2007

Final Report

Acceptance of driving environment, driver comfort, and services applications: A survey under Dutch Drivers.

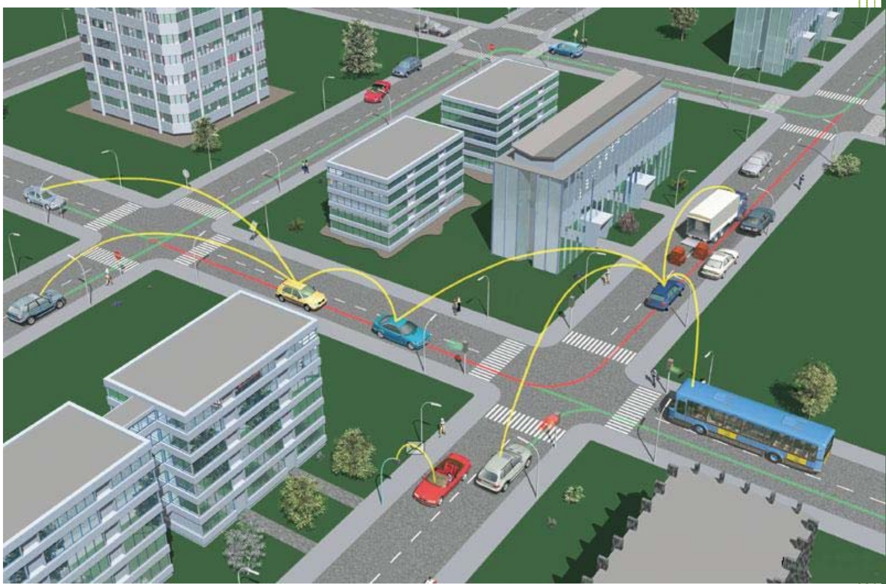

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Table of Contents

Abstract

The next generation Intelligent Transportation Systems (ITS) are based on vehicle to vehicle/infrastructure communications. The success of these systems heavily depends on the acceptance of the end-users: the drivers. The acceptance of some applications has been investigated by means of a web-based survey that got 460 responses of Dutch drivers. Three types of applications have been investigated in this research: driving environment information applications, driver comfort applications and services applications. Driving environment applications are applications in which de driver is provided with information on his/her driving environment (E.g. weather, traffic condition). Driver comfort applications are applications that relieve the driver of one or more driving tasks (e.g. platooning).Services applications are applications that provide the driver with entertainment, information and reservation services (e.g. internet). The results show that 62 percent of the drivers accept the driving environment information applications, 67 percent of the drivers accept the driver comfort applications and the acceptance of the services depends on the risk that it has for the driver. The applications are more accepted when drivers feel in charge of the vehicle and are less distracted by the applications.

Preface

This is the report on a study performed as part of an internship at Twente Institute for Wireless Mobile Communication of Ray Bodok. The internship was focused on revealing the acceptance of some Intelligent Transportation Systems based on vehicle to vehicle and vehicle to infrastructure communication in the framework of the HIghly DEpendable ip-based NETworks and Services (HIDENETS) project. This is the final part of the Civil Engineering bachelor course at the University of Twente. This assignment was supervised by Tom Lippmann (TI-WMC) and Mohamed Mahmod (University of Twente).

I would like to thank Mr. Bart Van Arem (University of Twente), Mr. Mohamed Mahmod (University of Twente), Ms. Cornelie van Driel (University of Twente), Mr. Tom Lippmann (TI-WMC), Mr. John de Waal (TI-WMC), Mr. Stanley Bodok, Mrs. Marvis Djaoen, Ms. Andra Iacob, and Mr.Jursley Koots for their guidance, recommendations and encouraging words throughout this assignment; I also would like to thank Mrs. Ellen van Oosterzee-Nootenboom (University of Twente) for the support in the early stage of this assignment, Mrs. Els Gellevij-Even (ITBE,) Ms. Marjo Bos (ITBE), and others from ITBE for their technical assistance with survey software and e-mail address in survey; Forum administrators for their permission and last but not least all companies and individuals who contributed with responses.

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Ray Bodok

1 Introduction

The present day traffic problems have grown to a certain extent that regular measures can no longer solve these problems on the long run. This is where Information and Communication Technology (ICT) comes in. ICT could at least help to solve some or all the problems on the present and future roads. A possibility is to use vehicle-vehicle communication or vehicle-infrastructure communication for traffic coordinating purposes. Inter-vehicle communication can have benefits for the drivers, the traffic controllers, and the environment.

Technology has developed in a certain way that in a few years the end-user will be presented with many options to deal with his/her traffic situation. These options vary from cruise control to in car information on available hotels in the area. Not only drivers will get benefits out of this situation, traffic controllers and the environment will also profit from the situation. Even though these systems offer the end-user many possibilities, they can only be implemented if the end-users understand, afford, trust and are comfortable with this technology which nowadays is still considered to be luxury. A good way to get an idea of what the end-users think about the services that inter-vehicle communication can make possible is by means of a survey. The present day driver has to perceive more and more information every day. Not only from outside the car, but also from within. Equipment like cruise control and the hands free cell phone also put pressure on the drivers' cognitive capacity.

One way of dealing with the more complicated traffic situations is by informing the driver. The idea behind this is that an informed driver can handle complex situations better than the uninformed driver, which means that the amount and the gravity of the problems could be reduced. This can be done by giving the driver more information on accidents, road traffic conditions, weather conditions and other non-safety information (Mahmod, 2006).

Another way of dealing with more complicated traffic situations is by trying to influence vehicles from traffic control centers. Research has shown that Inter vehicle communication (IVC) can lead to improvement in traffic flow stability and efficiency (Arem, 2006).

This assignment is focused on getting an overview of the different applications of inter-vehicle and vehicle-infrastructure communications and what the end-users think about some of these applications. A majority of these applications are possible end-use-cases for the HIDENETS project at Twente Institute for wireless mobile communication (TI-WMC).

TI-WMC is a company that researches and develops communication technologies. This company is a spin-off from Ericsson Eurolab Netherlands that participates in a large number of European and Dutch research projects. The focus is mainly on radio and networking technology which is crucial in the development process of communication between vehicles and communication between vehicles and infrastructure.

The HIDENETS project focuses on end-to-end dependability aspects of wireless car to car systems with or without support of infrastructure. These networks are also suitable for intelligent transport systems. One of the main problems of these systems is market penetration. It is important to know how the users will accept such a system. The different aspects of the system determine the benefits that end users have from the system which on its turn will determine how the system is accepted. That is why this research will focus on the user-acceptance of the several use-cases of inter-vehicle communication and vehicle-infrastructure communication.

1.1 Goal

The goal of this research is to get an overview of ITS applications that use inter-vehicle communication (IVC), vehicle-infrastructure communication and how the end-user accepts these systems by means of literature studies and a survey.

This goal leads to the following problem statement:

How well accepted are the options regarding intelligent transportation systems that inter-vehicle communication and vehicle-infrastructure communication generate?

1.2 Research Questions

The problem statement could be divided in three research questions. One question could be assigned to each part of the research.

1. What are the options regarding intelligent transportation systems that inter-vehicle communication and vehicle-infrastructure communication generate for drivers?
2. What are the characteristics of the most common survey methods, which one is more suitable for this assignment, and what is the most appropriate way to carry the chosen survey method out?
3. In what degree do end-users (drivers) accept the driver assistance systems that inter-vehicle communication/vehicle-infrastructure communication generates?

1.3 Phases

There are three main phases in the project which on their turn have been divided in to tasks that have to be completed, an overview is provided below:

1. A literature study on ITS implications/ cases which have been and can be applied in the HIDENETS project.
    - Driver assistance: Provide the driver with more information on his/her driving task
2. A literature study on various survey methods:
    - Telephone surveys
    - Face-to face surveys
    - Web-based surveys
    - Mail surveys

3. A survey on user acceptance. This is the most complicated task of them all. This task can be divided into eight parts:
    - Identifying objectives: define terms, literature study;
    - Design the survey: choose a survey design, decide on sample size
    - Prepare the survey instrument: identify existing and appropriate instruments, adapt some or all questions on existing instruments;
    - Pilot-test the instrument: identify the sample for the pilot test, analyze the pilot-test data, revise the instrument to make it final;
    - Administer the survey: send out the questionnaire , supervise the questionnaire, conduct interview;
    - Organize the data: code responses, enter data into a computer, run a preliminary analysis, prepare a codebook;

- Analyze the data: prepare an analysis plan; analyze the results of the survey
- Report the results: write the report (Fink , 1995, pp. 78-80)

1.4 Risk factors

The biggest risks are found in the third part of the assignment, the survey. The success of this part of the assignment highly depends on the chosen survey method, the amount of questions that are formulated, how the questions are formulated and most important the amount of responses.
The weakest point of this survey phase is the pilot-test part and the administering part. These parts depend upon the willingness to cooperate with the survey.

The survey method in the first place will determine the type of work prior to getting the responses, in the administering phase. The method used to get to the respondents also plays a role in the amount of responses that will be achieved, so will the category of the respondents. Secondly the number of questions determines how much people are willing to cooperate with the research. The more questions there need to be answered, the fewer are the people that want to cooperate with the survey. This means that the focus has to be on formulating questions that can lead to more information. More complicated questions on their turn lead to misinterpretation of the questions, so basically the length and complexity of the questionnaire must be balanced.

The fact that a pilot test must take place also puts pressure on the time available to the researcher to complete this study. In this phase it is essential to make a questionnaire that represents the final questionnaire to get the maximum benefits out of the test. Mistakes in the final questionnaire can have a catastrophic impact on the planning of the research which can put the completion of the research in danger.

This report contains four main chapters: theoretical background, setting up the survey, results and analysis and conclusions. In the theoretical background an overview of the literature study on vehicle-vehicle/infrastructure communication based ITS applications is given, followed by an overview of the literature study on web-based surveys. In the setting up the survey chapter the research goals are defined more precisely, after which the questionnaire is set up, the survey sample characteristics are calculated, and the pilot test is carried out. In the results and analysis chapter the basic characteristics of the obtained sample are given, after which the data is analyzed. The last chapter, conclusions and recommendations contains the conclusions and recommendations based on the analysis in chapter 4.

2 Theoretical Background

This chapter contains the HIDENETS applications, the findings on ITS applications that use vehicle to vehicle or vehicle to infrastructure communication, and this will be followed by a short summary on the findings on the acceptability of driver assistance systems.

