. When designing the questionnaire for the study such driving systems were taken as examples for possible in-car solutions in eCoMove and put then in the context of a cooperative traffic systems. A quick overview on each system is given in the following.

Honda Ecological Drive Assistant System
Hondas assistant system gives the driver feedback on her or his driving behaviour for a single trip but also informs about long-term fuel efficiency. The system also gives advices on how to improve the driving style towards a more ecological driving experience according to Honda

(2008). While driving the current “fuel efficiency” is displayed using an ambient meter which turns from green (highest efficiency) to blue (high consumption). The post-trip feedback of the Ecological System provides information on the amount of saved fuel in comparison to the long-term fuel consumption. The visualized feedback on driving as described here seems to have high priority among developers since it can be found in various other cars.

Fords SmartGauge
The system visualises an increasing fuel-efficiencie of the driver with a growing amount of leaves displayed on the cars dashboard. SmartGauge uses two display (LCD) screens on either side of the analog speedometer that can be configured to show different levels of information, including fuel and battery power levels, average and instant miles-per-gallon. Growing leaves and vines track and reward the driver’s efficiency (Ford (2008)).

PLX Kiwi
This portable device is a stand-alone system and available as a mobile phone application. It records acceleration and deceleration parameters through an On-Board-Diagnose (OBD) connector. The software provides an analysis of the long-term driving style improvements. It also shows to what extend the optimal revs have been achieved and how much fuel has been saved (PLX 2010).

Vexia Econav
This system represents a navigation device which records driving efficiency (based on average speed, trip time and route length) and gives an overview on its long term development. The system saves information about previously driven routes and can give an estimation on which alternatives are more efficient than others (Ecological route-function) (Vexia 2010).

Travolution (AUDI, Technische Universität München, City of Ingolstadt)
The test field of the TRAVOLUTION project investigates potentials of signal control and car-to-infrastructure communication for improved urban traffic. An in-vehicle display shows the driver the green wave ahead of him. The aim is to encourage an anticipatory, safe and economical way of driving. First test runs have resulted in around 20% reduced waiting time at traffic lights (Travolution 2010).

Fiat eco:drive
Fiat developed a system called Blue&Me to record driver and engine performance for later analysis. The data can be collected using a USB interface and evaluated at home on the PC. Emissions and fuel consumption are shown in the summary and a so called eco Index is calculated. The driver receives recommendations for driving style improvements according to his acceleration/deceleration behaviour, gear changing and speed use. Fiat mentions savings in fuel and emissions of up to 15% Furthermore drivers can join an online community in which drivers and users of eco:drive can exchange their driving experiences and jointly work on lowering emissions (FIAT 2010).

Ford and DVR Eco-Driving
Ford Germany offers drivers training to improve their driving skills. A professional driving trainer - certified by the German council for traffic safety “Deutscher Verkehrssicherheitsrat”

(DVR) – shows the driver in real traffic situations how to improve his driving style. This service promises a substantial decrease in fuel consumption (up to 25%). In addition, Ford offers a car and driving performance check (Econo) at selected Ford dealers. It includes an inspection of car parts which substantially influence fuel consumption (e.g. sufficient air pressure and tread depth of tires). The driver himself can assess his driving style in a seven days performance check. In this period driving and engine parameters such as speed, revolutions and temperature of cooling liquid are collected via the OBD II interface. The driver receives a report about his driving performance and recommendations to improve his driving style. Also the yearly monetary savings are shown in the report (Ford 2010).

The DVR has also developed a training program focussing on professional drivers. Through a fleet specific (car pool, driver profiles, driving performance) driver training and continuous monitoring of driver skills the operating costs are lowered. The advantages for fleet owners in any business sector are (DVR 2010):

- Sustainable reduction of fuel consumption (10 to 25%)
- Lowered long-term maintenance costs (gear box, tires, braking system)
- Lowered safety risks through smooth and defensive driving style
- Less insurance fees due to lowered safety risk
- Improved company image since vehicles are a medium of communication to customers
- Balanced driving style raises the travel comfort of passengers

The DVR states that drivers have to be motivated in order to have them following eco-driving advices sustainably. Showing the driver his potentials for improvement may result in a less stressful every-day driving experience. Further incentives can help sustainably drive eco, e.g. participation in fuel savings, handing out prizes for drivers with improved driving skills and awarding drivers in company communication media.

A challenge to all measures aiming in changed driving behaviour is the low public understanding of the potential and benefits. Many drivers are not aware of the impact of their driving style on the fuel efficiency. This makes it difficult to define the potential group of users of eco assistance systems. Studies on more political eco-driving measures have shown that a successful change of driving behaviour is only achievable with well thought-out, well-funded combination of interventions to achieve the desired output on a large scale (Barkenbus (2010)). It's somewhat the same with technological improvements; they are best implemented together in a cooperative way.

Accessible users for eco assistance systems are for instance young drivers. They have recently learnt strategies for driving efficiency and should be helped to perceive the economical driving style in the future. Also the society today raises more and more environmental issues and points at the transport sector which is one of the major producers of GHG emissions. On the other hand drivers who choose vehicles according to engine specs are most likely not reachable with eco assistance systems.

The implementation of eco driving assistant systems in larger vehicle fleets may also be a mean of large scale market penetration. The DVR (2010) study discussed before showed that drivers tend to fall back to old habits if they are not constantly reminded about their success. Commercial drivers may be "forced" to apply eco-driving strategies if efforts are for instance recorded. In this case the acceptance of driver is not relevant but more the rate of compliance. When it comes to private drivers the downside of all additional systems is the additional payment or price. Any raise needs to be justified to get users choose eco assistance systems. The barrier of high initial costs of eco assistance systems can to some extend be overcome with financial incentives (especially thinking about tolling or parking fees).

4.3. Issues and hypotheses

The difficulty of studies explained earlier in the literature review is that data in this research field is not available on a larger scale; especially user acceptance studies are rare. Existing studies are based on rather small sample sizes which represent often a biased group of respondents. Man et. al. (2010) surveyed for instance mainly students (sample size 198, 51% students) between 18 and 24 years with low car possession. Also the two different means to reach respondents (in one country through a personal network and in the other one through university and company mailing lists) reduce the possibility to compare the two samples. In the eCoMove study this is avoided by using explicitly a standardized questionnaire on the same platform and by addressing both professional and non-professional vehicle drivers of all ages. Meschtscherjakov, A. et al. (2009) had a sample size of 57 participants who own a driving licence. However the low sample size does not allow too many socio-demographic comparisons, e.g. the identification of different driver types. As it is the case with the eCoMove study the approach of Davis was used as a basis to formulate questions.

In the entire previous studies “user acceptance” and “perceived usefulness” as terms are often discussed differently which makes their comparison somewhat difficult. However previous approaches were useful when preparing the eCoMove European driver study. The focus of course was laid here on a very specific topic: assessing the perceived usefulness of a (cooperative) traffic system using C2X communication. The purpose here is to conduct a study with a sufficiently large sample size which allows to draw conclusions on the user acceptance and carrying out a comparison analysis between European regions. Such an acceptance study has not been conducted yet previous to the current study.

The findings in the literature review made it clear that user acceptance is not a simple issue to be assessed. It is even more difficult to assess user requirements and acceptance of eco driving assistance systems for such a diverse region like Europe. It is however necessary to evaluate if there are certain areas in Europe where the rate of potential users is higher than in other regions. A potential user would find the system useful for her/him and would be willing to pay for services provided by the system. Further the system should be easy to use and the aim towards a positive impact on the environment should be noticeable from a user’s point of view. The literature review provided a broad view on existing tools to assess user acceptance. The here mentioned research objectives are based on the criteria of assessing of technology acceptance (c.f. Meschtscherjakov, A. et al. (2009) and Davis, F. (1989)) which were adopted towards the focus of eco driving assistance systems.

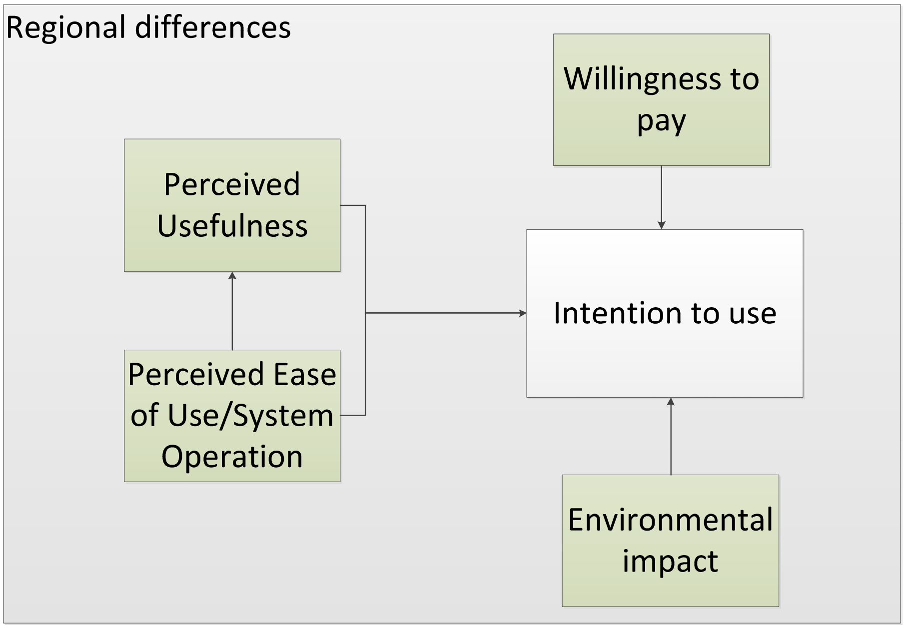


Figure 29: Criteria for research objectives

The criteria which were used to formulate hypotheses and research objectives were taken on the one hand from existing surveys of technology acceptance (usefulness, system operation). On the other hand willingness to pay is relevant when potential future markets are identified and the environmental impact is directly related to eCoMove topic of reduced emissions. So the description of usage intention was extended by these two factors.

The following hypotheses were formulated:

1. The overall rating of driver assistant systems depends on the perceived usefulness, its environmental impact and the privacy (significant factors)
2. Europeans drivers differ in their perception of driver assistant systems
    a. In terms of private data use
    b. In terms of environmental impact and fuel saving potential
    c. In terms of willingness to pay for such systems
3. The leading driving motive of a driver is connected with his/her acceptance of certain assistant systems, these motives being:
    a. time
    b. the attitude towards environment and consumption
    c. seeing the possibilities for changing their driving behaviour

<u>Research objective 1:</u>

The major objective is to evaluate the acceptance of eCoMove driver assistant systems on a European level, as reported by the questionnaire participants. In the focus hereby were three factors to describe the acceptance: positive environmental impact by saving fuel, the systems usefulness and the willingness of drivers to pay for such a system. In terms of payment it is assumed that the willingness will correlate to a high extent with the perceived usefulness.

Research objective 2:

It is of great interest to evaluate whether there are significant differences among European regions in for acceptance of eco driving assistant systems. Perceptions of drivers may vary when comparing northern and southern regions or eastern and western. Here the existing preconditions play an important role. It is assumed that drivers from regions with a high standard of traffic management do not see the need for additional in-car or roadside technologies to improve traffic efficiency. On the other hand, drivers in regions with lower standards and regulations might rate any type of improvement as useful and necessary.

Research objective 3:

In the study on driver behaviour and motivation in chapter 2 three different driver types were identified by evaluating certain driver motives for eco-driving and general driving behaviour. It will now be questioned if the driver's motivation (time, environment and consumption or their sense for possible behavioural change) determines the acceptance for specific eco-driving assistant systems.

4.4. Method and Design of the Study

The main focus of this study is to analyse needs and requirements of potential users of eCoMove applications. Well estimated predictions on these applications should be assessed according to three main factors: the perceived usefulness, environmental impact and WTP for such systems. In order to receive valid functionality descriptions of eCoMove driver assistant systems several iterative meetings with project partners were held. The outcome of workshops and meetings resulted in further detailed pictures of potential eCoMove applications. It was early agreed that a detailed picture or illustration with system functionalities will provide the best way to present the system to survey participants. It must be stated that it was difficult to design a close to reality use case scenario of eCoMove applications at this project stage. Therefore much iteration of concepts was necessary between designers of the survey and project partners.
For the developers of eCoMove applications such non-technical requirements represent valuable information what the end user would think about such innovations. As it was mentioned earlier in the literature review such loops of assessing user needs in the development process phase are important in order to test the development's acceptance of the target group. The results of this survey will be included into the validation of eCoMove applications in forthcoming project work packages. Besides the evaluation of the perception of eCoMove applications, potential buyers of such applications were also identified.
Chapter 2 identified three driver types which potentially would buy an eco assistant system or not. The dataset of the study discussed here and that the results of chapter 2 were combined. The process will be explained later in this section. By looking at the regional distribution of driver types and the respective rating of assistant systems, a rough estimate can be made where such systems have a greater chances to be accepted or bought than in others.

4.5. Choice of method

Considering the objective of reaching a large number of responses around Europe in a short time, an online survey was found to be the suitable method. The advantages of online surveys are obvious but should be mentioned shortly (Thielsch, M. and Weltzin, S. (2009)):

- Time efficiency: collection, evaluation and presentation of large datasets
- Low costs for dissemination: printing, deliverance, coding, interviewers digitalizing of data becomes obsolete
- Data insert automated: low chance of inserting wrong data and thus create false answers since results are collected and processed online
- Heterogeneous samples: more likely than through offline interviews because of easier data handling
- Availability: remotely located but relevant respondent groups may be reached easily online
- High data quality: monitoring and controlling of data consistency possible
- High acceptance: respondents answer voluntarily and anonymously

Based on good experiences from a study on user needs and requirements within the CVIS project, the method of online survey was found suitable to address drivers on a European level. Material for the preparation included the CVIS questionnaire (CVIS (2005)) and similar user acceptance surveys found in the literature.

Nevertheless there are also restrictions on online questionnaires. Since the data collection happens through a webpage which people visit (mostly) infrequently seeking for automotive related information the sample is not steerable as it would be by inviting participants directly for example via e-mail. Putting the questionnaire on automobile club homepages leads to the fact that more owners and drivers of cars will respond to it which creates bias. But since the focus was not on describing the responding population (which requires representative samples) but rather collect as much rating results for eco assistance systems as possible this methodological downside was accepted.

In the beginning of the study the target group was differentiated to private and commercial car drivers. Since eCoMove applications might be used on portable or in-vehicle installed devices they could also be used by motorcyclists or truck drivers. It was agreed to include these groups as well and identify their special needs. To assure comparability of studies made in different countries open questions were excluded from the design and the focus laid on multiple choice questions.

The desired time for answering the questionnaire was calculated to be 10 minutes. Otherwise it was found to be too long and respondents were expected not finish it completely. In several iterative steps a questionnaire was developed which would meet the time restriction and the contextual requirements (complex issue vs. easy to understand). A preliminary version of the questionnaire was tested in-house with experienced survey developers. A pre-test with ten test respondents was carried out subsequently which led to minor modifications in the wording. All questions were revised in English and prepared for translations into 8 different languages. In order to avoid language mistakes the questionnaire was shared among partners in the project to receive further suggestions for improvement.

4.5.1. Survey tool

The study was designed using the online survey platform Zoomerang (http://zoomerang.com/) as a distribution and data collection method. To avoid partial responses as much as possible a questionnaire could not be finished without answering all the questions. The number of finished questionnaires was controlled and recorded on regular basis to estimate the significance of the country specific sample. An excerpt from the control file is shown in Annex 20: Study Control File

4.5.2. Survey dissemination

Since it was intended to receive responses mainly from passenger vehicle drivers the eCoMove driver study was conducted in cooperation with several European automobile clubs. The EuroTest association (http://www.eurotestmobility.com/) served as contact platform for the dissemination of the survey. 18 automobile clubs are associated in EuroTest; EuroTest is member of the Fédération Internationale de l'Automobile (FIA).
The automobile club association provided contacts to national clubs which assisted in disseminating the questionnaire by placing a survey link on their homepages. In order to raise the attention of visitors of automobile club homepages a dynamic banner was designed which was again translated into the respective languages. The figure below shows the front side of the banner with slogan.

Figure 30: Questionnaire Banner

As mentioned before the questionnaire was linked to national automobile club homepages to reach a high share of the target group. The participating countries were:

Country	Automobile Club
Portugal	ACP
Germany	ADAC
Finland	AL
Slovenia	AMZS
France	FFAC
Norway	NAF
Austria	ÖAMTC
Spain	RACC
Belgium	TCB
Switzerland	TCS
Croatia	HAK
(Italy)	(not considered)
(Luxemburg)	(not considered)
(Serbia)	(not considered)
(UK)	(not considered)

In the initial stage the UK, Italy, Luxembourg and Serbia were contacted and joined the survey. The low numbers of responses in these countries did not allow a valid comparison of country responses so that they were excluded from calculations.
Each survey was supposed to be online for a time period of not less than four weeks. The first surveys were put online on the 3rd of September and data collection for all surveys ended on the 1st of November 2010..

4.6. Questionnaire concept

The questionnaire consisted of three main parts:

- PART I: socio-demographic information and vehicle information
- PART II: eCoMove Driver Assistant Systems
- PART III: Questions on driving behaviour motives.

Each part will be explained in this section. It is helpful to have a look at Annex 15: Questionnaire Logic to understand the sequence in which the question appeared to the respondents.

The first question in PART I of the questionnaire defined which questions the respondent would receive throughout the questionnaire. Three answering paths were distinguished: from a private vehicle driver perspective, a business driver perspective and from a non vehicle driver perspective. Important to notify is that in this question the vehicle usage was asked, not the actual ownership. Private and business vehicle drivers were assessed separately because it was assumed that business drivers follow different motives when rating eco-driving assistant systems. The term business driver was used when asking the respondent if she or he uses the car mainly for business purposes. This could either mean the driver is not the owner of the car but the company or the driver drives a car registered on his own name but uses it for business purposes (e.g. self-employed).

The path for the questionnaire was constructed in such way that non-vehicle drivers would not receive vehicle or driving behaviour related questions in order to avoid random or false answers. Even though respondents not driving a vehicle can of course be owners of cars they do not drive or simply have driven a car earlier but not anymore. Nevertheless they were included in the sample which rated eCoMove applications. Questions which all respondents answered considered their gender, age and work profession.
In the next section those respondents indicating to drive a vehicle gave information on their driving experience, annual mileage and vehicle type. The possible vehicle types included as options a motorcycle, car and for business drivers also a truck. A question was asked about the driving environment (urban, motorway or rural) and the usual trip purposes for which the vehicle is used. For trip purpose a selection of possibilities was given (such as work trip, shopping or visiting family) and respondents were asked how often they use their vehicle for the specific purpose.

Those respondents driving cars were led to a page to give more information about the cars' age, the category and the cars' engine type. For the questionnaire the 12 car segments used by the European Commission for market distinction (EC (1999)) were reduced to 7 main classes: small (mini, small class), medium (medium class), large (large, executive and luxury class), sports coupés, multi-purpose cars, SUVs and vans. For a better understanding of each category several representative model examples were mentioned.

The following questions addressed all vehicle owners. First the type of registration of the vehicle was asked (personal or business registration) Then the respondents were represented a selection of assistant systems and vehicle equipment for better fuel consumption control (such as fuel indicator or low resistance tyres) and asked if they use such systems or not. Later the respondent

was asked if he/she uses a navigation device or not. Based on the response the next questions referred to the navigation device usage. The usage frequency was answered ranging from "on every trip" to hardly ever" on a five level scale. Eight standard functions of navigation devices were presented and asked if respondents use them or not.
Questions from the survey on mobility behaviour in Germany ("Mobilität in Deutschland 2008") were used and adapted to meet the requirements of the eCoMove study. The vehicle based questions were formulated on the basis of literature findings and the current state-of-the-art of assistant systems.

PART II includes a selection of scenarios showing possible eCoMove sample applications. A more detailed insight in the development of these scenarios is given in section 4.7.

PART III of the questionnaire consisted of 10 questions taken from the study on driver motivation and behaviour. Each question represented a certain driving motive: erratic /fast, locus of control, object of utility, quest for low fuel consumption or social norm. A more detailed description on these items is given in section 2.3.1. The idea here was to make both studies comparable and compare results for the three group of drivers identified in section 2.3.2:

- Group A: Focus on Time as main motive
- Group B: Focus on Environment and consumption
- Group C: Focus on Possibilities to change driving behaviour

Overlaps between these groups were not possible in this analysis; due to the high number of responses a single respondent was clearly assigned to one of the three driver types. A detailed overview on the driver type is given in section 4.12
The driver types were in a next step connected with the rating of scenarios. The idea was to find out which assistant systems are preferred by drivers who are motivated according to the three factors. The distribution of driver types in Europe was of interest since it can be an indicator for possible markets for eCoMove solutions.

4.7. eCoMove Application Scenarios

The eCoMove scenarios were designed in a way that they explain to respondents visually and textually about the application's main functionalities. Since the questionnaire was supposed to be deployed online the response time was an important factor. The illustration was supposed to explain a given application in a way that respondents can answer without questioning the functionality.

Table 12 shows exemplary how the aspect of sustainable coaching was realized and included in the scenarios in the questionnaire design phase. The application functionalities were categorized according to the part of a trip in which the system is applied: pre-trip, on-trip and post-trip.

eCoMove short term for app.	**Trip type**	**Application description**	**Requirements for illustrator**
Example: Long-term coaching strategy	Pre-trip/ On-trip/ Post-trip	Drivers receive frequent training to reduce fuel consumption, improve driving skills, anticipatory driving, using momentum. A coaching session will be recommended by the device if eco-driving performance has dropped. The session will be held by a professional trainer who evaluates performance report of the driver	Illustration: Two pictures: business car driver in small transporter or so sees on the display his eco-performance for this month (+10% better than last month), this information is updated with fleet manager, driver receives message on his cash eco-Bonus is this month (e.g. 50Euro) / next picture: device shows a negative eco-performance and a "professional trainer" sitting in the car and instructing the driver with economical driving advices.

Table 12: Question design / pre-work

In this design stage several modifications were made to the initial descriptions. It was found that some applications had similar objectives and were merged into one representative scenario.

The following section includes a short discussion on the motivation of each scenario which was selected in the final design stage. The potential target group indicates which driver type from the study on Driver Behaviour and Motivation are addressed by the respective scenario.

4.7.1. Scenario 1: Dynamic Green Routing

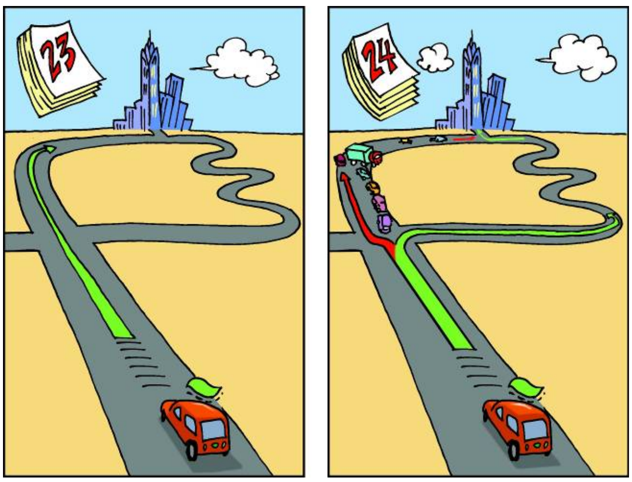


Figure 31: Dynamic Green Routing

Motivation: The idea of this application is to save fuel by intelligent (green) routing. Green Routing is a dynamic service which reacts to changing traffic situations on regularly driven routes. It is used during the trip and reacts to incoming traffic information. A route is considered green or environmentally-friendly if traffic on this route is flowing smoothly. Traffic Information could be provided for instance using floating car data (FCD). Road users and a traffic

management unit (TMU) are connected for current data exchange. The route suggestions are based on the latest traffic information. This service will help drivers avoid traffic jams and save driving time and thus reduce emissions.
Discussion: The user of such a system could see the time savings as a positive effect and also consider it useful for everyday trips on routes with high traffic density such as those to work or shopping in inter-urban areas. Drivers ready to use this system want to be up to date about traffic information and are possibly daily drivers.
Potential target group: Drivers with time as a motive, environmentally conscious drivers, drivers with high perception of possibilities to change driving style.

4.7.2. Scenario 2: Post trip analysis

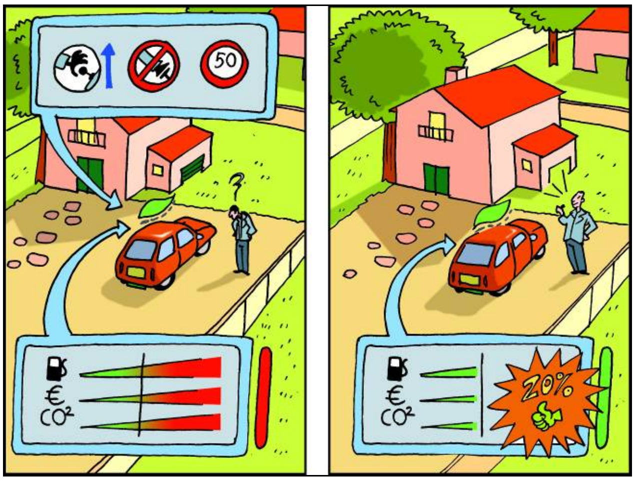


Figure 32: Post trip analysis

Motivation: This service helps the driver to improve her/his driving skills sustainably. Information about the personal driving style is provided after the trip using a display device with animations or icons. Three factors explain easily the advantages of this functionality for users: the amount of fuel saved, saved fuel converted into monetary value and the amount of reduced CO2 emissions on the last trip. A positive effect occurs if parameters compared to previous trips have improved. A congratulations message will appear. In case of negative development of skills the driver is shown where the potential reasons for this are. Such could include gear shifting, adhering to speed limits and anticipative braking. This information could either be calculated through map tracking (speed) or directly taken from engine parameters (fuel injection, speed etc.)
Discussion: Drivers are motivated to reduce their fuel consumption by changing their driving behaviour according to the information given by the application. Supposed drivers should be open to adapt their driving behaviour.
Potential target group: Environmentally conscious drivers, drivers with high perception of possibilities to change driving style

4.7.3. Scenario 3: Adaptive Balancing and Control

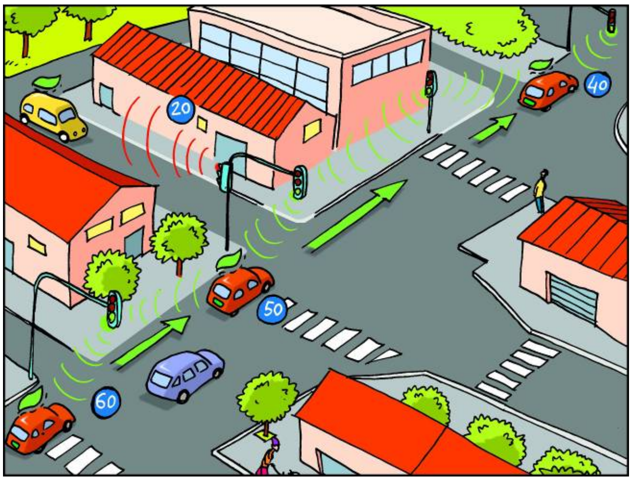


Figure 33: Adaptive Balancing and Control

Motivation: An in-car display shows a suitable speed advise which allows the driver to not stop at upcoming traffic lights during a trip. The traffic system needs information on upcoming cars which is processed to calculate the optimum driving speed. This information is fed back into the driver's assistant system.

Discussion: Stop and go is a major driver of air pollution. Thus emissions in urban environments should be reduced using smart traffic control. In this system, communication between infrastructure and vehicles is realized. Besides speed advises also instant gear changes and engine brake could be suggested. Those systems are tested already in real life but the full potential will only be achieved using an integrated approach.

Potential target group: Environmentally conscious drivers, drivers with high perception of possibilities to change driving style.

4.7.4. Scenario 4: Consumption Map

Figure 34: Consumption Map

Motivation: The idea behind this system is a learning map. The system records routes which are used frequently. Before starting a trip, the driver receives information about traffic and pollution

on those routes and offers route alternatives. Those alternative routes are coloured as "greener routes" according to the expected emissions. The route might take longer than the original one.
Discussion: Here, the environmental aspect while driving is addressed rather than the time motive.. In pre-trip situations the driver prepares to drive a route he has defined for himself and needs information on the current traffic situation. At this stage he can still decide whether his objective is to get to his destination fast or choose the more ecological route.
Potential target group: Environmentally conscious drivers, drivers with high perception of possibilities to change driving style.

4.7.5. Scenario 5: Motorway Management

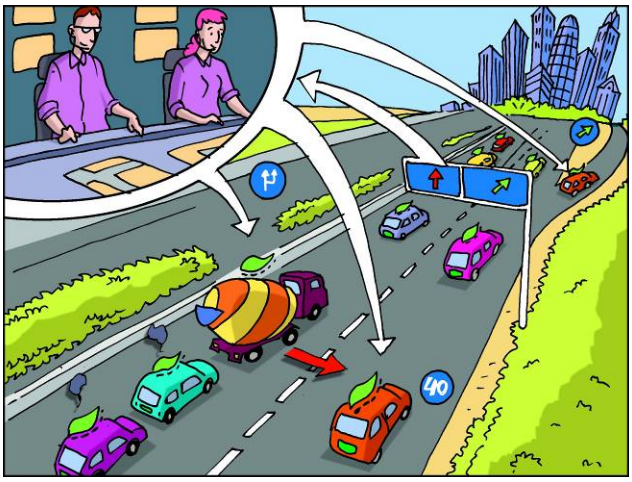


Figure 35: Motorway Management

Motivation: The traffic control centre monitors the traffic situation on highly frequented motorways and adapts signals and messages on dynamic road side units or in-car systems. The information is also sent to the eCoMove system recommending speed adjustments for smooth traffic flow or lane switch for heavy and light duty vehicles. In high density traffic situations traffic is directed through alternative routes to avoid congestion beforehand.
Discussion: The idea of dynamic routing is not new but is accompanied in this scenario with individual recommendations depending on the type of vehicle and the destination.
Potential target group: Drivers with time as a motive, Environmentally conscious drivers, drivers with high perception of possibilities to change driving style.

4.7.6. Scenario 6: Low emission zoning

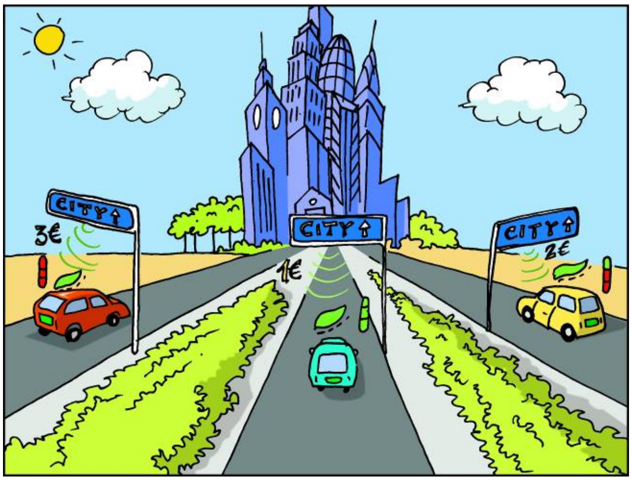


Figure 36: Low emission zoning

Motivation: The eco-driving assistant system saves the driver's profile and information on the driving behaviour. The records are shared with the traffic management centre which takes this information into account when calculating car-specific city congestion charges.
Discussion: Drivers with economic driving behaviour are rewarded in an every day situation which can describe a motive to use such systems and see the point in sharing information. Especially in countries with low acceptance for data exchange (e.g. Germany) this incentive is expected to receive less approval.
Potential target group: Environmentally conscious drivers, drivers with high perception of possibilities to change driving style.

4.7.7. Scenario 7: Post-trip analysis 2

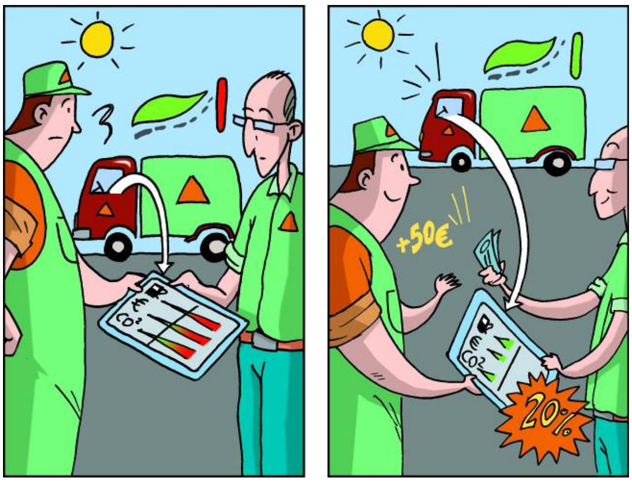


Figure 37: Post-trip analysis 2

Motivation: Similar to scenario 2 "Post trip analysis" the driver receives post-trip information on his driving efficiency. The driver receives a bonus payment for efficient driving. The service is applicable for situations in which the driver uses a company vehicle and can be rewarded.

Discussion: For the group of business drivers it is interesting to know if the acceptance to use such a system in work situations differs from the similar situation in "private life" and if they accept such a "system of surveillance" in work situations.
No target group for such system can be given since drivers here are obligated to use it and not buyers of the system.

4.8. Questionnaire Items

Each application (scenario) was rated according to several perceptual items. The items were selected according to similar user acceptance studies such as in Davis, F. (1989) and adopted to the questionnaire focus. Davis considered the technology acceptance as a function of "ease of use" and the "usefulness". The approach was extended by two aspects: the environmental impact and the willingness to pay.

The applications' *usefulness* is considered here as the users' rating on the driving comfort, the extent of personal data usage, the time saving factor, the restriction of personal freedom while driving and the perception of the personal usefulness.

The *ease of use* of an application is described through the necessary technical knowledge, the possibility of planning trips better, the decrease of stress while driving and the perceived need for having an on-off option.

The *environmental impact of the application* is described through its ability to improve the traffic flow, help to anticipate driving situations, assistance in reducing fuel consumption, helping to improve driving skills and the user's perception on the environmental protection effect.
The factor *willingness to pay* covers the readiness to buy such system or pay for using it.

Respondents were asked for to state their agreement on a bipolar Likert scale: strongly agree (1), agree (2), neither agree nor disagree (3), disagree (4), strongly disagree (5).

Table 13 includes the set of 13 items selected in the questionnaire design phase. Each item belongs to one of the four topics which were explained above. The items were assigned to each scenario in order to assess the respondents opinion on the usefulness, ease of use, environmental impact and payment of driver assistant systems. One item does not necessarily appear in every scenario. For instance, the item "restricts my freedom while driving" appears in scenarios 1, 3, 4, 5 and 7 as indicated in **Table 13: Questionnaire items**. The tendency of an item means that a strong agreement to this item is a rather negative judgement of the respondent. For example, if a respondent agrees strongly on the item "restricts my freedom while driving" it implicates a negative or low perceived usefulness.

Item	Tendency	Scenario						
		1	2	3	4	5	6	7
Usefulness								
...restricts my freedom while driving	-	X		X	X	X		X
…saves travel time	+	X		X	X	X		
…uses too much personal information	-	X	X	X		X	X	X
…helps to improve my driving skills			X	X				X
…would be useful for me	+	X	X	X	X	X	X	X
Ease of use								
…requires technical knowledge to use it	-	X	X	X	X	X		
…makes trip planning easier	+				X		X	
…should be turned off if I want	-	X	X	X	X	X	X	
...makes driving less stressful	+	X		X	X	X	X	X
Environmental impact								
…improves traffic flow	+	X		X	X	X	X	
…helps me actively contribute to environmental protection	+	X	X	X	X	X	X	X
...helps to save fuel	+	X	X	X	X	X		X
Payment								
...is worth to pay for	+	X	X	X	X	X	X	

Table 13: Questionnaire items

Each item from the list was assessed on how it would describe user needs and requirements for a specific scenario. It must be stated that a comparison of all scenarios was only intentioned in terms of usefulness, potential to contribute to environmental protection and the WTP; thus the order of or inclusion of single items does not match other items.

4.9. Methodology of Data Analysis

Participants of the driver survey were visitors at web pages of different European automobile clubs. They did not have to sign in or be member of the respective club. The data analysis used comparative values (means) to compare results on European level and between different European regions. In the following a brief socio-demographic overview is given on the sample of respondents. This is based on the results of PART I of the questionnaire.

The overall acceptance for the specific scenario was of interest on a European level. Here the ratings of all items were included to calculate the acceptance. The values shown in corresponding figures are percentages of the overall sample (whole Europe). For a comparison of different European regions three items were used: fuel saving impact, environmental protection and general WTP. In the results section 4.10 mean values were used as factors for comparison. A higher mean value (from 1.0=highest to 5.0=lowest) indicates a stronger agreement on the respective item.

4.9.1. Country Responses

The population of each country which took part was filtered by the following factors:

- Population between 15 and 74 years (potential drivers)

- Degree of motorization (passenger cars per 1000 inhabitants)

There are significant disparities in the ownership of passenger cars within the regions of the different European countries. The number of passenger cars per inhabitant provides an illustration of this phenomenon, with the highest regional rate registered in the European Union being more than eleven times the lowest one. At EU-27 level, the average rate is established at 0.54 passenger car per inhabitant in 2007 (EURO STAT (2006))..

In the end 5807 responses were collected; in the initial stage the estimated number of responses was 5000. The following table shows the number of calculated responses for each country and the percentage of target reached (actual divided by target numbers in %).