Human beings have only a limited line of sight. This line of sight is not enough, because 90% of traffic accidents occur due to human errors (Treat & Stansifer, 1977).Inter-vehicle communication is a possible way of extending the drivers horizon. Inter-vehicle communication systems could make it possible for the driver to look further away in distance to anticipate remote events, get information earlier about future scenarios and emergencies, and extract more detailed information on non-obvious attributes, rules, experiences, and intentions (Meitzner, 2007). Most of the conventional communications between vehicles are one way. This means that one driver has to estimate the behavior of another driver based on the signals that the other driver gives. The other driver transmits his/her intention with a blinker or brake lamps. Making the communication two-way enables clearer transmission of the intention of the driver, which leads to safer and more efficient traffic (Kato, Minobe, & Tsugawa, 2003) . Driver assistance systems support the perception, decision-making or operation by the driver, where the inter-vehicle communications help drivers acquire information on the neighboring vehicles. This condition has to be satisfied: all vehicles must be equipped with an inter-vehicle communications function (Kato, Minobe, & Tsugawa, 2003).

2.1 HIDENETS use-cases

In the HIDENETS project a list of applications have been formulated, which have later been merged to six use-cases. This can be found in the HIDENETS Deliverable 1.1 (Radimirsch, et al., 2006). This section will provide an overview on which applications have been merged to what use-case.

The first use-case that is considered is called the platooning use-case. This use-case contains only the platooning application. This application provides both positional and velocity control of vehicles in order to operate safely as a platoon on the highway. This requires vehicle-vehicle communication and in some cases also vehicle infrastructure applications. Platooning keeps cars at a safe distance from each other, which is an advanced form of automated highway systems (Tsugawa, 2002). Keeping a constant distance between the vehicles means less variation in speed and has a reduction on shock waves. Shock wave is the term used for the change in traffic flow. This change in traffic flow can move upstream or downstream in traffic and can be seen at the beginning or the end of congestions. When vehicles use cooperative-driving, they can use roads at a higher density. An experiment showed that if vehicles are kept at a distance of 6.5m from each other, a theoretical maximum flow of 6400 vehicles per hour could be achieved instead of 3000 vehicles per hour with regular sensors (Rajamani & Shladover, 2001). Keeping a constant distance between vehicles also leads to fuel savings of up to 15% (Van Arem, 2007). This means that there also will be a decline in the emissions of the vehicles. As a vehicle accelerates more or changes gear more often, it emits more exhaust (Ericsson, 2001). With this platooning case the amount of times a vehicle accelerates and changes gear per time unit decreases which leads to a reduction in emission.

The second use-case is the infotainment case. For this use-case five different applications will be applied. First online gaming: here interactive games can be played between cars on the road which are not far away from each other. There are two points that have to be considered when looking at this application. The first point is who will be able to play these games and where in the vehicle these games will be available for playing. This gaming should not interfere with the driving task of the driver. Research has shown that in-vehicle tasks interacting with an entertainment system can affect measures of driving performance such as maintaining speed, and preparedness to react upon an unexpected hazard (Horberry, Andersen, Regan, Triggs, & Brown, 2006). The second point concerns the distance between the vehicles. The report (Radimirsch, et al., 2006) suggests that games will be played between vehicles that are close to each other. Traffic flows contain vehicles with different origins and different destinations. People will also travel at different speeds because of different priorities. This means that vehicles that can interact on a short distance by playing games are probably vehicles that have the same destination and are traveling at the same speed this almost leads to the conclusion that the vehicles are traveling together. Even if communication may not require much time, when playing multi user games it must be kept in mind that it does take some time before a game comes to its end. The second application in this use-case is streaming audio and video. Streaming audio is used in radio programs and music, while streaming music may be used in video on demand and TV applications. Again driver distraction as mentioned in Horberry (2006) is a factor. The third application of his use-case is streaming data, where information is transmitted that has to be continuously updated. This application could be used for real-time information on traffic condition. Then there is non-interactive data communication and messaging. This is communication between vehicles only or between a vehicle and another device in the network. This information can be used for purposes such as positioning of the vehicle for traffic coordinating or as information for driver assistance systems such as merging. The last application for this use-case is called interactive data. This means that the user receives responses from other users or servers within a limited time. This application involves interactive data interchange between cars and data access to the internet. Examples of such applications are web browsing, document sharing, and some collaborative gaming applications. Even though web browsing offers great opportunities, it should be limited to a certain extent. Not all drivers are accompanied by passengers. This means that the passengers have to be able to use this application with minimum effort.

Then there is the third use-case: Car incident. This use-case contains three applications, of which the first one is called distributed black box. Here typical black box data is spread out through the network by spreading information through vehicles. Vehicles then store information on their neighboring cars, and if connection with infrastructure is available, the vehicles will back it up on fixed servers. This will be done by the use of two other applications: non-interactive communication and messaging, and interactive data. Considering the complexity of traffic flow it would be better to always have the connection with the infrastructure. Let us consider an example where an accident takes place and no connection with infrastructure is available. After the accident, other cars who were not part of the accident but who were in the area continue their journey to their final destination. If this information has to be traced back, it would take a lot of coordination to get the information on vehicle X, because the vehicles who were in the area at that moment could be virtually everywhere.

The fourth use-case concerns assisted transportation. This use-case consists of six applications. The first application of this use-case is unusual driver behavior warning. Here a warning is issued from the car whose driver shows unusual behavior. The question is if only cars are considered here or if other types of vehicles are considered as well. The second application is called floating car data. This application collects data about traffic flow and calculates up-to-date information on traffic flows. The third application extends traffic signs by allowing centralized control of the information indicated by each sign and allowing one-way direct communication between signals and some nearby cars. This information is valuable for the drivers, since they will get to know what rules they have to comply with. This information could also be used for the control of active gas pedals. An active gas pedal will let the driver feel a counterforce when the driving speed is too high. Research has shown preference for these kinds of applications compared to physical speed countermeasures (Almqvist & Sverker, 1998). The next two applications concern hazard warning between vehicles, and warnings about the own vehicle. These applications concern road condition warning, traffic jam warning, cooperative forward collision warning and vehicle alert warning between vehicles. They also include the detection of a possible crash (pre-crash sensing), corporate glare reduction, visibility assistance and overtaking collision warning. Some of these applications have also been mentioned under the name of multiple collision avoidance (Kato, Minobe, & Tsugawa, 2003, Misener, 2007, Meitzner, 2007). Another application of assisted transportation is maintenance and software updates: this option relies on the idea of a central agency that tracks the information about maintenance of the vehicle and informs the driver on the status automatically or on request of the driver. Software updates are also available through this application. It is important to get corrections and improvement on the in-vehicle software to guarantee optimal performance. The final application of interactive car data is also included in this case.

The fifth use-case that has been formulated is brigade communication. This use-case relies on the mobile communication center application. In this application there is a control center which serves as a mission control center for brigades such as police, fire brigades, road construction and TV report brigade. Because this use-case focuses on small groups it is not within the scope of this assignment.

The final use-case is the service discovery use-case. Here people request services which are in ad-hoc networks (e.g. taxi) near the geographical location of request. The people who request these services are not in the ad-hoc networks themselves: the requests do not come from within a vehicle. Because this is not an in-vehicle application it is outside the scope of this assignment.

2.2 Other ITS applications

In the literature there is a wide range of ITS applications that use inter-vehicle communication and vehicle-infrastructure communications are mentioned. These vary from safety measures, to comforting measures, to services. The applications have been categorized to get a better overview of the applications. First there will be information on vulnerable road user applications. Even though this is a small group of applications, it will be seen as a group because accidents involving vulnerable road users have a greater chance on fatalities. The next categories are called driving environment information, driver comfort, followed by collision warning applications and services.

2.2.1 Vulnerable road user applications

Vulnerable road users (VRU) are the road users that move at lower speeds e.g. by bike or by foot. The applications in this category will not be included in the survey which is why more detailed information are located in the appendices. For the motivation behind this decision see section 3.1.

2.2.2 Driving Environment Information

It is of crucial importance for the driver to know what happens in the driving environment. Today the driver has to perceive more and more information. This is why applications are developed to extend the drivers horizon and to take over some of its tasks. This category contains applications of roadway information, and weather condition.

The first sub-category consists of roadway information applications. Vehicles can also notify each other about road features. Here the vehicles share information with each other about roadway information. Each vehicle can add value to the information (Misener, 200, Meitzner, 2007). Another way of giving information on roadways is to give other vehicles a recommendation on a maximum speed they should comply with in a curve. In this application one vehicle transmits information on a curve to another vehicle with recommendations on a maximum speed via a transponder (Vivo, 2006). This application is visible in Figure 1, where numbers 1 and 2 are the vehicles and number 3 is the transponder.

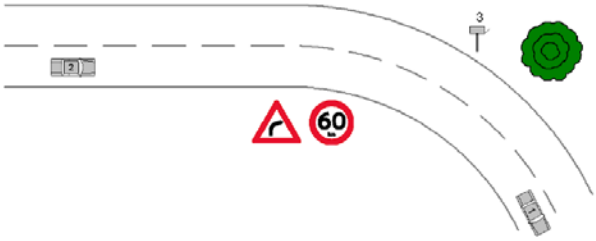

Figure 1: Curve speed warning (Vivo, 2006)

Information could also be given on the selection of routes in urban routes and interurban routes (Waes, 2006). Communication between vehicles, infrastructure, and service centers will be used to provide drivers with information on travel times. This communication could also be used for enhanced driver awareness: here the drivers are informed about the traffic rules and non-regular events on roadways (Koningsbruggen, 2006). Route suggestions of trucks carrying dangerous goods could also be provided with vehicle –infrastructure communication. The suggestions are based on the dimensions and the types of goods that are transported (Nygren, 2006). The driver could also be informed on the speed of a leading vehicle in a tunnel from two specific sources: the infrastructure and inter-vehicle communication (Vivo, 2006).

The other sub-category consists of weather condition applications. There are several options in the literature for giving information on weather condition. The first option is that one car gets information via its sensors on the weather and spreads it out via inter-vehicle communication (Meitzner, 2007). The second option is that traffic control centers spread out information on weather condition. The information is then sent out to road side units which serve as nodes to get the information to the vehicles (Eurpean commision information society and media, n.d.). There might be a difference between the reliability of the systems. In the first system conflicting information might be possible. This possibility is ruled out by the centralized information source that is used in the second option.

2.2.3 Driver comfort

The third application category is the driver comfort category. In this category several options are presented that have been developed to relieve the driver from some tasks. One of them is the use of inter-vehicle communication to help drivers comply with speed limits. This way a safe distance to the preceding vehicles is kept, especially trucks carrying dangerous goods. Keeping distance could also be seen as a form of cruise control. Research showed that people do not like driving in congestion. This is why the congestion assistant has been developed (Driel & Arem, 2006). The system gives congestion warning and information. Before arriving in the congestion area, information on the traffic jam ahead is given. While the vehicle is in the traffic jam information will be provided on the length of the traffic jam. The system is also equipped with an active gas pedal. While approaching a traffic jam, the driver will feel a counterforce on the gas pedal if the speed is too high. The third function of the congestion assistant is taking over the following and the speed regulating functions from the driver (Driel & Arem, Impacts of a congestion assistant on driving behaviour, workload and acceptance, 2006). The HIDENETS platooning use-case is also a form of driver comfort. The following and speed regulation tasks are taken over by the driver assistance system to relief the driver of performing this task himself.

2.2.4 Collision warning applications

The fourth category is collision warning applications. Collision warning applications are applications that warn the driver about possible collisions in traffic. These are collisions on all types of roads. This category of applications also will not be used in the survey which is why more details can be found in the appendices.

2.2.5 Services

This category has applications in services that are made available for the driver via inter-vehicle or vehicle-infrastructure communication. For these applications monetary transactions may have to take place. The first service application concerns heavy transport. Heavy transport vehicles could use vehicle-infrastructure communication to book parking spaces in advance. This way the drivers in commercial traffic are secured of a spot for loading/unloading or in rest areas (Nygren, 2006). Another possibility is for vehicles to connect securely and insecure to Roadside Units (RSU) with or without the use of internet protocol. Here several services could be provided from post-crash warnings to drive-thru payment to in-vehicle hotel reservations (Meitzner, 2007). The HIDENETS Infotainment case is also offers various services. As was illustrated in the previous chapter the infotainment use-case contains several forms of entertainment and information. Parts of the assisted transportation case could also be considered as a service. Here the maintenance and software updates application is referred to. The car incident use-case is also considered to be a service. Not a service for the driver, but it will probably be a service for insurance companies. Here information is provided on the pre-crash status of the vehicle. If this system is implemented, the cause of accidents could be determined.

2.2.6 Acceptability of driver assistance systems

Market penetration is one of the biggest obstacles for the driver assistance systems. The systems have to be designed in a way that the consumers' needs are met. Figure 2 gives an impression on what the consumer looks for in driver assistance systems. This figure illustrates the priority in consumers' needs by starting with the highest priority of the consumer in the center and then going down step by step. The category with the most applications is collision avoidance. This means that most developers are developing products according to consumer needs. The HIDENETS project however does not have a whole lot of applications concerning safety. The assisted transportation use-case has some safety applications, as well as the Car incident use-case. The next step is navigation. Here information is provided such as real time traffic and navigation information. The category of driver environment information and driver comfort is mainly based on navigation and advanced safety. The assisted transportation case from HIDENETS also has applications on this level. If the following level, advanced safety and remote car functions, is considered it becomes clear that the HIDENETS case assisted transportation as well as the driving environment information & driver comfort and the collision warning category have applications on this level. The whole infotainment case is based on the two lower hierarchical levels in this figure. Figure 2 illustrates that the HIDENETS case is not entirely focused on meeting consumers' needs, but on creating a communication platform to facilitate any possible consumer need.

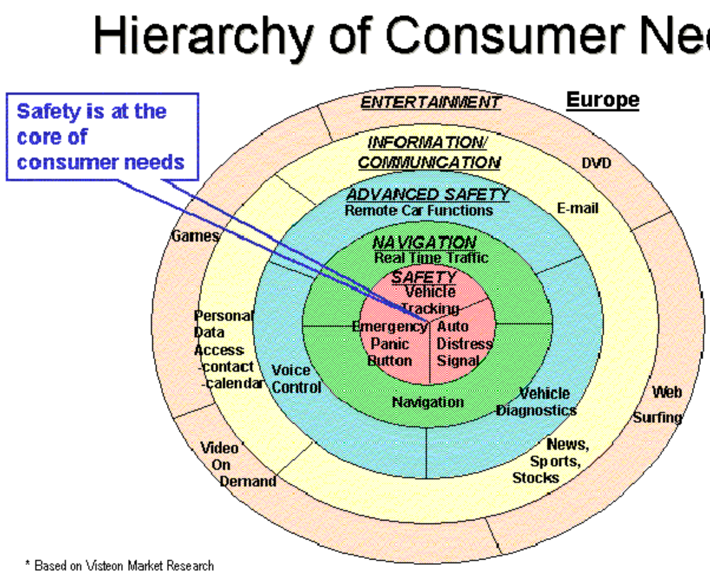

Figure 2: Hierarchy of consumer needs (Parnell, 2003).

If the opposite perspective is considered, then the reasons for not buying in-car systems come into scope. These reasons are fear of excessive warnings, too expensive service, reduction of driver responsiveness, fear of reliable systems, and high price (Van Arem, 2007).

Several researches have been conducted to get the opinion of the end-user on the Advanced Driver Assistance Systems (ADAS) (Almqvist & Sverker, 1998). In Sweden the drivers have been given the opportunity to experience such a system. In the town of Eslov 25 vehicles were equipped with adaptive speed control. During the field trial an active accelerator pedal prevented the vehicles form exceeding the citywide speed limit of 50 km/h, with the system being activated by roadside transponders located on the 10 roadways entering the city. The drivers were then interviewed after a 2-month evaluation period. It seems that 75% of the drivers consider adaptive speed control more positively than before the trial. This shows that it is important to let the people experience the ADAS. The study also showed that more than half of the participants found the driving experience more comfortable with the system engaged.

Another research was conducted on Advanced Traveller information Systems (ATIS) (Charles River Associates Incorporated, 1996). People tend to make their travel decision based on several factors. The first one is travel time related factors. Here not only the amount of travel time is important, but also the reliability of the time. Drivers have also expressed interest in safety issues. This interest however does not have much practical effect in influencing the marginal travel decisions. Personal comfort and convenience aspects are also important. When these factors are ranked, reliability (time & safety) is in the first spot, followed by convenience and comfort, travel time, and then cost. However this research has also shown that people are prepared to pay for quality transportation service.

A third research that will be mentioned here is a research on user needs for driving assistance, which was carried out by means of an internet questionnaire (Driel & Arem, 2006). This research revealed that drivers have preference for downstream warnings, followed by blind spot warnings, warning for imminent crash, and warnings for badly visible objects. The research also revealed that there is a greater need for driver assistance on motorways. Respondents wanted less help from their cars while driving on rural roads and even less on urban roads. If the level of support is considered, respondents mainly would like their cars to help them by giving information or warnings. They hardly indicated any need for driver support functions that consisted of control. However in some cases respondents did want the car to take over control. Drivers want to maintain a self chosen speed and would like the car to take over the longitudinal driving task or even the whole driving task when they are driving in traffic jams independent of the road type. The research also revealed information on what type of driver characteristics have influence on the willingness to accept an application of driver assistance. The results can be seen in Table 1.

Type of driver assistance	Driver characteristics of influence
Reduced visibility	Gender
Imminent crash	-
Car following-motorway	-
Regulating speed – motorway	Gender
Congestion driving- motorway	Gender, age, education, average annual mileage, familiarity with ACC
Driver fatigue	-
Regulating speed-rural road	Gender
Car following – rural road	Age, familiarity with ACC
Negotiating non-sign. Intersection-rural road	Gender
Negotiating non-sign. Intersection- urban road	Gender

Table 1: Influence of driver characteristics on types of driver assistance in an ideal system (Driel & Arem, 2006).

How willing is the driver to pay for an ADAS? In general, the willingness to pay for ADAS is rather low (Driel & Arem, 2006). Driel & Arem (2006) also mention the findings of Van der Heijden & Molin, which is that drivers are more willing to pay for an ADA system if systems such as ISA are combined with other ADA systems.

As is shown in figure 3, are two mechanisms that can lead to successful market introduction. The first mechanism is that there is a visible added value of technology for the consumer and/or there is a regulative order with no alternative that requires its use (Matheus, et al., (n.d.)).

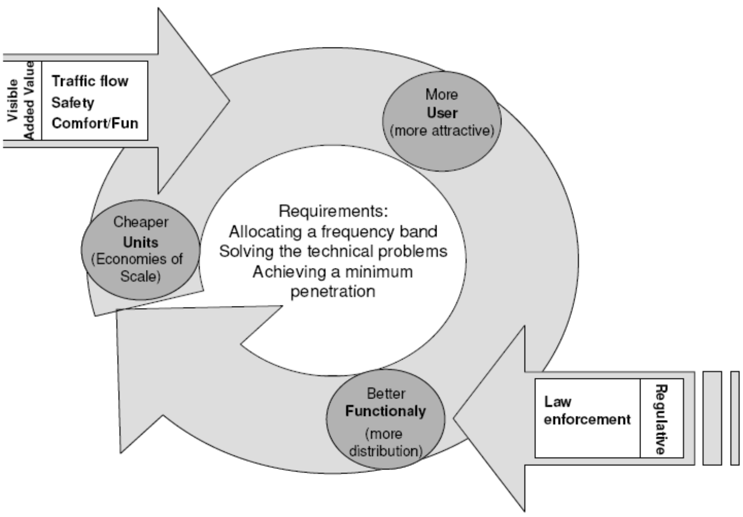

Figure 3: (Matheus, et al., (n.d.))

2.3 Literature on survey methods

To get a wider view on the user acceptance of the in-vehicle systems a user survey will be carried out. Prior to designing a survey several survey methods have been considered. In the past decades a lot has changed in the way survey research is carried out. As technology advances new methods for carrying out survey research are born. Today a variety of survey methods are available. Each method has its own characteristics, in other words its own strengths and weaknesses. To get an overview on these characteristics a literature review on survey methods will be carried out.

In this section the telephone survey, face-to-face survey, mail survey, and web survey will be considered. After enlightening a few characteristics of these methods a choice will be made. The following section will have some more detailed information on the selected method and how to deal with its weak points.

2.3.1 Survey Methods

The first method to be reviewed is the telephone survey method. The telephone survey is characterized by greater flexibility as regards conduct of the interview and to be less expensive (Hox & De Leeuw, 1994). But there seems to be some doubt in the representativeness of the sample. Nowadays more people have a cell phone which means that fewer people have listed numbers. Experiences in some countries have shown that surveys on mobile phones are not practically applicable (Paskota, 2004). The question is whether it is assumable that this population is identical to that which takes parts in surveys. By using telephone surveys researchers are able to get a larger sample size in with a smaller staff and lower costs compared to face-to-face surveys. But these costs are higher than web-based surveys.

The second method is the face-to-face survey. The face-to-face survey is particularly functional in surveys where personal opinion is crucial (Hox & De Leeuw, 1994). This is the only way to take surveys among non-listed population (Paskota, 2004). People tend to experience face-to-face surveys as more personal than the other methods. Compared to the other methods of surveying it has high costs (Paskota, 2004): more manpower is necessary to get the same amount of responses that telephone and web-based surveys would get with less manpower. The sampling size of a face-to-face survey is small. However, by executing a face-to-face survey a higher percentage in responses is achieved.