Country	Target Responses #	Actual responses #	Target reached (%)
Spain	858	615	71.68%
France	1210	675	55.79%
Austria	171	287	167.87%
Portugal	175	367	209.71%
Norway	91	124	136.26%
Belgium	198	303	153.03%
Switzerland	152	130	85.53%
Finland	100	125	125.00%
Slovenia	41	145	353.66%
Germany	1917	2915	152.06%
Croatia	88	121	137.50%
Total	**5000**	**5807**	**116.14%**

Table 14: Country shares

The target numbers were exceeded in all countries except Spain, France and Switzerland. To get representative responses in each country a projection factor (target number divided by actual number) was introduced which weighted each response collected. For instance, responses from Spain were weighted with a factor of 858 (target number) divided by 615 (actual number) = 1.395 and responses from Austria were weighted with 171 divided by 287 = 0.597. This way the country data was brought to a comparable level. The weighted responses add up to 5000 responses in total. All statistical calculations were made based on the weighted responses. The detailed calculation of target response shares can be found in the Annex 17: Calculation of Country Weights

The countries participating were later categorized into five regions. A region was assembled by considering its geographical location and the response numbers in this region. The following regions are analysed separately:

- Northern Europe: Finland, Norway
- Western Europe: France, Belgium, (Luxembourg)
- Germany
- Alp Region: Switzerland, Austria
- Southern Europe: Spain, Portugal
- Eastern Europe: Slovenia, (Serbia), Croatia

The categorization was kept when analyzing the results of the study. The number of respondents in countries was supposed not to differ largely. However Germany represents an own region since the ration between population and response numbers was significantly larger than for any other country.

4.10. Results

4.10.1. Participants

Even though the target number of 5000 responses was overreached none of the national samples represent its population considering the socio-demographic items. Description of participants is given based on the total sample collected for the purpose of this study. The first question in the questionnaire identified the driver type. The far majority of respondents were private vehicle drivers (91.1%). Only a share of 6.3% describe themselves as business drivers and 2.7% said they do not drive any kind of vehicle. The following figure gives an overview on the distribution of responses within Europe:

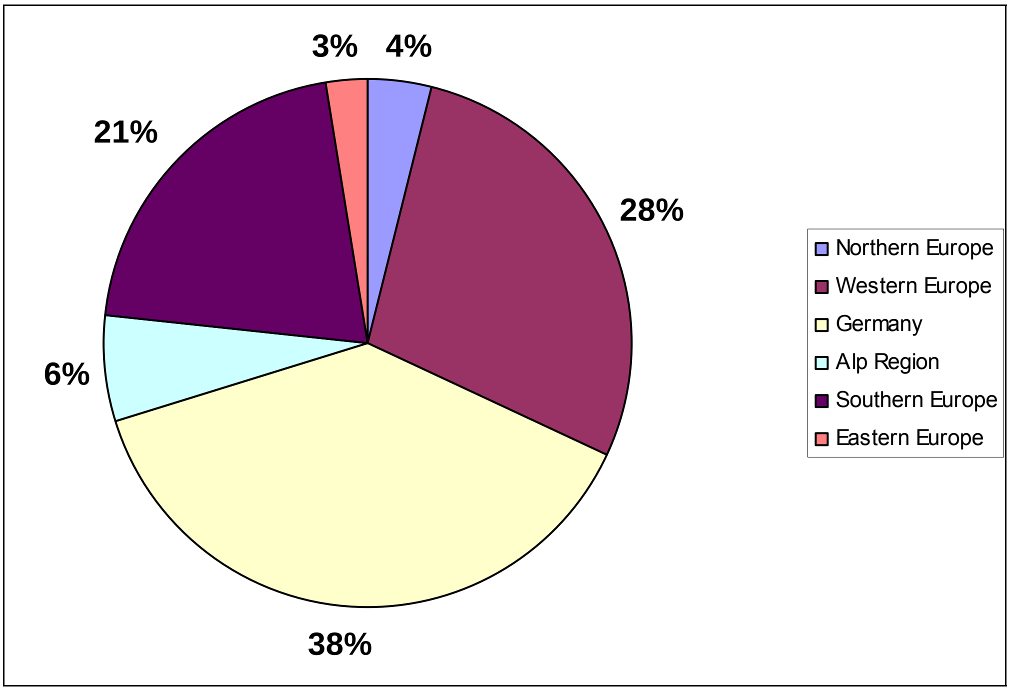


Figure 38: Shares of regions

Four out of five respondents were male (78.2%) which raises the question if women feel less addressed by the topic of eco driving than men. On the other hand the sample was taken from automobile club pages which might reflect the low share of women being members of in those clubs. Question 32:"The car is just an object of utility for me, to get from A to B" was found suitable to compare if male and female responses have a different attitude towards driving in general. This did not bring mentionable differences in the answering behaviour.. (60% of female respondents answered they agree on this item, compared to around 50% among male respondents). The average questionnaire respondent was between 35 and 49 years old (median category).

Figure 39 shows the age structure of the respondents:

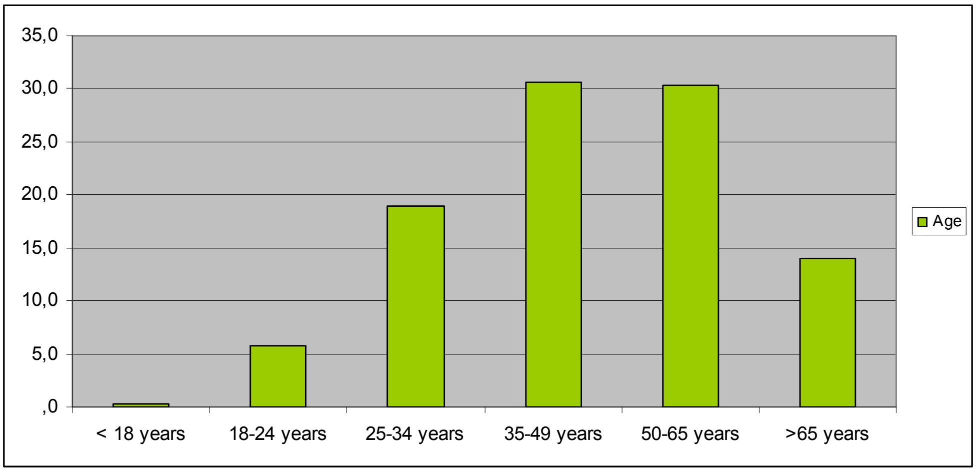


Figure 39: Respondents' age distribution

The sample indicates that around 85% of respondents were younger than 65 years. According to Eurostat statistics (Eurostat 2011), this share is slightly higher than in most countries participating in this study. A Eurostat comparison of the age group 0 to 64 years old in Belgium, Germany, Spain, France, Austria, Portugal, Slovenia, Finland, Norway and Switzerland showed that in average 82 % are younger than 65 years in these countries taken together.
Two thirds of respondents (66.1%) are drivers in city environment, the highest share of city drivers is found in Eastern Europe (78.3%) and the lowest in the Alp Region (53.6%). Almost every second European driver drives regularly on highways/motorways 43.1%). Persons owning a car use it for most of their activities carried out like shopping (89.3%), visiting friends and family (88.8%), vacation (80.6%), leisure (78.7%) and fetching children (30.9%). Interestingly the trip purposes with the lowest relevance were work trips (27.0%).

4.10.2. Vehicle Information

Looking at the age structure of cars in different regions the respondents from Western Europe drive the newest cars (45.6% are less than 3 years old) and the share of old cars is the highest in Eastern Europe (39.1%). Figure 40: Car age gives an overview on the car age structure in European regions:

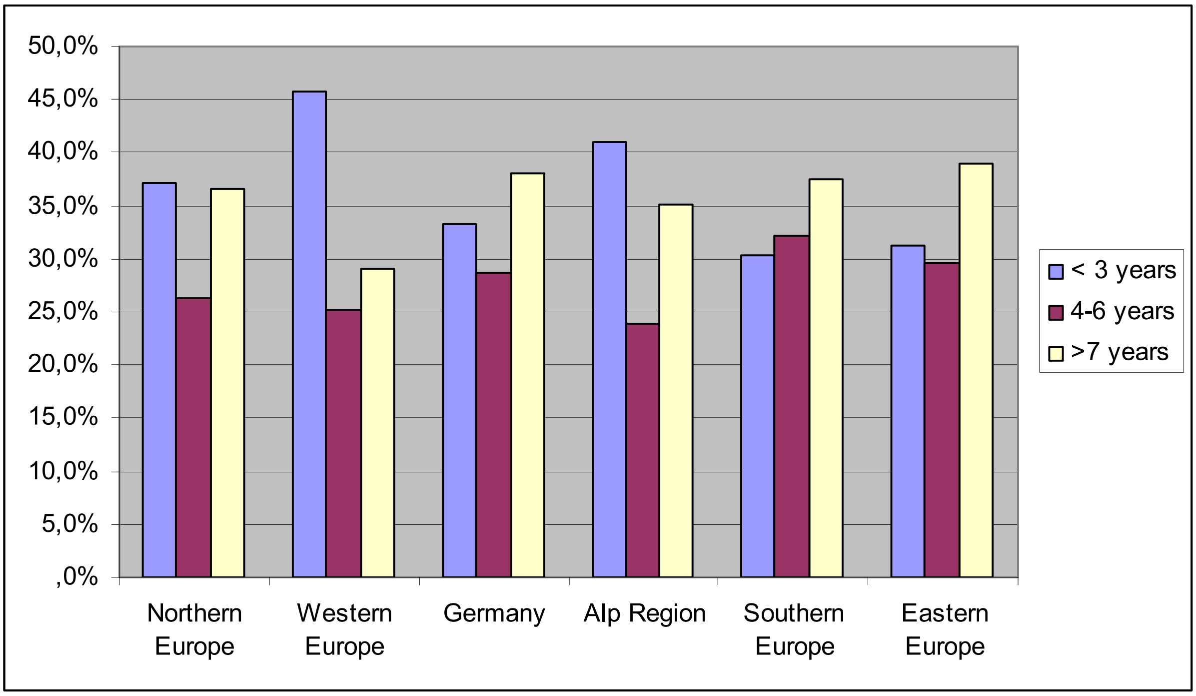


Figure 40: Car age

Southern and Eastern Europeans drive smaller cars compared to other regions. In each region around 27.0% of total car ownership and every fifth respondent from Western Europe drives a large car (22.5%). In the Alp Region a share of 15.0% states that they use a multipurpose car.
Within the questionnaire the respondents were given a selection of car examples for each car segment. It was aimed to use models which have the highest market share in this specific country. The listing below shows several car models which were used in the questionnaire:

- Small: FIAT Punto, 500, Ford Ka, Fiesta, Peugeot 107, 206
- Medium: FIAT Linea, Fiat Bravo, VW Golf, Ford Mondeo, Peugeot 308, BMW 3 series
- Large: Citroën C6, Peugeot 607, Audi A6, Mercedes E-Class
- Sport Coupe: Volvo C70, BMW 6 series
- Multi Purpose: FIAT Idea, VW Touran
- SUV: Fiat Sedici, BMW X-series, Peugeot 4007
- Van: Ford Galaxy, Renault Scenic, Toyota Urban Cruiser, VW Sharan

Figure 41: Car Types shows the shares of car type ownership on European level:

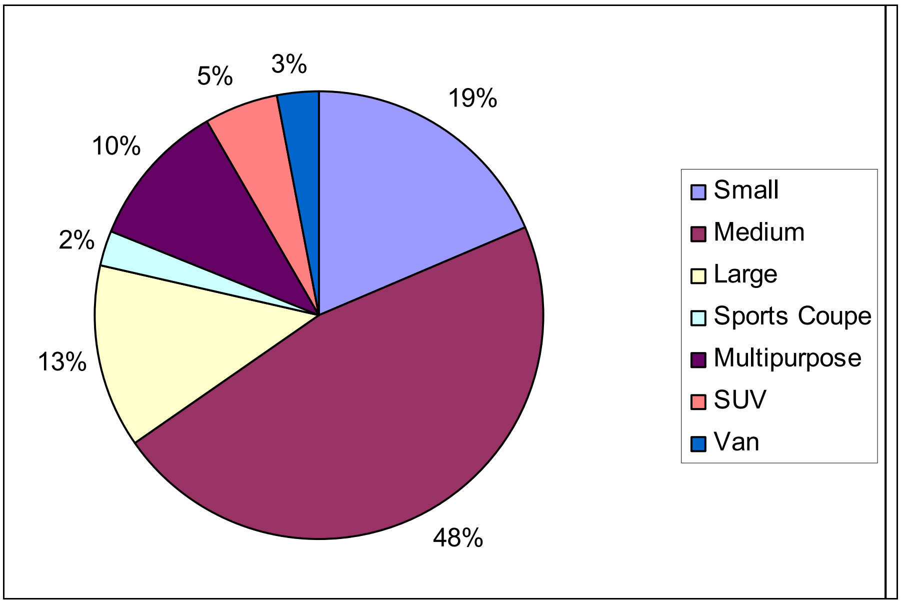


Figure 41: Car Types

The results of the questionnaire showed that shares of gasoline and diesel cars are almost equally distributed: 47.7% gasoline cars and 49.8% diesel engine cars.

Most car owners stated they have registered their car privately (93.4%) and only 5.8% have a commercially registered car. Those registering privately are primarily private car drivers (98.2%) as expected and of those registering commercially 78.5% are business car drivers. The share of respondents driving a commercially registered car and using it privately is mostly self-employed (65.8%).

Most of the driver assistant systems used in cars to help reduce fuel consumption are not familiar to respondents or they do not use it regularly. Only the fuel consumption indicator (66.0%) and speed control (48.1%) are used quite frequently whereas automatic start and stop, gear shift assistant or automatic tire pressure monitoring are used by less than 15%.

A quite high share of respondents uses a navigation device (67.0%) either installed in their car, as a portable device or installed in their mobile phone. Of those using a navigation device 41.6% use it frequently or on ever trip. As expected, respondents use their navigation device mostly for finding an address (89.0%). All other functionalities are rather secondary of which the Points-of-Interest (40.0%) and Traffic Message Channel (39.7%) are used by more respondents. Figure 42 shows which functionalities are used commonly and which are less used.

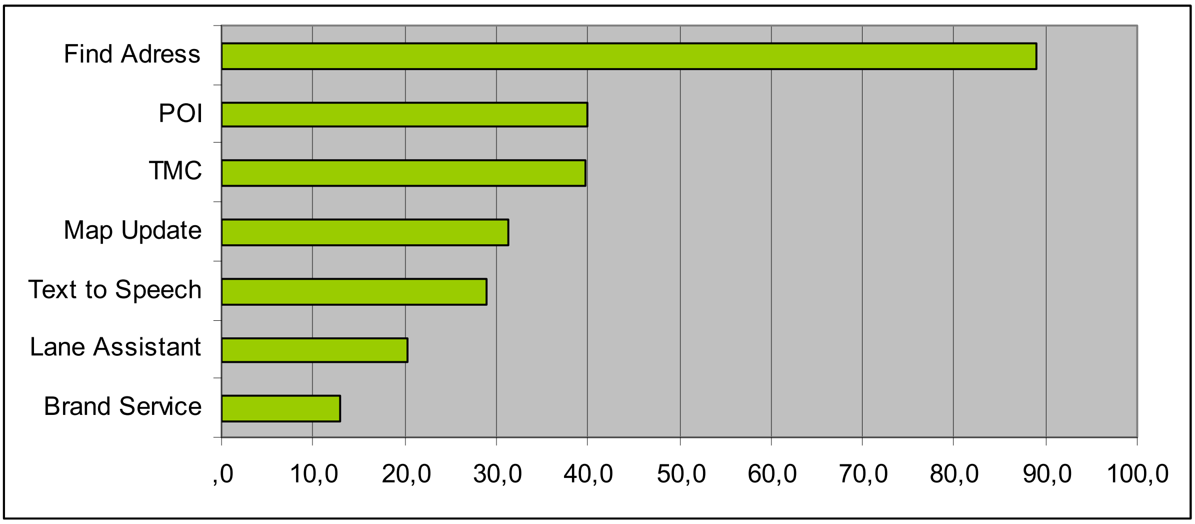
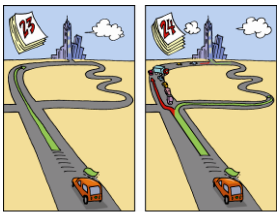


Figure 42: Navigation device functionalities

4.11. Analysis of eCoMove Applications

This chapter represents the results of the main part of the passenger car survey. The respondents were faced with a pictorial and textual description of seven different situations where different functionalities of eCoMove applications were used. The respondents had to rate their attitude towards different items (statements) describing the utility, drivers and barriers to use these applications in real life.
For each scenario the analysis has been carried out on a European level as well as for different European regions as defined before, and concluding with a short summary comparing all regions. For the regional comparison the analysis was reduced to the items usefulness, environmental impact and readiness to pay. For a more detailed overview see Annex 18: Mean Values for Regional Comparison

4.11.1. Scenario 1: Dynamic Green Routing



Application description*: The eco-driving assistant system receives real-time information about closed and congested routes. If a certain route is affected repeatedly your assistant system will remember this route as inefficient.*

European Level: A main purpose of Dynamic Green Routing is to avoid traffic jams and thus save driving time. The large majority of respondents agreed that this system would actually save time in traffic. Dynamic Green routing adopts the route suggestion to the current traffic situation which supposedly would need position information from vehicles on the given routes. However the aspect of too much personal data use was not a strong negative issue for Europeans (mean=3.6). The system helps reducing stop-and-go traffic and assures smooth traffic flow which decreases CO_2 emissions. Two third of the respondents agree that it would help them do so and recognized the potential to save fuel with this application. Four out of five think that green routing would make driving less stressful. Even though the perception is generally positive, most Europeans wish to have the possibility to turn the system off if desired.

The majority rates the system as useful but only every fifth is willing to pay for using such a system.

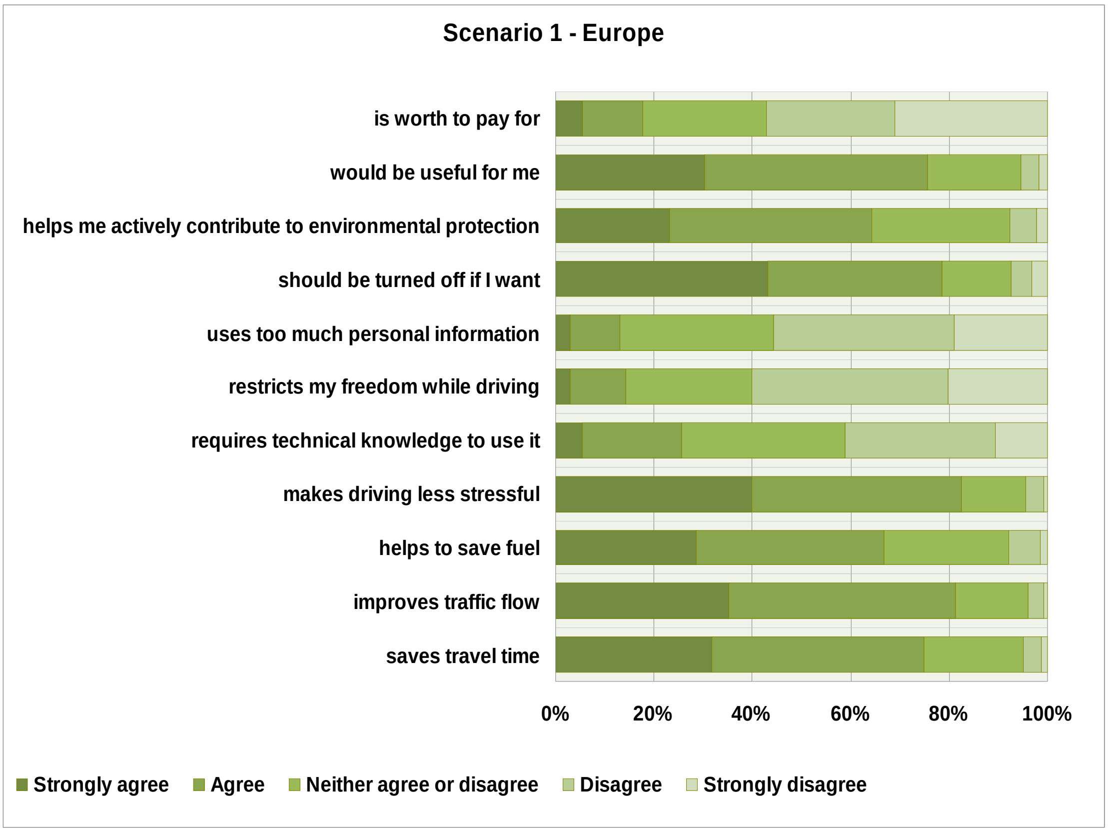


Figure 43: Scenario 1 - Percentages

<u>Regional comparison</u>: A quite large variation can be observed on the WTP for the Dynamic Green Routing. Whereas Eastern Europeans rather agree on a payment (mean= 2.8), German respondents disagree (mean= 4.0). The mean values vary less on the environmental impact or the perceived usefulness. In average both items were agreed on or strongly agreed on. Southern Europeans rate the usefulness the highest with a quite low deviation (mean= 1.7) and Eastern European the environmental impact the highest (mean=2.0). The diagram below shows the average rating (mean value between strongly agree (1) and strongly disagree (5)) of the items *willingness to pay (abbreviation: Q18_Scenario_Payment)*, *usefulness* (Q18_Scenario_Usefulness) and *environmental impact* (Q18_Scenario_Saves_Environment) in all European regions:

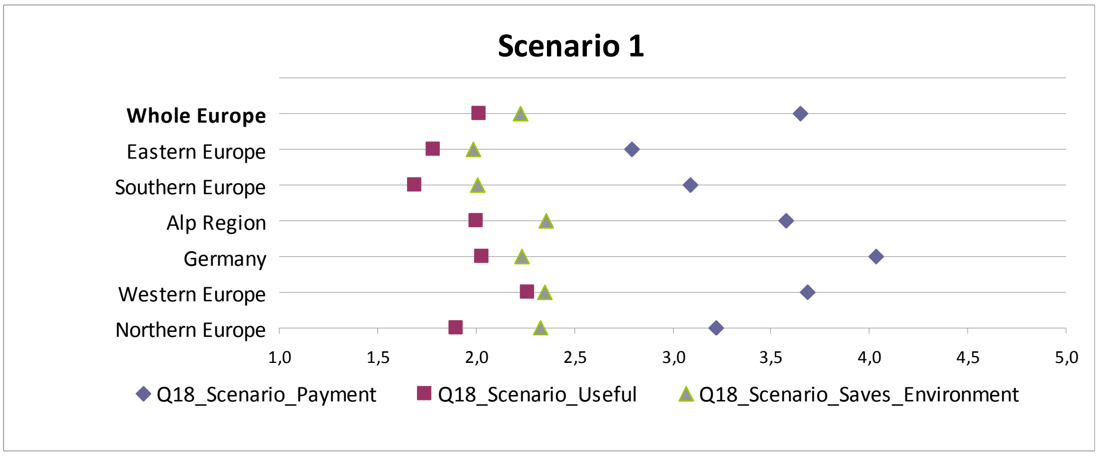
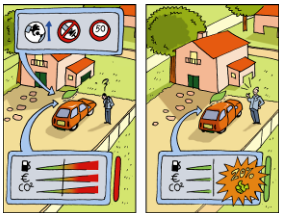


Figure 44: Scenario 1: Mean values

4.11.2. Scenario 2: Post trip analysis



Application description: *After a journey the eco-driving assistant system provides you information on how economically you drive and helps to improve your driving style.*

European Level: The effect of saving fuel with the application Post Trip Analysis is rated very high. Respondents are aware that improving their own driving style leads to a more economic driving. The fact that the system itself tells the driver how to do so is considered useful and helping to contribute to environmental protection. The majority states that the decision if the system is running or should give feedback or not should still stay with the driver. The system's positive impact on personal driving skills and driving efficiency was expressed by the respondents. Two thirds believe or at least are neither in favour nor against the statement that the system will need technical knowledge to use it. In the provided illustration, the system functionalities were pictured in a rather easy to understand way. The general willingness to pay is low on the European level. Only every ninth European is actually willing to pay for such system.

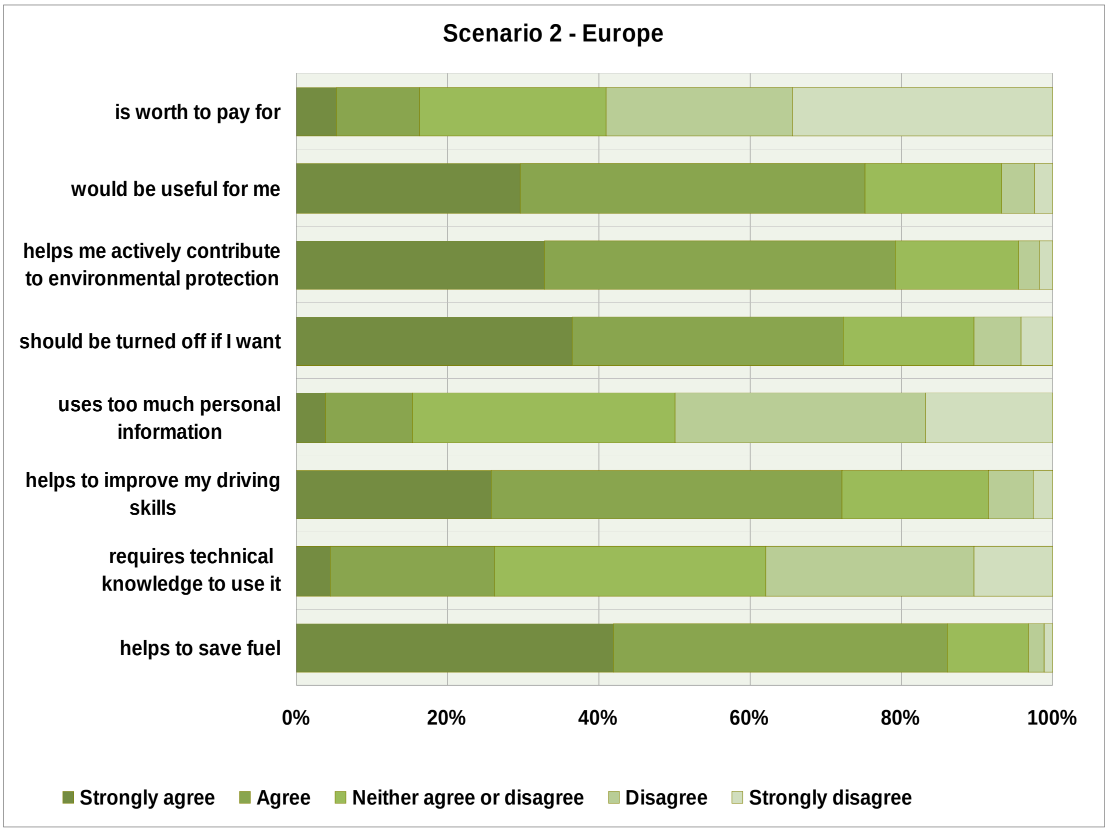


Figure 45: Scenario 2 - Percentages

Regional comparison: For the Post Trip Analysis application the response behaviour is similar to the first scenario. In terms of *willingness to pay* for such system, Eastern Europeans and Germans represent the highest and lowest rating. In Eastern Europe respondents agree or are neither agree nor disagree (mean=2.8) to pay for a system with post trip analysis whereas in Germany the majority would refuse to pay for it (mean=4.2). The responses on the *environmental impact* were throughout the regions very positive; the mean ratings are between 2.1 in Western Europe and 1.7 in Eastern Europe. Same applies for the *usefulness* of the application; it was rated rather good ranging from 2.4 in Western Europe to 1.7 in Southern Europe. There were no larger differences noticed looking at the ratings for *environmental impact* of the system; in general respondents agreed that it would have a positive impact. Southern Europeans rated both *usefulness* and *environmental impact* highest.

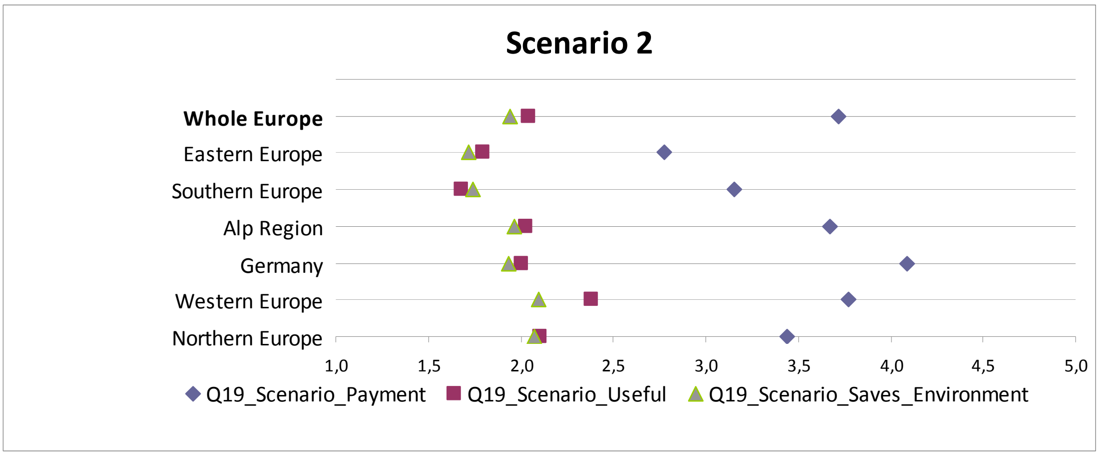
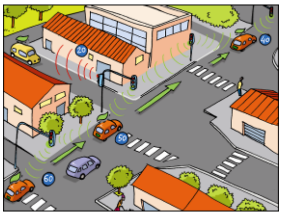


Figure 46: Scenario 2 - Mean values

4.11.3. Scenario 3: Adaptive Balancing and Control



Application description: *While driving your eco-driving assistant system receives information from traffic lights ahead. It suggests you the appropriate speed to avoid stopping at traffic lights.*

European Level: The high rating on *traffic flow improvement* through Adaptive Balancing and Control was expected. More than 80% said the system would meet this purpose. An even higher share of respondents felt that the system would *save fuel*. The far majority is aware that stop-and-go traffic raises fuel consumption and does see the system's usefulness. Driving without stopping is also sensed as *less stressful* driving. Only a few respondents feel this technical system would require *knowledge to use*. It might be unclear for some how the speed information is displayed since this information was not given to the respondents. The vast majority of the respondents agreed that they should be able to turn off the system's function. More than two thirds say the system should not work autonomously. The positive environmental impact receives a slightly less high agreement than the fuel saving factor which actually is linked to the first one. Summarizing, it can be found that around 80% of the Europeans state that the application Adaptive Balancing and Control would be *useful*.

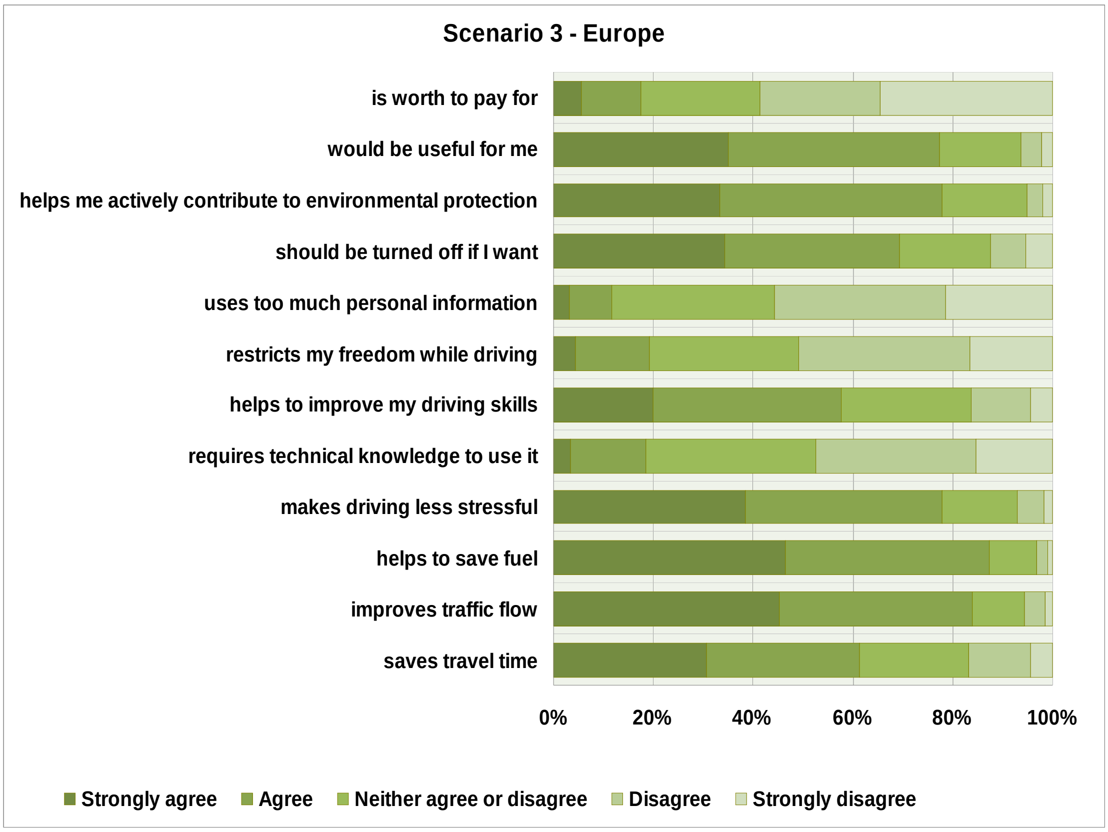


Figure 47: Scenario 3 - Percentages

<u>Regional comparison</u>: For Adaptive Balancing and Control respondents are answering with disagreement to statement that the system is *worth to pay* for. Only Eastern Europeans rate this system far better than respondents from other regions (mean=2.7). As it was the case for the first two previous systems other regions are indecisive or disagree on the *value to pay*. A slightly higher *willingness to pay* can be identified here than in other scenarios. No clear difference is noticeable on respondents' perception to *environmental impact* or the *usefulness* of Adaptive Balancing and Control. In most cases the usefulness is rated as high as the *environmental impact*.

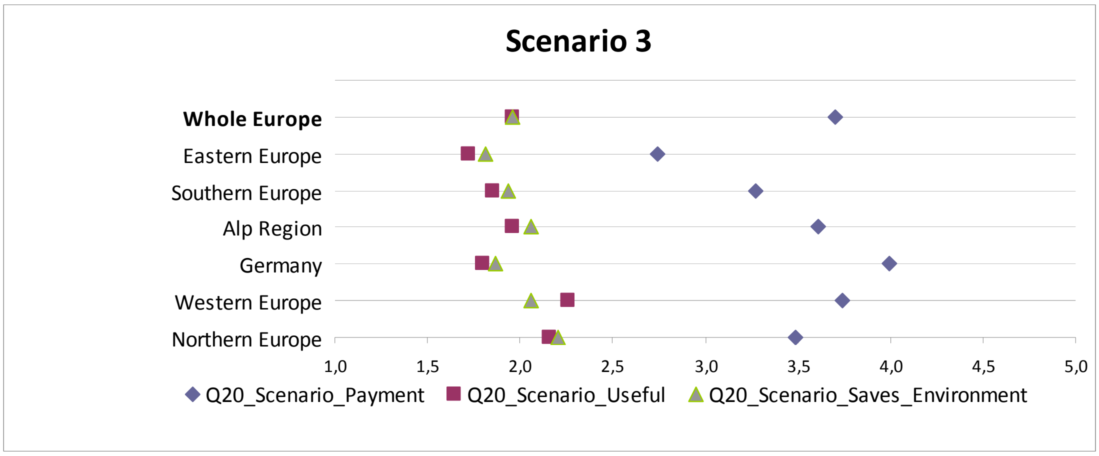
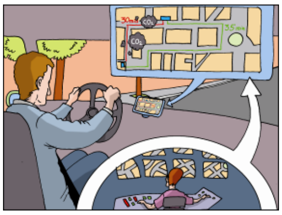


Figure 48: Scenario 3 - Mean values

4.11.4. Scenario 4: Consumption Map



Application description*: Before you start your journey the eco-driving assistant system provides you with the latest information on how eco-friendly your preferred routes are (pollution, congestion etc.) and they will be coloured as such on your screen (green = eco, red = not eco). These alternative routes might take longer but will help reducing pollution in highly affected areas.*

European Level: The Consumption Map application should not guide the driver necessarily the fastest route to her or his destination. It should rather extend the usual navigation functionality with "green" route alternatives. Nevertheless almost every third respondent felt it does reduce driving time. When designing the application description, the focus was on the environmental impact when the driver gets to choose the route by its eco rating. Surprisingly, this application was rated less environmentally friendly As it was the case with previous applications the Consumption Map should be turned off if needed. Also the usefulness is rated lower. A small share of around 12% say they would pay for the application.