A third method is the web-based survey. Web-based surveys compared to usual survey methods cost less money and they have a shorter turnaround time (Cole, 2005). Another research (Andrews, Nonnecke, & Preece, 2003)mentions several studies that illustrate the ability of electronic survey to achieve the same results with the advantages of speedy distribution and response cycles. They also have the advantage of applying interactive design and various formats of questionnaires. Moreover they provide access to large populations and reach “rare and hidden populations”. Answers to web surveys can often be downloaded, avoiding data entry process which saves costs again and it illuminates human errors that can usually occur during data entry. One of the major problems is that only people who have access to the web can respond to surveys (Cole, 2005). For populations that are known to be web users, web-based surveys should be able to obtain representative random samples, while for populations that are not known to be web users, web-based surveys may not be as helpful as mail surveys. Furthermore, Selm & Jankowsky (2006) mention the study of Kay and Johnson (1999) where six advantages of web technology are mentioned:

1. Possibility of point and click responses
2. Provision of structured responses
3. Use of an electronic medium for data transfer and collation.
4. Provision of visual presentation of the questions permitting review
5. Flexible time constraints for respondents

6. Employment of adaptive questions to reduce the number and complexity of questions presented to users.

Advantages of mail surveys are greater as they are repeated more (Kwak, 2002). Reminders play an important role in the effectiveness of the survey. This means that strict planning and implementation is necessary to achieve the best results (Bergka, Gassea, Schnellb, & Haefelia, 2006). When compared to other methods mail surveys have higher response rates than electronic questionnaires but they have a longer turnaround period (Cole, 2005). They also have the advantage that people can be geographically categorized.

In the previous paragraphs characteristics of survey methods were given. The method that seems to have more benefits is the web based method. One of the crucial goals is to get as much responses as possible in the little time slot that is available. In this assignment time is one of the biggest constrains. Because web surveys offer the most benefits in time (shorter turnaround time, no time needed to train people to get respondents, no time needed for data entry) it is the best method for this assignment.

2.4 Web based survey method

In recent years the number of people that use internet has grown substantially. In the Netherlands the number of internet users has grown from 3,900,000 users in the year 2000 to 10,806,328 in the year 2006 which represents 65,9% of the population(Miniwatts Marketing Group, 2006). This means that more and more people have access to web surveys, which leads to higher response rates than before when carrying out web surveys. For carrying out the survey, the same tasks can be defined as in other types of surveys. The following eight tasks can be identified (Fink , 1995, pp. 78-80):

1. Identifying objectives: define terms, literature study;
2. Design the survey: choose a survey design, decide on sample
3. Prepare the survey instrument: identify existing and appropriate instruments, adapt some or all questions on existing instruments;
4. Pilot-test the instrument: identify the sample for the pilot test, analyze the pilot-test data, revise the instrument to make it final;
5. Administer the survey: send out the questionnaire , supervise the questionnaire, conduct interview;
6. Organize the data: code responses, enter data into a computer, run a preliminary analysis, prepare a codebook;
7. Analyze the data: prepare an analysis plan; analyze the results of the survey;
8. Report the results: write the report

The tasks prior to the administering task contain elements that can partially determine the amount of error that the survey will be carried out with. For this reason an overview of the errors is presented in this section. In addition, a summary of the quality criteria for designing surveys can be found in Table 13 in the appendices along with the principles for designing a web survey.

2.4.1 Coverage Error, Sampling Error, and Measurement Error

This section will focus on coverage errors, sampling errors and measurement errors. Coverage errors concern the probability that all units do not have an equal probability of inclusion in the sample that is drawn to represent the entire population. Various measures can be taken to achieve the desired level of randomness and representativeness. These are:

1. Random selection of mail addresses from newsgroups;
2. Use of stratified samples of proprietary bulletin board users;
3. Employment of a sampling frame from lists of users who have free access to the internet;

4. Use of a stratified sample of individuals whose e-mail addresses are obtained from Usenet newsgroups (Selm & Jankowski, 2006).

Sampling errors are a consequence of only surveying a portion of the sample rather than all members. One way of reducing the sampling error is by increasing the number of responses. In web surveys this is not particularly a difficult task (Selm & Jankowski, 2006).

A third type of error is measurement error. Measurement error simply stated is the deviation of the answers of respondents from their values on the measure. Measurement errors in self-administered surveys could arise from the respondent or from the instrument. Examples of some errors that could arise from the respondent are: lack of motivation, comprehension problems, and deliberate distortion. On the other hand there are the examples of errors that arise from the instrument: poor wording or design, technical flaws. In interviewer-administered surveys, well-trained interviewers can often explain unclear terms to respondents (Couper, 2000). Here the use of clarification features comes in. Research has shown that rollover clarification requests are more frequent and have a larger effect on answers than click requests (Conrad, Couper, Tourangeau, & Peytchev, 2006). Unsolicited information that is easily available are routinely ignored or actively suppressed by users. Thus clarification features need to be both immediately available for the respondents as they need to be controllable (Conrad, Couper, Tourangeau, & Peytchev, 2006). Instrument error can also be reduced by selecting the right type of questions.

First check-all and forced-choice questions are considered. Here the freedom of the respondent lies between the ability to choose and the obligation to make a choice. In check-all questions the respondent is asked to choose all the options that apply for him/her. Forced-choice questions: here respondents are obliged to make a choice for a particular option (or not) (Smyth, Dillman, Christian, & Stern, 2006). In general, forced-choice questions require the people to give more thought on their alternative than in the case of a check-all question. People spend significantly more time on forced-choice questions than they do on check-all questions.

The second consideration is open-ended versus close-ended questions (Waddington, 2000). Open ended questions are questions which do not have definite answers. By using open-ended question the respondents gets the possibility to enter whatever answer they like. This will lead to a large variety of answers, which will lead to problems during the analysis of the results. There are five styles of closed-ended questions (Waddington, 2000). It is important to choose the right style of question for each question, or else the validity of the results is at stake.

1. The first style is the Linkert-scale, which is a form of an interval measuring level (Molenaar, 1993). This is a measuring scale that has unequal values, ordinal values, and a scale with fixed intervals. The respondents must indicate how closely their feelings match the question or statement on a rating scale. The number at one end of the scale represents least agreement, and the number at the other end of the scale represents most agreement. If the scale includes other words at either end to further clarify the meaning of the numbers, it is known as a Linkert-style question.
2. The second style is the well known Multiple-choice format. A multiple-choice question is a form of nominal measurement level (Molenaar, 1993). The scale consists of unequal values. This is used when it is required for the respondents to pick the best answer or answers from among all the possible options.
3. The ordinal question (or ordinal measurement level (Molenaar, 1993)) is the third style. When it is required for the respondent to rank the question, people must ask an ordinal question.
4. The next type of question is the categorical type of question (or nominal measurement level (Molenaar, 1993)(Theuns, 2003)): here the answers are categories, and each respondent must fall into exactly one of them.

5. The last type of question is the numerical type of question. These are used when the respondent has to fill in real numbers. This could be done at two levels. The first level is the interval measuring level (Molenaar, 1993). The second level is called the ratio measuring level (Molenaar, 1993).The ratio level is defined as the measuring scale that has unequal values, ordinal values, a scale with equal intervals, and has a fixed zero point.

2.4.2 Response related issues

Another major point of concern are the responses. There are two types of non-responses. Unit non-response is when the unit fails to participate in the survey, and item non-response is when the respondent fails to answer one or more questions in the survey (Burkey & Kuechler, 2003). The first issue regarding responses that will be considered here is calculating the response rate. One way of dealing with this uncertainty is by placing a counter on the survey site that keeps track of the number of visitors. However, counters do not make the distinction between the single time viewing of the webpage by multiple users and the multiple-time viewing of the webpage by a single user (Selm & Jankowski, 2006). The other issues concern the attempts to increase the response rate. The response rate could be increased in several ways. The first way is by sending out a personalized invitation and informing the respondent on the value of the research and his/her contribution (Selm & Jankowski, 2006). Research has shown that personalization, regardless of type, increased the response rate by a few percentage points (Heerwegh & Loosveldt, 2006). Although personalization might increase response rates, it could also compromise privacy, as Heerwegh & Loosveldt (2006) cite the study of Joinson et al. (n.d.).

One of the key issues when conducting an online survey is privacy. Selm & Janowsky (2006) mention the study of Sheenan & McMillan (1999) where they consider assurance of respondent anonymity a key issue in the debate on the potential of online surveys. Confidentiality can be assured by informing respondents that their email addresses will not be recorded with their survey responses, in addition to the fact that the survey data will only be analyzed at the aggregate level. Criteria for privacy and confidentiality quality can be found in Table 14 in the appendices. Language is also an important factor. It is of crucial importance to write the questionnaire in the language that is most widely spoken by the respondents.

The use of sponsor logos also plays a role in the willingness to contribute with the survey. If the respondents hold the organization in a high esteem, then the repeating logo on each survey screen could decrease break-off rates. If the respondents feel the other way, they show the adverse behavior (Heerwegh & Loosveldt, 2006).

Attention should also be focused on the length of the survey. In web surveys the length of a questionnaire is, more than in postal surveys, relevant as an average print page can take up the space of several computer screens (Selm & Jankowski, 2006). This can lead to a negative influence on the response rate. A basic rule-of-thumb proposed is that the longer the questionnaire, the less likely people will respond.

Not only the length of the survey has its role, but also the length of each individual question. Andrews, Nonnecke, & Preece mention the study of Nielsen (2000) that emphasizes that shorter sentences seem to be better for reading on the screen, as people do not read web pages, they scan them. The statement made about the length of the survey when asking respondents to participate in the survey also has effect. Even though it is not statistically significant, a vague statement will have a more positive effect on the response rate than a specific length statement (Heerwegh & Loosveldt, 2006). Selm & Jankowski also mention the study of Medlin et al. (1999) that states the important function of dynamic graphics. These could be incorporated in a web survey to reduce fatigue on behalf of the respondents. Simple variations in layout of the web page used to conduct the survey have an impact on the answers provided in web surveys (Couper, Web Surveys: The Questionnaire Design Challenge, n.d.).

Arem & Driel (2006) also mention the study of Becker et al. in which they mention the representativeness of questionnaires based on how the questions are presented. The use of questionnaires with text description may not provide a sufficiently detailed picture of the system for the subject to give an accurate response.

Progress indicators are also a method to stimulate the respondent in the surveying process. Research has shown that a majority of respondents like to keep track of their progress (Heerwegh & Loosveldt, 2006). Heerwegh & Loosveldt (2006) mention the study of Coopers (2001) in which they conclude that displaying a progress bar leads to an increase of 3.5% (not statistically significant) in the completion rate. The authors argue that the effect of the progress bar might have been cancelled out in certain extent by the increase in download time that is caused by the (graphical) progress indicator. However, the respondent perceives shorter time when a progress bar is present (Heerwegh & Loosveldt, 2006). The progress bar also leads to a decrease in non-response (Heerwegh & Loosveldt, 2006).