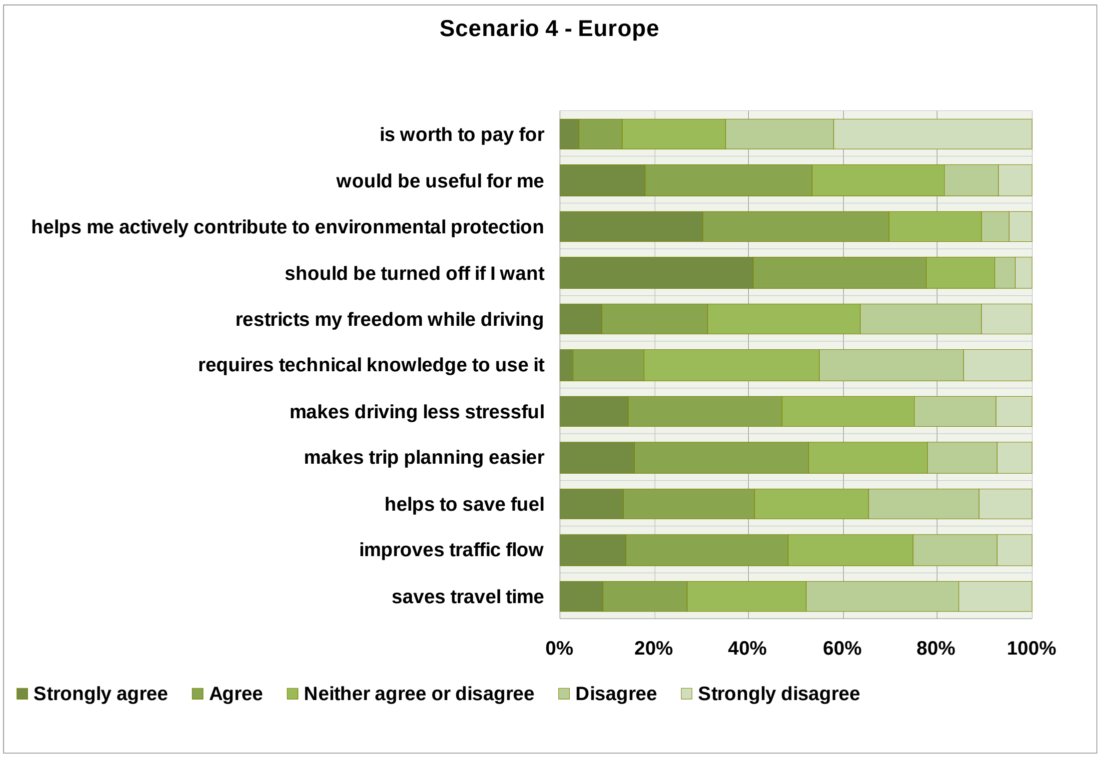


Figure 49: Scenario 4 - Percentages

Regional comparison: Respondents from Germany are the least *willing to pay* for the Consumption Map application among all scenarios (mean= 4.3). Except for Eastern and Southern Europe regions respondents tend to rate it more often as not worth to pay for. The perceived usefulness is spread more clearly this time among regions. Germans and the Alp Region rate the *usefulness* lowest (mean < 2.8) and Southern Europe highest (mean= 2.0). In each region the *environmental impact* of the Consumption Map is rated slightly higher than the overall usefulness of the system. A significantly high rating for environmental impact was observed in Southern Europe (mean= 1.8)

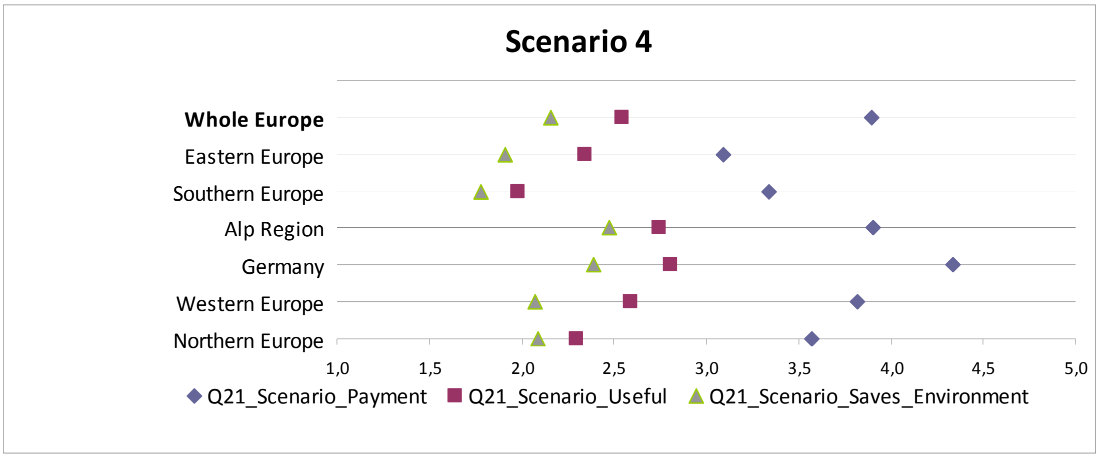
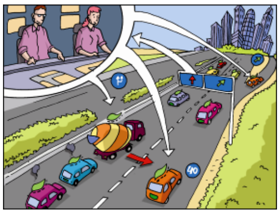


Figure 50: Scenario 4 - Mean values

4.11.5. Scenario 5: Motorway Management



Application description: *Your eco-driving assistant system receives information from traffic management about speed and lane adjustment in dense traffic situations. You will receive recommendations on taking alternative routes to avoid congestion ahead.*

European Level: Motorway Management does have the potential to save drivers time in traffic if it notifies about traffic jams ahead. Over 70% were aware of this fact and agreed to that statement. As was expected, traffic flow improvement was rated high among the majority. An interesting result was that respondents did not perceive this system as restricting their freedom while driving. As it was mentioned in the scenario description this system certainly does influence driving in many ways (dynamic road signals, in car messages) and it was assumed it would receive more disagreement in this matter. However, contradicting the previous finding, people still felt the need to turn the application off at any time. Summarized, this can be interpreted by saying respondents do not see their freedom limited if in the end they have the possibility to turn it off if desired. The usefulness and positive environmental impact score a similarly high rate with over 70% of agreement. The willingness of respondents to pay for Motorway Management is low; less than 20% would pay for it.

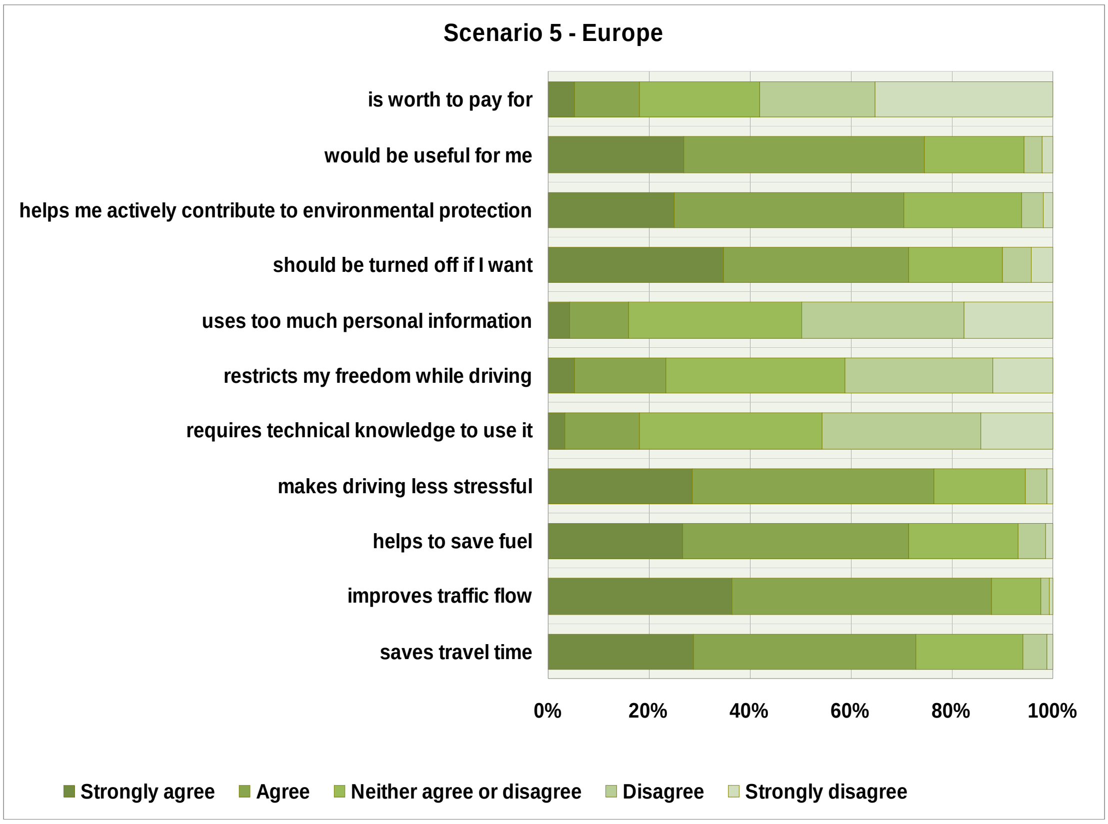


Figure 51: Scenario 5 - Percentages

<u>Regional comparison</u>: The highest willingness to pay is identified again for Eastern European respondents for the Motorway Management system (mean= 2.7). The ratings for *usefulness* and *environmental impact* are again very similar between the regions; no larger differences were found. The Southern and Eastern Europeans are steadily rating these two items slightly higher in average than the respondents from other regions. The respondents rated the *usefulness* and the *environmental impact* very similar so that there is no clear distinction possible between the regions.

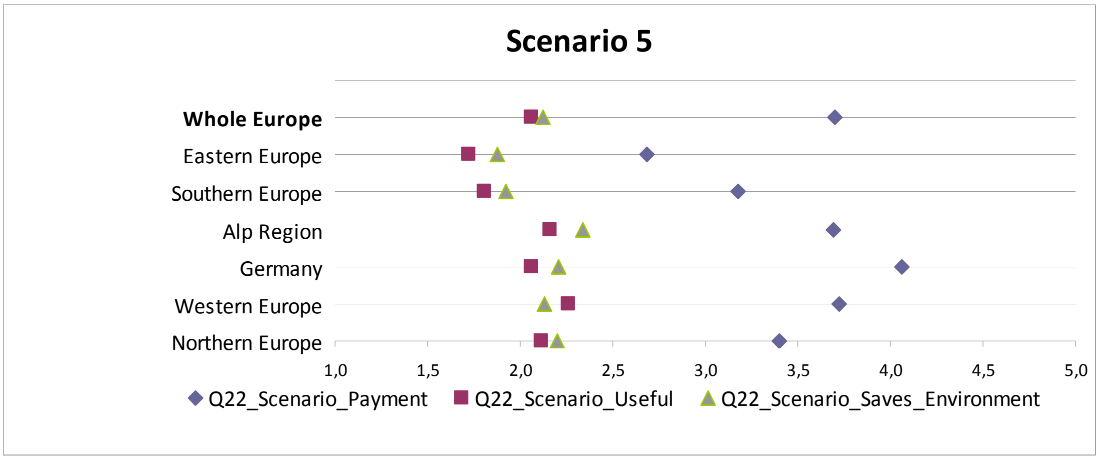
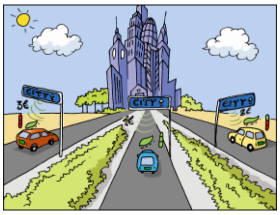


Figure 52: Scenario 5 - Mean values

4.11.6. Scenario 6: Low emission zoning



Application description*: The eco-driving assistant system exchanges information about your driving efficiency with the city traffic control centre. According to your driving profile it rewards you for example with discounts on city congestion charges or parking fees.*

European Level: As expected the Low Emission Zoning system is found to use *too much personal information* more than the other systems. The fact that a profile is created which records driving habits could be the reason for disagreement to the statement Overall the application was rated useful by around 50%. Also this application should not work *autonomously* and include a function to be *turned off*. Also few Europeans are *willing to pay* for the application. Low Emission Zoning did receive lower agreement on a positive *environmental impact* than the other systems.

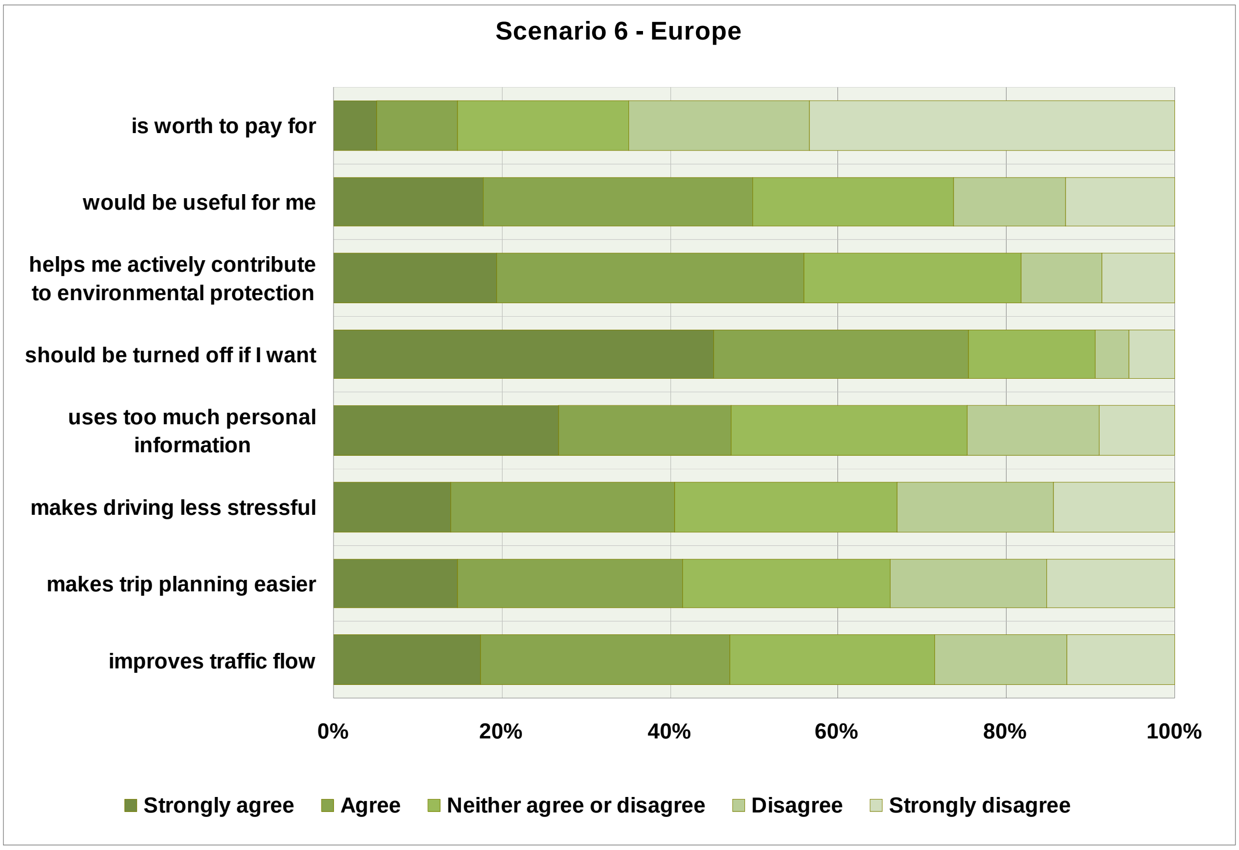


Figure 53: Scenario 6 - Percentages

It must ne noted that this system did not specifically address the matter of eco driving directly rather as a way to make drivers aware of the benefits; in this case monetary incentives. Therefore the results on the systems positive environmental impact are not discussed in the regional comparison but the results are shown in Figure 54: **Scenario 6 - Mean values**.

Regional comparison: The *willingness to pay* followed more or less the same pattern as it did for the previous scenarios. Eastern Europeans do neither agree nor disagree to *pay* for such a system (mean= 2.8). The perceived *usefulness* is much lower compared to the other systems. Especially in the Alp Region (mean=3.0) and in Germany (mean=3.1) this scenario received rather low results, in Eastern and Southern Europe the *usefulness* was rated only somewhat lower than in other scenarios.

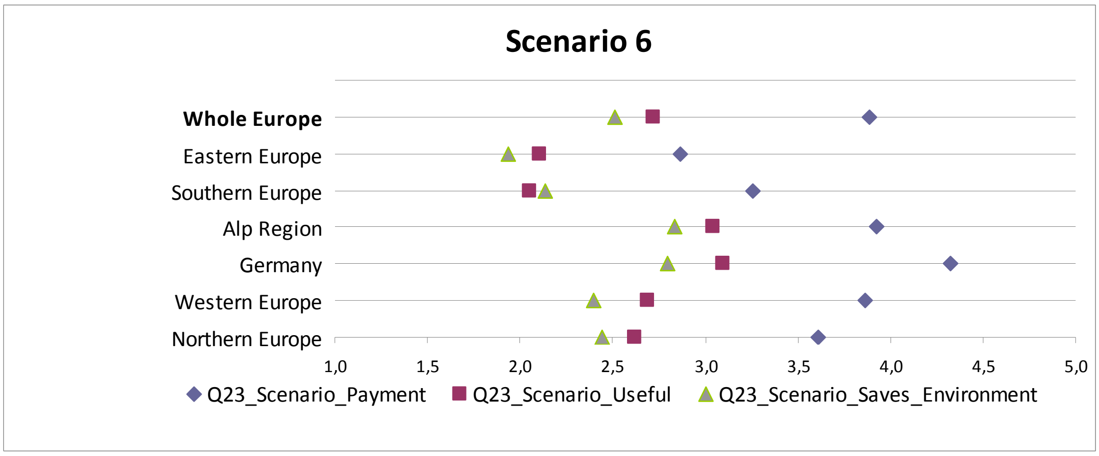
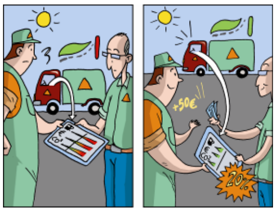


Figure 54: Scenario 6 - Mean values

4.11.7. Scenario 7: Post-trip analysis 2



Application description*: Your eco-driving assistant system constantly informs your employer about your driving performance. Each month you receive a reward for driving efficiently or the system advices you how to improve your driving style.*

Only business vehicle drivers rated the Post-trip Analysis 2 system (N=313). This scenario refers strongly to the second scenario which has a focus on private vehicle drivers. In both scenarios the driver receives advices on how to improve her or his driving skills. In case of the Post-trip Analysis 2 application the driver has the additional monetary motive to drive “green” since the improved driving style will be rewarded. Since the option of buying this system does not apply it was dropped for this scenario.
European Level: Business drivers around Europe rate this scenario’s *usefulness* very low and are strongly in favour of having the *on-off option*. The high requirement for an *on-off option* indicates that business drivers don’t want to be forced to use such applications but rather to decide on themselves if participating or not. The majority feels the system uses *too much personal information* and *restricts freedom* while driving. The fact that the employer needs to assess the driving information was mentioned in the scenario description. Respondents felt that this is too much. On the other hand, most respondents do see the positive impact and agreed that the system will assist in *saving fuel* and contributing to *environmental protection*. Only very few (less then 20%) say hat the system will need *too much technological knowledge* to use it. Figure 55 shows the European responses on the Post-trip Scenario.

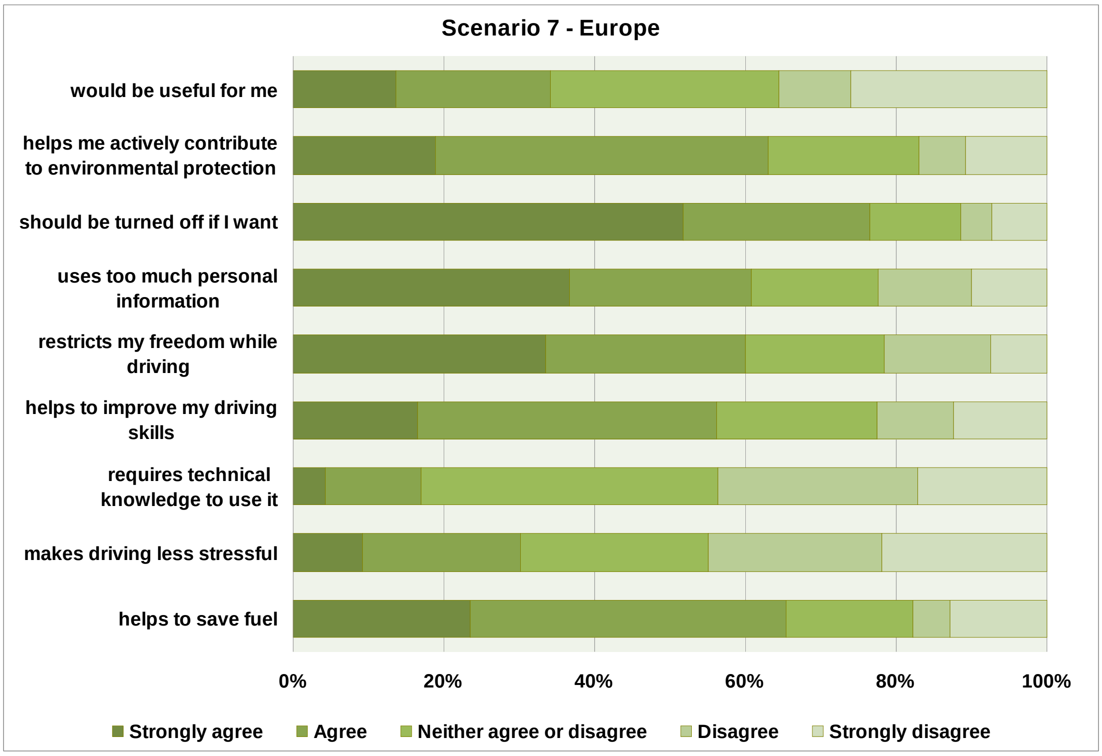


Figure 55: Scenario 7 - Percentages

A regional comparison was not conducted for this scenario since the dataset for certain regions was too small for comparisons.

4.12. Driver Types

The study in chapter 2 identified three main driver types which were described according to their driving behaviour and motives. The intention was to compare the results of the study on Driver Behaviour and Motivation (here referred to be the first driver study) with the results of the European study. The first driver study identified three different driver types: 1) Focus on time as main motive, 2) focus on environment and consumption and 3) focus on possibilities on possibilities to change driving behaviour. The task was now to find similar drivers in the European driver study. Based on the statistical method of cluster analysis a division of the sample in three groups was conducted using questions on driving characteristics as basis for calculation. Not all variables carry weight on the distance calculation between the clusters, meaning that not all variables may be used to explain differences between clusters.
By doing this an attempt was made to compare the result with those group characteristics found in the first driver study (chapter 2) since they used partially the same questionnaire items. In the following the terminology of group A, B and C will be used which are linked to the three driver groups from the study in chapter 2 as following:

Group A: Focus on time as main motive Group B: Focus on Environment and consumption
- Group C: Focus on Possibilities to change driving behaviour

4.12.1. Separation of driver types

The results of the cluster analysis are shown in table 13. The 3-point-scale used in table 13 indicates to what extent the driver group agreed on this item (+), was indifferent (0) or opposed/disagreed on this item (-).

		Group A	Group B	Group C
Q26	"I drive on the fast lane on motorways, as I drive faster than others anyway."	+	-	-
Q27	When driving at very high speeds on the motorway I do not feel safe any more.	-	0	+
Q28	I adhere to the speed limit even though all other road users drive too fast.	0	+	+
Q29	I brake and accelerate very dynamically.	0	-	+
Q30	As the environment is important to me, I check my fuel consumption regularly.	+	+	+
Q31	I do not think that CO2 emissions of vehicles have a big impact on climate compared with that of industries.	+	0	0
Q32	The car is just an object of utility for me, to get from A to B.	0	+	+
Q33	Driving gives me a feeling of freedom.	+	0	0
Q34	I would describe my driving style as being defensive.	-	+	+
Q35	My family's/friends' opinions of my driving behaviour are important to me.	0	+	0

Table 15 Questions on Driver Characteristics

Each group is described shortly in terms of what kind of respondents are included and afterwards the groups are compared with each other. Further an analysis was conducted on how the groups are present in European regions. Finally it was investigated how the respondents in each group rated the driver assistant systems in the scenarios.

Group A: This group corresponds with the driver type "time as a motive". The share of male persons within group A is higher (81%) than compared to the overall sample. Drivers within this group say they generally drive faster than others (*question 26*) and do not feel insecurity while driving fast (*question 27*). Respondents say they do check their fuel consumption regularly *(question 30)* which could describe rather a monetary motive than an environmental motive. It was found out that all groups rated this question with agreement but drivers in group A with the least strong tendency. Drivers in this group state that pollution from traffic has a minor impact than other sources of pollution *(question 31)*. Additionally group A contains a very high share of respondents who say they feel driving gives them a feeling of freedom *(question 33)*. This group describes their driving style as not being defensive *(question 34)* which is understandable since they like the freedom of driving and like to drive fast.

Group B: This group corresponds with the driver type "environment and consumption". The group B driver is not in a rush on motorways *(question 26)* and sticks to given speed limits *(question 28)*. These drivers have a strong focus on fuel consumption *(question 30)*. Persons within this group treat their car rather as an object of utility *(question 32)* than a status symbol. Furthermore they describe their driving style as defensive *(question 34)* and state that the opinion of others about their driving is important to them *(question 35)*.

Group C: This group corresponds with the driver type "Possibilities to change driving behaviour". Fast driving is also not common within group C *(question 26)* and moreover they feel rather insecure when driving with high velocities *(question 27)*. Therefore it is understandable that they adhere to the speed limits *(question 28)*. Interestingly they indicated to have a quite dynamic acceleration and deceleration behaviour *(question 29)*. It is the only group which has a strong opinion on their own driving behaviour in this aspect compared to other groups. These drivers also do keep a close eye on their fuel consumption *(question 30)* and do strongly see their vehicle only as an object of utility *(question 32)*. It does fit to the overall picture that this groups defines their own driving style as defensive *(question 34)*.

Comparing the groups, the most significant differences are found between groups A and C. Group C has the highest share of female respondents (28.3%) and Group A the lowest (18.2%). Group B has the more experienced drivers (70.4% more than 21 years of experience). 38.6% of drivers in Group A have an annual mileage of more than 20.000 km, higher than that of other groups (lowest: group C with 25.6%). The share of large cars is twice as high in group A (16.4%) as in group C (8.4%). A significant difference between group A and C respondents can also be observed looking at the engine type: 54.9% of group A drivers have a diesel engine. These drivers also have the highest annual mileage. On the other hand drivers in group C have a share of 40.4% of diesel engine cars.

4.12.2. Regional distribution of driver types

Group B is by far the largest group (N= 2894) and also represents the most interesting target group for eCoMove applications, followed by group A (N=1446) and group C (N=660). The share of respondents belonging to each group within the analysed regions is depicted in the following figure:

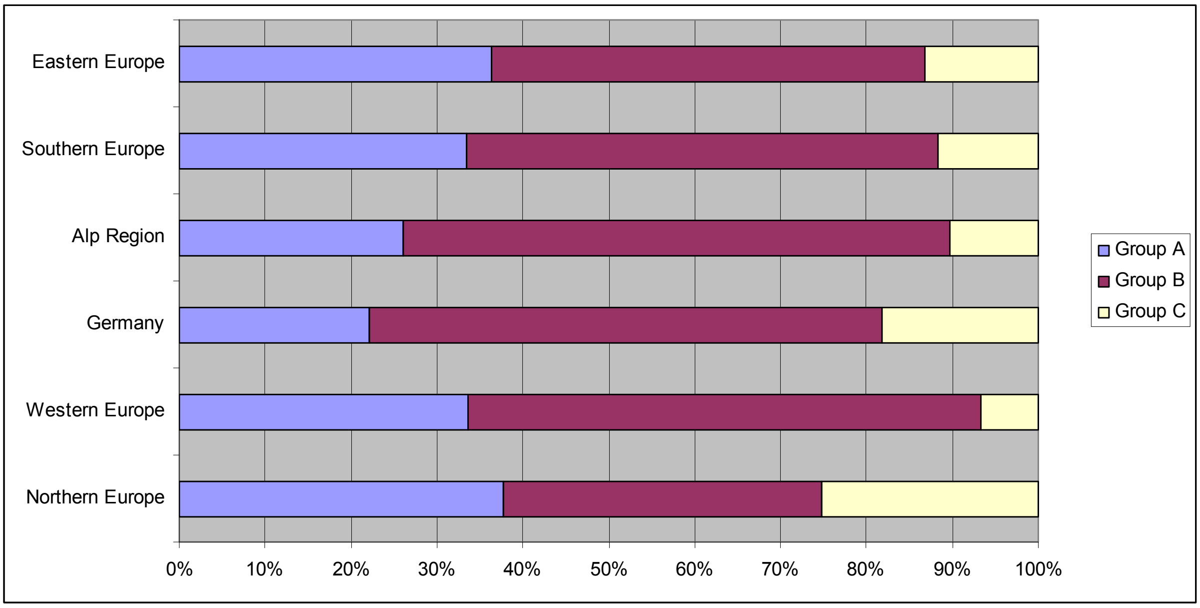


Figure 56: Groups in European Regions

Germany has a surprisingly low share (22.1%) of Group A drivers with "time" as main motive whereas this group is highly represented in Northern Europe and Eastern Europe. Group B drivers (environmentally conscious) are least represented in Northern Europe with a share of 37.2%. All other regions are on a quite similar level. The most Group C drivers are again found in Northern Europe (25.1%) and least in Western Europe and the Alp Region.

4.12.3. Rating of eCoMove applications according to driver types

The rating results on driver assistant systems' usefulness are shown in the following. The lower the mean value is (Minimum = 1.0) the higher is the perceived usefulness. Figure 57: **Rating of Group A** shows the results for respondent group A. the Adaptive Balancing Control system received the strongest agreement on the statement "this service would be useful for me", the Post-Trip Analysis 2 system received the lowest.

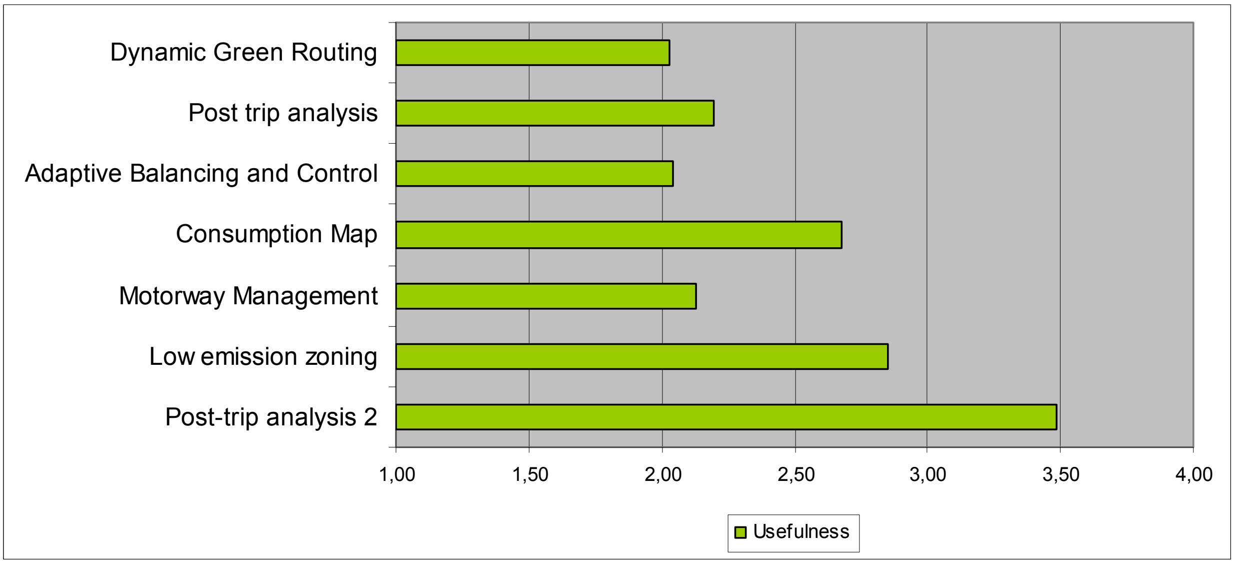


Figure 57: Rating of Group A

Group A drivers rated the scenarios usefulness less positive than other Group drivers. The most useful application was the Dynamic Green Routing application and the Post-Trip Analysis for business driver the least well perceived.

The rating of scenarios for Group B drivers is distributed as follows:

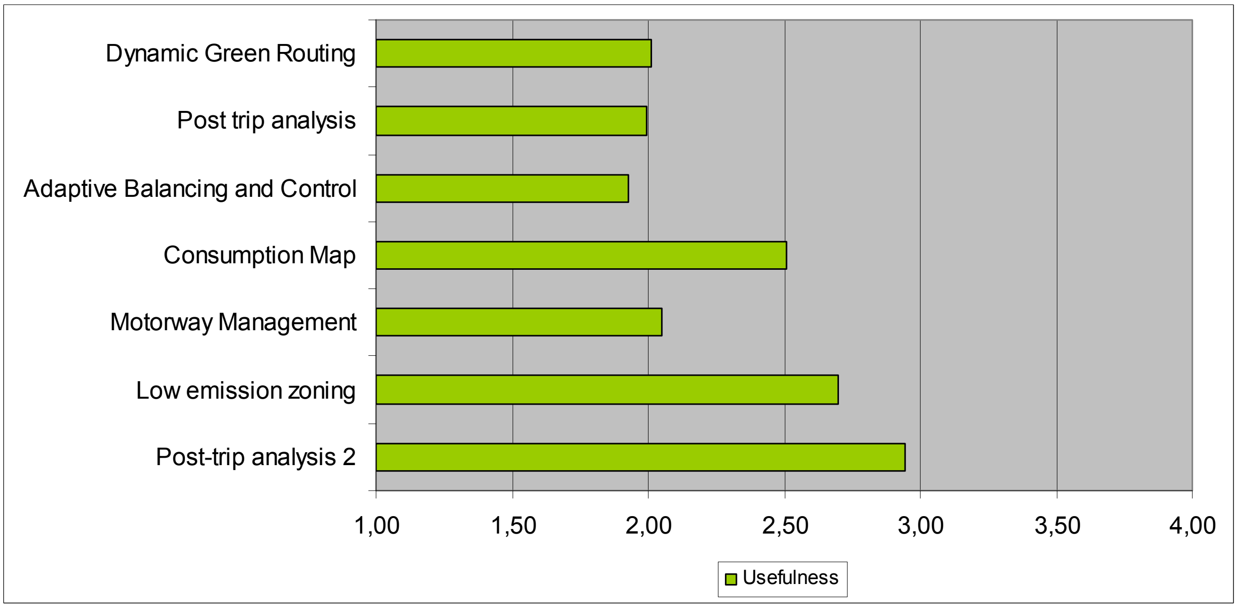


Figure 58: Rating of Group B

The results for Group B respondents vary much less than those of Group A drivers. The result shows that environmentally orientated respondents rate such applications which aim in environmental driving generally positive. The highest usefulness was mentioned for the Adaptive Balancing and Control (1.93). Environmentally orientated business drivers however are not convinced about the impact of Post-Trip Analysis 2. As well as in Group A applications in Scenarios 4, 6 and 7 received the lowest average usefulness rating (smaller than 2,50).

The following figure shows the Group C ratings on eCoMove assistant systems:

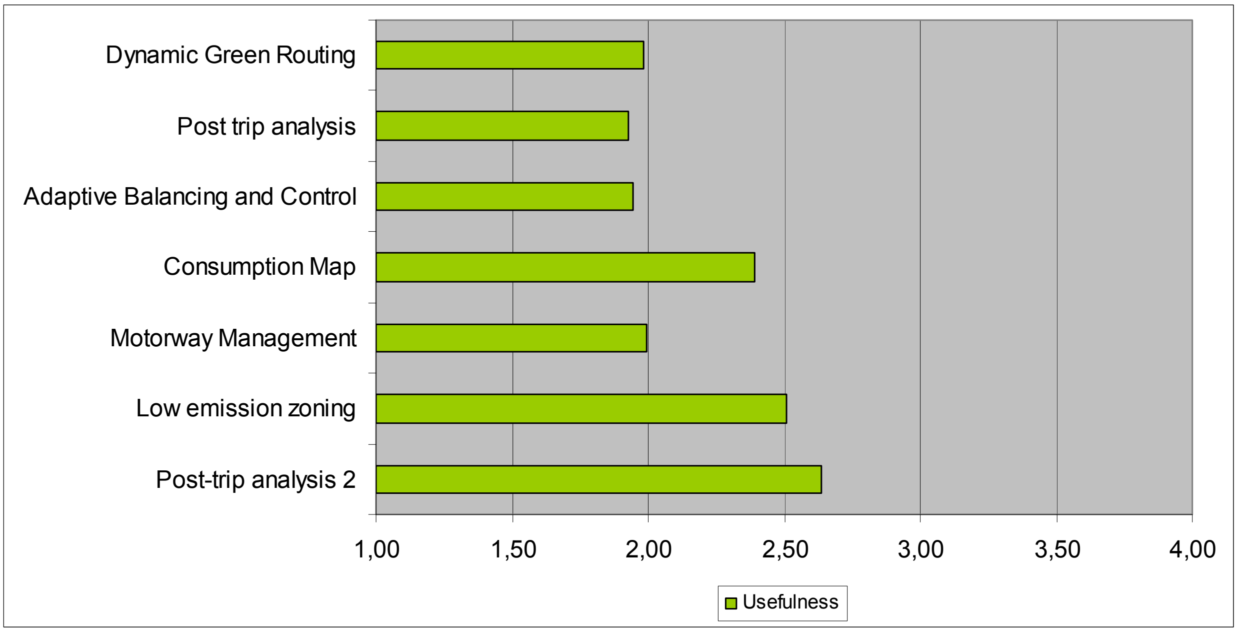


Figure 59: Rating of Group C

Drivers in Group C rated the applications' usefulness higher than Group A or B drivers. These drivers are motivated by their objective to improve their driving skills. The Post-Trip Analysis system would be a desirable application for this group; it also received the highest score (1.93). Only the applications Post-Trip Analysis 2 and Low Emission Zoning received a rating of less than 2, 50 (between "agree" and "neither agree or disagree").

The groups of drivers represent potential users of eCoMove applications. Given the fact that Group A drivers have a high motivation to reach their destination fast, they appear to be a group of less potential buyers of eCoMove applications. Group B and C drivers appear to have a higher possibility to be interested in eCoMove applications.

In Europe, Germany (77.9%) and the Alp Region (74.0%) have the highest shares of Group B and C drivers. Hypothetically these regions represent more certain markets than the ones in Northern Europe (62.3%) or Eastern Europe (63.6%). On the other hand, the willingness to pay is low for all regions but for Germany it is the lowest. This applies to all applications. The conclusion here is that each system has its benefits but potential buyers have to be convinced about the worthiness to pay for them.

4.13. Conclusions

In the previous sections many differentiations were made with individual analyses. In this chapter a summary of the main results will be given. Each system was assessed according to four main factors described in chapter 4.8 Questionnaire Items: the *ease of use, usefulness, environmental impact and payment*. This section will summarize the results based on these four factors.

First a list of needs and requirementsis presented which give a starting point for the conclusions. The list of requirements was collected during two stakeholder workshops (stakeholders were invited by eCoMove partners to a one-day workshop) where each topic was discussed. Details from the studies presented in Deliverable 6.1 were used also as basis for discussions. The workshop was visited by representatives of car manufacturers, automobile clubs, logistic company representatives and eCoMove partners. The overall number of attendees was around 25. The list of topics gathered represents inputs from stakeholders other than drivers but also fleet managers, haulers and vehicle associations. The original list consists of a larger amount of topics but only those needs and requirements are mentioned here which address the user or driver and which were assessed in the European driver questionnaire (c.f. Eikelenberg, N. et al. (2010))):

- Raise awareness of eco driving
- Clarify benefits of eco driver assistant systems (cost & fuel savings)
- Instead of displaying bad driving performance system should encourage behaviour change through incentives
- Personal freedom should not be limited
- System should be transparent and reliable
- Costs of system use should be appropriate
- Only necessary personal data should be collected in a reasonable way.

Ease of use

The study showed that drivers around Europe do not oppose the idea of providing information to cooperative information systems. 50.0 % agree (strongly) that applications such as the Post Trip Analysis which aim to improve driving skills or help to make traffic smoother do not use too much personal information. An exception was identified for the Low Emission Zoning system in which the eco driving records of the driver result in parking discounts in urban areas or lowering congestion fees. Only 24.6% agreed it would not use too much personal information. The perception here was much less positive compared to the other applications assessed. Apparently, a limit is reached if the driver feels monitored through the recording of her or his driving habits. The necessity of having an on-off button is especially strong for this kind of application. 75,5% of respondents want it for the Low Emission Zoning and 72.4% for the Post-Trip Analysis. It was assumed that drivers would have more difficulties accepting that the eco driving assistant systems use personal data.

➔ The results could be interpreted in a way that as long as the driver decides on provision of data she/he sees the benefit in using the provided service. The use of personal data should be transparent as much as possible and can be used for different additional incentives (e.g. information on improved driving behaviour can be converted into reduced congestion charges)

Another important factor was the question if such a system would restrict the freedom of the driver while driving, which would mean the driver loses the ability to make his own decisions about using the system. Respondents did not feel that the systems would do so. Only 31.1% see the Motorway Management system, 19.3% the Adaptive Balancing and Control and 14.2% the Post-Trip Analysis system restricting driving freedom. Nevertheless results for the Post Trip Analysis 2 system rating show that business drivers feel themselves more restricted in their freedom of driving using such a system (60.0%).

- ➔ Any system which collects information about driving behaviour of professional drivers is felt as a “threat” or limitation for decision making. However, fleet managers may offer incentives which tackle such issues. If a driver is paid extra for following system suggestions the perceived usefulness may raise and the limitation aspects can be overcome. Offering incentives may lead to high usage rates without forcing drivers to use it.
- ➔ For private drivers the freedom while driving is a more relevant issue since the vehicle belongs to oneself and is used for several purposes. The usage could be rewarded with incentives such as reduced parking fees or congestion charges. Such additional (political) measures should be considered as additional impact factor when the overall eCoMove system is evaluated.

For none of the discussed applications there was a large number of respondents who expected to need specific prior technical knowledge to use it. 26.2% said the Post-Trip Analysis would need prior technical knowledge which was the highest share of all systems.

- ➔ Respondents do not feel helpless with the technology presented in form of a partly-autonomous eCoMove assistance systems; the reason is probably because possible difficulties are hard to estimate based on a short introduction on functionalities and a sketched use case explaining how the system will work while driving (distracting messages, buttons to push etc.). On the other hand people might not want to admit their lack of technical knowledge. The eCoMove HMI studies will give further hints on the interrelation between information to drivers and the resulting level of compliance while driving.

The effect of increasing driving comfort in terms of less stress while driving was perceived very differently for the applications. Whereas more than 77.8% answered that the Adaptive Balancing and Control and the Dynamic Green Routing would decrease stress while driving; only 30.2% said that the business driver system Post Trip Analysis 2 would do so.

- ➔ Users may react with higher acceptance if the driving comfort is enhanced when using eCoMove assistance systems. If driving comfort can be raised when using the system this “selling-point” should be promoted besides fuel saving effects. Shorter travel time is clearly an important system benefit. Driving comfort related topics can also be assessed in HMI studies (e.g. when simulating traffic jams).

Usefulness
The application's usefulness was determined by the perceived usefulness and its ability to help the driver to improve his or her driving skills.

Especially The Post Trip analysis system received a very positive feedback; 75.3% private vehicle drivers think it is useful for them. On the other hand only 34.1% of business drivers think that Post Trip Analysis 2 would be useful. When considering such applications for business drivers strong incentives are needed. If someone does not see the benefit of such service personally, the acceptance will be low.

- ➔ The intention to use the systems depends strongly on the perceived usefulness. For instance the aspect of personal data usage correlates with a low perceived usefulness. The more transparent the system functionalities are for users the easier it will be to convince them about the system's usefulness.

Environmental impact
The overall aim of eCoMove solutions is to reduce traffic emissions. The study showed that eCoMove applications can help achieve this goal from the user perspective. The reduction of emissions is possible if the traffic flow will be smoothened or drivers get an advice to re-route. Improved driving skills will also contribute to reducing traffic emissions. It seems that displaying the fuel savings in monetary values motivates the driver to drive more economically. The results on the fuel saving impact of the post trip application supports this. 79.2% say that this system would help in protecting the environment which is the highest rating for all systems. The lowest environmental impact is expected for the Low Emission Zoning system (55.9%) and the Post-Trip Analysis 2 (63.0%) which still indicate a high rating in general for the eCoMove assistant systems.
The environmental benefit of such systems might not be obvious at first; the overall effects (reduced external costs such as healthiness of people living in affected areas) can be quantified after a large number of vehicles are equipped with eCoMove applications. When such positive effects are known they should be communicated publicly to users and non-users.

Payment
The study showed that overall the willingness to pay is quite low. The agreement to pay for the systems was less than 18% for all systems. A statement on the worthiness to pay for such innovative systems is rather difficult to make based on an illustration and a short description. Further studies could deliver valuable information on the reasons for low WTP. No high acceptance was expected, but it was rather surprising that there was little differentiation between the different applications in terms of WTP for the use. Nevertheless the large majority rated the systems useful. The benchmarks here are existing systems which address the aspects of routing, traffic management or driving skills improvement.

- ➔ Based on the data available it is difficult to explain the low WTP. Nevertheless and most importantly the system benefits should exceed the costs, so the benefits need to be clarified to users: reduced fuel leads to cost savings, a high usage level in the traffic network leads to lower travel times. Since WTP is a major success factor for eCoMove applications it could be assessed more in-depth parallel to the system development when more profound information about final system functionalities is available (post-prototype stages). Relevant would be e.g. to assess under which conditions (price levels, payment of single services vs. flat usage fees) users are willing to pay for services and under which not.

5. Study results and conclusions

The studies explained in chapters 2, 3 and 4 offered relevant insights on private and professional drivers' motivation and acceptance towards systems and services helping them to save fuel. The surveys gave a first impression on how traffic users react on the aspect of influencing driving behaviour using advanced ITS solutions. Colleting the opinion in this early stage of the project helps to reflect on the projects objectives. Important to know is that there are certain driver types for which eCoMove applications might be more or less relevant. It should also not be forgotten that mobility is strongly based on individual choices and it is difficult to convince people to use systems and services which would restrict them in their choices. Rejection might occur for instance if transparency of data usage is neglected or if the system is felt rather distractive than helpful. The objective for system developers should be: ***eCoMove systems and services should be developed, tested and evaluated according to driver's personal requirements and needs.*** It needs to be remembered that driving environmentally friendly is not the primary motive; drivers might not exclusively choose for instance the greenest route but the studies showed that they want to receive relevant information on their fuel savings. It is clear that the benefits need to be communicated to drivers; only by doing this the market opportunities are raised.
The pricing of eCoMove assistance systems was not a focus of any study carried out here but the low indicated WTP tells that it is a crucial point to achieve higher acceptance. Unfortunately people often consider such applications easily as given and do not want to pay for them. Users choose a certain product based on individual preferences and choices. The following factors should be considered when pricing schemes for eCoMove solutions are planned:

- Payment should be easy and accessible to users: accepting most payment methods via internet or charging points at commonly used places such as toll points or gas stations.
- Information about the service provider (eCoMove) and transparency on user data has to be communicated openly.
- Involve partners such as car insurances, driving schools or automobile clubs which can help to promote eCoMove applications and services through combining them with other products.
- Communicate positive impact on the environment to and monetary benefits through effective web and social media presence.

The following table provides an overview on the most important findings from the empirical studies.

5.1. Summary of conclusions

The deliverable produced various results using empirical data. The findings will help those conducting the system conception and the validation of eCoMove applications.

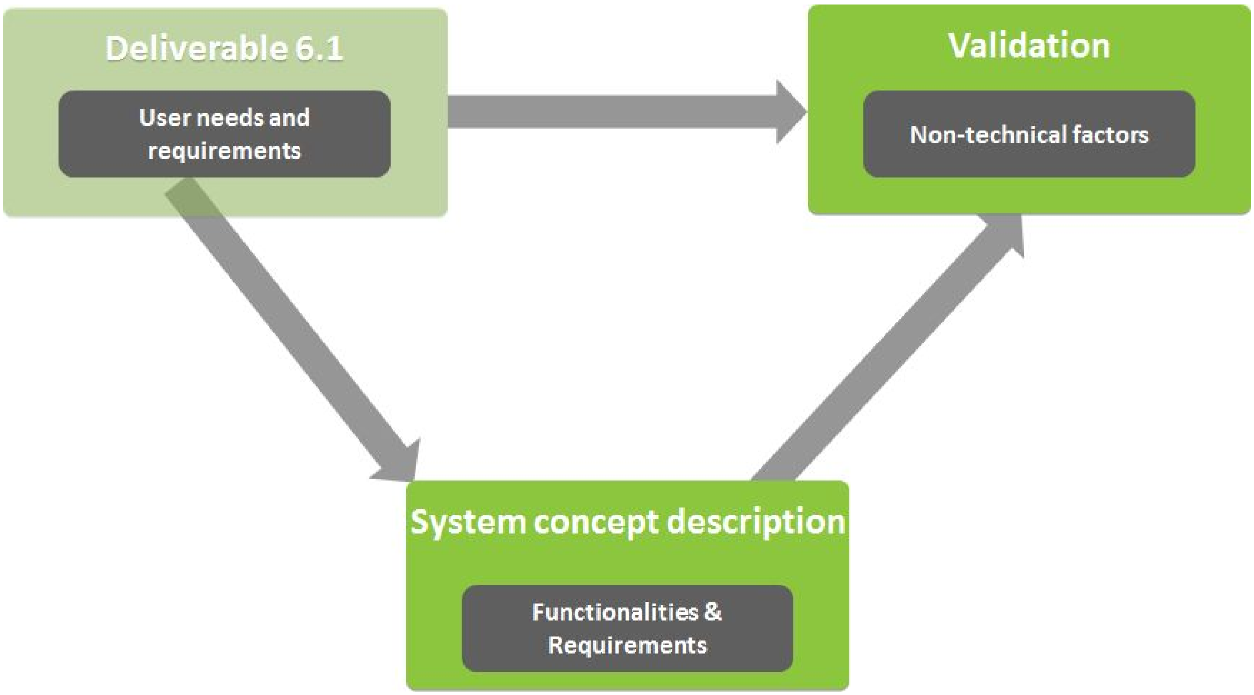


Figure 60: Deliverable results in the eCoMove context

The table below compromises of the most important findings from each study:

- Study 1: Driver Behaviour and Motivation of Private Drivers
- Study 2: Driver Behaviour and Motivation of Commercial Drivers
- Study 3: European Study on the Usefulness of Eco-Driving Assistant Systems

A link to other project activities (HMI study, real-world test, modelling impact) is given where possible. Some very relevant findings from stakeholder workshops are included to point out their importance as non-technical requirements for the design of eCoMove applications.

Identification of driving motives for different driver groups	• The three main motives: “time”, “environment / consumption” and “possibilities to change” are selectively important and distinctive for various driver groups (p. e. time is important for high annual mileage drivers (Study 1) • Different strategies and applications or systems are necessary to change the behaviour of all drivers and to convince them that the eco system will work beneficial for them (Study 1)

Functionality of eCoMove driver assistance systems	• Use of visual format for giving information, present simple information (e. g. current consumption rate, financial savings) (Study 1) • Partly automated features, such as cruise control/lane keeping, turning off the engine, display of the optimal gear and the optimal time to shift gears (Study 1) • Planning and anticipating actions e. g. through educational measures in order to improve knowledge (Study 2) • Self-monitoring and feedback by the companies (Study 2) • Good interface with back office of fleet management to prevent double work during the pre-trip route planning phase (Study 2) • Support in making sure the vehicle conditions are most optimal (Study 2) • Control of system usage should stay with the driver (On-Off option) (Study 3) • Users indicate to have enough technical knowledge to use and understand the system functionalities (Study 3) • Last decision of private data usage needs to be with the driver (Study 3) • Data collection on driving performance is well accepted which can be used to calculate an “eco-driver-profile” which again is used to give incentives such as congestion charge reduction (Study 3). • Any system functionality improving driving comfort (equals less stressful driving) should be pointed out as an additional “selling point” (Study 3) • Appropriate payment methods need to be elaborated (e.g. payment of single services vs. flat fees) (Study 3)
Information provided to the driver	• Suggestions for optimal speed and routes, improving traffic flow (Study 1) • Route planning and support in checking the vehicle status (e.g. tire pressure) without losing a lot of time is desired (Study 2) • General information about fuel consumption of truck drivers directly instead of only to the company (Study 2) • Causes and severity of fuel consumption influences (Study 2) • Warnings about in efficient vehicle conditions (e.g. spoiler height incorrect, wrong tire pressure etc.) (Study 2) • Information on fuel saved after the trip is highly appreciated and should be presented as cost savings (Study 3) • Instead of displaying bad driving performance system should encourage behaviour change through incentives (Stakeholder workshop) • Create strong incentives for professional drivers so that negative perception on data collection through employer can be overcome (Study 3).

General recommendations	• Raise awareness of eco driving (Stakeholder workshop) • Clarify benefits of eco driver assistant systems (cost & fuel savings) • Personal freedom should not be limited (Stakeholder workshop) • System should be transparent and reliable (Stakeholder workshop) • Costs of system use should be appropriate (Stakeholder workshop) • Only necessary personal data should be collected in a reasonable way. (Stakeholder workshop) • Time pressure is a large factor in the routine of a commercial driver, so if it is possible to support the commercial driver in checking vehicle parameters without causing extra work or time delay, it is most likely to be used to improve and thereby making the vehicle conditions more efficient (Study 2) • Low willingness to pay can be overcome with well communicated benefits (low travel times, raising driving comfort, additional incentives etc.) (Study 3)

Table 16: Relevant findings for driver motivation, system functionality and driving information

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Annex(es)

Annex 1: Questionnaire of study1

Dear Participant,

Within the framework of an ongoing project at the DLR Institute of Transportation Systems we would like to ask you for your active support.

The objective of the large-scaled integrated project eCoMove is the development of applications to optimize fuel consumption of vehicles. This could be e.g. the application of new in-vehicle assistance systems that assist drivers in terms of eco driving strategies. On the other side cooperative infrastructure facilities of traffic management could be developed that lead to a better, more economic and ecologic traffic routing and management within urban areas.

In order to gather information about applications having the biggest benefit and above all being accepted by you as the driver, we developed a questionnaire in which we would like to ask you about your preferred driving style as well as your attitudes towards the use of a vehicle as means of transport and fuel consumption. Of course all information will be treated confidentially and analysed anonymously.

In the first section of the questionnaire we ask you for some basic information about you as a driver as well as your use of a vehicle as a means of transport.

The second part of the questionnaire comprises statements concerning your driving style. Please rate the statements by ticking one of the 5 boxes which best indicates the extent to which you agree or disagree with the statement.

The third section covers some questions about your knowledge of fuel saving strategies; you can choose multiple answers in this section.

In the last section of the questionnaire we would like to know whether you already actively use in-vehicle information about your fuel consumption. Answering the last question you have the possibility to name and describe measures and applications that would motivate you towards energy efficient driving behaviour.

Answering the questions will take about 15 minutes.

Please answer all questions honestly and completely.

Thank you very much indeed for participating and Good luck!

Your eCoMove Team

Basic Information

1. Age ______________________

2. Gender ☐ male ☐ female

3. When did you obtain your driving license (year)? __________________________________

4. What is your annual mileage (in km)?

☐ < 3.000 km ☐ 3001< 9.000 km ☐ 9001< 12.000 km
☐ 12001< 20.000 km ☐ 20001< 30.000 km ☐ 30001< 50.000 km
☐ > 50.000 km

5. How often do you use your vehicle?

☐ every day ☐ only on working days ☐ 3-4 times per week
☐ once a week ☐ 1-3 times per month ☐ less than once a month

6. What kind of vehicle (make and model) do you drive most frequently? __________________

7. How would you describe your driving style?

☐ very erratic ☐ rather erratic ☐ rather anticipatory/smooth
☐ very anticipatory/smooth

8. For what kind of trip do you usually use the vehicle? (multiple choice)

☐ drive to work ☐ business trips / travelling salesman
☐ shopping, errands ☐ leisure activities (e.g. sports club)
☐ fetching children ☐ visiting friends and family
☐ others: ____________________

9. What is your highest school leaving certificate?

☐ no certificate ☐ elementary school ☐ secondary school

☐ college of higher education

☐ others: ______________________

10. What is your current occupational activity?

☐ employee ☐ worker ☐ freelancer

☐ public servant ☐ student ☐ pupil

☐ retiree ☐ houseman/housewife

☐ others: ______________________

11. Are you a professional driver?

☐ yes ☐ no

Attitudes & Driving behaviour

		Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
12	I drive on the left lane on motorways, as I drive faster than others anyway.	☐	☐	☐	☐	☐
13	Driving gives me a feeling of freedom.	☐	☐	☐	☐	☐
14	When driving at very high velocities on the motorway I do not feel safe any more.	☐	☐	☐	☐	☐
15	The car is just an object of utility for me, to get from A to B.	☐	☐	☐	☐	☐
16	I do not care about the make of my car.	☐	☐	☐	☐	☐
17	For the sake of the environment I, e.g. take the bike, join car pools, use public transport and leave my own car parked.	☐	☐	☐	☐	☐
18	During the last few years fuel prices have increased so much that I increasingly have to watch my fuel consumption.	☐	☐	☐	☐	☐
19	Most other road users exceed the speed limit by 20 km/h on motorways.	☐	☐	☐	☐	☐
20	Many of my family members / friends have an economical driving style.	☐	☐	☐	☐	☐
21	It happens that other vehicles close the gap ahead of my vehicle.	☐	☐	☐	☐	☐

		Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
22	A general urban speed limit of 60 km/h would be just as safe as 50 km/h.	☐	☐	☐	☐	☐
23	My colleagues' opinions of my driving behaviour are important to me.	☐	☐	☐	☐	☐
24	I do not like following a car that drives slower than the allowed speed-limit	☐	☐	☐	☐	☐
25	I think that it is easy to change my driving behaviour.	☐	☐	☐	☐	☐
26	I brake and accelerate very erratically.	☐	☐	☐	☐	☐
27	In my opinion the worlds' energy resources are far from being exhausted yet.	☐	☐	☐	☐	☐
28	I drive slowly in order to reach my destination unstressed / comfortable.	☐	☐	☐	☐	☐
29	I drive faster than most of the other road users.	☐	☐	☐	☐	☐
30	I drive with the preferably highest gear in order to reduce my pollutant emission.	☐	☐	☐	☐	☐
31	I drive approx. 20 km/h faster than actually allowed.	☐	☐	☐	☐	☐
32	I do not think that CO_2 emissions of vehicles have a big impact on climate compared with that of industries.	☐	☐	☐	☐	☐
33	I do not think that it would change anything for the environment if I leave my car parked.	☐	☐	☐	☐	☐
34	I adhere to the speed limit even though all other road users drive too fast.	☐	☐	☐	☐	☐
35	My family's/friends' opinions of my driving behaviour are important to me.	☐	☐	☐	☐	☐
36	I love the feeling of freedom when accelerating on an empty motorway.	☐	☐	☐	☐	☐
37	I prefer sleeping longer in the morning and try to save time on my travel to work.	☐	☐	☐	☐	☐
38	On routes which I know well I try to set time records.	☐	☐	☐	☐	☐
39	I would describe my driving style as being defensive.	☐	☐	☐	☐	☐
40	Driving the car is very low priced compared to the use of public transport.	☐	☐	☐	☐	☐
41	My air conditioning is always active although this increases the fuel	☐	☐	☐	☐	☐

		Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
	consumption.					
42	After a long working day I only want to get home and therefore driver faster than on my way to work.	☐	☐	☐	☐	☐
43	After being caught up in a traffic congestion, I try to regain lost time by driving faster.	☐	☐	☐	☐	☐
44	Many other car drivers drive rather economically.	☐	☐	☐	☐	☐
45	Many of my family members / friends drive fast or erratically.	☐	☐	☐	☐	☐
46	Many of my colleagues have an economically driving style.	☐	☐	☐	☐	☐
47	As the environment is important to me, I check my fuel consumption regularly.	☐	☐	☐	☐	☐
48	If I want to pass a slower car on the highway, I take care that the road is not going uphill.	☐	☐	☐	☐	☐
49	If I go to an appointment, I use time buffers in order to compensate for traffic jams and other unforeseen events.	☐	☐	☐	☐	☐
50	For commuting I can only afford a small car with low fuel consumption.	☐	☐	☐	☐	☐

Questions about fuel consumption (you may select more than one)

51. What happens if the tire pressure falls below the permitted limit?
    - ☐ The car consumes more fuel.
    - ☐ The CO2-emissions will be reduced.
    - ☐ The friction between the tire and the road increases.

52. Which driving style leads to higher fuel consumption?
    - ☐ Fast acceleration and abrupt braking
    - ☐ Low-speed, anticipating and smooth driving
    - ☐ Driving at high velocities

53. Why does your car need more fuel during the rush hour than on other times?
    - ☐ Because you have to stop and start often.
    - ☐ Because you drive using higher gears than at other times.

54. How can you drive further, using less fuel?
    - ☐ Fast acceleration and abrupt braking.
    - ☐ Low-speed, anticipating and smooth driving.
    - ☐ Through using fuel efficient engine oil and fuel efficient tires.

55. When does your car need more fuel?
    - ☐ If the tire pressure is too high.
    - ☐ If there are additions like roof luggage racks or bicycle racks.
    - ☐ Through usage of electronic devices in the car like air conditioning or rear window heaters.

Average fuel consumption (please only tick one of the boxes)

56. Do you have the in-vehicle information about your average fuel consumption in the car you most frequently drive?
    - ☐ yes
    - ☐ no

57. If so, do you check your average fuel consumption regularly?

- ☐ several time a trip
- ☐ once a trip
- ☐ once a tankful
- ☐ less than a tankful
- ☐ never

58. Why do you use the function of the in-vehicle application for the average fuel consumption? (you may select more than one)
    - ☐ for information and control
    - ☐ for optimizing fuel consumption
    - ☐ others ________________

59. Please describe situations in which you notice a strong interaction between your driving behaviour and your average fuel consumption.

    ____

    ____

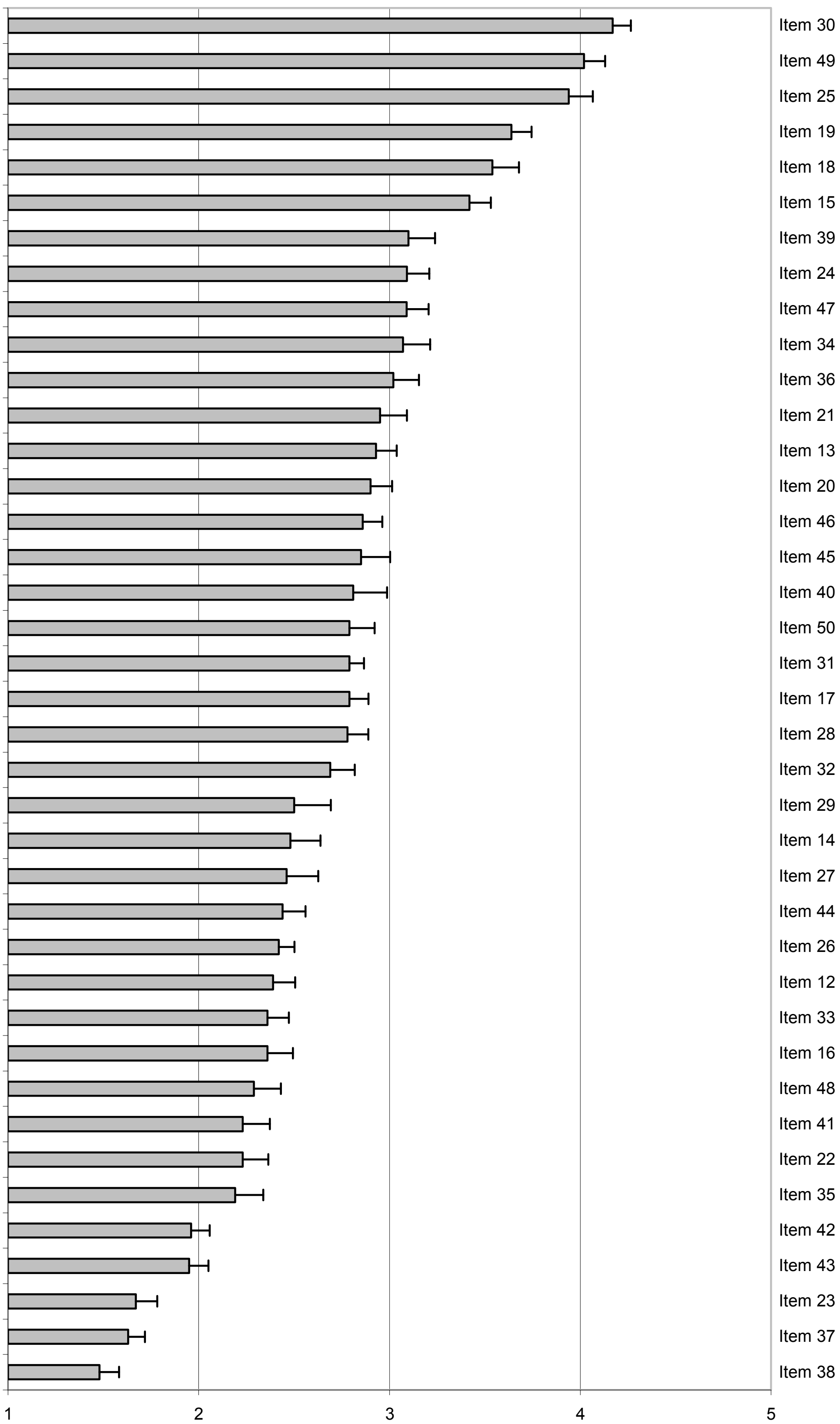
    ____

    ____

Which measures, applications or information could you imagine that support and motivate you to save fuel?

____

Annex 2: Mean values of the 39 items assessing motives



Annex 3: Rotated factor matrix(PAF, varimax rotation, 36 iterations)

Items	Factor													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
q_29 faster than others	,742	-,197	-,138	-,060	,061	,114	-,009	,064	,200	,060	,035	-,194	,052	,080
q_28 slow and relaxing	-,655	,110	,096	,141	-,226	,095	-,017	-,087	,132	,115	-,013	,054	,270	,189
q_12 always in the left lane	,572	-,131	-,071	-,244	,117	,016	-,109	-,070	,326	-,057	,206	-,185	-,012	,010
q_36 feeling of freedom on the highway	,559	,342	-,200	-,219	,044	,036	-,071	-,018	,044	-,001	-,154	,259	,069	-,012
q_31 20 km/h faster than permitted	,523	-,099	-,106	-,027	,153	,042	-,141	,469	,007	-,069	,257	,068	,154	,137
q_39 cautious driving style	-,495	-,059	,160	,020	,024	,071	,250	-,084	-,094	,087	-,030	,056	,015	,208
q_14 don’t feel save when driving with high speeds	-,491	,304	-,174	,138	-,033	-,032	-,153	-,009	-,016	-,049	-,034	,153	-,150	-,125
q_34 always complied with speed limits	-,472	,107	,180	-,193	,028	,076	,108	-,426	,024	,037	-,270	,030	-,086	-,168
q_24 don’t like driving behind slower vehicles	,397	-,013	-,014	-,006	-,040	-,047	,014	,147	-,168	-,090	-,016	,058	,123	-,095
q_48 no overtaking during uphill driving	-,150	,691	,159	,106	-,100	,075	,053	-,010	,052	-,026	-,004	,016	-,107	,037
q_50 using a smaller vehicle for commuting	-,105	,622	,188	,111	-,018	,119	-,060	-,031	-,010	,009	,002	-,079	,170	,099
q_37 time savings when driving to work	,008	,355	-,201	-,091	-,082	,110	,018	,171	,089	,093	,232	-,063	,242	-,045
q_18 pay increased attention to fuel consumption	-,154	,310	,665	-,006	-,035	,027	,075	,022	,008	-,007	-,163	-,035	,096	-,200
q_47 regular inspection of fuel consumption	-,138	,017	,652	-,174	-,025	,104	-,008	-,060	,023	,030	-,088	,247	-,126	,016
q_38 set new time records on known routes	,382	-,017	-,398	-,111	,124	-,025	-,049	,042	,120	-,137	,127	-,019	,215	,077
q_26 dynamic braking and accelerating	,304	,002	-,340	-,165	,026	,124	,015	,196	,239	-,020	-,213	-,125	,070	-,063
q_49 drive with a time buffer before meetings	-,003	,108	,247	,029	-,029	,074	-,195	-,042	,145	,010	-,234	-,048	-,063	,157
q_15 vehicle as object of utility	-,163	,032	-,048	,812	-,026	,000	-,011	,014	-,056	,036	-,040	,047	,031	-,181
q_16 make of the vehicle is irrelevant	-,056	,258	-,077	,565	-,077	-,039	-,101	,024	,107	-,009	-,018	,013	-,046	,106
q_13 driving elicits a feeling of freedom	,303	,357	-,174	-,505	,004	-,003	-,004	,118	,052	,100	-,093	,246	,166	,135
q_32 effects of CO2-emissions on the environment	,135	,072	,051	-,114	,649	-,008	-,085	,037	,081	,084	-,071	-,008	,046	,145
q_33 drive the car less frequent because of the environment	-,003	-,100	-,093	,039	,638	,031	-,075	,047	-,036	-,019	,096	-,046	-,069	-,011
q_27 using energy ressources	,023	-,025	,014	,037	,492	,046	,281	-,074	-,033	-,080	-,024	-,039	,165	,019
q_17 using bike, car pooling, public transportation	-,083	,192	,150	,189	-,417	,144	,089	-,122	-,040	-,006	-,045	,229	,022	,195
q_41 air-conditioning and fuel consumption	,058	-,108	-,003	-,061	,222	,161	,008	,051	,061	-,194	-,026	,096	,153	-,031
q_35 attitudes of family7friends concerning driving behavior	,034	,073	,024	,050	,047	,832	-,019	,014	-,024	-,034	,048	-,002	-,056	-,072
q_23 attitudes of colleagues concerning driving behavior	-,050	,119	,067	-,078	-,015	,741	-,020	-,026	,036	,012	-,028	,006	,050	,111
q_20 efficient driving style of family/friends	,038	,163	,001	-,071	-,065	-,051	,727	-,099	,235	,060	,012	,088	-,045	,027
q_45 dynamic driving style of family/friends	,185	,140	-,025	,032	,005	,005	-,638	-,042	,064	,062	-,020	-,040	,107	-,155
q_19 others drive 20 km/h faster	,125	,012	-,064	,013	,002	,042	,022	,642	-,104	,106	,101	-,022	-,067	,019
q_22 city speed limit 50 vs. 60 km/h	,085	,098	,113	-,072	,182	-,166	-,074	,356	,176	-,042	-,192	-,082	,119	-,045
q_46 efficient driving style of colleagues	-,008	-,004	-,017	-,028	,027	,089	,284	,062	,625	,021	,012	,162	,064	-,125
q_44 efficient driving style of other drivers	,201	,053	-,040	,021	-,060	-,042	-,040	-,141	,441	-,095	-,051	-,135	,021	,079
q_40 cheap vehicle compared to public transportation	-,117	,068	,088	,112	,180	-,060	-,084	,022	,306	,036	,086	,104	-,219	,025
q_21 other vehicles are pushy	-,148	-,015	,053	-,016	-,001	-,009	-,010	,097	-,033	,945	-,012	,014	-,007	-,085
q_43 compensating a traffic jam through fast driving	,125	,048	-,147	-,027	,028	,032	,017	,113	,031	-,007	,707	-,060	,122	-,121
q_30 higher gear, less emissions	-,144	-,057	,159	,009	-,122	,003	,121	-,047	,034	-,010	-,027	,718	,070	,028
q_42 drive faster on way home after a long day of work	,124	,127	-,106	-,024	,156	-,040	-,171	,007	-,003	-,031	,212	,116	,551	-,016
q_25 can easily change driving behavior	-,055	,074	-,080	-,089	,055	,021	,130	,049	-,016	-,063	-,099	,024	-,010	,490

Annex 4: Group comparisons of the specific driver groups dependent from the main motives

a. high versus normal versus low annual mileage

Factors / motives	Annual mileage	Average	Std. deviation	F-Test (F-value, p)	
				F	p (2-tailed)
Velocity and dynamics	Low	2.6623	.64695	2.914	.057
	Normal	2.7898	.56018		
	High	2.9612	.71234		
Environmental orientation	Low *	2.8942	1.13473	4.932	<.01
	Normal	2.4205	1.14943		
	High	2.1837	1.24455		
Focus on low fuel consumption	Low	3.5330	.62603	1.822	.164
	Normal	3.7644	.68237		
	High	3.6327	.83089		
Vehicle as object of utility	Low	2.9308	.85325	0.131	.877
	Normal	2.9697	.90639		
	High	2.8867	1.01376		
Low internal locus of control	Low *	2.3255	.90880	8.752	<.001
	Normal	2.7216	.75851		
	High	2.9750	.74102		
Subjective norm: personal driving behaviour	Low	2.8160	.47574	0.002	.998
	Normal	2.8155	.44607		
	High	2.8112	.48555		
Subjective norm: driving behaviour others	Low	1.9537	.98703	1.113	.331
	Normal	2.0057	.94533		
	High	1.7700	.70862		
Subjective norm: handling of speed limits	Low	2.8519	.85578	0.441	.644
	Normal	2.9489	.77697		
	High	3.0000	.87482		

b. Comparison of drivers with a more or less pronounced focus on fuel efficiency

Factors / motives	Freq. of checking fuel consumption	Average	Std. deviation	t-Test (t-value, p)	
				t	p (2-tailed)
Velocity and dynamics	Low	2.8957	.63064	.397	.692
	High	2.8355	.63848		
Environmental orientation / attitude	Low	2.4130	1.10425	.660	.511
	High	2.2303	1.18164		
Focus on low fuel consumption	Low	3.4239	.57126	-2.228	<.05
	High	3.7961	.73565		
Vehicle as an object of utility	Low	3.0580	.91371	1.632	.106
	High	2.7149	.87382		
Low internal locus of control	Low	3.0109	.87086	1.199	.233
	High	2.7697	.83742		
Subjective norm: driving behaviour of others	Low	2.8043	.45824	-.392	.696
	High	2.8487	.47972		
Subjective norm: personal driving behaviour	Low	2.0217	.77574	1.110	.270

	High	1.8026	.84490		
Subjective norm: handling of speed limits	Low	3.4565	.87792	3.534	<.01
	High	2.7697	.79767		

c. Comparison of drivers driving different vehicle makes and models

Factors / motives	Vehicle category	Mean	Std. deviation	t-Test (t-value, p)	
				t	p (2-tailed)
Velocity and dynamics	Small	2.7707	.60060	-1.504	.134
	Big	2.9277	.65498		
Environmental orientation / attitude	Small	2.6381	1.18320	3.020	<.01
	Big	2.0426	1.10252		
Focus on low fuel consumption	Small	3.6748	.65351	.498	.619
	Big	3.6170	.76587		
Vehicle as an object of utility	Small	2.9778	.89331	1.285	.201
	Big	2.7801	.95117		
Low internal locus of control	Small	2. 6500	.77640	-.795	.428
	Big	2.7609	.92640		
Subjective norm: driving behaviour of others	Small	2.7901	.46803	-.670	.504
	Big	2.8444	.47461		
Subjective norm: personal driving behaviour	Small	1.8815	.87291	-.506	.614
	Big	1.9574	.92566		
Subjective norm: handling of speed limits	Small	2.9370	.82279	.082	.935
	Big	2.9255	.84041		

d. Comparison of drivers having different theoretical knowledge about fuel saving

Factors / motives	Points (knowledge)	Mean	Std. deviation	t-Test (t-value, p)	
				t	p (2-tailed)
Velocity and dynamics	High	2.8458	.2302	-1.504	<.05
	Low	2.6027	.64441		
Environmental orientation / attitude	High	2.4346	.12203	3.020	.195
	Low	2.7222	.10653		
Focus on low fuel consumption	High	3.6316	.72898	.498	.187
	Low	3.8041	.62953		
Vehicle as an object of utility	High	2.8463	.90036	1.285	<.01
	Low	3.3153	.90249		
Low internal locus of control	High	2.7256	.83322	-.795	.106
	Low	2.4797	.80013		
Subjective norm: driving behaviour of others	High	2.8183	.44768	-.670	.819
	Low	2.7986	.52719		
Subjective norm: personal driving behaviour	High	1.9032	.84342	-.506	.490
	Low	2.0405	.11265		
Subjective norm: handling of speed limits	High	2.9258	.78706	.082	.785
	Low	2.9730	.97144		

e. Comparison of drivers concerning the factor age

Factors / motives	Age	Mean	Std. deviation	F-Test (F-value, p)	
				F	p (2-tailed)
Velocity and dynamics	≤ 24 y *	2.9625	.65229	3.672	<.05

	25-64 y	2.7938	.63414		
	≥ 65 y *	2.5000	.48013		
Environmental orientation	≤ 24 y *	2.9375	1.27192	3.709	<.05
	25-64 y *	2.3798	1.12808		
	≥ 65 y	2.3000	1.30182		
Focus on low fuel consumption	≤ 24 y *	3.3375	.63687	10.358	< .001
	25-64 y *	3.6880	.70019		
	≥ 65 y *	4.1750	.61825		
Vehicle as object of utility	≤ 24 y	2.6833	.88659	2.294	.104
	25-64 y	3.0280	.91431		
	≥ 65 y	2.8500	.93955		
Low internal locus of control	≤ 24 y	2.7073	.88548	1.732	.180
	25-64 y	2.6212	.80046		
	≥ 65 y	2.9875	.87913		
Subjective norm: personal driving behaviour	≤ 24 y	2.7561	.53470	.470	.626
	25-64 y	2.8260	.42624		
	≥ 65 y	2.8625	.53481		
Subjective norm: driving behaviour others	≤ 24 y	1.9268	.82584	1.450	.237
	25-64 y	1.8817	.85896		
	≥ 65 y	2.2500	1.26179		
Subjective norm: handling of speed limits:	≤ 24 y	3.1463	.83099	1.733	.180
	25-64 y	2.8779	.78714		
	≥ 65 y	2.8750	.99835		

f. Comparison of drivers concerning the factor gender

Factors / motives	Gender	Mean	Std. deviation	t-Test (t-value, p)	
				t	p (2-tailed)
Velocity and dynamics	Female	2.7508	.63288	-.712	.477
	Male	2.8209	.63414		
Environmental orientation / attitude	Female	2.7083	1.12856	1.727	.087
	Male	2.3876	1.21553		
Focus on low fuel consumption	Female	3.6750	.62825	.127	.899
	Male	3.6609	.75052		
Vehicle as an object of utility	Female	3.2022	.92951	2.783	<.01
	Male	2.8128	.88825		
Low internal locus of control	Female	2.4917	.73353	-2.118	.036
	Male	2.7634	.86063		
Subjective norm: driving behaviour of others	Female	2.7719	.41533	-.834	.405
	Male	2.8333	.48244		
Subjective norm: personal driving behaviour	Female	1.9016	.83076	-.293	.770
	Male	1.9427	.93776		
Subjective norm: handling of speed limits	Female	2.9344	.79831	-.005	.996
	Male	2.9351	.83757		

g. Comparison of drivers concerning different trip purposes

Trip purpose	factors	Value	mean	std. deviation	t-Test (t-value, p) t	p (2-tailed)
Drive to work	Low internal locus of control	Yes	2.4875*(?)	.95707	-2.604	<.05
		No	2.8153	.69879		
Business trips	Focus on low fuel consumption	Yes	3.7092	.68792	1.752	.081
		No	3.4792	.79142		
Leisure activities	Environmental orientation	Yes	2.7407	1.13774	2.540	<.05
		No	2.3009	1.20734		
	subjective norm: personal driving behaviour	Yes	2.1446	.99551	2.845	.005
		No	1.7661	.79223		
	Subjective norm: handling of speed limits	Yes	2.7952	.86615	-2.070	<.05
		No	3.0413	.77617		

Annex 5: Descriptive values for the driver comments dependent the named measures/applications.