According to the research of Watt (1999) mentioned by Sills & Song (2002) responses for internet surveys could also be increased by incentives such as donation to charity, sweepstakes, or simply making respondents feel that their input is worthwhile by for instance providing the survey results (Sills & Song, 2002, Andrews, Nonnecke, & Preece, 2003). Research has also shown that prize draws significantly increase the willingness to participate, the number of sample units starting the survey, increased actual participation, and reduced the number of uncompleted participation patterns (Bosnjak & Tuten, 2003). Prepaid incentives and promised incentives however showed no advantage over a simple "thank you". When delivering monetary incentives different methods should be considered. People do may not trust online organizations. Well-recognized banking institutions would be more effective even when delivery is online (Bosnjak & Tuten, 2003).

Reminders could also be used to increase response rates. In a research (Vehovar, Batagelj, Manfreda, & Zaletel, 1999) they mention several studies in which they say that reminders contribute to one third of the final sample size. They also mention the studies of Batagelj & Vehovar (1998) and Wilke et al. (1999) where they say that reminders contribute to the achievement of a more representative sample, since late respondents often differ from early respondents.

2.4.3 Software requirements

Use of software can ease the process of designing the user interface which is used to interact with the respondent. Selm & Jackowsky mention some features in the study of Medlin et al. (1999) that some software offer. These are:

1. Check for non-completion of the questions
2. Require the completion of all questions before allowing respondents to proceed;
3. Automatically control for branching according to respondent answers;
4. Vary the order of questions during the instrument testing;
5. Monitor response time for sections or for the whole instrument.

The research of (Andrews, Nonnecke, & Preece, 2003) mentions the studies of Birnbaum (2000) and McCoy & Marks (2001) which say that software like SurveyWiz, FactorWiz, QUIS, Survey Pro, Survey Said, Zoomerang, Survey Monkey, and WebSurveyor eliminate manual construction and administrative challenges.

2.4.4 Pilot testing of web surveys

Pilot testing is the process of conceptualizing, and re-conceptualizing the key aims of the study and making preparations for the fieldwork and analysis so that not too much will go wrong and nothing will be left out (Andrews, Nonnecke, & Preece, 2003). The balance between brevity, friendly tone, and accurate description must be found during this task. Pilot testing examines the readiness for deployment of not only the survey instrument itself, but the data collection software on the server and the entire administration process (Burkey & Kuechler, 2003). But because of the time constraint in this assignment, the focus will be mainly on the survey instrument itself.

2.4.5 Processing data

Data cleaning remains necessary in online surveys but can efficiently be performed with internet facilities. Cookies can be used to restrict respondents to participate in the survey multiple times (Selm & Jankowski, 2006). Another method is by registering the IP of the internet users. The problem with this method is that multiple users may have the same IP or that a user gets another IP-address assigned each time they connect to the internet.

The time that each respondent spends on the questionnaire also determines the reliability of the results. Questionnaire forms that are filled in quickly could manually be checked (Selm & Jankowski, 2006). To get comments an e-mail address could be used. This email address must only be used for this purpose to protect the researcher (Andrews, Nonnecke, & Preece, 2003).

2.4.6 Link between literature on web surveys and assignment

This section will give an impression on which elements of the literature on web surveys the focus of attention will be during the assignment. First the coverage error, sampling error, and measurement error will be considered. Measures will be taken to avoid these errors as much as possible, even though the ability to take some measures depends on the selected software. For more information on the limitation of the software see the implementation section 3.3. If the questions are considered, the focus will be to make the respondents think as much as possible before providing a response on a question. This is why check-all questions will be avoided as much as possible. Furthermore, closed-ended questions will be used as much as possible. Of course at least one open-ended question has to be used to enable the respondent to give his/her opinion. But by limiting the amount of open-ended questions the processing of the data will be less complicated.

Now the response related issues follow. The manner in which the responses will be counted depends on the use of software. To get more responses the survey will be held as short as possible, the questions themselves will be held as clear and short as possible, reminders, progress indicators, and maybe sweepstakes will be used.

The third issue of discussion will be the pilot test. In this assignment the focus will only be on getting an idea of the functioning of the instrument and the formulation of the questions. Here some people will be asked to give their opinion on the questions and the interface.

3 Setting up the survey

This chapter consists of three sections. In the first section the research goals are redefined. They will be made more specific in this section now the literature study is complete. In the second section the sample size is calculated and the characteristics of the sample are determined. The characteristics of the sample have to be determined to see if the sample obtained from the survey is representative or not. After that the survey questions are formulated, which will be reviewed in the pilot test. The last section will contain information on the pilot test. The pilot test has the final version of the questionnaire as a result which will be available in the appendices.

3.1 Redefined research goals

In chapter 1 the following goal has been formulated:
How well accepted are the options regarding intelligent transportation systems that inter-vehicle communication and vehicle-infrastructure communication generate?

Now the specific research areas are clear, this research question could be formulated more specifically. Many applications have been found during the literature study. It would take more than one questionnaire to figure out the acceptability of these applications. The pilot test and administration process would take twice as much time as is planned. This is why this questionnaire will only focus on some of the categories. These categories have been chosen based on the amount of HIDENETS applications and on the amount of applications. The category that has the most HIDENETS applications is the services category. Of the two largest categories the driving environment information and driver comfort category has the most HIDENETS applications. This is why these two categories have been selected. The new research question (based on these two categories) will be as follows:

How well accepted are the applications that fall under the categories Driving Environment Information, driver comfort, and Services?

As was mentioned before the research question will be divided into several sub-questions. The sub-questions are categorized as follows:
As was mentioned before the research question will be divided into several sub-questions. The sub-questions are categorized as follows:

A. General characteristics of the respondents: questions on the characteristics of the respondents.
    1. How do the motives of transportation relate to one another?
    2. How do the primary motives of transportation relate to one another?
    3. How does driving experience relate to age, income level, and education level?
    4. How does the motive of transportation relate to the income level, driving experience, education level, age and gender?

B. General application characteristics: questions on the willingness to pay and the preferred road category of use.
    1. Do end-users want the presented applications on all types of roads?
    2. What is the willingness to pay for the presented categories?

C. Driving environment information category applications: questions on the applications of the driving environment information category applications.
    1. Do the end-users accept the presented applications regardless of sex, age, education, income, vehicle type, experience, and motive?

2. Do end-users want to be informed within their vehicle or outside their vehicle?
3. What influence does the motive of transportation have on the perception of the best route?
4. What kind of interface do end-users prefer?
5. What is the influence of gender, age, education, income, vehicle type, experience, motive of transportation, average driving time per day, and vehicle type on the acceptance?

D. Driver comfort category applications: questions on the driver comfort category applications.
    1. Do the end-users accept the presented applications regardless of sex, age, education, income, vehicle type, experience, and motive?
    2. How do end-users feel about technology controlling their vehicle?
    3. What is the influence of gender, age, education, income, vehicle type, experience, motive of transportation, average driving time per day, and vehicle type on the acceptance?
    4. What do end-users think of the fully automated congestion assistant?

E. Service category applications: questions on the services category applications.
    1. Do the end-users accept the presented applications regardless of sex, age, education, income, vehicle type, experience, and motive?
    2. How do end-users perceive the risks of the applications?
    3. Do end-users accept the parking service?
    4. What is the influence of gender, age, education, income, vehicle type, experience, motive of transportation, average driving time per day, and vehicle type on the risk perception of the respondents

3.2 Sample Characteristics

Prior to pilot testing and administering the survey the characteristics of the sample need to be determined. In this section the sample size and the characteristics of the target population will be determined.

The ideal sample is a sample that has the same distribution as the population (Fink, 1995). Because information on the age distribution under drivers is hard to find on European level, the focus will be on people in the Netherlands. This also has the advantage that the questionnaire could be designed in a language better understood and spoken by the target population: Dutch. By designing a questionnaire in Dutch people who do not understand Dutch are not able to participate in the survey. Most of the people who speak Dutch live in the Netherlands, while people who understand English live all over the world. By using English, exclusion of people outside Europe is almost impossible. Dutch serves as a language barrier which helps to keep the sampling error at a lower level.

According to Selm & Jakowsky (2006) stratified samples must be used for web-based surveys. In stratified samples the study population is grouped according to meaningful characteristics or strata. Issues are that sample sizes for each subgroup must be calculated and it can be time consuming and costly to implement if many subgroups are necessary (Fink A. , How to sample in surveys, 1995). In this assignment the study population is divided into age groups, education level groups, and gender.

3.2.1 Age distribution of the respondents.

First the distribution of age under the respondents will be calculated. This will be done by considering the vehicle use, internet use and driver's license possession. In Table 2 it is visible how the total distance driven by Dutch drivers is distributed among the age groups. The distance driven per time interval is seen as a measure of vehicle use. The possession of driver's license could also be considered here as a form of the distribution of the sample. In Table 3 it can be seen how the possession of driver's license is distributed among the age categories.
Both approaches have their issues. The problem with using distance as vehicle use is that the number of drivers is not taken into account. It could be possible that drivers in one category drive more kilometers than drivers in another category, but this does not mean that there are more drivers in the corresponding category. The problem with driver's license possession is that there are people who possess a driver's license that do not drive. Vehicle ownership, however, should not be used because this leads to exclusion of a part of the population. People who possess a driver's license but do not own a vehicle are then excluded. To insure that each category is well represented under the respondents, the maximum value of driver's license possession and travel distance will be used.

Age Category	18-19	20-24	25-29	30-39	40-49	50-59	60-64	65-74	75=>
Distance (%)	3.91	10.4	15.6	17.9	16.3	15.3	11.1	6.51	2.93

Table 2: Proportion of the covered distance per age group (%).

Age Category	18-19	20-24	25-29	30-39	40-49	50-59	60-64	65-74	75=>
People possessing a Driver's license	146436	710829	791982	1884870	2075699	1701837	687901	944909	465911

Table 3: Possession of driver's license per age group

Because this is an online survey, the distribution of the respondents among age groups is not only dependant of the characteristics mentioned in the previous paragraph. The age distribution under internet users is also relevant to determine the distribution of respondents. The distribution of people with no internet experience can be seen Figure 4.

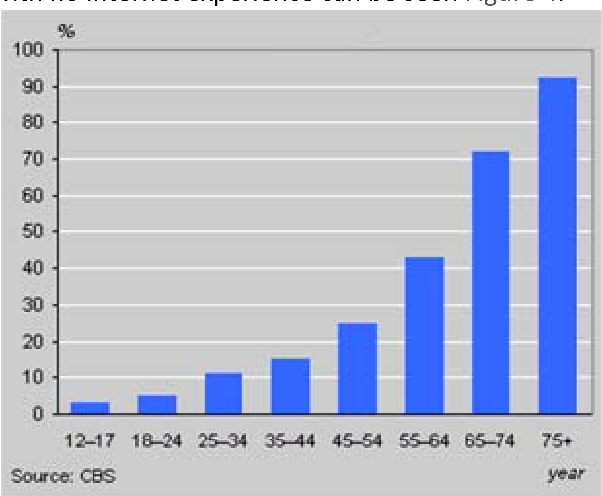

Figure 4: Distribution of people with no internet experience among age groups (CBS, 2005).