The basis for the analysis is the total number of the named application which is also displayed in the tables.

	Increase prizing (total frequency = 16)	
	frequency (absolute)	frequency (in %)
High annual mileage drivers	2	12.5
Young drivers	2	12.5
High knowledge	**11**	**68.8**
High frequency of fuel checking	2	12.5
Small vehicles	**11**	**68.8**
Trip purpose: leisure activities	5	31.3
Female drivers	**10**	**62.5**
Trip purpose: drive to work	**14**	**87.5**

	Economical engines (total frequency = 15)	
	frequency (absolute)	frequency (in %)
High annual mileage drivers	5	33.3
Young drivers	0	0.0
High knowledge	**10**	**66.7**
High frequency of fuel checking	6	40.0
Small vehicles	**11**	**73.3**
Trip purpose: leisure activities	6	40.0
Female drivers	4	26.7
Trip purpose: drive to work	**11**	**73.3**
	Start/stop automatic (total frequency = 12)	
	frequency (absolute)	frequency (in %)
High annual mileage drivers	3	25.0
Young drivers	4	33.3
High knowledge	**12**	**100.0**
High frequency of fuel checking	5	41.7
Small vehicles	**8**	**66.7**
Trip purpose: leisure activities	**9**	**75.0**
Female drivers	0	0.0
Trip purpose: drive to work	**9**	**75.0**

	Optimizing construction of vehicles and techniques/(total frequency = 11)	
	frequency (absolute)	frequency (in %)
High annual mileage drivers	1	9.1
Young drivers	1	9.1
High knowledge	**11**	**100.0**
High frequency of fuel checking	5	45.5
Small vehicles	**6**	**54.5**
Trip purpose: leisure activities	5	45.5
Female drivers	0	0.0
Trip purpose: drive to work	**6**	**54.5**

	iNavi (total frequency = 10)	
	frequency (absolute)	frequency (in %)
High annual mileage drivers	1	10.0
Young drivers	2	20.0
High knowledge	**10**	**100.0**
High frequency of fuel checking	6	60.0
Small vehicles	**8**	**80.0**
Trip purpose: leisure activities	**10**	**100.0**
Female drivers	2	20.0
Trip purpose: drive to work	5	50.0

	iACC (total frequency = 10)	
	frequency (absolute)	frequency (in %)
High annual mileage drivers	4	40.0
Young drivers	0	0.0
High knowledge	**6**	**60.0**
High frequency of fuel checking	2	20.0
Small vehicles	**7**	**70.0**
Trip purpose: leisure activities	**7**	**70.0**
Female drivers	4	40.0
Trip purpose: drive to work	**5**	**50.0**

	Automatic engine (total frequency = 9)	
	frequency (absolute)	frequency (in %)
High annual mileage drivers	0	0.0
Young drivers	1	11.1
High knowledge	**7**	**77.8**
High frequency of fuel checking	4	44.4
Small vehicles	**7**	**77.8**
Trip purpose: leisure activities	**5**	**55.6**
Female drivers	0	0.0
Trip purpose: drive to work	**5**	**55.6**

	Public transport (total frequency = 8)	
	frequency (absolute)	frequency (in %)
High annual mileage drivers	1	12.5
Young drivers	2	25.0
High knowledge	**6**	**75.0**
High frequency of fuel checking	2	25.0
Small vehicles	**8**	**100.0**
Trip purpose: leisure activities	2	25.0
Female drivers	4	50.0
Trip purpose: drive to work	**5**	**62.5**

	Training (total frequency = 7)	
	frequency (absolute)	frequency (in %)
High annual mileage drivers	1	14.3
Young drivers	0	0.0
High knowledge	**5**	**71.4**
High frequency of fuel checking	**5**	**71.4**
Small vehicles	**7**	**100.0**
Trip purpose: leisure activities	**4**	**57.1**
Female drivers	3	42.9
Trip purpose: drive to work	**5**	**71.4**

	Recuperative engines (total frequency = 6)	
	frequency (absolute)	frequency (in %)
High annual mileage drivers	3	50.0
Young drivers	1	16.7
High knowledge	**5**	**83.3**
High frequency of fuel checking	**4**	**66.7**
Small vehicles	**6**	**100.0**
Trip purpose: leisure activities	**4**	**66.7**
Female drivers	1	16.7
Trip purpose: drive to work	**4**	**66.7**

	Subsidization (total frequency = 6)	
	frequency (absolute)	frequency (in %)
High annual mileage drivers	1	16.7
Young drivers	1	16.7
High knowledge	**5**	**83.3**

High frequency of fuel checking	2	33.3
Small vehicles	**3**	**50.0**
Trip purpose: leisure activities	2	33.3
Female drivers	**3**	**50.0**
Trip purpose: drive to work	2	33.3

	Competing situation (total frequency = 4)	
	frequency (absolute)	frequency (in %)
High annual mileage drivers	0	0.0
Young drivers	2	50.0
High knowledge	**4**	**100.0**
High frequency of fuel checking	1	25.0
Small vehicles	**4**	**100.0**
Trip purpose: leisure activities	**3**	**75.0**
Female drivers	2	50.0
Trip purpose: drive to work	2	50.0

Annex 6: Frequency of measurements for each group (based on N participants)

	High annual mileage (N=36)	Young drivers (N=23)	High knowledge (N=110)	High frequency fuel checking (N=57)	Small vehicles (N=92)	Trip purpose: leisure (N=75)	Female drivers (N=37)	Trip purpose: drive to work (N=81)
iTM	**58.3% (21)**	**26.1% (6)**	**38.2% (42)**	**47.4% (27)**	**33.7% (31)**	**42.7% (32)**	**27.0% (10)**	**37.0% (30)**
IVIS	**36.1% (13)**	**30.4% (7)**	**29.1% (32)**	**26.3% (15)**	**25.0% (23)**	**33.3% (25)**	**35.1% (13)**	**27.2% (22)**
iADAS	**19.4% (7)**	**47.8% (11)**	**30.9% (34)**	**19.3% (11)**	**29.3% (27)**	**32.0% (24)**	**29.7% (11)**	**34.6% (28)**
Increase prizing	5.6% (2)	8.7% (2)	10.0% (11)	3.5% (2)	12.0% (11)	6.7% (5)	**27.0% (10)**	17.3% (14)
Eco engines	13.9% (5)	0.0% (0)	9.1% (10)	10.5% (6)	12.0% (11)	8.0% (6)	10.8% (4)	13.6% (11)
Start/stop	8.3% (3)	17.4% (4)	10.9% (12)	8.8% (5)	8.7 (8)	12.0% (9)	0.0% (0)	11.1% (9)
vehicle technique	2.8% (1)	4.3% (1)	10.0% (11)	8.8% (5)	6.5% (6)	6.7% (5)	0.0% (0)	7.4% (6)
iNavi	2.8% (1)	8.7% (2)	9.1% (10)	10.5% (6)	8.7% (8)	13.3% (10)	5.4% (2)	6.2% (5)
iACC	11.1% (4)	0.0% (0)	5.5% (6)	3.5% (2)	7.6% (7)	9.3% (7)	10.8% (4)	6.2% (5)
Automatic engines	0.0% (0)	4.3% (1)	6.4% (7)	7.0% (4)	7.6% (7)	6.7% (5)	0.0% (0)	6.2% (5)
Public transport	2.8% (1)	8.7% (2)	5.5% (6)	3.5% (2)	8.7% (8)	2.7% (2)	10.8% (4)	6.2% (5)
Training	2.8% (1)	0.0% (0)	4.5% (5)	8.8% (5)	7.6% (7)	5.3% (4)	8.1% (3)	6.2% (5)
Recuperative engines	8.3% (3)	4.3% (1)	4.5% (5)	7.0% (4)	6.5% (6)	5.3% (4)	2.7% (1)	4.9% (4)
Fiscal subsidization	2.8% (1)	4.3% (1)	4.5% (5)	3.5% (2)	3.3% (3)	2.7% (2)	8.1 % (3)	2.5% (2)
Situation of competition	0.0% (0)	8.7% (2)	3.6% (4)	1.8% (1)	4.3% (4)	4.0% (3)	5.4% (2)	2.5% (2)

Annex 7: HMI Study 2

Questionnaire

Dear Participant,

Within the framework of an ongoing project at the DLR Institute of Transportation Systems we would like to ask you for your active support.

The objective of the large-scaled integrated project eCoMove is the development of applications to optimize fuel consumption of vehicles. This could be e.g. the application of new in-vehicle assistance systems that assist drivers in terms of eco driving strategies. On the other side cooperative infrastructure facilities of traffic management could be developed that lead to a better, more economic and ecologic traffic routing and management within urban areas.

In order to gather information about which applications might have the biggest benefit and acceptance by you as the driver, we are conducting a study in which we would like to ask you for your help.

The first part of the study includes two questionnaires in which we ask about information such as demographics and characteristics of your vehicle usage. Please indicate on the 5-point rating scale how much you agree or disagree with the statements.

The second part of the study consists of three scenarios in which you will be introduced to possible driver-assistance functions. Please evaluate the respective functions using the tables and indicate how much you agree or disagree with the statements.

In the third part of the study we would like find out about your ideas for possible driver assistance functions. At first we would like you to name functions which you find useful. Afterwards please specify how this function should be implemented.

The last part of the study consists of lists of implementations for driver assistance functions. We would like you to rate, and comment on and criticize these options.

Please be honest and answer all questions. There are no right or wrong answers, we only you're your opinion.

Thank you very much for your time and effort!

The eCoMove-Team

Basic Information

12. Age ___________________________

13. Gender ☐ male ☐ female

14. When did you obtain your driving license (year)?

____

15. What is your annual mileage (in km)?

☐ < 3.000 km ☐ 3001< 9.000 km ☐ 9001< 12.000 km
☐ 12001< 20.000 km ☐ 20001< 30.000 km ☐ 30001< 50.000 km
☐ > 50.000 km

16. How often do you use your vehicle?

☐ every day ☐ only on working days ☐ 3-4 times per week
☐ once a week ☐ 1-3 times per month ☐ less than once a month

17. What kind of vehicle (make and model) do you drive most frequently?

____

18. How would you describe your driving style?

☐ very erratic ☐ rather erratic ☐ rather anticipatory/smooth
☐ very anticipatory/smooth

19. For what kind of trip do you usually use the vehicle? (multiple choice)

☐ drive to work ☐ business trips / travelling salesman
☐ shopping, errands ☐ leisure activities (e.g. sports club)
☐ fetching children ☐ visiting friends and family
☐ others: ________________________

20. What is your highest school leaving certificate?

- ☐ no certificate
- ☐ elementary school
- ☐ secondary school
- ☐ college of higher education
- ☐ others: ______________________

21. What is your current occupational activity?

- ☐ employee
- ☐ worker
- ☐ freelancer
- ☐ public servant
- ☐ student
- ☐ pupil
- ☐ retiree
- ☐ houseman/housewife
- ☐ others: ______________________

22. Are you a professional driver?

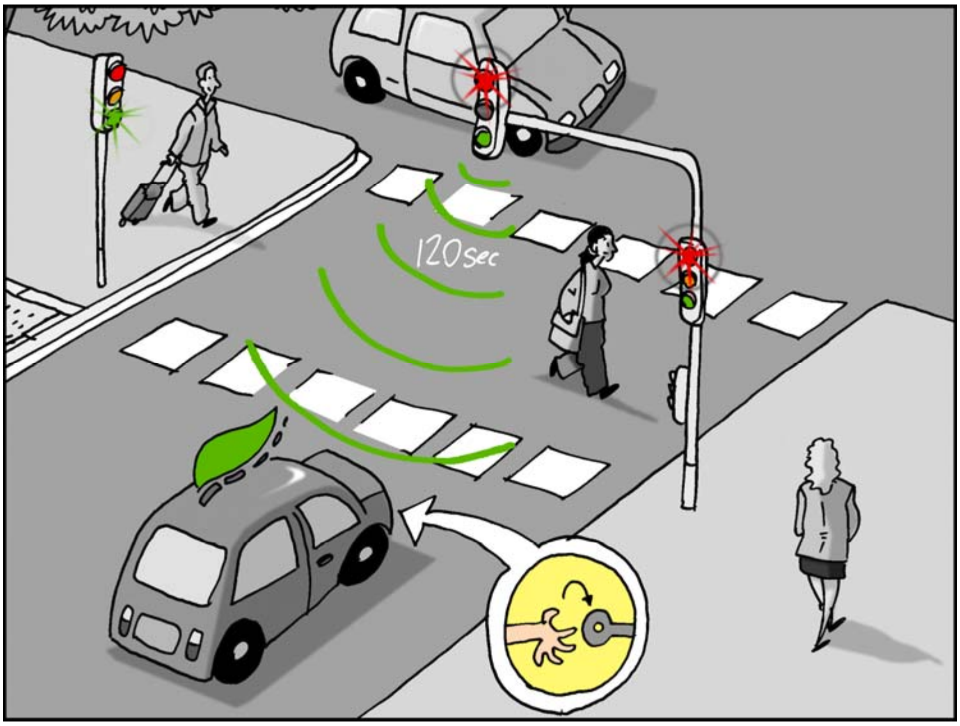
- ☐ yes
- ☐ no

Attitudes & Driving behaviour

		Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree
1	I drive on the left lane on motorways, as I drive faster than others anyway.	☐	☐	☐	☐	☐
2	When driving at very high velocities on the motorway I do not feel safe any more.	☐	☐	☐	☐	☐
3	During the last few years fuel prices have increased so much that I increasingly have to watch my fuel consumption.	☐	☐	☐	☐	☐
4	I do not like following a car that drives slower than the allowed speed-limit	☐	☐	☐	☐	☐
5	I brake and accelerate very dynamically.	☐	☐	☐	☐	☐
6	I drive slowly in order to reach my destination unstressed / comfortable.	☐	☐	☐	☐	☐
7	I drive faster than most of the other road users.	☐	☐	☐	☐	☐
8	I drive approx. 20 km/h faster than actually allowed.	☐	☐	☐	☐	☐
9	I adhere to the speed limit even though all other road users drive too fast.	☐	☐	☐	☐	☐
10	I love the feeling of freedom when accelerating on an empty motorway.	☐	☐	☐	☐	☐
11	I prefer sleeping longer in the morning and try to save time on my travel to work.	☐	☐	☐	☐	☐
12	On routes which I know well I try to set time records.	☐	☐	☐	☐	☐
13	I would describe my driving style as being defensive.	☐	☐	☐	☐	☐
14	As the environment is important to me, I check my fuel consumption regularly.	☐	☐	☐	☐	☐
15	If I want to pass a slower car on the highway, I take care that the road is not going uphill.	☐	☐	☐	☐	☐
16	If I go to an appointment, I use time buffers in order to compensate for traffic jams and other unforeseen events.	☐	☐	☐	☐	☐
17	For commuting I can only afford a small car with low fuel consumption.	☐	☐	☐	☐	☐

Driver assistance scenarios

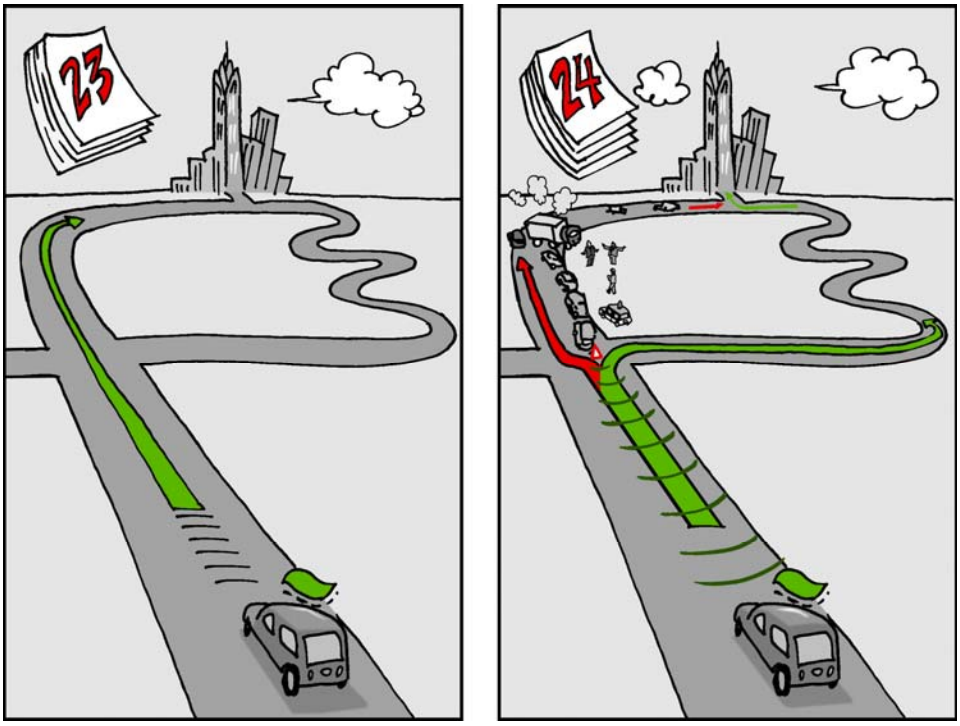
Scenario 1: Please imagine that you own a car with a new driver assistance system. This system receives information about waiting times at traffic lights and obstacles. Based on this information the system might recommend turning off the engine in order to optimise fuel consumption.



Please rate the system explained in the scenario by reading every statement for every line and indicate how much you agree or disagree with it.

The function …	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree
… is superfluous	☐	☐	☐	☐	☐
… enhances environmentally friendly driving	☐	☐	☐	☐	☐
… supports me	☐	☐	☐	☐	☐
… improves my driving behavior	☐	☐	☐	☐	☐
… is desirable	☐	☐	☐	☐	☐
… limits my driving freedom	☐	☐	☐	☐	☐
… is helpful	☐	☐	☐	☐	☐
… matches my attitude	☐	☐	☐	☐	☐
… is useless	☐	☐	☐	☐	☐

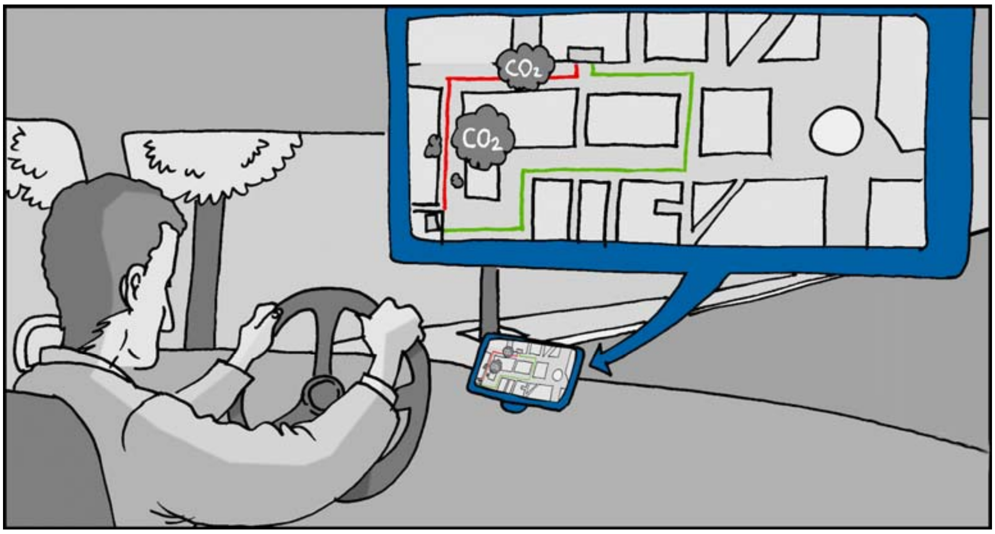
Scenario 2: Please imagine that you own a car with a new driver assistance system. This system receives on-line information about closed and congested routes. If a specific route is affected several times, the driver assistance system will memorise it and classify this route as being inefficient. By doing so, it can suggest the best alternative route which will lead to time savings for you.



Please rate the system explained in the scenario by reading every statement for every line and indicate how much you agree or disagree with it.

The function …	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree
… is superfluous	☐	☐	☐	☐	☐
… enhances environmentally friendly driving	☐	☐	☐	☐	☐
… supports me	☐	☐	☐	☐	☐
… improves my driving behavior	☐	☐	☐	☐	☐
… is desirable	☐	☐	☐	☐	☐
… limits my driving freedom	☐	☐	☐	☐	☐
… is helpful	☐	☐	☐	☐	☐
… matches my attitude	☐	☐	☐	☐	☐
… is useless	☐	☐	☐	☐	☐

Scenario 3: Please imagine that you own a car with a new driver assistance system. Before each drive the system will provide the most up-to date information about Co^2 emissions on your preferred route. If your plans are affected it will be indicated on your map. Based on this information, the system will provide suggestions for avoiding this route. This lessons environmental pollution in areas with a high volume of traffic.



Please rate the system explained in the scenario by reading every statement for every line and indicate how much you agree or disagree with it.

The function …	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree
… is superfluous					
… enhances environmentally friendly driving					
… supports me					
… improves my driving behavior					
… is desirable					
… limits my driving freedom					
… is helpful					
… matches my attitude					
… is useless					

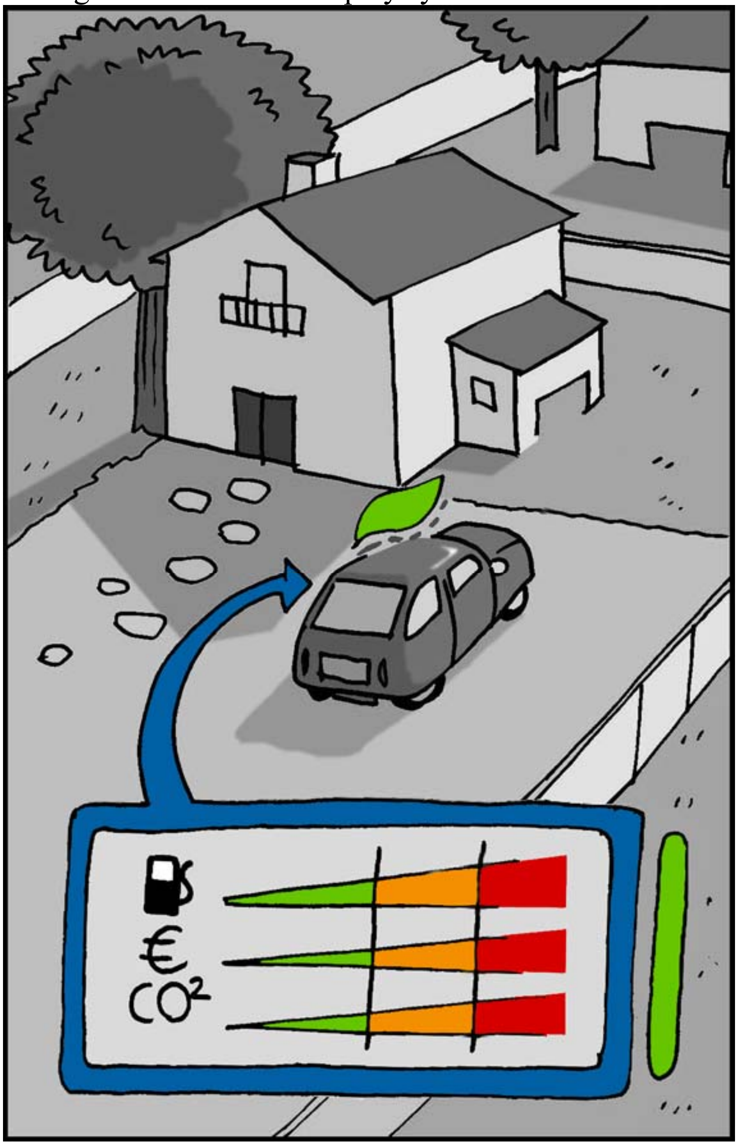
Interview

Now we would like to ask you to think about assistance functions that you personally find interesting. Please describe this function and why you think it is helpful.

Based on your description of an assistance function we would like to ask about the implementation of that function. Please be as specific as possible, i.e. please indicate which modality (visual, auditory, haptic or else) and other design options.

Intelligent vehicle information system (IVIS)

Please imagine having a vehicle which displays your current fuel consumption.

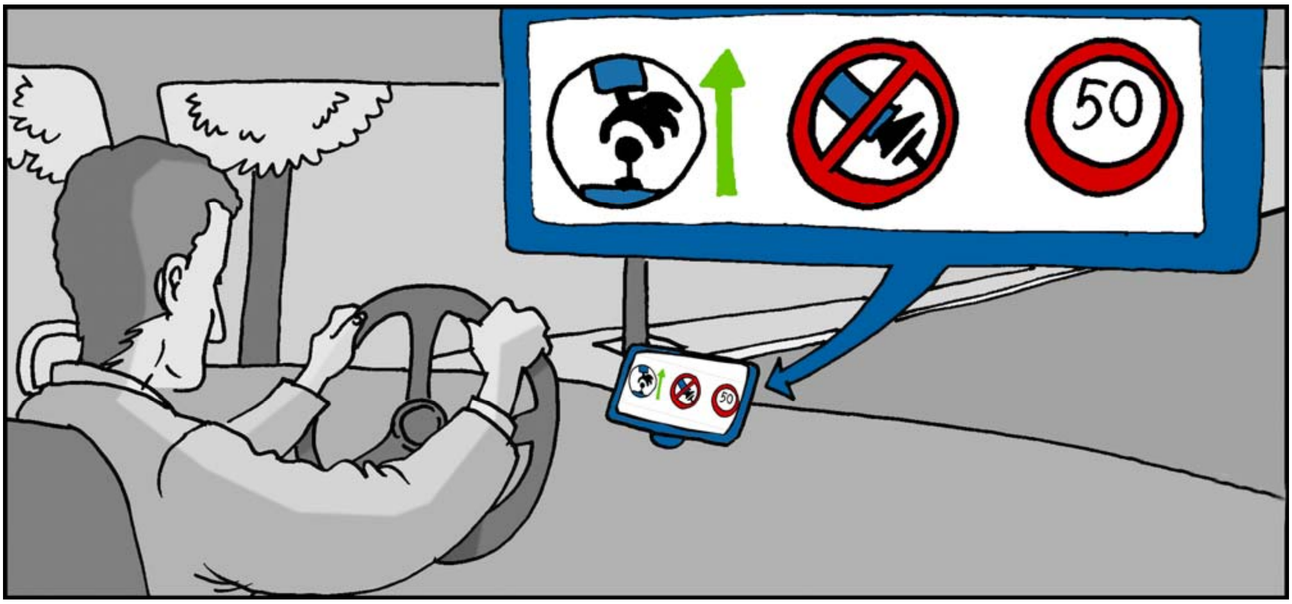


In the following table you see several options of a driver assistance system. Please try to picture them as much as possible and evaluate them. Please also comment and criticise them and provide ideas on how to improve them.

Intelligent vehicle information system	Not useful	Less useful	Neither nor	More useful	Very useful	commentary/design suggestion/ranking
Display of current consumption rate (green, yellow, red)	☐	☐	☐	☐	☐	
Auditory/visual consumption display	☐	☐	☐	☐	☐	
Display of possible savings based on kilometers	☐	☐	☐	☐	☐	
Consumption display based on driving profile	☐	☐	☐	☐	☐	
Digital light display (green to red)	☐	☐	☐	☐	☐	
Lights above the speedometer that shows the consumption rate	☐	☐	☐	☐	☐	
Display of the monetary savings	☐	☐	☐	☐	☐	
Display of a consumption-diary	☐	☐	☐	☐	☐	
Display consumption/time	☐	☐	☐	☐	☐	
Display of consumption savings compared to the last gas tank	☐	☐	☐	☐	☐	

Intelligent advanced driver assistance system (iADAS)

Please imagine having a vehicle which displays suggestions about fuel-optimised driving behaviour or automatically intervenes to ensure optimised driving.

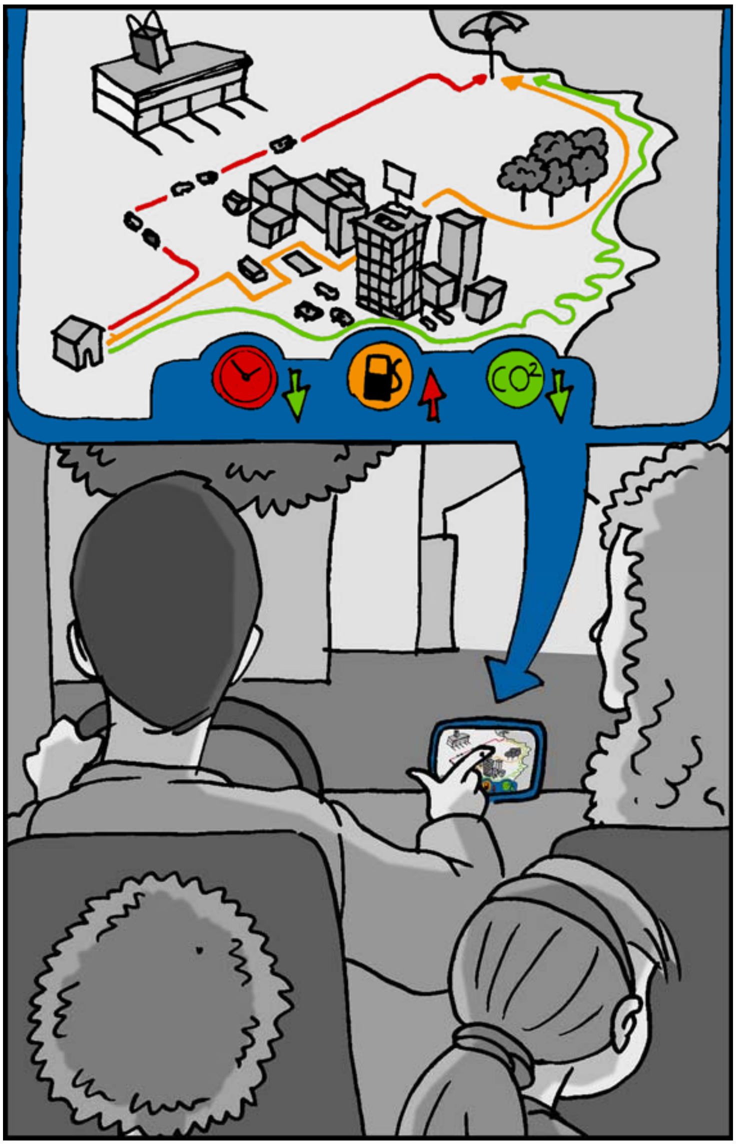


In the following table you see several options of a driver assistance system. Please try to picture them as much as possible and evaluate them. Please also comment and criticise them and provide ideas on how to improve them.

Intelligent driver assistance system	Not useful	Less useful	Neither nor	More useful	Very useful	commentary/design suggestion/ranking
Display of the optimal gear	☐	☐	☐	☐	☐	
Display of the optimal time to shift gears	☐	☐	☐	☐	☐	
Motor engine adapting to a driving profile	☐	☐	☐	☐	☐	
Display of the current driving style	☐	☐	☐	☐	☐	
Warning based on the driving behavior	☐	☐	☐	☐	☐	
Comparison of current versus optimal driving style	☐	☐	☐	☐	☐	
Automatic gear changing based on optimal gear	☐	☐	☐	☐	☐	
Active gaspedal	☐	☐	☐	☐	☐	
Information about usage of additional systems	☐	☐	☐	☐	☐	
System that automatically turns off the engine	☐	☐	☐	☐	☐	

Intelligent Navigation system (iNavi)

Please imagine having a vehicle which has an intelligent navigation system. It provides suggestions for optimizing your route.

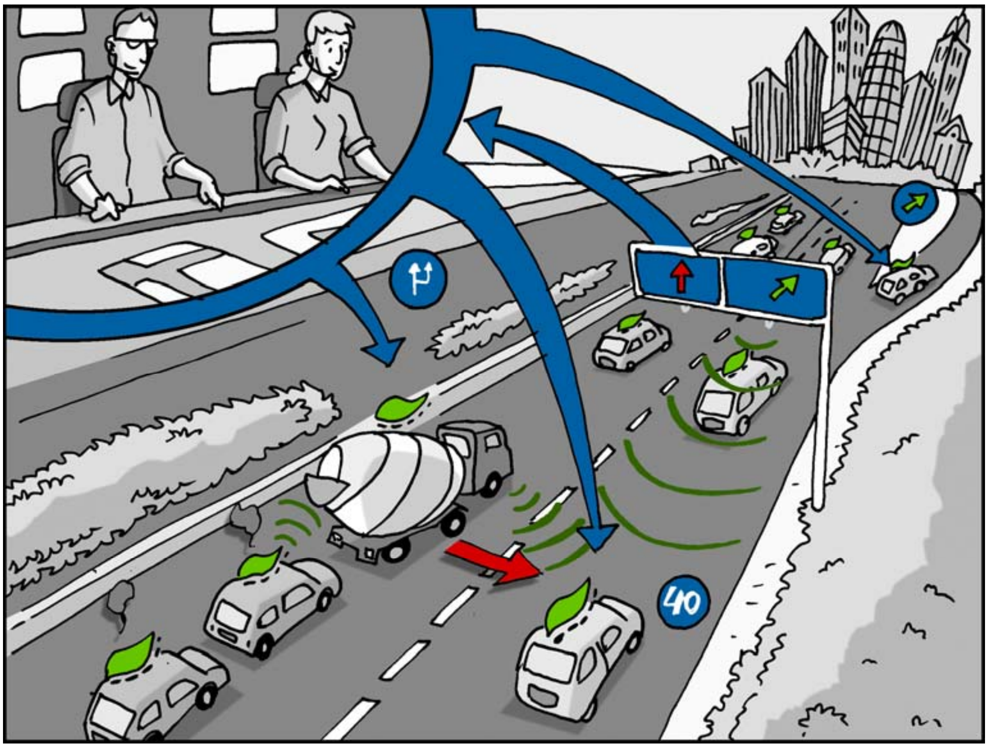


In the following table you see several options of a driver assistance system. Please try to picture them as much as possible and evaluate them. Please also comment and criticise them and provide ideas on how to improve them.

Intelligent navigation system	**Not useful**	**Less useful**	**Neither nor**	**More useful**	**Very useful**	**commentary/design suggestion/ranking**
Route planning based on driving behavior	☐	☐	☐	☐	☐	
Display of upcoming curves, traffic lights etc.	☐	☐	☐	☐	☐	
Traffic- and situational adaptive navigation	☐	☐	☐	☐	☐	
Display of the topography of the route	☐	☐	☐	☐	☐	
Route suggestions based on possible savings	☐	☐	☐	☐	☐	
Route planning based on the purpose of the drive	☐	☐	☐	☐	☐	

Intelligent traffic management (iTM)

Please imagine having a vehicle with a system that communicates directly with an intelligent traffic management center. This allows for the system to display information about your route.



In the following table you see several options of a driver assistance system. Please try to picture them as much as possible and evaluate them.

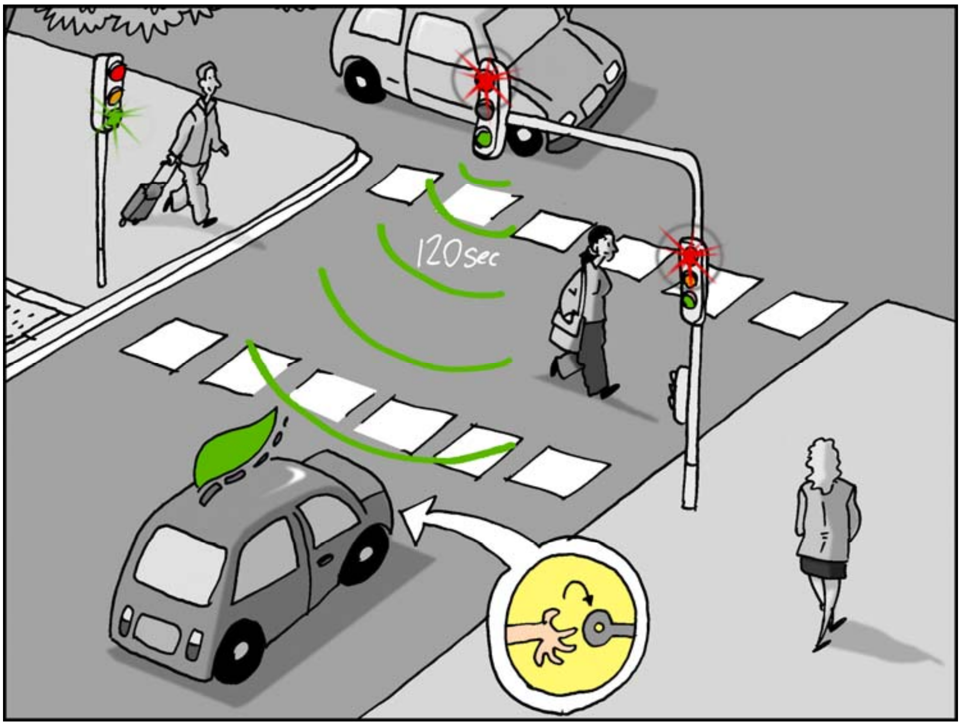
Please also comment and criticise them and provide ideas on how to improve them.