As can be seen in this figure, less than 10 percent of the people of 75 and over have ever used the internet. This indicates that oversampling might be necessary to include hard-to-get categories in the sample. To get the ideal distribution internet use has to be linked with vehicle use and driver's license possession. The variables necessary for the combinations will be defined as follows:

1. A: The age of internet users
2. B: Vehicle use at a certain age
3. C: The age of people who possess a driver's license.

Variable A is assumed independent of variables B and C, which means that the following formulas will be used (Poortema, 2004):

To calculate the age of people who use a vehicle and use the internet: $P(A \cap B) = P(A)P(B)$

To calculate the age of people who possess a driver's license and use the internet: $P(A \cap C) = P(A)P(C)$

After defining the variables, the total number of respondents will be calculated by multiplying P with the total sample size. To calculate the sample size, a sample size calculator (Raosoft, 2004)was used. Here the total population size (which is equal to the amount of people who possess a driver's license), error margin, spread, confidence interval have to be entered. The total population is 9,973,000(CBS, 2007)(CBS, 2007), that is if everyone who possesses a driver's license has internet access. This is not the case, but this value will be used since it will lead to a higher sample size. The error margin is the degree of error that will be allowed. Because it is an internet questionnaire, high precision is unrealistic. A value of 5% will be used. The confidence interval is the degree of insecurity that will be allowed. Here a confidence interval of 95% is chosen. The most conservative choice for spread is 50%. Entering these values leads to a minimum sample size of 385. In Table 4 the number of respondents per age category can be seen.

Age Category	**18-19**	**20-24**	**25-29**	**30-39**	**40-49**	**50-59**	**60-64**	**65-74**	**75=>**
Based on driver's license possession	8	38	43	99	98	64	19	15	2
Based on vehicle use	18	50	75	84	68	51	27	9	1
Maximum value of respondents	18	50	75	99	98	64	27	15	2

Table 4: Number of respondents per age category based on driver's license possession, vehicle use and the maximum of the two.

The maximum value of the respondents indicates how the respondents should be distributed among the age groups to guarantee the optimal representation of each age category in the sample. The total of the respondents exceeds the minimum value of 385 respondents, so this has to be corrected so that the total of the respondents is equal to 385. The total amount of respondents using the maximum values is equal to 488. This means that all age categories have to be multiplied with $\frac{385}{448} = 0.86$ to get to a total of 385 respondents. This leads to the result showed in Table 5.

Age Category	**18-19**	**20-24**	**25-29**	**30-39**	**40-49**	**50-59**	**60-64**	**65-74**	**75=>**
Number of respondents	16	43	64	85	84	55	23	13	2

Table 5: The corrected number of respondents per age group

Similar calculations have to be done to obtain the distribution of gender and education level under the respondents, these results will be presented in the following sections.

3.2.2 Distribution of education level under the respondents.

To see which education level categories must be used to analyze the sample, the education level categories used in the literature must be compared with the education levels used in the questionnaire to create a new categorization. The categories in the questionnaire have been kept as small as possible to simplify the re-categorization process. In the questionnaire the following education levels were formulated:

a) Lager Onderwijs
b) Lager beroepsonderwijs
c) Mavo/VMBO theoretische leerweg
d) VMBO overig
e) Middelbaar beroepsonderwijs
f) Havo/Vwo
g) Hoger beroepsonderwijs
h) Wetenschappelijk onderwijs

Again, only statistics of the internet use versus education level and vehicle use verses education level could be found. There was no information on driver's license possession. The statistics that have been found will be used to get a best possible description of the desired results. The Dutch Bureau of Statistics (CBS) has information on the internet use categorized by education level (CBS, 2000), which can be seen in Table 6. The bureau uses the following categorization:

a) Lager onderwijs
b) Vbo
c) Mavo
d) Havo/middelbaar beroepsonderwijs/vwo
e) Hoger beroepsonderwijs/wetenschappelijk onderwijs

Education level	**Internet use**	
	Percentage	Absolute (x1000)
Lager onderwijs	10	12
Vbo	12	15
Mavo	22	27.5
Havo/Middelbaar Beroepsonderwijs/vwo	22	27.5
Hoger beroepsonderwijs/wetenschappelijk onderwijs	34	42.5

Table 6: Internet use per education level

The ministry of Transport, Public works and Water management has information on the average number of kilometers that Dutch drivers drive per day categorized by education level(Ministry of Transport, Public Works and Water management, 2006), which can be seen in Table 7. The Ministry uses the following categorization:

a) Lager Onderwijs
b) Lbo/lavo/mavo

c) Mbo/havo/vwo
d) Hoger beroepsonderwijs/wetenschappelijk onderwijs

Education level	Vehicle use	
	Percentage (% of total average km driven per day)	Absolute (average km driven per day)
Lager Onderwijs	5	3.72
Lbo/lavo/mavo	21	15.44
Mbo/havo/vwo	31	22.25
Hoger beroepsonderwijs/wetenschappelijk onderwijs	44	32.65

Table 7: Vehicle use per education level

Data cannot be compared if they are categorized differently, which means that the categories must be modified. The new categories will be as follows:

a) Lager Onderwijs (lower education)
b) Lager beroepsonderwijs/Mavo/VMBO theoretische leerweg/VMBO overig/lbo/vbo (Medium-Low)
c) Middelbaar beroepsonderwijs/havo/vwo (Medium-High)
d) Hoger beroepsonderwijs/wetenschappelijk onderwijs (High)

The following variables will be defined:

1. A: Internet use at a particular education level
2. B: Vehicle use at a certain education level

The following formulas have to be used to calculate the number of people who use the internet at a certain education level who possess a driver's license. $P(A \cap B) = P(A)P(B)$.
This leads to the results shown in Table 8.

Education level	percentage	Absolute
Low	1.7	7
Medium-Low	24.3	93
Medium-High	22.6	87
High	51.3	198

Table 8: Expected distribution of education level under the respondents

3.2.3 Distribution of gender under the respondents.

The distribution of gender will be calculated the same way as the distribution of age groups under the respondents. 46% of people who possess a driver's license is female (CBS, 2007). Besides that it is known that the 48% of females used the internet in 2001(CBS, 2002). There were 8,017,633 females in the Netherlands in 2001(CBS, 2007), which means that 3848463 females used the internet. On the other hand there were 7,846,317(CBS, 2007) males in the Netherlands in 2001 of which 67 percent (CBS, 2002) used the internet. With a simple calculation a total of 5,257,032 males who used the internet in 2001 can be retrieved. This means that 42% and 58% of internet users are female and male respectively.
The variables will be defined as follows:

1. A: A Dutch female uses the internet.
2. B: A Dutch male uses the internet.

3. C: A Dutch female possesses a driver's license.
4. D: A Dutch male possesses a driver's license.

To get the distribution of gender data on driver's license possession and internet use will be used. Information on females who use the internet and possess a driver's license is wanted.
For the female this calculation is $P(A \cap C) = P(A)P(C)$=0.19
For the male this calculation is $P(B \cap D) = P(B)P(D)$=0.31
So in the sample 38% of the respondents have to be female and 62% of the respondents have to be male (see Table 9). Note that here the vehicle use has not been taken into account because statistics on this field are not available. Out of the tables of CBS Statline it can be seen though that males use their vehicle more often than females.

Gender	Absolute	Percentage
Male	238	61.8
Female	147	38.2

Table 9: Number of respondents per gender

3.3 Implementation

Before administering the survey, a pilot-test was carried out. To make a pilot-test possible the questionnaire had to be put online. This means designing a graphical user interface (GUI) that enables the respondents to interpret questions right, to give their opinion, and easily navigate through the questions on one hand. On the other hand the researchers must be able to obtain the results in a certain way. It must be possible to store the results for processing in programs such as Microsoft Excel or SPSS.

The program that was used for the design of the GUI is Quaestio. This is a user friendly software package that allows the researcher to put the questions online by using a standard survey interface. A screenshot is provided in the appendices. The design of the questions themselves is in the hand of the researcher. The researcher is able to decide how many questions are displayed, what kind of questions are used, how the answers are sorted, the order of the questions (random or predefined), if multiple answers are available, linking questions to each other, code questions for later processing, the output of the results (Excel or SPSS), if they monitor the time, the IP address, if they want to use clarification features, and if they want to use a progress bar or not. Even though this is user-friendly software, some html knowledge is required to work with this software, especially when dealing with the layout of the questions. The first disadvantage of Quaestio is that only the department for Information Technology, Library & Education (ITBE) of the University of Twente has the license to use this software package which means that editing the questionnaire is only possible at the University when the Quaestio computers are available. The second disadvantage is that the survey interface cannot be edited. Compared to other available software Quaestio offers many opportunities. Most other software have a response limit, time limit, question type limits, limit the number of questions, or require extensive programming knowledge. Others which do not have these limitations require purchasing a license. Examples of some other options were PHP surveyor, Survey Console, Advanced survey, Survey Monkey, and Examine.

People who have spent little time filling out the questions will be excluded from the results. Here the assumption is made that people who have spent little time giving answers did not interpret the questions correctly. Only one open-ended question is used in the questionnaire. Open-ended questions complicate the data-analysis process. Answers in the questionnaire are measured using the Linkert scale, multiple-choice format, ordinal measurement level, and the numerical measurement level.

Several features of Quaestio have been used to improve the quality of the survey. In the introduction an indication of the total time the survey takes is given. There is also a progress bar at the bottom of each page. Clarification has been used at some questions that may require clarifying. The total fill out time and the IP addresses of respondents are monitored to prevent measurement errors. The variables have been pre-coded to ease the design of the code book in a later phase. The final code book can be found in the appendices.

3.4 Pilot test

After putting the survey online for pilot-testing several reactions were received. Some of the questions and terms used were not that clear. They had to be rephrased. Multiple comments were received on the questions that investigated the willingness to pay. It was not clear that the spending would be once or per time unit. Besides that everyone who reviewed the questionnaire had a comment on the Quaestio interface. The buttons are at the side and at the first screen there even is a button that says “Back”. People prefer to see these buttons at the bottom of each page. Unfortunately this could not be changed because that is how the program is designed. Another comment was that there was no indication of how many minutes it takes to do the survey. The format of the questions and relevance were also commented on. Recommendations were to change the yes/no questions to scaled questions (e.g. 1-5). Some questions appeared to be logical; suggestions were to ask more thoroughly. These comments were carefully considered after which the questionnaire was adapted. The questionnaire was located at the following URL: http://www.quaestio.com/utwente/quaestio.php?qst=TIWMC and the updated questionnaire can be found in the appendices as mentioned before.

4 Results and Analysis

This chapter describes the way the results were gathered, the results, the analysis plan, and the analysis of the data.

4.1 Results

This section provides an overview of the methods used to gather the results, in what degree these methods succeeded, what the most successful methods were, followed by the characteristics of the obtained sample.

4.1.1 Gathering the results

The administration process, as was mentioned before, is the most vulnerable part of the assignment. In this particular part of the assignment at least 385 responses had to be gathered by the use of the internet. This sub-section describes the process of gathering responses had.

Several methods have been used to get responses on the internet. These methods can be split up in e-mail based methods and web-posts. First an overview of 3 web-post methods will be given. The first method is by posting the link of the survey on news groups. The second method used is by creating a group at Google. The third and most successful method is by posting the link in forums. Here permission of the site administrators were asked and after permission was granted the link was posted in the forum. It has to be mentioned explicitly that the link is posted with permission of the administrators or else the link could be seen as spam. At least half of the responses were gathered via forums. In the beginning the Big-Boards website was used to see which the largest forums are (BigBoards.com, 2007). As the days went by the smaller forums were also used to gather responses. Not all forums can be used to gather responses. Forums that have nothing to do with transportation, that are focused on youth, or other specific topics cannot be used. Permission of the ANWB has also been asked to post the link in their forum but permission has not been granted.

Now an overview will be provided on the e-mail based methods. The first e-mail based method was the use of e-mail addresses of the staff of the University of Twente. Relatively few people from the University clicked on the link, which could be seen from the IP addresses of the respondents. The second e-mail based method that was used was to gather responses by selecting companies that have something to do with transportation and send them an e-mail in which they were asked to spread the questionnaire in their company. About 4 to 5 of these companies reacted on the request, which is less than 10% of the companies that were approached. The last method that was used was to ask friends and relatives to fill in the questionnaire, and to pass this questionnaire on in their social network. These people were more willing to cooperate than other people but this is a relatively small number of people.

The number of responses varied throughout the 4 week period that the administration took place. In the beginning of the administration period it was visible that a whole lot of people at least clicked on the link. 40-50% of these people also filled in the questionnaire. As time went by fewer people clicked on the link to the survey. The survey was increasingly seen as spam, which has lead to change in approach several times. The people were then approached friendlier. Several tips were given by site administrators and others to prevent that the survey was seen as spam. Despite these tips it was still necessary to put more effort into getting responses. In the final week of administration the conclusion was drawn that the most effective way to gain responses is via forums. Search engines such as Google and AltaVista were then used to search for any forum that could have registered members who can fill out the questionnaire. This intensified search for forums lead to a rapid increase in responses. It was also noticeable that a quite a few responses came between 16:00 and 21:00. This is probably the time of the day that people look at forums or check for new e-mails more often. Some people seemed to have a problem with opening the link of the survey. The reason is unknown; maybe Quaestio requires specific software to run.

When posting in forums it is essential to ask permission of the site administrators. Just posting the survey link in the forum leads to frustration of the administrators and of the forum members. This is why it is also recommended to say that you have permission of the site administrator. It is also recommended to see if the forum category matches the topic of the survey. General forums can be used most of the time but using a forum that matches the survey topic many times leads to a higher response rate. The message posted must also make clear that it is not a commercial research. People disgust commercial surveys as was visible in some of the reactions on the survey. Many administrators also said that they would not have granted permission if the survey was commercial.

4.1.2 Results

Prior to the analysis of the data, the data has to be filtered. Here uncompleted questionnaires have been filtered out by looking at the amount of questions finished. The minimum amount of questions required to finish the questionnaire is 30. This is not a guarantee that all people who finished more than 30 questions filled in all questions, but a very large proportion did. A total of 1058 people clicked on the link to look at the survey. Of these people 460 completed the survey. If the people who looked at the email, posts in newsgroups or forums are neglected the response rate is 43%. The obtained sample has been compared with the desired sample characteristics to see the representativeness of the sample. The Chi-Square test has been used to see if the desired sample characteristics significantly differed from the obtained sample characteristics. The results are visible in Table 10, Table 11 and Table 12. The obtained samples differed significantly from the desired distribution (at the 0.05 significance level). This means that data such as the overall willingness to pay, and other averages are influenced. To calculate these averages correct these results will be weighted.

	Desired	Obtained
Male	284	360
Female	176	100

Table 10: Gender distribution

	Desired	Obtained
18-19	19	25
20-24	51	81
25-29	76	72
30-39	102	101
40-49	100	101
50-59	66	58
60-64	27	14
65-75	16	8
75+	2	0

Table 11: Age distribution

	Desired	Obtained
Low	8	4
Medium-Low	112	56
Medium-High	104	121
High	236	278

Table 12: Education level distribution

4.2 Analysis plan

To analyze the data an analysis plan has been made. In this plan it is determined which information has to be obtained in each category. The analysis contains of overall analysis and analysis of each category. The first two categories are mainly about acceptance while the third category is more about risk perception.

4.2.1 Filtering

In this subsection the filtering methods are summarized. The original idea was to also filter on time and multiple responses. Filtering on time was not done because of software limitations: The time taken by the respondents to fill in the questionnaire could not be exported to SPSS. Filtering on multiple responses was also kept out because filtering on IP addresses is not realistic; different people can have the same IP address.

Distribution

The general data, in this case age, gender, and education, have to be analyzed to see if they meet the desired distribution that was determined beforehand.

Incompletion

The minimum amount of questions answered needed to complete the questionnaire is 30. People who answered less than this will be filtered out.

Outliers

Outliers are values that are numerically distant from the rest of the data. These can be filtered out using the following rule:

$> Q_3 + 3 \cdot IQR \; or < Q_1 - 3 \cdot IQR$ (Wikipedia, 2007)

This should be used for quantitative variables.

4.2.2 General characteristics of the respondents

1. Relationship between driving experience, age, income level, and education level.
2. Primary motives of transportation
3. All motives of transportation

4.2.3 Application categories (Services, driving environment information, driver comfort)

In this section an overview will be provided on how the data will be analyzed. First an analysis will be made on the road category and the willingness to pay per application category. Then each category will be analyzed individually to get the desired results mentioned in 3.1. Details can be seen below.

General application characteristics

1. The willingness to pay for the different application categories.
2. The road category on which drivers prefer to use the applications.

Driving environment information:

1. Overall acceptance
2. Where drivers would like to receive information (inside/outside)
3. Type of interface (audio/visual)
4. Best route description
5. Influence of general characteristics

Driver comfort

1. Overall acceptance
2. Level of control
3. Fully automated congestion assistant
4. Influence of general characteristics

Services

1. Risk perception
2. Service preference
3. Acceptance of the parking service
4. Influence of the general characteristics

Summary on comments

4.3 Analysis

This section provides the analysis of the data according to section 4.2. This means that the general characteristics of the respondents, general application characteristics, and the application categories will be analyzed. Each application category adds its own value to the view of the respondents on ITS applications. At the end of this section a summary of the comments of the respondents is also provided.

4.3.1 General characteristics of the respondents

The general characteristics of the respondents are age, gender, education level, income level, and transportation motive and vehicle type. First the driving experience of the respondents is analyzed. The average respondent has 16 years of driving experience and drives 2 hours a day. The average male respondent has less driving experience (16) than the female respondent (18). There is a relation between driving experience and age which is best described as a polynomial relationship of the second degree (Figure 5). People do not get their driver's license immediately after they turn 18, which is why the curve is more horizontal in the beginning. Older people drive less, probably because they do not have to work anymore.

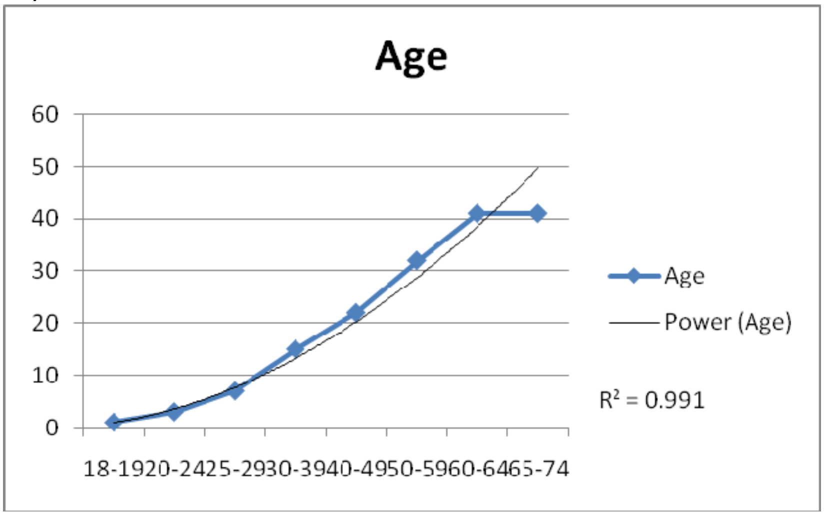

Figure 5: Age versus driving experience

If the relationship between driving experience and education level is considered it is remarkable that people with a lower education level have more driving experience. The relationship between driving experience and education level is seen in Figure 6.

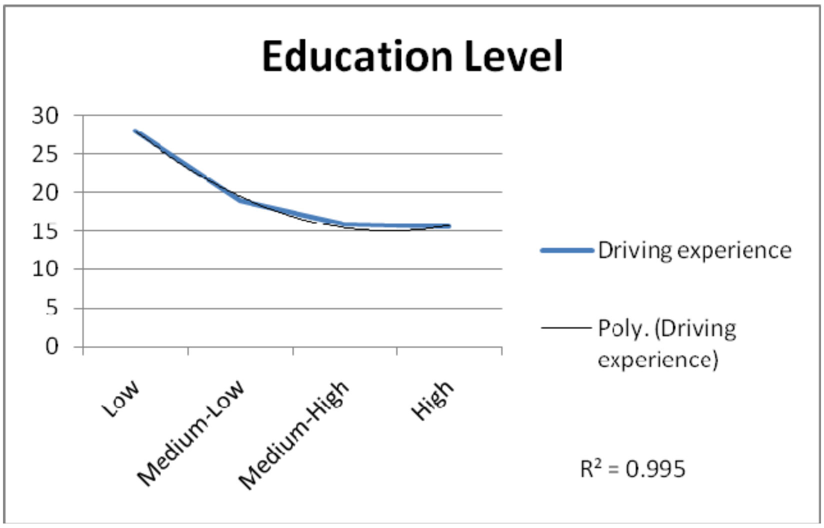

Figure 6: Relationship between driving experience and education level

The next relationship to be considered is the relationship between driving experience and income level. There is a negative correlation between driving experience and the education level. The relationship is shown in Figure 7.