Intelligent traffic management	Not useful	Less useful	Neither nor	More useful	Very useful	commentary/design suggestion/ranking
Suggestions for optimal speed and routes	☐	☐	☐	☐	☐	
Improving traffic flow (e.g. through traffic lights)	☐	☐	☐	☐	☐	
Improve park-and-ride and public transportation	☐	☐	☐	☐	☐	
Dynamic navigation to stay in the traffic flow	☐	☐	☐	☐	☐	
Timely information about obstacles, rerouting and traffic flow	☐	☐	☐	☐	☐	
Traffic lights with integrated display about waiting time	☐	☐	☐	☐	☐	
Timely information about local speed limits	☐	☐	☐	☐	☐	

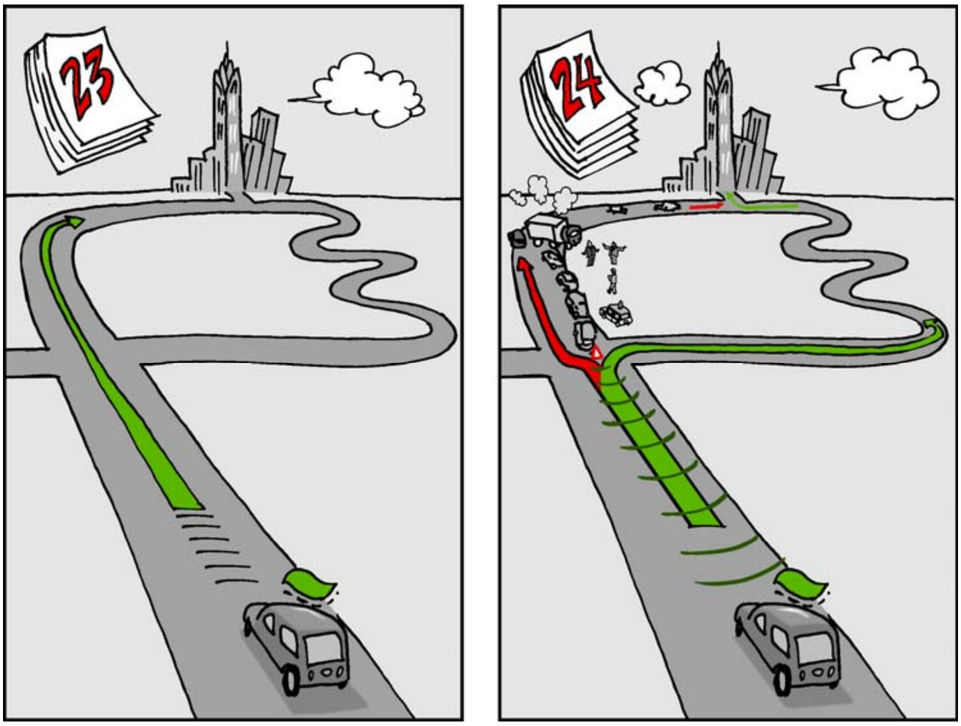
Thank you very much for your participation!

Annex 8: Scenario graphics

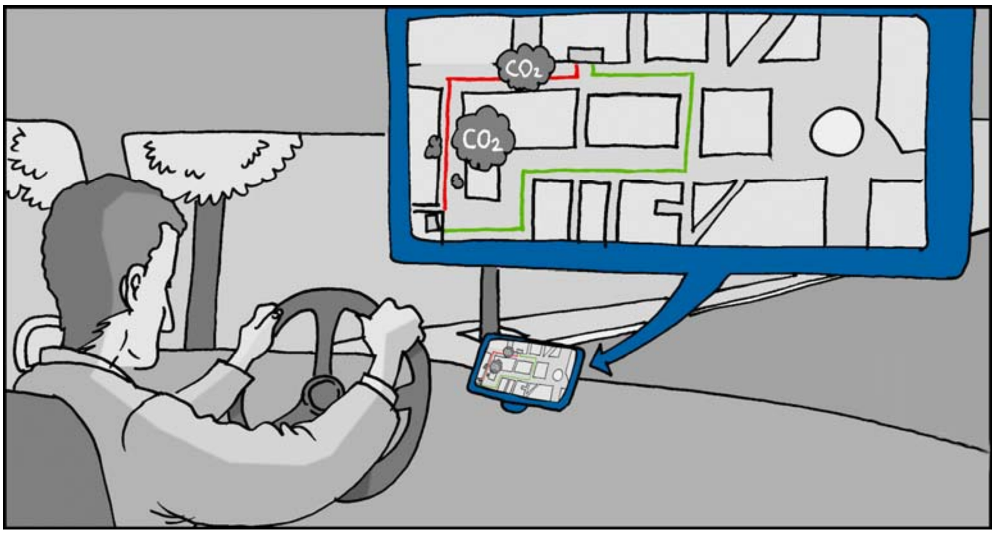
Scenario 1: consumption



Scenario 2: time



Scenario 3: environment



Annex 9: Participants characteristics concerning annual mileage and trip purposes

Table1: frequencies of annual mileage

annual mileage	absolute frequency	percentage frequency	cumulative percentage
< 3000 km	3	16,7	16,7
3001-9000 km	4	22,2	38,9
9001-12000 km	3	16,7	55,6
12001-20000 km	3	16,7	72,2
20001-30000 km	4	22,2	94,4
30001-50000 km	1	5,6	100

Table 2: frequencies of trip purposes

trip purpose	absoute frequency	percentage frequency
drive to work	10	55,6
business trips/ travelling salesman	1	5,6
shopping/errands	16	88,9
leisure activities	14	77,8
pick-up children	1	5,6
visiting friends/family	15	83,3
others	2	11,1

Annex 10: descriptive values for the ANOVAS / t-tests

Table 1: descriptive values for the annual mileage group and the motive time

	N	mean	std. deviation	minimum	maximum
≤ 9000 km	7	2.80	.25	2.54	3.31
9001-20000 km	6	3.01	.29	2.54	3.38
≥ 20000 km	5	3.14	.20	2.92	3.38
Total	18	2.97	.28	2.54	3.38

Table 2: descriptive values for age group and the motive time

	N	mean	std. deviation	minimum	maximum
18 - 24	5	3.17	.27	2.77	3.38
25 - 64	7	3.01	.21	2.69	3.31
> 65	6	2.74	.22	2.54	3.08
total	18	2.97	.28	2.54	3.38

Table 3: descriptive values for the factor trip purpose / drive to work and the motive time

	N	mean	std. deviation	minimum	maximum
not mentioned	8	2.84	.25	2.54	3.31
mentioned	10	3.07	.26	2.54	3.38
total	18	2.97	.28	2.54	3.38

Table 4: descriptive values for the vehicle group and the motive environment

	N	mean	std. deviation	minimum	maximum
small vehicle	9	2.96	.72	2	4
middle-class/van	8	2.17	.44	1.33	2.67
total	18	2.52	.75	1.33	4

Annex 11: Results concerning the driving scenarios matched to the three motives

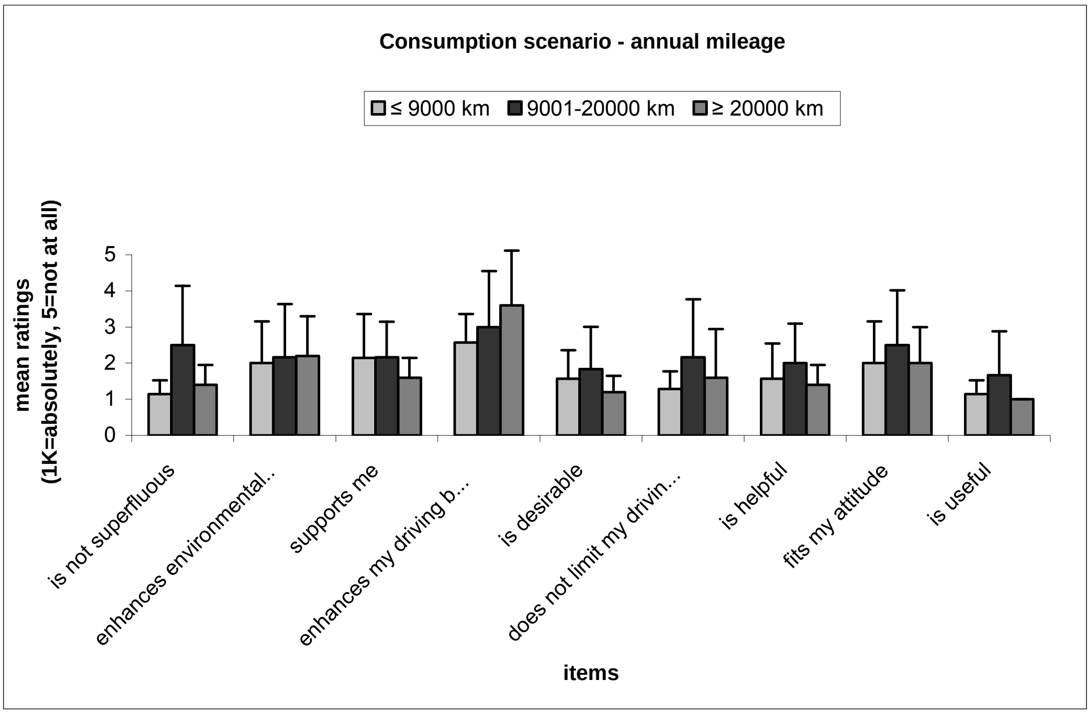


Figure A: descriptive values for the consumption scenario and the annual mileage groups

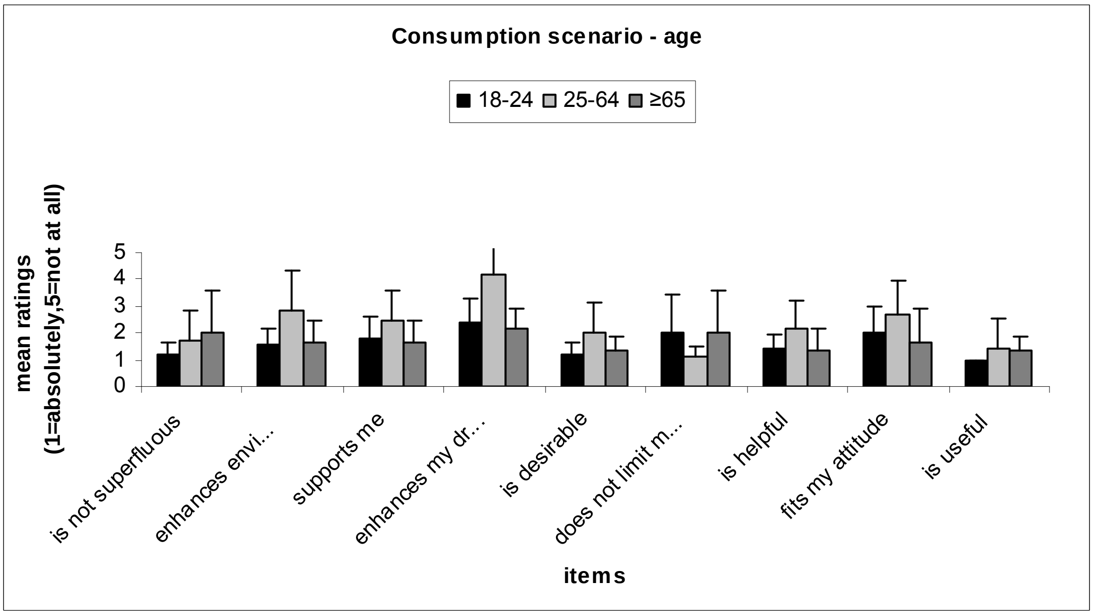


Figure B: descriptive values for the consumption scenario and the age groups

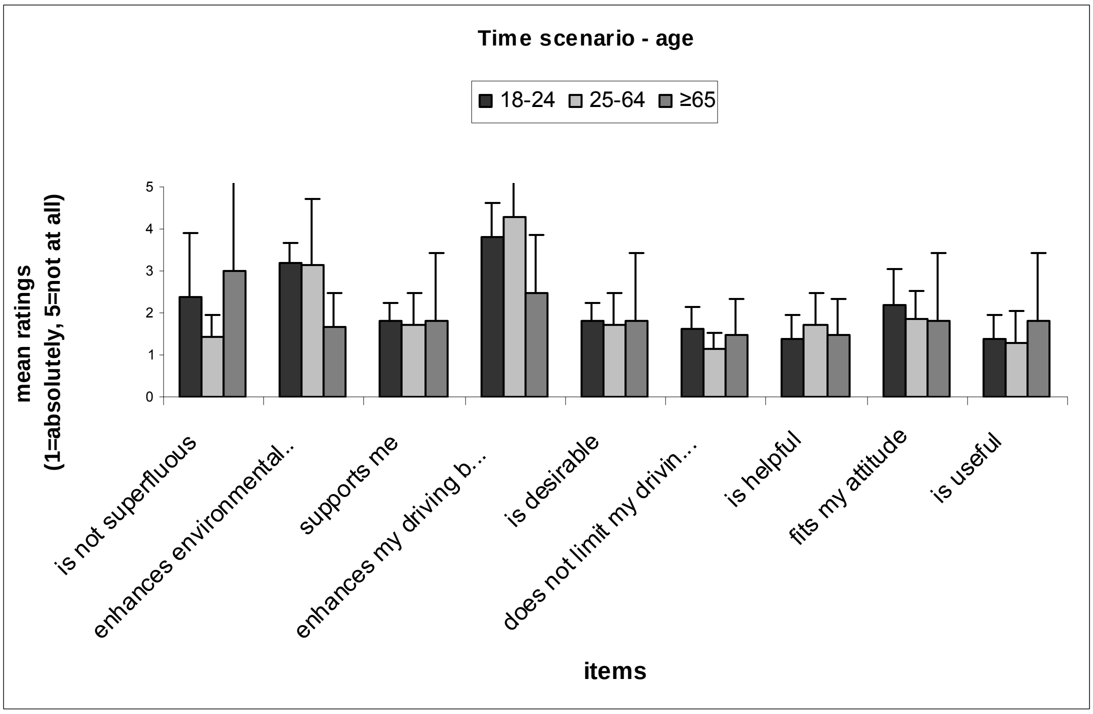


Figure C: descriptive values for the time scenario and the age groups

Fehler! Keine gültige Verknüpfung.Figure D: descriptive values for the environment scenario and the annual mileage groups

Fehler! Keine gültige Verknüpfung.Figure E: descriptive values for the environment scenario and the age groups

Annex 12: Results of the ratings of the specific options for the four systems

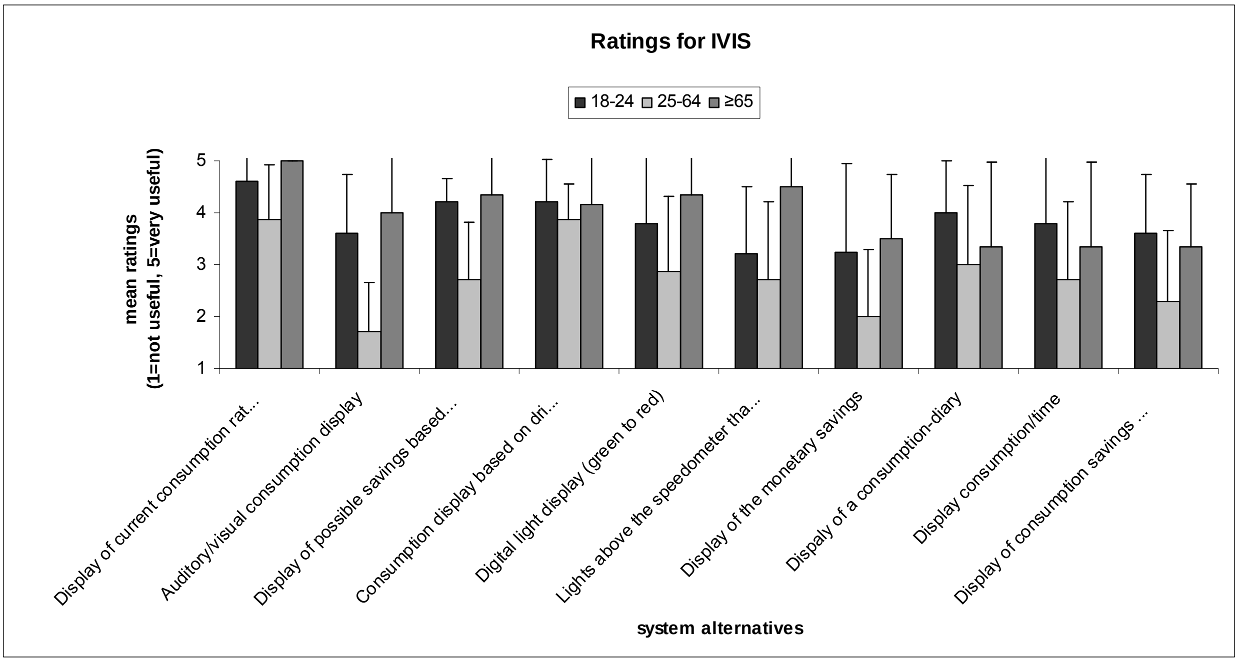


Figure F: descriptive values of the ratings for the IVIS options for the age groups

Fehler! Keine gültige Verknüpfung.

Figure G: descriptive values of the ratings for the iADAS options for the age groups

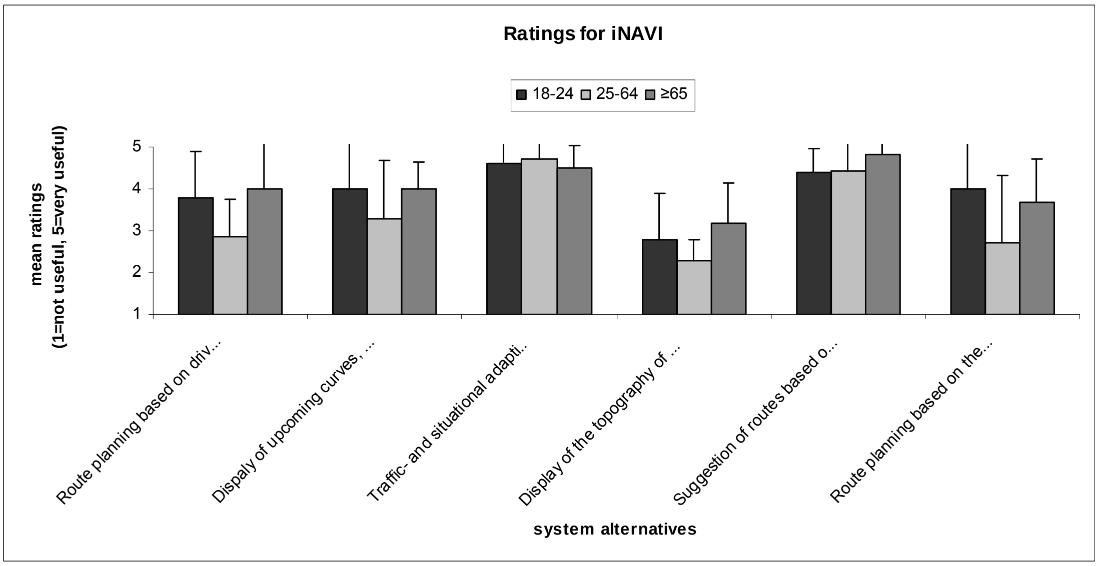


Figure H: descriptive values of the ratings for the iNAVI options for the age groups

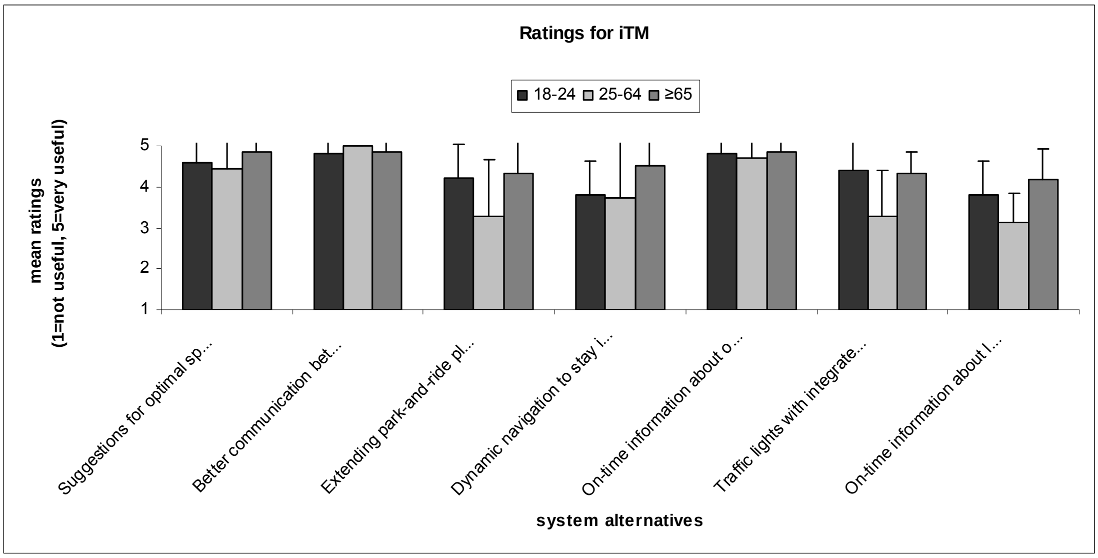


Figure I: descriptive values of the ratings for the iTM options for the age groups

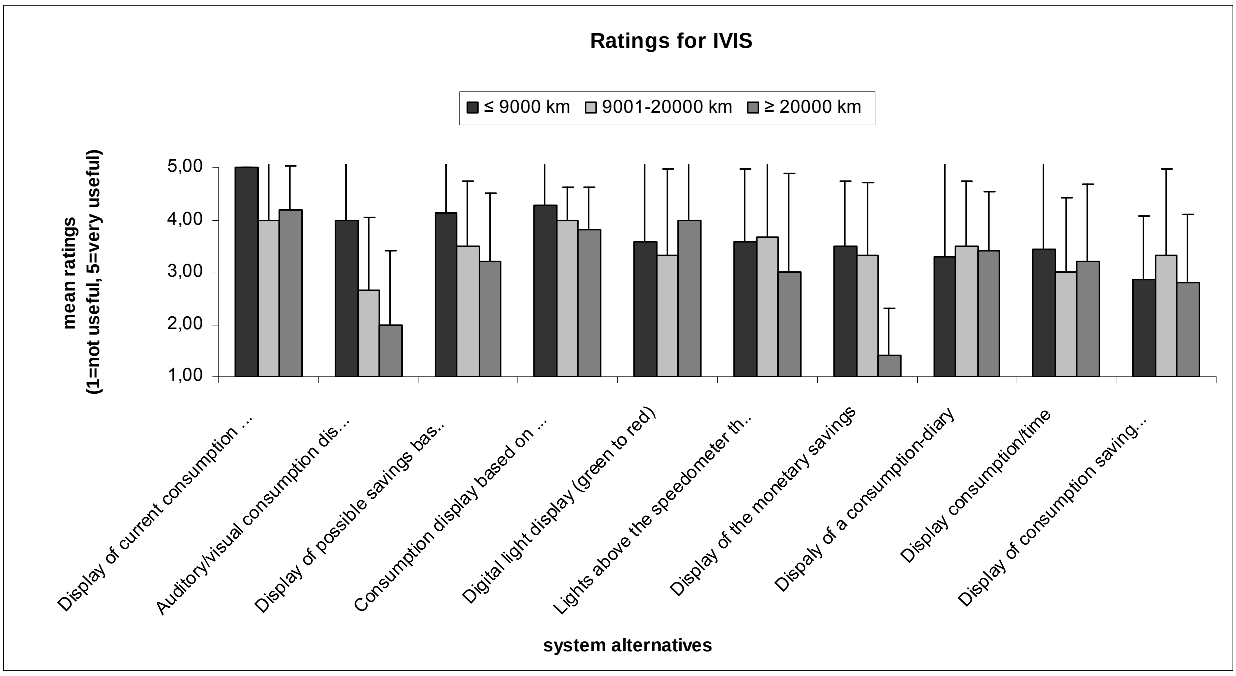


Figure J: descriptive values of the ratings for the IVIS options for the annual mileage groups

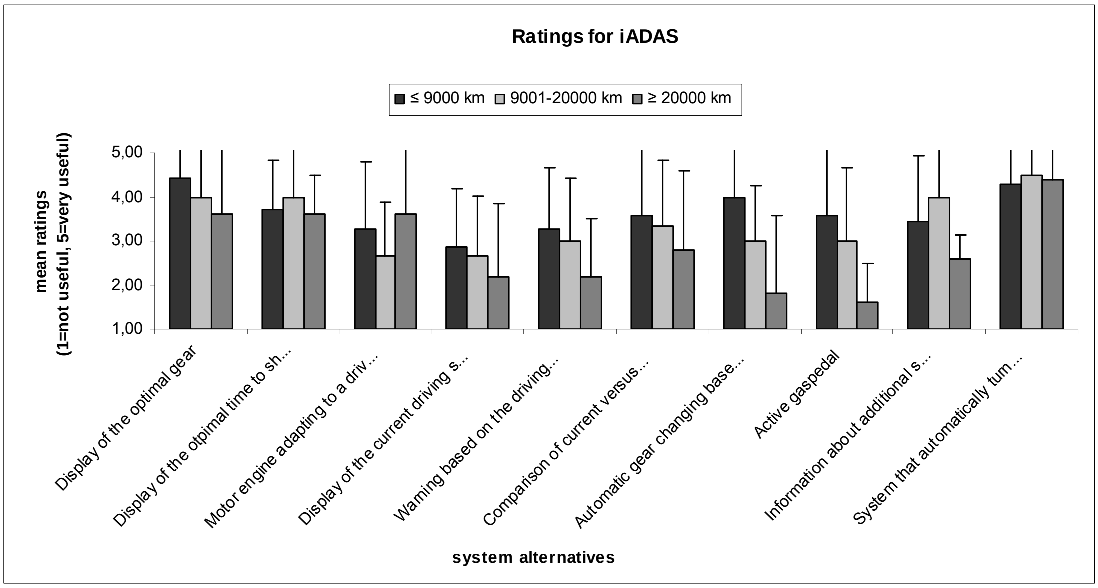


Figure K: descriptive values of the ratings for the iADAS options for the annual mileage groups

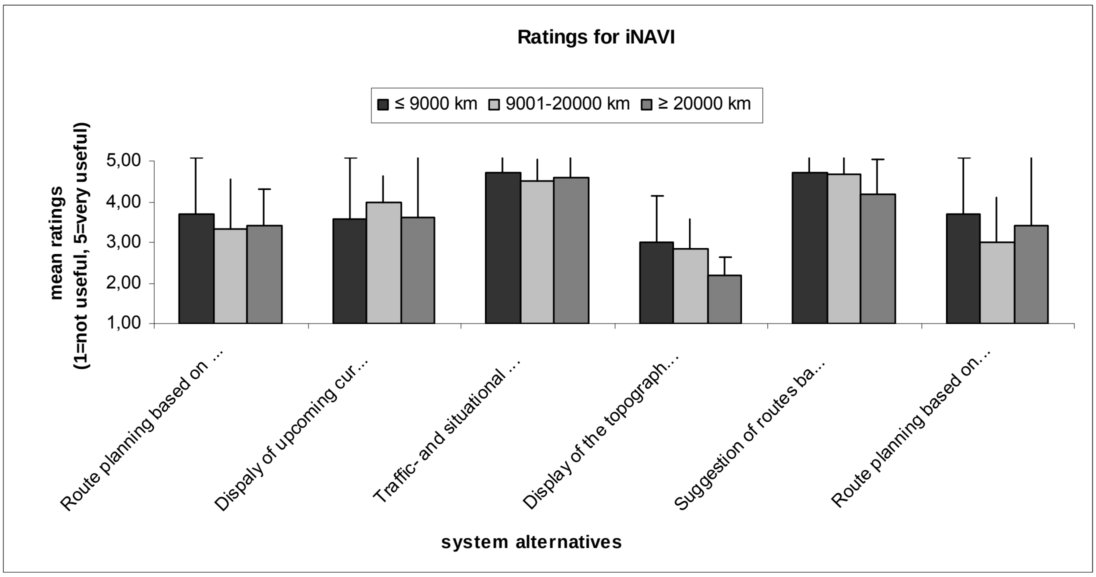


Figure L: descriptive values of the ratings for the iNAVI options for the annual mileage groups

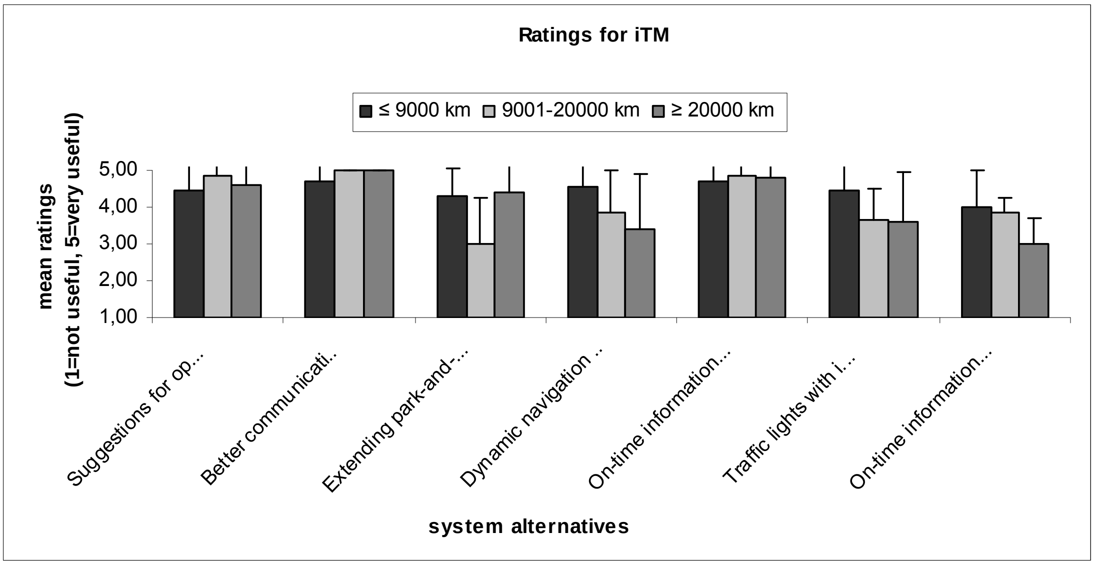


Figure M: descriptive values of the ratings for the iTM options for the annual mileage groups

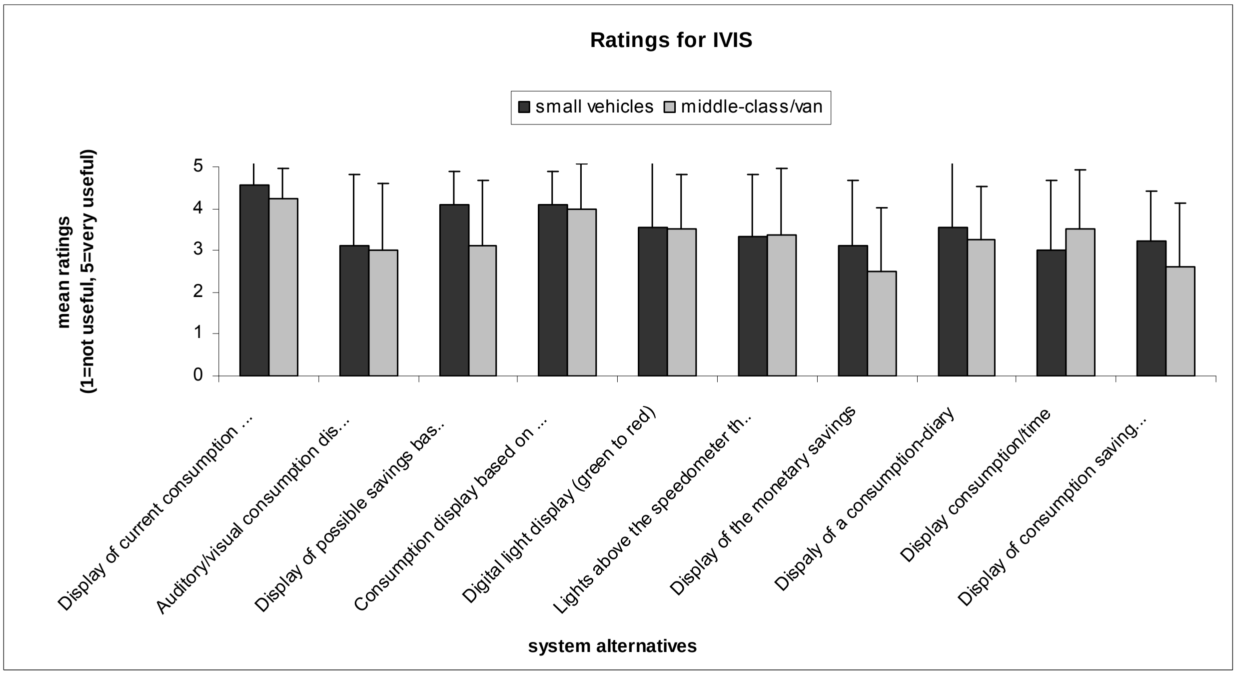


Figure N: descriptive values of the ratings for the IVIS options for the vehicle model groups

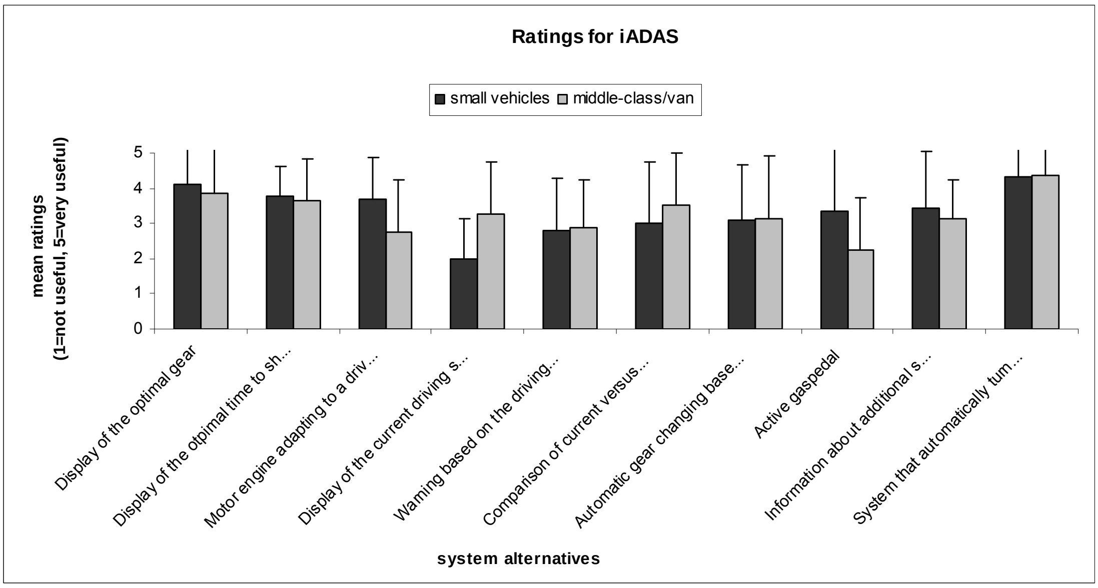


Figure O: descriptive values of the ratings for the iADAS options for the vehicle model groups

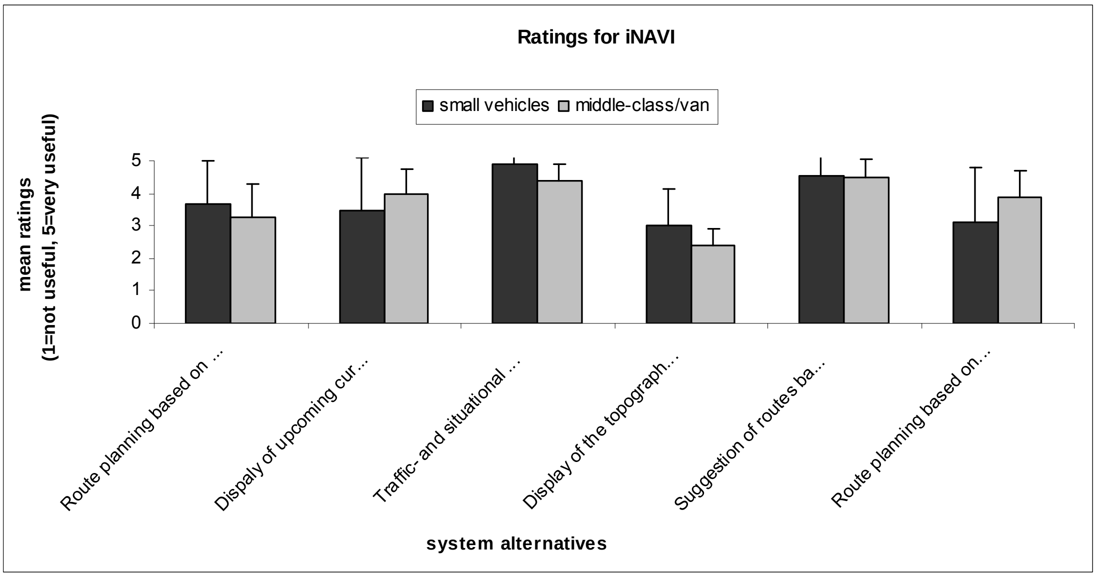


Figure P: descriptive values of the ratings for the iNAVI options for the vehicle model groups

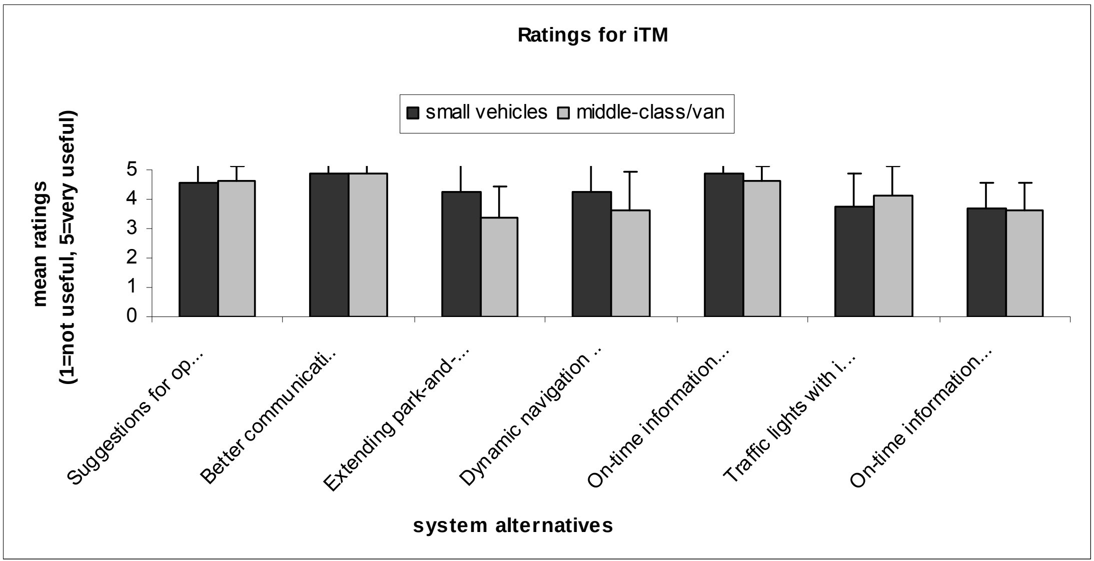


Figure Q: descriptive values of the ratings for the iTM options for the vehicle model groups

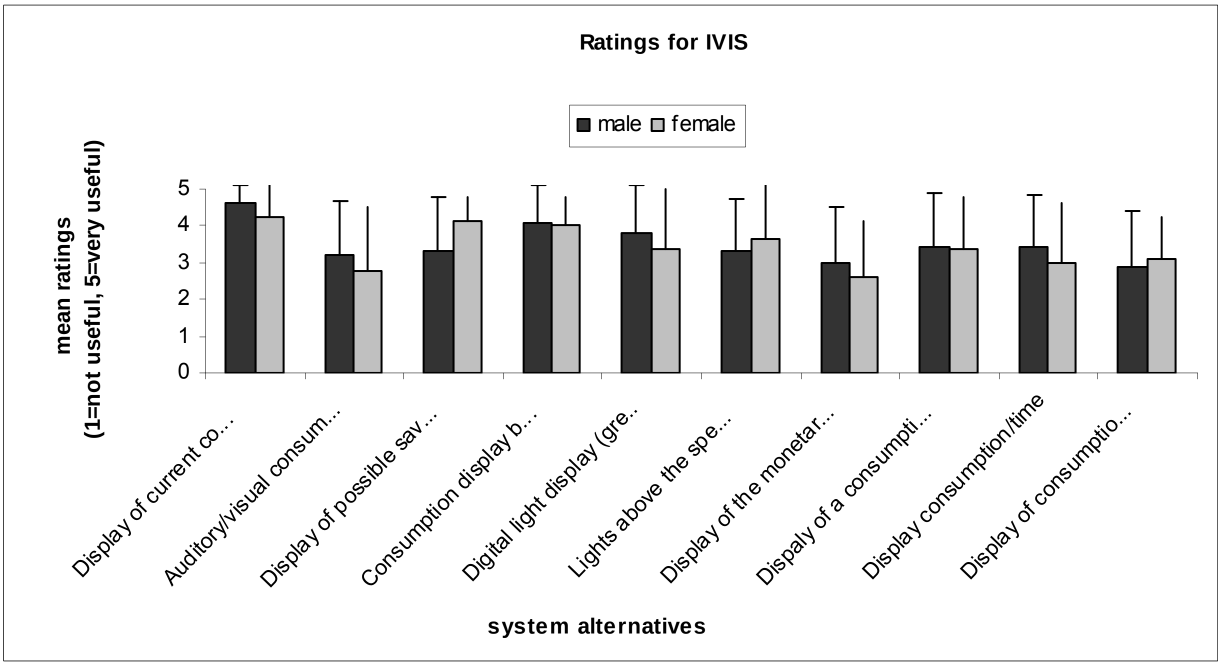


Figure R: descriptive values of the ratings for the IVIS options for the sex groups

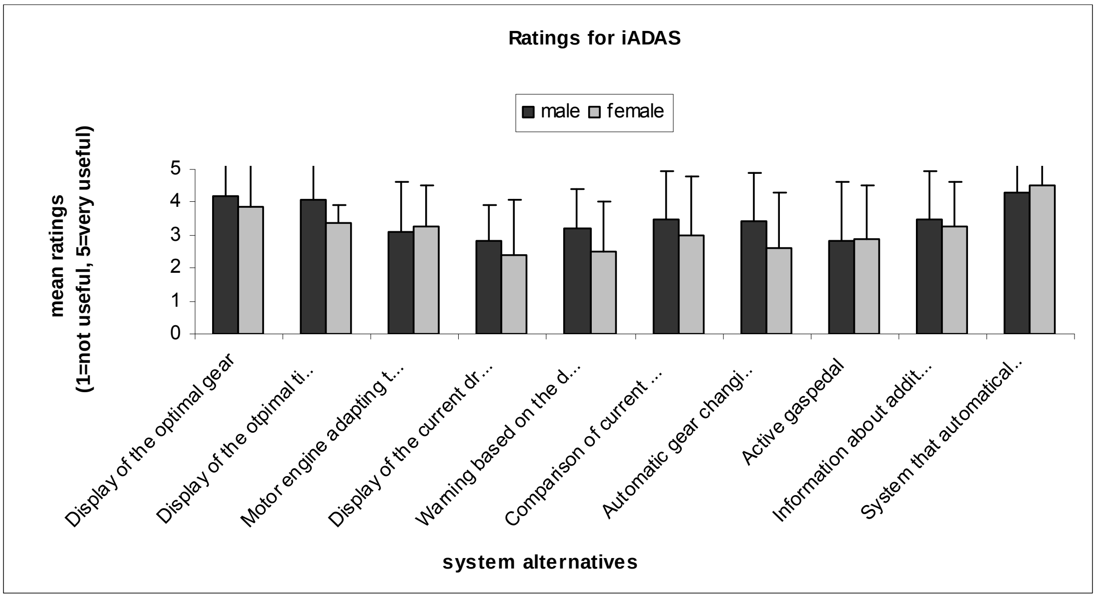


Figure S: descriptive values of the ratings for the iADAS options for the sex groups

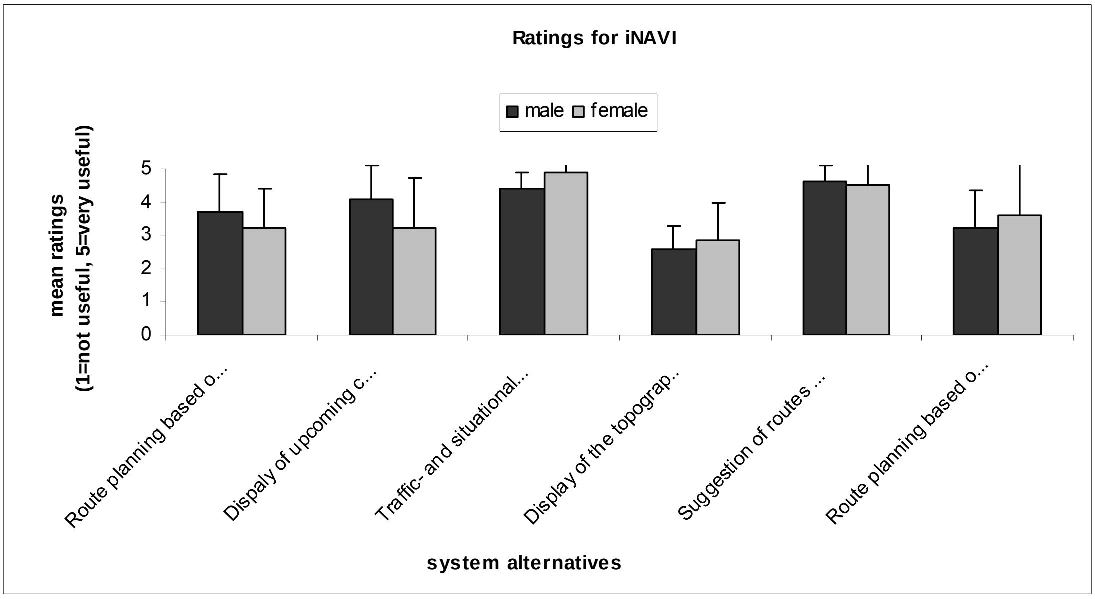


Figure T: descriptive values of the ratings for the iNAVI options for the sex groups

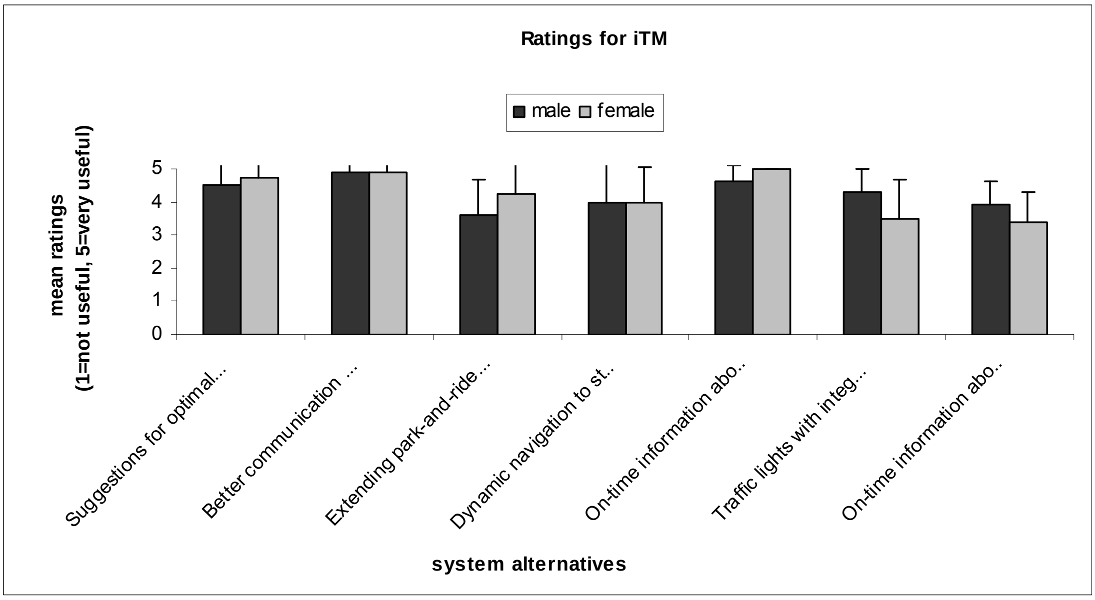


Figure U: descriptive values of the ratings for the iTM options for the sex groups

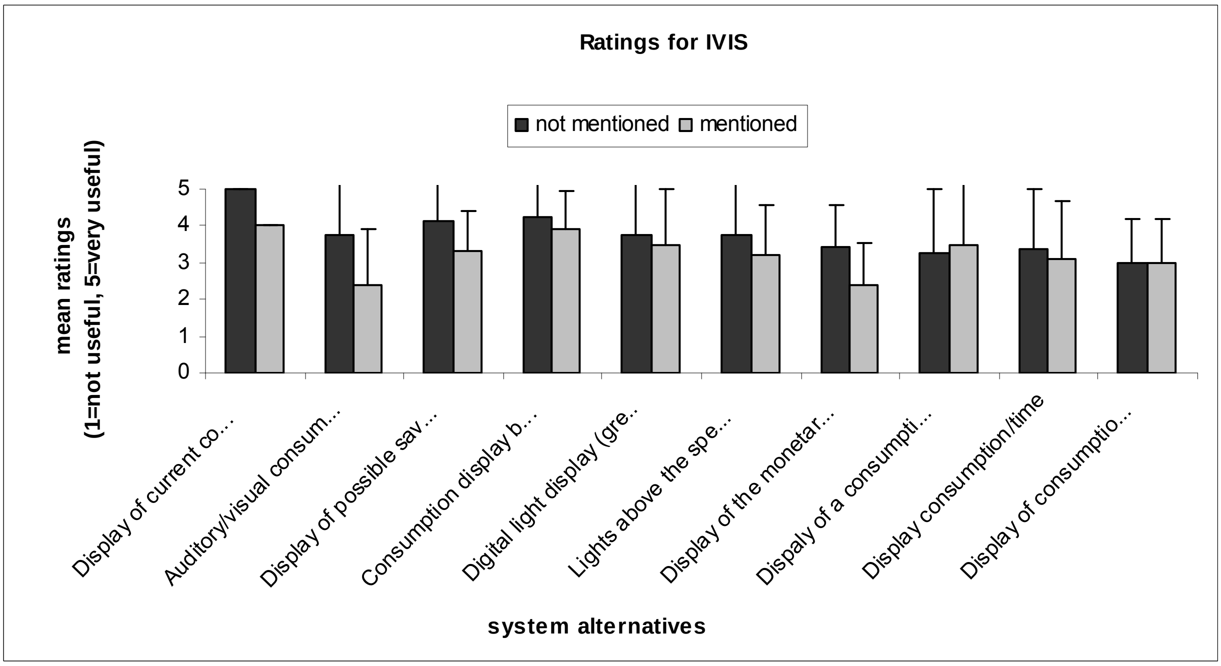


Figure V: descriptive values of the ratings for the IVIS options for the trip purpose – drive to work

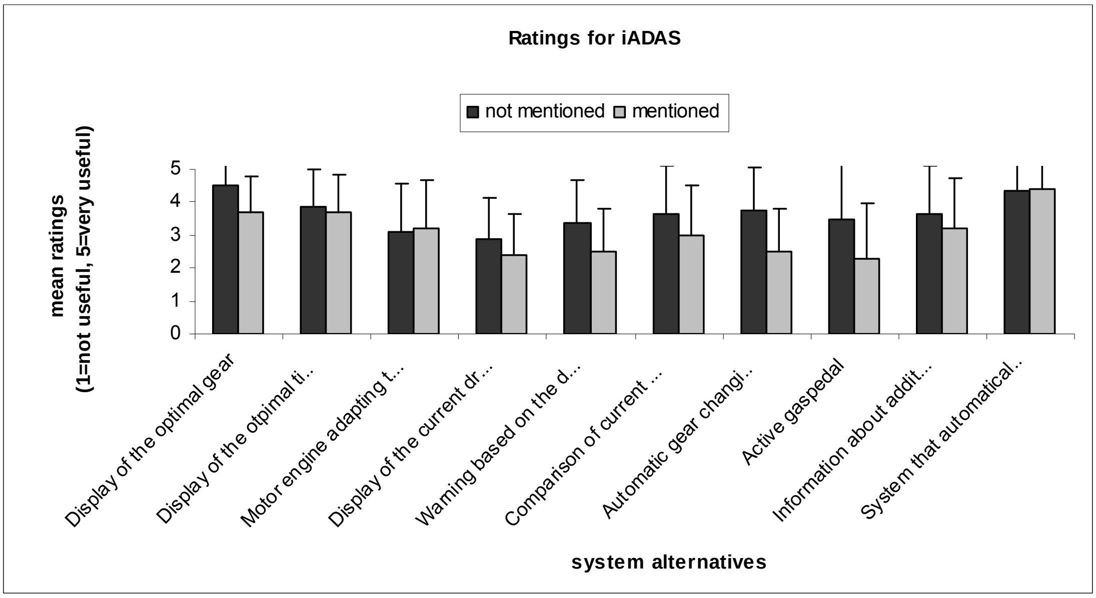


Figure W: descriptive values of the ratings for the iADAS options for the trip purpose – drive to work

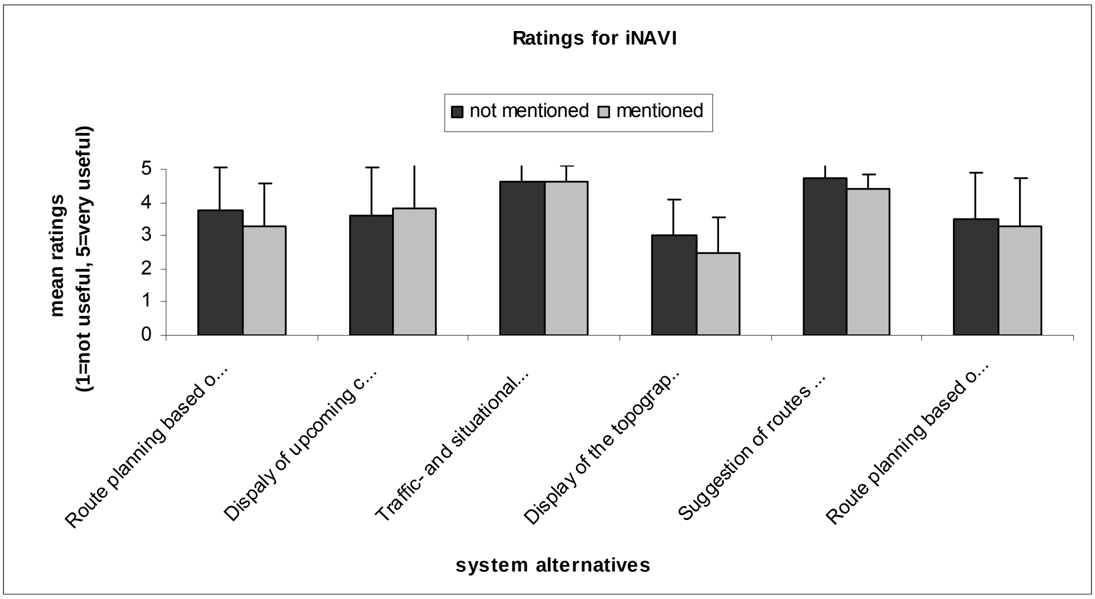


Figure x: descriptive values of the ratings for the iNAVI options for the trip purpose – drive to work

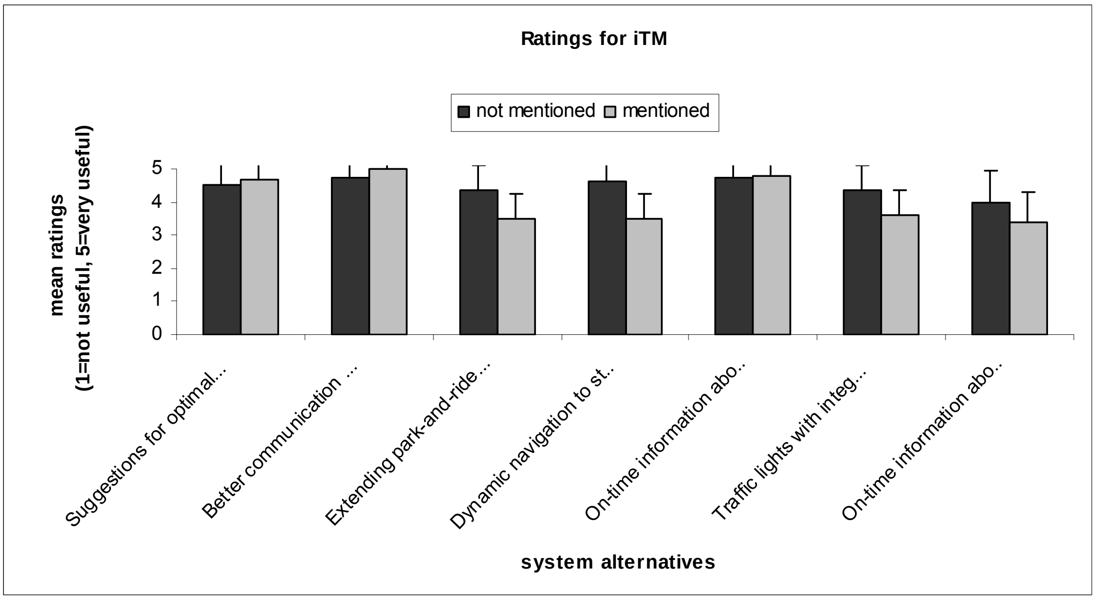


Figure Y: descriptive values of the ratings for the iTM options for the trip purpose – drive to work

Annex 13: Rankings of the four systems

Table 1: rankings for the IVIS consumption displays

	Ranking 1	Ranking 2	Ranking 3	Total
Display of current consumption rate (green, yellow, red)	8	2	3	13
Digital light display (green to red)	3	4	2	9
Auditory/visual consumption display	3	2	1	6
Lights above the speedometer that shows the consumption rate	3	1	2	6
Consumption display based on driving profile	1	6	4	11
Display of a consumption-diary	1	2	1	4
Display of the monetary savings	1	2	0	3
Display of consumption savings compared to the last gas tank	1	2	0	3
Display consumption/time	0	3	3	6
Display of possible savings based on kilometers	0	3	2	5

Table 2: rankings for the iADAS

	Ranking 1	Ranking 2	Ranking 3	Total
System that automatically turns off the engine	6	4	2	12
Display of the optimal gear	4	4	2	10
Information about usage of additional systems	2	2	3	7
Warning based on the driving behavior	2	2	1	5
Motor engine adapting to a driving profile	2	2	0	4
Display of the optimal time to shift gears	1	5	2	8
Automatic gear changing based on optimal gear	1	2	3	6
Comparison of current versus optimal driving style	1	2	1	4
Display of the current driving style	0	2	2	4
Active gaspedal	0	1	2	3

Table 3: rankings for iNavi

	Ranking 1	Ranking 2	Ranking 3	Total
Traffic- and situational adaptive navigation	7	5	4	16
Route suggestions based on possible savings	6	7	3	16
Route planning based on the purpose of the drive	4	1	3	8
Display of upcoming curves, traffic lights etc.	3	2	2	7
Route planning based on driving behaviour	1	1	4	6
Display of the topography of the route	0	1	1	2

Table 4: rankings for the iTM

	Ranking 1	Ranking 2	Ranking 3	Total
Suggestions for optimal speed and routes	8	3	1	12
Improving traffic flow (e.g. through traffic lights)	5	6	4	15
Dynamic navigation to stay in the traffic flow	2	1	4	7
Traffic lights with integrated display about waiting time	1	3	1	5
Improve park-and-ride and public transportation	1	1	0	2
Timely information about obstacles, rerouting and traffic flow	0	6	6	12
Timely information about local speed limits	0	2	1	3

Annex 14: Results of the interviews

Table 1: Frequency of categorized comments about specific applications

Category	absolute frequency	percentage frequency
iADAS	16	88.89
IVIS	12	66.67
iNavi	8	44.44
Start-Stop mode SSM	7	38.89
iTM	6	33.33
Post-trip evaluation	5	27.78
Synchronized traffic lights	4	22.22

Table 2: frequency of categorised comments about specific implementations

	absolute frequency	percentage frequency
Information	15	83.33
Visual	11	61.11
No Auditory	6	33.33
Intervention	5	27.78
Auditory	5	27.78
Symbols instead of Text	4	22.22
Support	2	11.11
Haptic	1	5.56
No visual - blinking	1	5.56

Questionnaire: eCoMove

Dear Participant,

This questionnaire is an action in the EU-funded project eCoMove. The purpose of eCoMove is to reduce the emission of CO_2 (carbon dioxide) from vehicles. The overall issue is to limit the causes of climate change. The matters that are dealt with in this project can also benefit the transport industry as well as individual fleets, for example by improving the conditions to reduce fuel consumption and fuel costs.

In this phase of the project, user requirements are collected through a series of surveys. Using the following questionnaire we would like to gather information about your driving style and your ideas on fuel efficient driving. This is not a test on fuel efficiency. We are interested in your own opinions about different factors that have direct and indirect influence on driving behaviour and fuel consumption, so do not be afraid you might give "incorrect" answers.

Your input is important and we would greatly appreciate you filling in this questionnaire!

Filling in this questionnaire will take approximately 10 minutes of your time.

All information will be treated confidentially and analysed anonymously.

You can find further information about the project on our website: www.ecomove-project.eu

Thank you very much for your participation!

Basic information

1. Age: ____
2. Gender: Male ☐
   i. Female ☐
3. Nationality ____
4. Nationality of the truck company______________________________
5. How many trucks in the company?
   a. less than 10 ☐
   b. 11-50 ☐
   c. 51-100 ☐
   d. more than 100 ☐
   e. don't know ☐
6. How many years of experience do you have as a truck driver? _______
7. What is your field of work
   a. Distribution ☐
   b. Long haul ☐
   c. Construction ☐
   d. Other _________________________
8. What is the brand of your truck that you drive most often?
9. ☐ DAF ☐ Volvo ☐ Mercedes ☐ Scania
10. ☐ Renault ☐ MAN ☐ Iveco ☐ Other________
11. What is your trucks year of production? __________
12. What is the loading capacity of your vehicle?
    a. less than 3,5t ☐
    b. 3,5t – 7,5t ☐
    c. 7,5t – 15t ☐
    d. 15t - 40t ☐
    e. More than 40t ☐
13. What is your annual mileage (in km)?
14. ☐ Less than 20.000 km ☐ 20.000 – 50.000 km ☐ 50.000 – 100.000 km
15. ☐ 100.000 – 150.000 km ☐ more than 150.000 km ☐ don´t know

16. How many days of the week are you driving a truck?

17. ☐ 1-2 days ☐ 3-4 days ☐ 5-6 days

Information about your job (Please try to answer with yes or no)

		Yes	No	Don't know
13	Do you always drive the same truck in your current job?	☐	☐	☐
14	Do you notify your employer/fleet manager if the truck is not OK?	☐	☐	☐
15	Does your company actively monitor fuel consumption?	☐	☐	☐
16	Do you have a device in your truck that monitors fuel consumption?	☐	☐	☐
17	Do you receive feedback on your fuel consumption from your company?	☐	☐	☐
18	Does your company have a reward system for fuel efficient driving?	☐	☐	☐
19	Do you get any form of "penalty" if you don't meet fuel targets?	☐	☐	☐
20	Does your company communicate openly on fuel consumption among all other drivers	☐	☐	☐
21	Do you have a device in your truck that helps to avoid traffic jams?	☐	☐	☐

Your own driving behaviour (Please try to answer with yes or no)

		Yes	No	Don't know
22	Do you use your brakes more often in heavy traffic situations?	☐	☐	☐
23	Does the correct choice of gears reduce your fuel consumption?	☐	☐	☐
24	Do you consume more fuel if you drive in a safe way?	☐	☐	☐
25	Does fuel efficient driving cause less damage to the cargo?	☐	☐	☐
26	Does a traffic jam increase fuel consumption?	☐	☐	☐
27	Does excessive braking increase fuel consumption?	☐	☐	☐
28	Does more horse power increase fuel consumption?	☐	☐	☐
29	Does a tight delivery schedule lead to faster driving?	☐	☐	☐
30	Does defensive driving save fuel?	☐	☐	☐
31	Does accelerating on full throttle lead to higher fuel consumption?	☐	☐	☐

Driving behaviour of others (Please try to answer with yes or no)

		Yes	No	Don't know
32	Is horse power an important topic amongst truck drivers you speak to?	☐	☐	☐
33	Is your colleagues' opinion about your driving behaviour important to you?	☐	☐	☐

Do you agree with the following statements? (Please try to answer with yes or no)

		Yes	No	Don't know
34	I enjoy driving faster than most of the other truck drivers.	☐	☐	☐
35	The amount of horse power in my truck is important to me	☐	☐	☐
36	I can check fuel consumption regularly in order to improve fuel efficiency	☐	☐	☐
37	I love the sound of the engine when accelerating on full throttle.	☐	☐	☐
38	It is important to deliver on time	☐	☐	☐
39	Looking ahead on the road can save fuel	☐	☐	☐
40	Looking ahead on the road can save time	☐	☐	☐
41	I can save a lot of time by good route planning	☐	☐	☐
42	I can save a lot of time by driving faster	☐	☐	☐

How much do you agree with the following statements?(Please indicate strength)

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
43	I like to work overtime	☐	☐	☐	☐	☐
44	I always try to follow company rules	☐	☐	☐	☐	☐
45	CO_2 emissions of vehicles have a big impact on climate change compared with that of other industries.	☐	☐	☐	☐	☐
46	The worlds' energy resources are far from being exhausted yet.	☐	☐	☐	☐	☐
47	I can easily change my driving behaviour into a more fuel efficient driving style	☐	☐	☐	☐	☐
48	Rising fuel prices lead to fuel reducing actions by transport companies	☐	☐	☐	☐	☐
49	There are actions to take for each truck driver that will benefit the fuel	☐	☐	☐	☐	☐

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
	consumption					
50	Accessories like a refrigerator or a coffee maker have a big influence on fuel consumption	☐	☐	☐	☐	☐
51	The amount of Horse power has a strong influence on fuel consumption	☐	☐	☐	☐	☐
52	Fuel efficient driving increases the time on the road	☐	☐	☐	☐	☐
53	Fuel efficient driving leads to decreased maintenance costs for the vehicle	☐	☐	☐	☐	☐
54	Driver time regulations lead to faster driving	☐	☐	☐	☐	☐
55	Most other truck drivers exceed the speed limit.	☐	☐	☐	☐	☐
56	Many of my colleagues are aware of eco-driving.	☐	☐	☐	☐	☐
57	Many other truck drivers drive fuel efficiently.	☐	☐	☐	☐	☐
58	It is important to respect the speed limit	☐	☐	☐	☐	☐
59	It is my obligation as a professional driver to drive in a fuel efficient way	☐	☐	☐	☐	☐
60	I can regain lost time by driving faster after being caught up in traffic congestion	☐	☐	☐	☐	☐

Statements considering fuel saving

Which pre-trip actions have the most influence on fuel consumption?

(Rank the most important influences with 1, 2 and 3)

Action	Rating
Checking spoiler height/position	
Checking tyre pressure	
Checking tyre status (wear/tear)	
Checking oil level	
Tightening the load	
Checking suspension pressure	
Cleaning the truck	
Pre-trip route planning	

Which behaviour is most important for fuel efficient driving?
(Rank the most important influences with 1, 2 and 3)

Action	Rating
Respecting speed limits	
Coasting	
Avoiding unnecessary idling	
Looking ahead	
Driving in high gear	
Minimizing brake usage	
Using Cruise Control	

What information would you need to drive more fuel efficient?
(Rank the most important influences with 1, 2 and 3)

Action	Rating
Information while driving on factors that influence fuel consumption	
Instructions and pointers while driving	
Feedback directly after the trip on your driving performance with regards to fuel efficient driving,	
Improve general knowledge on fuel efficient driving	
Regular training in fuel efficient driving	
Clear rules and routines from fleet managers/employer	
Clear targets on speed, fuel consumption and idling etc.	
Rewards based on your driving performance with regards to fuel efficient driving	
Other	

What would motivate you to drive more fuel efficient?
(Rank the most important influences with 1, 2 and 3)

Action	Rating
Rewards based on your driving performance with regards to fuel efficient driving	
Instructions and pointers while driving	
Clear targets on speed, fuel consumption and idling etc.	
Information while driving on factors that influence fuel consumption	
Clear rules and routines from fleet managers/employer	
Improve general knowledge on fuel efficient driving	
Regular training in fuel efficient driving	
Feedback directly after the trip on your driving performance with regards to fuel efficient driving,	
Other:..	

65 How much fuel do you think you can save through a more fuel efficient driving behaviour? ____________ %

66 Did you previously participate in training on fuel efficient driving?

Yes ☐ (please specify in next question)

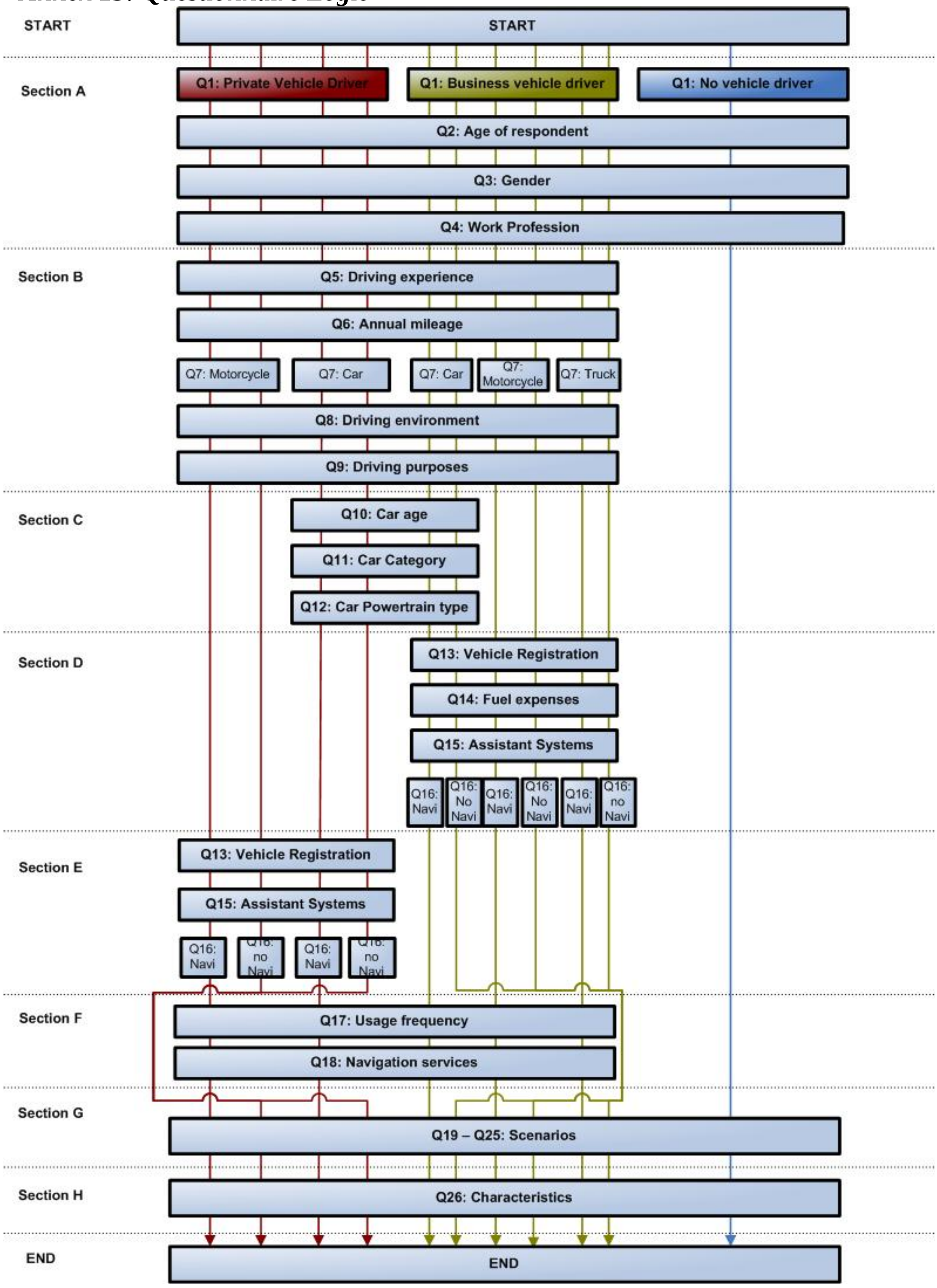
No ☐

67 Did you previously participate in training on fuel efficient driving?

Action	**Yes**
Theoretical training (e.g. e-learning or books)	☐
Simulator training	☐
Interactive E-learning	☐
Training in an actual truck	☐
Combination of theoretical and practical training	☐
Other:..	☐

Thank you very much for answering our questions!

Annex 15: Questionnaire Logic



Annex 16: European Driver Questionnaire

Dear Participant,

The purpose of this questionnaire is to gather information about your driving habits and asking your opinion on how to make driving environmental or eco-friendly. Therefore we like to know:

- how eco-friendly you drive
- what your impression on innovative eco-services is
- what assistant systems you use to safe fuel

We greatly appreciate if you would give us your honest answers to the questions provided; it won't take longer than 10 minutes. All information will be treated confidentially and analysed anonymously.

Thank you very much for participating in our survey!

Basic Information

23. Do you mainly drive a business / company or your own motorized vehicle? Please choose appropriately below.

☐ Private vehicle driver ☐ Business vehicle driver ☐ I do not drive a motorized vehicle

24. What is your age:

☐ <18 ☐ 18 – 24 ☐ 25 – 34 ☐ 35 – 49 ☐ 50 – 65 ☐ > 65

25. Your gender: ☐ male ☐ female

26. What corresponds best to your work profession?

☐ employee (white collar worker) ☐ public sector ☐ self-employed
☐ manufacturing (blue collar worker) ☐ student / pupil
☐ housewife / househusband ☐ other:________________________

27. What is your driving experience (in years)?

☐ < 2 ☐ 3 – 5 ☐ 6 – 10 ☐ 11 – 20 ☐ 21 – 40 ☐ > 40

28. What is your annual mileage (in km)?

☐ < 3.000 km ☐ 3.001< 9.000 km ☐ 9.001< 12.000 km
☐ 12.001< 20.000 km ☐ 20.001< 30.000 km ☐ > 30.000 km

29. What type of motor vehicle do you mainly use?

☐ car (any engine) ☐ goods vehicle / truck ☐ motorcycle

30. How would you describe the environment you drive your vehicle regularly (daily, weekly)?

☐ urban ☐ rural roads ☐ motorways

31. To what extent do you use your vehicle for the following purposes? Each of the statement rated from 0 (never) to 5 (very often)

	(5) Very often	(4) Often	(3) Sometimes	(2) rarely	(1) very rarely	(0) never
drive to work	☐	☐	☐	☐	☐	☐
shopping, errands	☐	☐	☐	☐	☐	☐
visiting friends and family	☐	☐	☐	☐	☐	☐
leisure activities (e.g. sports club, cinema, dine out)	☐	☐	☐	☐	☐	☐
business trips	☐	☐	☐	☐	☐	☐
collecting children	☐	☐	☐	☐	☐	☐
vacation	☐	☐	☐	☐	☐	☐
other: ____________________	☐	☐	☐	☐	☐	☐

Vehicle Information

(IF CAR USER IN QUESTION 4 (BASIC INFORMATION))

In this last part we ask you to provide us some basic information about your car and assistant systems you might already use.

32. How old is your car (in years)?

☐ < 1 ☐ 1 – 3 ☐ 3 – 6 ☐ 6 – 10 ☐ > 10

33. What category suites the car you mainly use the most (examples shown in brackets)?

☐ Small (Fiat 500, Ford Fiesta, VW Polo) ☐ Medium (VW Golf, Ford Mondeo, BMW 3series) ☐ Large (Audi A6, Mercedes S Class, VW Touareg) ☐ Sport Coupés (Volvo C70, BMW 6 series) ☐ Multi purpose (FIAT Idea, VW Touran) ☐ SUV (Ford Kuga, BMW X-series, VW Touareg) ☐ Van (Ford S-MAX, VW Sharan, Peugeot 3008)

34. What type of powertrain does your car have?

☐ Gasoline / Petrol ☐ Diesel ☐ Petrol Gas (LPG or CNG) ☐ Hybrid ☐ Electric drive

35. How is your vehicle registered?

☐ Privately ☐ commercial ☐ other

36. FOR BUSINESS VEHICLE DRIVERS: Who covers the fuel expenses?

☐ I pay fuel expenses ☐ I partly pay fuel expenses ☐ Employer pays fuel expenses

37. Do you have a navigation device (GPS)?

☐ Yes, installed in car ☐ Yes, portable device ☐ Yes, installed on mobile phone
☐ No navigation device

38. IF NAVIGATION DEVICE: How often do you use your navigation device while driving?

☐ On every trip ☐ frequently ☐ occasionally
☐ Infrequently ☐ hardly ever

39. IF NAVIGATION DEVICE: Which navigation services do you use?

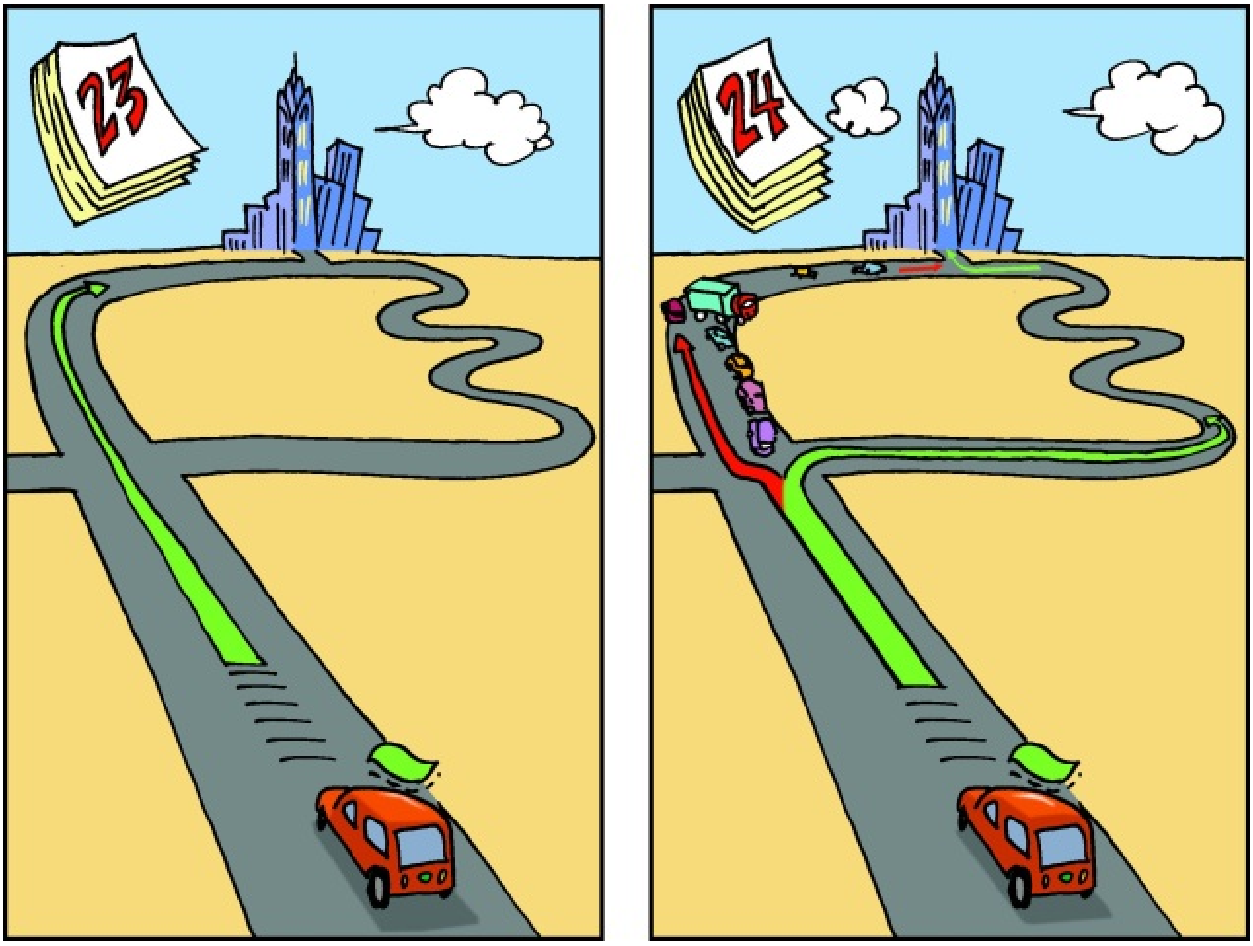
☐ Lane assist ☐ TMC / TMC Pro traffic Information ☐ Text to Speech (e.g. road names)
☐ Points of interest on route (e.g. gas station) ☐ Navigation map update
☐ Brand specific service (traffic information) ☐ To find an address
☐ None of the above

40. Is your vehicle equipped with one or more of the following assistant systems or features?

☐ Fuel consumption indicator ☐ automatic start / stop system (engine shuts down when car comes to a stop)
☐ Speed control ☐ Gear shift indicator ☐ Tire pressure monitoring ☐ Low resistance tires ☐ None of the above

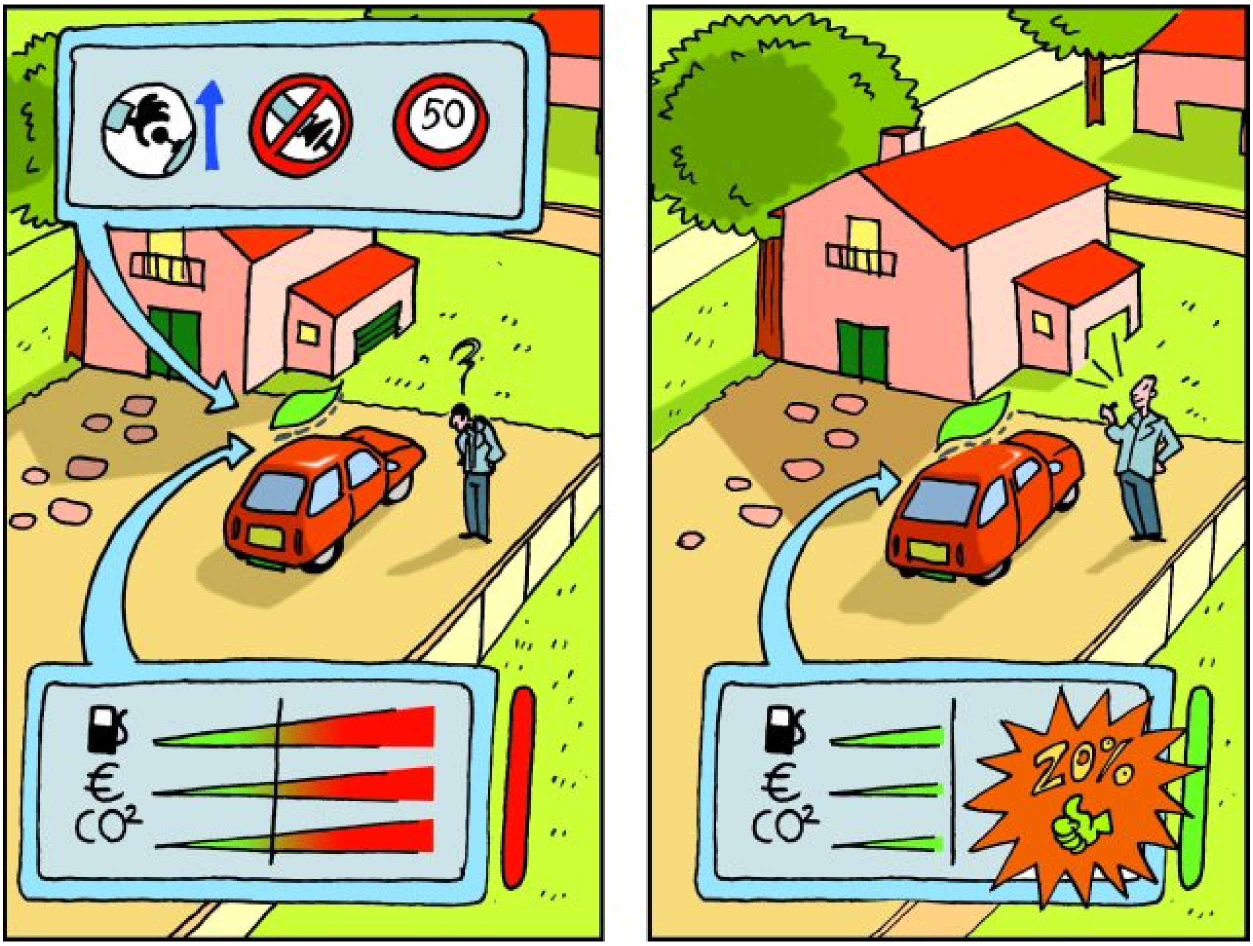
Eco Driving Assistant Systems

Now you are introduced to several traffic scenarios which describe driver assistant services. In each scenario your vehicle has the ability to communicate with other vehicles and also with road side traffic units. Your car is equipped with an onboard driver assistant system which helps you not only to navigate but also save fuel and reduce CO2 emissions. For each scenario you receive response options. Please rate all options.



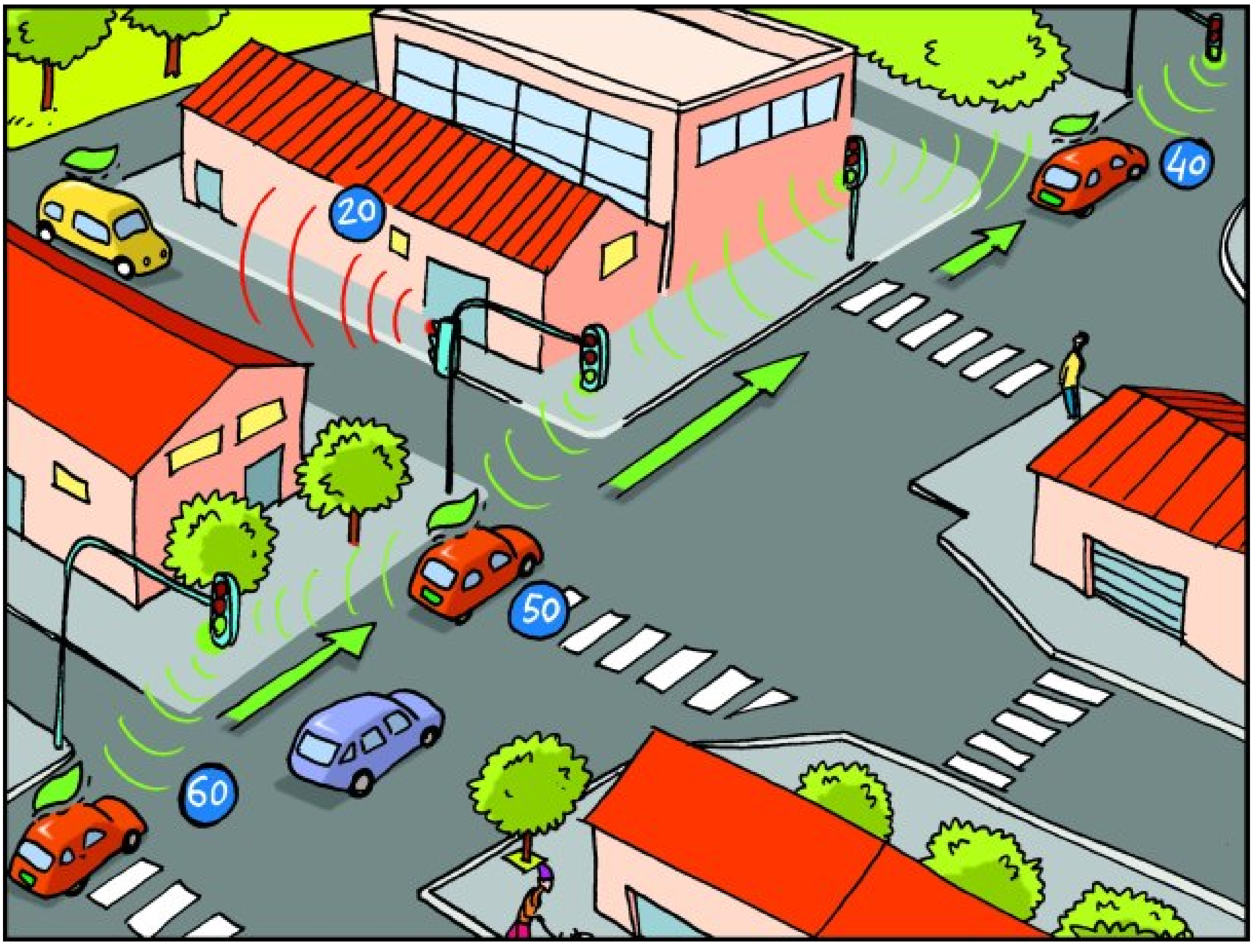
41. Scenario: The eco-driving assistant system receives real-time information about closed and congested routes. If a certain route is affected repeatedly your assistant system will remember this route as inefficient.

This service...	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongl y disagree
...saves travel time	☐	☐	☐	☐	☐
...improves traffic flow	☐	☐	☐	☐	☐
...helps me to save fuel	☐	☐	☐	☐	☐
...makes driving less stressful	☐	☐	☐	☐	☐
...requires technical knowledge to use it	☐	☐	☐	☐	☐
...restricts my freedom while driving	☐	☐	☐	☐	☐
...uses too much personal information	☐	☐	☐	☐	☐
...should be turned off if I want	☐	☐	☐	☐	☐
...helps me actively contribute to environmental protection	☐	☐	☐	☐	☐
...would be useful for me	☐	☐	☐	☐	☐
...is worth to pay for	☐	☐	☐	☐	☐



42. Scenario: After a journey the eco-driving assistant system provides you information on how economically you drive and helps to improve your driving style.

This service...	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree
...helps me to save fuel	☐	☐	☐	☐	☐
...requires technical knowledge to use it	☐	☐	☐	☐	☐
...helps to improve my driving skills	☐	☐	☐	☐	☐
...uses too much personal information	☐	☐	☐	☐	☐
...should be turned off if I want	☐	☐	☐	☐	☐
...helps me actively contribute to environmental protection	☐	☐	☐	☐	☐
...would be useful for me	☐	☐	☐	☐	☐
...is worth to paying for	☐	☐	☐	☐	☐

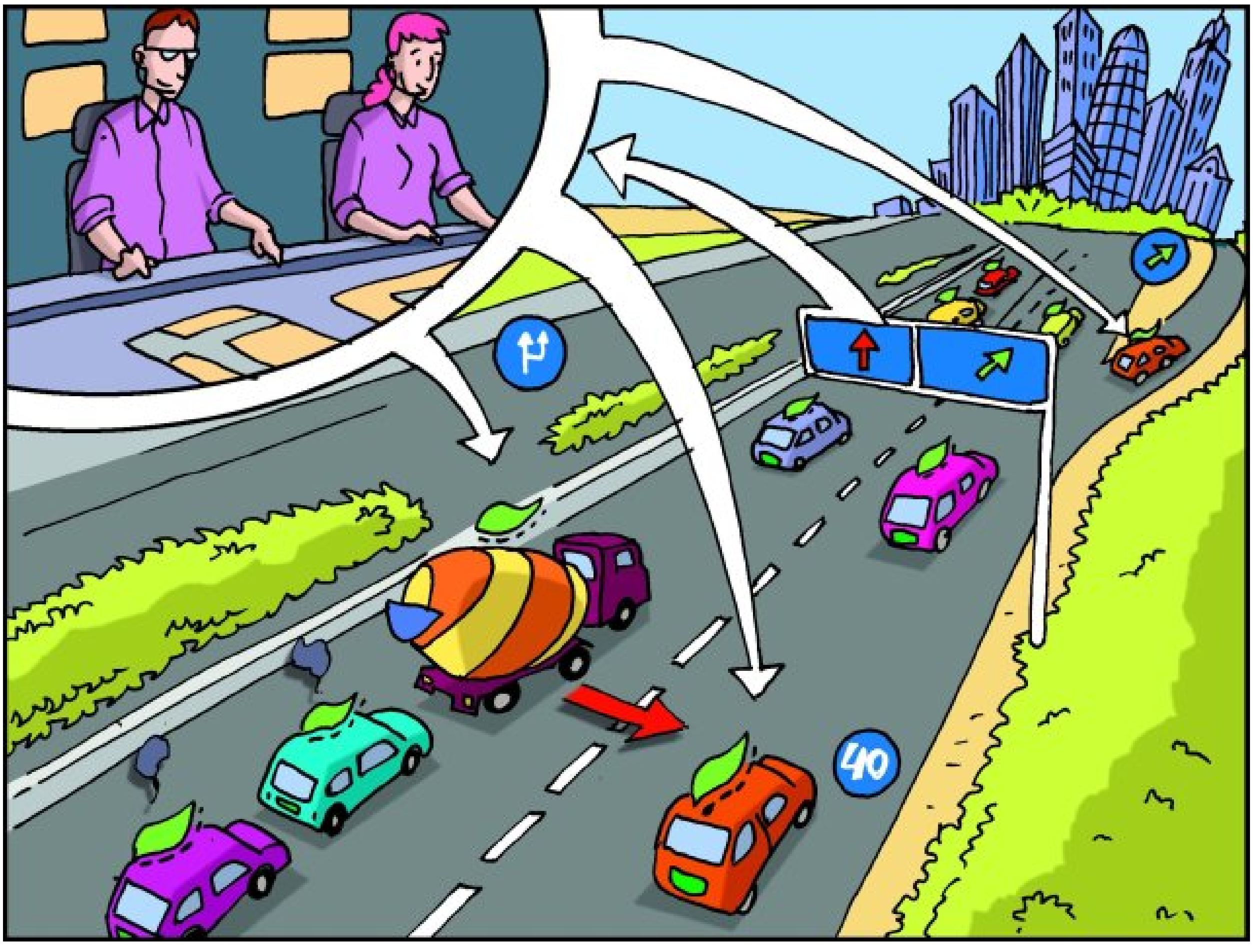


43. Scenario: While driving your eco-driving assistant system receives information from traffic lights ahead. It suggests you the appropriate speed to avoid stopping at traffic lights.

This service...	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree
...saves travel time	☐	☐	☐	☐	☐
...improves traffic flow	☐	☐	☐	☐	☐
...helps me to save fuel	☐	☐	☐	☐	☐
...makes driving less stressful	☐	☐	☐	☐	☐
...requires technical knowledge to use it	☐	☐	☐	☐	☐
...helps to improve my driving skills	☐	☐	☐	☐	☐
...restricts my freedom while driving	☐	☐	☐	☐	☐
...uses too much personal information	☐	☐	☐	☐	☐
...should be turned off if I want	☐	☐	☐	☐	☐
...helps me actively contribute to environmental protection	☐	☐	☐	☐	☐
...would be useful for me	☐	☐	☐	☐	☐
...is worth to paying for	☐	☐	☐	☐	☐

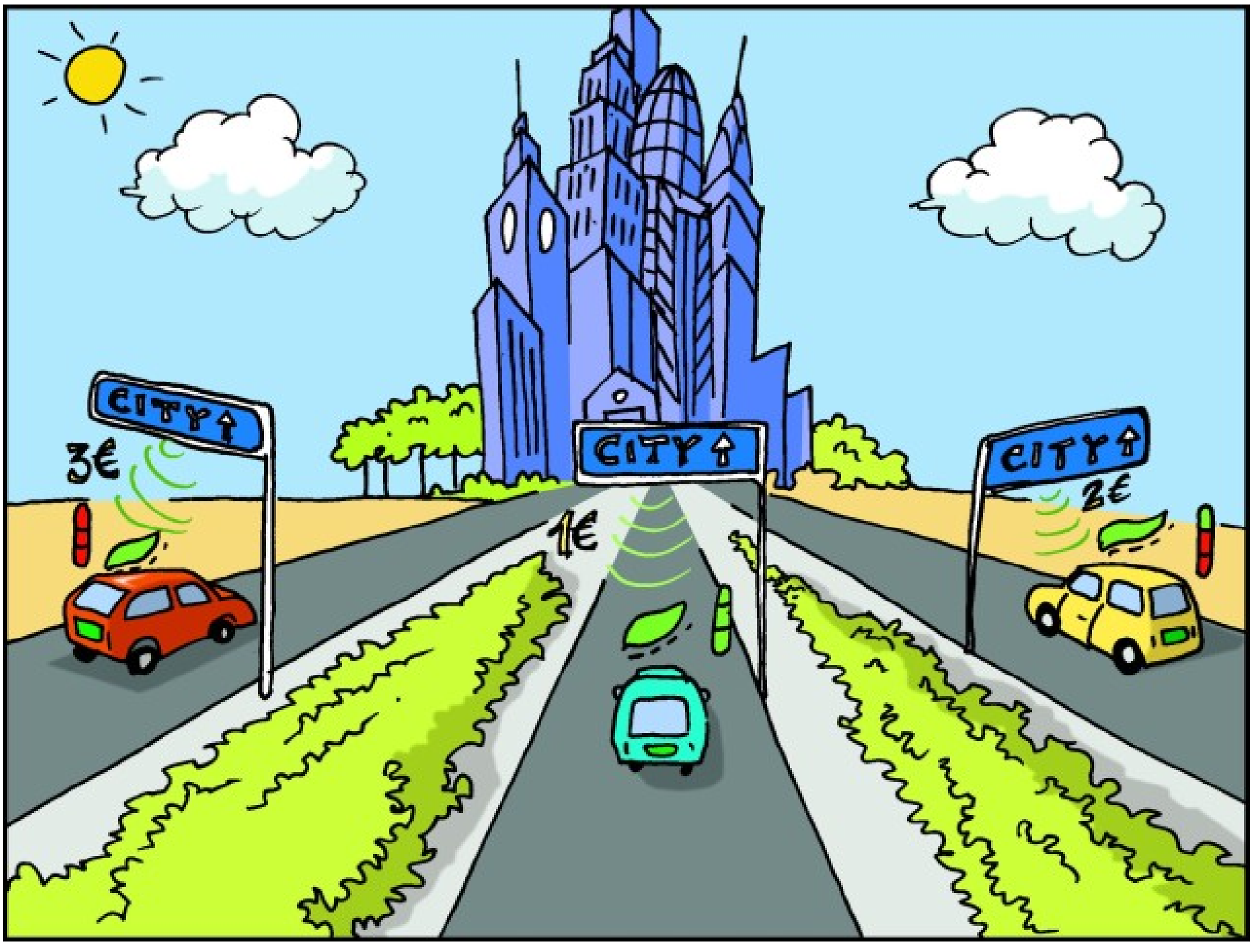
44. Scenario: Before you start your journey the eco-driving assistant system provides you with the latest information on how eco your preferred routes are (pollution, congestion etc.) and they will be coloured as such on your screen (green = eco, red = not eco). These alternative routes might take longer but will help reducing pollution in highly affected areas.

This service...	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree
...saves travel time	☐	☐	☐	☐	☐
...improves traffic flow	☐	☐	☐	☐	☐
...helps to save fuel	☐	☐	☐	☐	☐
...makes trip planning easier	☐	☐	☐	☐	☐
...makes driving less stressful	☐	☐	☐	☐	☐
...requires technical knowledge to use it	☐	☐	☐	☐	☐
...restricts my freedom while driving	☐	☐	☐	☐	☐
...should be turned off if I want	☐	☐	☐	☐	☐
...helps me actively contribute to environmental protection	☐	☐	☐	☐	☐
...would be useful for me	☐	☐	☐	☐	☐
...is worth to paying for	☐	☐	☐	☐	☐



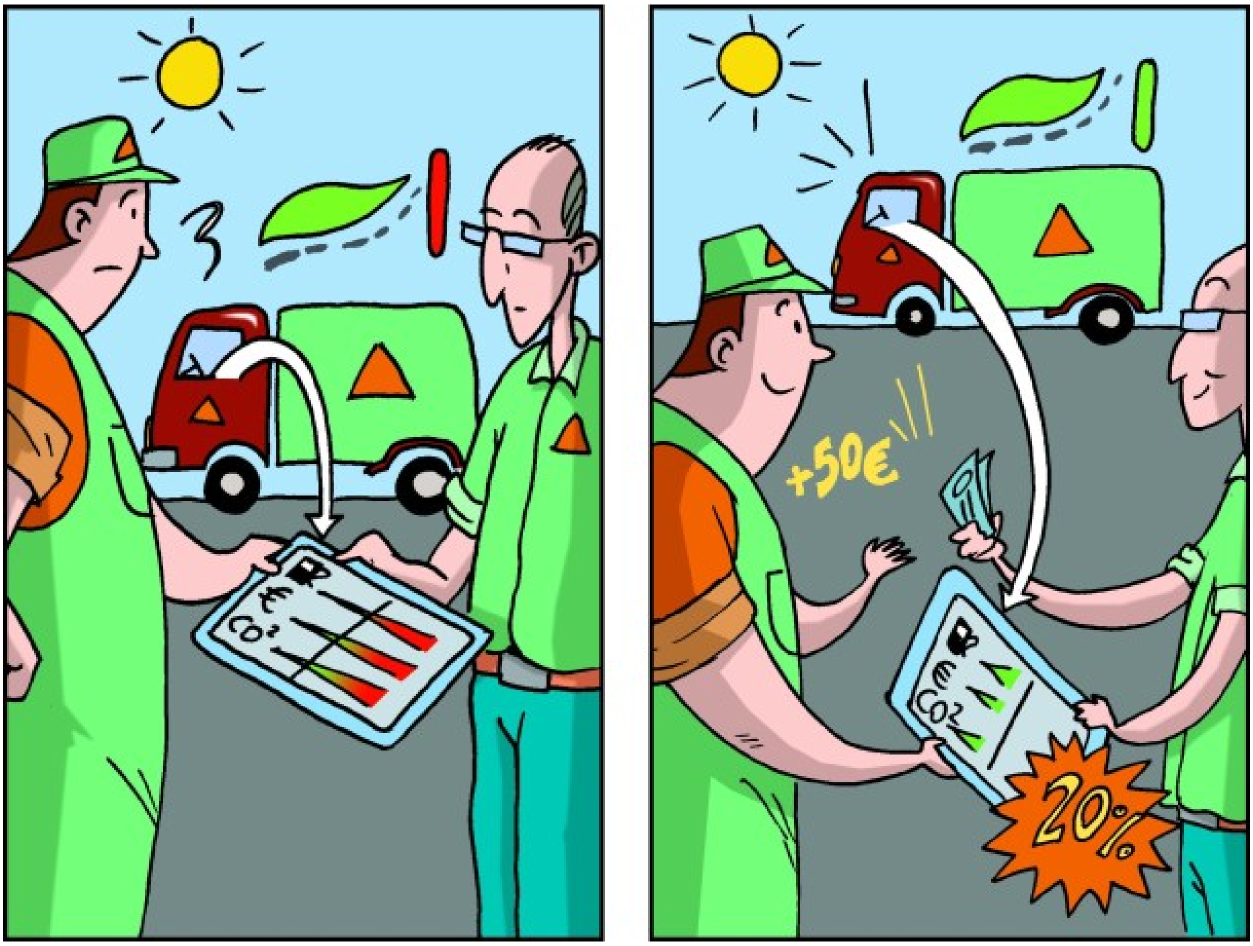
45. Scenario: Your eco-driving assistant system receives information from traffic management about speed and lane adjustment in dense traffic situations. You will receive recommendations on taking alternative routes to avoid congestion ahead.

This service...	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree
…saves travel time	☐	☐	☐	☐	☐
…improves traffic flow	☐	☐	☐	☐	☐
...helps me to save fuel	☐	☐	☐	☐	☐
...makes driving less stressful	☐	☐	☐	☐	☐
…requires technical knowledge to use it	☐	☐	☐	☐	☐
...restricts my freedom while driving	☐	☐	☐	☐	☐
…uses too much personal information	☐	☐	☐	☐	☐
…should be turned off if I want	☐	☐	☐	☐	☐
…helps me actively contribute to environmental protection	☐	☐	☐	☐	☐
…would be useful for me	☐	☐	☐	☐	☐
...is worth to paying for	☐	☐	☐	☐	☐



46. Scenario: The eco-driving assistant system exchanges information about your driving efficiency with the city traffic control centre. According to your driving profile it rewards you for example with discounts on city congestion charges or parking fees.

This service…	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree
…improves traffic flow	☐	☐	☐	☐	☐
…makes trip planning easier	☐	☐	☐	☐	☐
...makes driving less stressful	☐	☐	☐	☐	☐
…uses too much personal information	☐	☐	☐	☐	☐
…helps me actively contribute to environmental protection	☐	☐	☐	☐	☐
…would be useful for me	☐	☐	☐	☐	☐
…should be turned off if I want	☐	☐	☐	☐	☐
...is worth to paying for	☐	☐	☐	☐	☐



47. Scenario: Your eco-driving assistant system constantly informs your employer about your driving performance. Each month you receive a reward for driving efficiently or the system advices you how to improve your driving style.

This service...	Strongly Agree	Agree	Neither agree or disagree	Disagree	Strongly disagree
...helps me to save fuel	☐	☐	☐	☐	☐
...makes driving less stressful	☐	☐	☐	☐	☐
…requires technical knowledge to use it	☐	☐	☐	☐	☐
…helps to improve my driving skills	☐	☐	☐	☐	☐
...restricts my freedom while driving	☐	☐	☐	☐	☐
…uses too much personal information	☐	☐	☐	☐	☐
…should be turned off if I want	☐	☐	☐	☐	☐
…helps me actively contribute to environmental protection	☐	☐	☐	☐	☐
…would be useful for me	☐	☐	☐	☐	☐

Characterstics

Please indicate to what extend the following statements apply to you as a driver (One answer per statement)

		Strongly agree	Agree	Neither agree or disagre e	Disagree	Strongl y disagre e
48.	"I drive on the fast lane on motorways, as I drive faster than others anyway."	☐	☐	☐	☐	☐
49.	When driving at very high speeds on the motorway I do not feel safe any more.	☐	☐	☐	☐	☐
50.	I adhere to the speed limit even though all other road users drive too fast.	☐	☐	☐	☐	☐
51.	I brake and accelerate very dynamically.	☐	☐	☐	☐	☐
52.	As the environment is important to me, I check my fuel consumption regularly.	☐	☐	☐	☐	☐
53.	I do not think that CO2 emissions of vehicles have a big impact on climate compared with that of industries.	☐	☐	☐	☐	☐
54.	The car is just an object of utility for me, to get from A to B.	☐	☐	☐	☐	☐
55.	Driving gives me a feeling of freedom.	☐	☐	☐	☐	☐
56.	I would describe my driving style as being defensive.	☐	☐	☐	☐	☐
57.	My family's/friends' opinions of my driving behaviour are important to me.	☐	☐	☐	☐	☐

Annex 17: Calculation of Country Weights

Country	Population aged 15-74 (Source: EUROSTAT 2008)	Degree of Motorization in cars per 1000 inhabitants (Source EUROSTAT 2006)	Factorization of Population x Motorization	Share by country	Target respones by country	Actual response	Projection factor
Germany	63.960.083	566	36.201.406.978	0,38	1917	2915	0,65752
Spain	34.920.050	464	16.202.903.200	0,17	858	615	1,39488
France	46.725.195	489	22.848.620.355	0,24	1210	675	1,79216
Switzerland	5.815.532	493	2.867.057.276	0,03	152	130	1,16765
Austria	6.382.550	507	3.235.952.850	0,03	171	287	0,59695
Slovenia	1.586.943	488	774.428.184	0,01	41	145	0,28277
Belgium	7.958.842	470	3.740.655.740	0,04	198	303	0,65362
Norway	3.473.916	493	1.712.640.588	0,02	91	124	0,73125
Finland	3.993.303	475	1.896.818.925	0,02	100	125	0,80341
Portugal	8.143.052	405	3.297.936.060	0,03	175	367	0,47577
Croatia	3.423.023	485	1.660.166.155	0,02	88	121	0,72642
Overall	**186.382.489**	**485**	94.438.586.311		**5000**	**5807**	

Annex 18: Mean Values for Regional Comparison

Means

Scenario 1		Q18_Scenario_Saves_Environment	Q18_Scenario_Useful	Q18_Scenario_Payment
Tendency		+	+	+
Northern Europe	0	2,3	1,9	3,2
Western Europe	1	2,4	2,3	3,7
Germany	2	2,2	2,0	4,0
Alp Region	3	2,4	2,0	3,6
Southern Europe	4	2,0	1,7	3,1
Eastern Europe	5	2,0	1,8	2,8
Whole Europe	6	2,2	2,0	3,6
Scenario 2		Q19_Scenario_Saves_Environment	Q19_Scenario_Useful	Q19_Scenario_Payment
Tendency		+	+	+
Northern Europe	0	2,1	2,1	3,4
Western Europe	1	2,1	2,4	3,8
Germany	2	1,9	2,0	4,1
Alp Region	3	2,0	2,0	3,7
Southern Europe	4	1,7	1,7	3,2
Eastern Europe	5	1,7	1,8	2,8
Whole Europe	6	1,9	2,0	3,7
Scenario 3		Q20_Scenario_Saves_Environment	Q20_Scenario_Useful	Q20_Scenario_Payment
Tendency		+	+	+
Northern Europe	0	2,2	2,2	3,5
Western Europe	1	2,1	2,3	3,7
Germany	2	1,9	1,8	4,0
Alp Region	3	2,1	2,0	3,6
Southern Europe	4	1,9	1,9	3,3
Eastern Europe	5	1,8	1,7	2,7
Whole Europe	6	2,0	2,0	3,7
Scenario 4		Q21_Scenario_Saves_Environment	Q21_Scenario_Useful	Q21_Scenario_Payment
Tendency		+	+	+

Northern Europe	0	2,1	2,3	3,6
Western Europe	1	2,1	2,6	3,8
Germany	2	2,4	2,8	4,3
Alp Region	3	2,5	2,7	3,9
Southern Europe	4	1,8	2,0	3,3
Eastern Europe	5	1,9	2,3	3,1
Whole Europe	6	2,2	2,5	3,9
Scenario 5		Q22_Scenario_Saves_Environment	Q22_Scenario_Useful	Q22_Scenario_Payment
Tendency		+	+	+
Northern Europe	0	2,2	2,1	3,4
Western Europe	1	2,1	2,3	3,7
Germany	2	2,2	2,1	4,1
Alp Region	3	2,3	2,2	3,7
Southern Europe	4	1,9	1,8	3,2
Eastern Europe	5	1,9	1,7	2,7
Whole Europe	6	2,1	2,1	3,7
Scenario 6		Q23_Scenario_Saves_Environment	Q23_Scenario_Useful	Q23_Scenario_Payment
Tendency		+	+	+
Northern Europe	0	2,4	2,6	3,6
Western Europe	1	2,4	2,7	3,9
Germany	2	2,8	3,1	4,3
Alp Region	3	2,8	3,0	3,9
Southern Europe	4	2,1	2,1	3,3
Eastern Europe	5	1,9	2,1	2,9
Whole Europe	6	2,5	2,7	3,9

Annex 19: Characteristics

Item in Part III	Driver Type: Time velocity/dyn	Driver Type: Time quest follow fuel consumption	low internal locus of control	Utility	subjective norm / own behaviour
"I drive on the fast lane on motorways, as I drive faster than others anyway."	X				
When driving at very high speeds on the motorway I do not feel safe any more.	X				
I adhere to the speed limit even though all other road users drive too fast.	X				
I brake and accelerate very dynamically.		X			
As the environment is important to me, I check my fuel consumption regularly.		X			
I do not think that CO2 emissions of vehicles have a big impact on climate compared with that of industries.			X		
The car is just an object of utility for me, to get from A to B.				X	
Driving gives me a feeling of freedom.				X	
I would describe my driving style as being defensive.	X				
My family's/friends' opinions of my driving behaviour are important to me.					X

Annex 20: Study Control File

Country	Automobile Club	Language translation	Date Banner online	Date Banner offline	Partial responses	Completed Responses	Target responses	% completed responses	% with partials
Spain	RACC	Catalan	06/09/2010	19/10/2010	66	88	865	53%	91%
		Spanish		19/10/2010	161	194			
		Catalan	19/10/2010		15	26			
		Spanish			93	147			
France	FFAC	French	03/09/2010		163	642	1138	56%	71%
Austria	OAMTC	German	07/09/2010	24/09/2010	157	287	160	180%	278%
Portugal	ACP	Portuguese	08/09/2010	07/10/2010	180	367	202	182%	271%
Italy	ACI	Italian	09/09/2010		20	38	1105	3%	5%
Norway	NAF	English	06/09/2010	13/10/2010	78	123	90	136%	222%
Belgium	TCB	Dutch	09/09/2010		68	154	198	151%	211%
		French			49	146			
Switzerland	TCS	Italian	24/09/2010		13	32	144	76%	112%
		German			22	57			
		French			17	21			
Finland	AL	Finnish	03/09/2010		33	103	100	103%	137%
Slovenia	AMZ	Slovenian	20/09/2010		123	145	40	365%	675%
Germany	ADAC	German	20/09/2010		1353	2906	1527	190%	279%