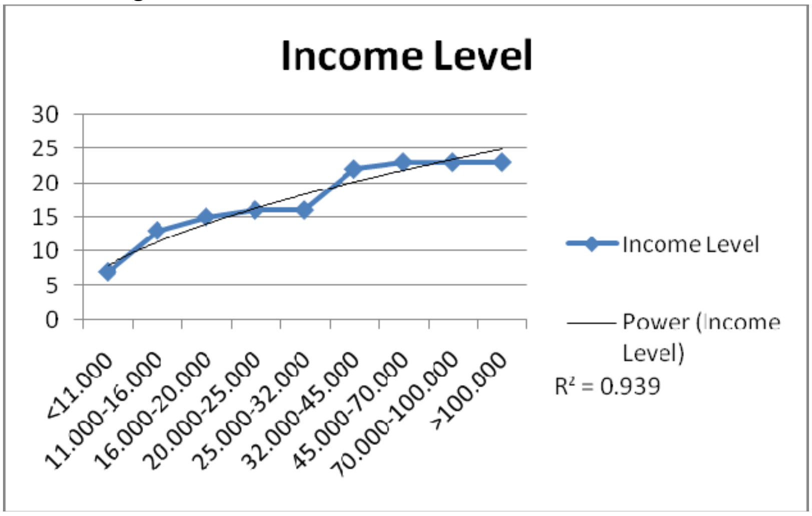

Figure 7: Relationship between driving experience and income level.

The average time per day indicates the average number of hours each driver spends behind the steering wheel per day. Data indicates that males drive more than female drivers. Male drivers drive 2 hours a day against 1 hour for the female drivers. Younger people tend to drive more than older people. People with a higher education seem to drive less than people with lower education. On the other hand people with a higher income drive more than people with a lower income. This makes it interesting to analyze the relationship between income and education level of the respondents. There is positive correlation between income level and the education level of the respondents. Thus the conclusion can be drawn that people with higher education mobilize less than people with lower education in their profession, which is why the lower educated people obtain their driver's license in an earlier stage in life.

The primary motive of transport has been analyzed to see if the distributions vary with the characteristics (Figure 8). Chi-square tests were carried out to compare the expected distribution with the obtained distribution.

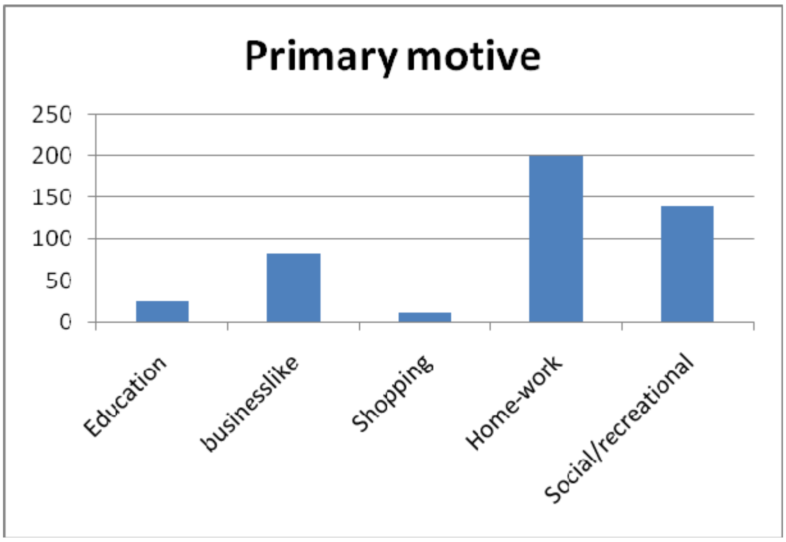

Figure 8: Distribution of the primary motive of transportation

Results show that gender does not have an influence on the primary motive. Home-work movement remains the largest primary motive under the respondents. Age has its influence on transportation motive. Younger people more often have education as their primary motive of transportation and older people have social/recreational motives more often. People with a low yearly income have education as their primary motive more often than the average respondent. Respondents with a high income do not have education as a primary motive for transportation at all. Besides that fact some have shopping as their primary motive. If the educational level of the respondents is considered, it is clear that people with lower education have different primary motives for transportation than the average respondent. They neither have education nor business as a primary motive of transportation. Considering all motives of transportation in general, it is clear that, education and shopping are very often motives of transportation, despite the fact that they are not selected as primary motives of transportation that often. This can be seen in Figure 9.

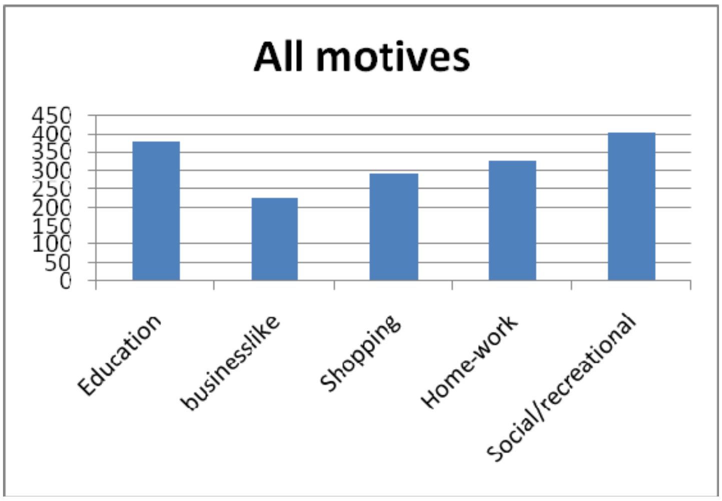

Figure 9: All motives of transportation

4.3.2 General application characteristics

The willingness to pay (WTP) depends on all general characteristics (age, gender, education level, income level, primary motive) for all three application categories. The relationship between the general characteristics and the WTP is different per category. For the driving environment information category there are only positive correlations for the characteristics. The overall WTP for this category is €91.70. If the education level, age and income level increase, the WTP also increases. Male respondents are more willing to pay for driving environment information than females. Motive for transportation also matters. This can be seen in Figure 10. Note that the figures showing WTP in this figure is different in reality because some categories are overrepresented.

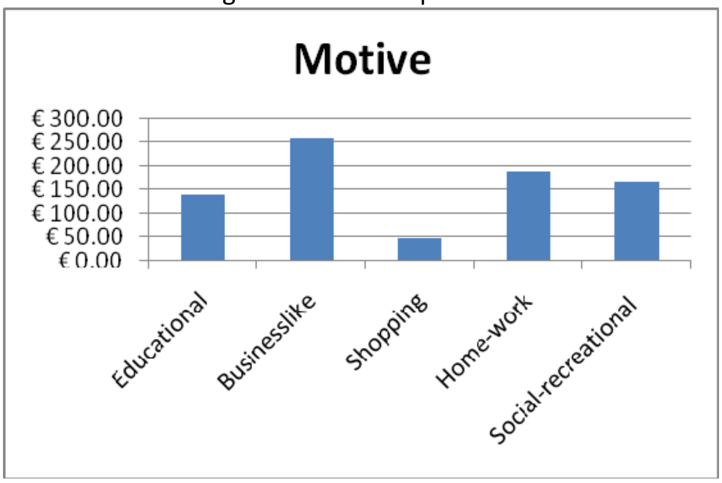

Figure 10: WTP for driving environment information per primary transportation motive

For the driver comfort category there are different relationships between age, income level and the willingness to pay. There is a small negative correlation between these characteristics and willingness to pay which means that with an increasing income level and age the willingness to pay for driving comfort decreases. The overall WTP for this category is more than the WTP for the driving environment information category (€97.84). Male respondents are still willing to pay more for driver comfort applications than female drivers. The relationship between motive of transportation and WTP also changed. This can be seen in Figure 11.

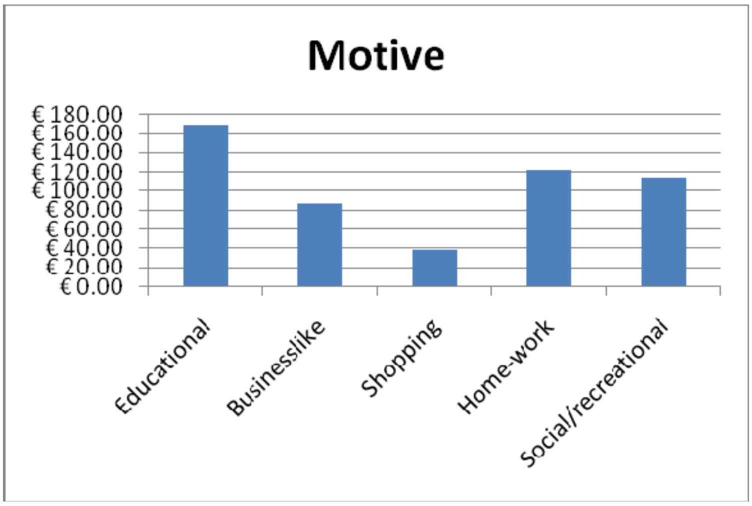

Figure 11: WTP for driver comfort applications per primary transportation motive

For the services category the willingness to pay has been calculated in a different way. Here the WTP was calculated per month which is why the amount cannot be compared with the amounts of the other two categories. However the relationships between the general characteristics and the WTP can be compared. For the services category the overall WTP is €6.69 per month. Males are less willing to spend on this category than females. The relationship between age, income and WTP are the same in the services category as for the driver comfort category. The relationship between education and the WTP for the services category is comparable with the same relation in the driving environment information category. The relationship between motive of transportation and WTP is comparable with the same relationship in the driver comfort category. This can be seen in Figure 12. Most of the people who have education as their primary motive are between the ages of 20-24.

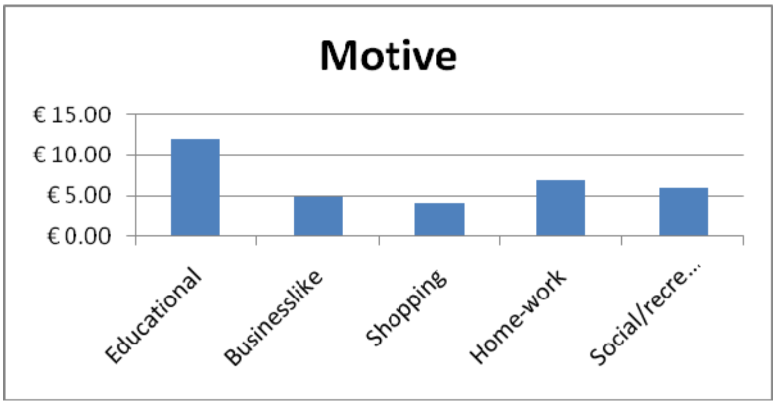

Figure 12: WTP for services applications per primary transportation motive

Road category

The road category has its influence on the acceptance of the applications. The results from the survey show that the respondents prefer to use the applications on motorways (54%), followed by interregional roads (36%) and urban roads respectively (10%). The percentages indicate the relation of usage of the applications on the different roads. The results can be seen in Figure 13. The general characteristics do not make a difference in the preference of the drivers.

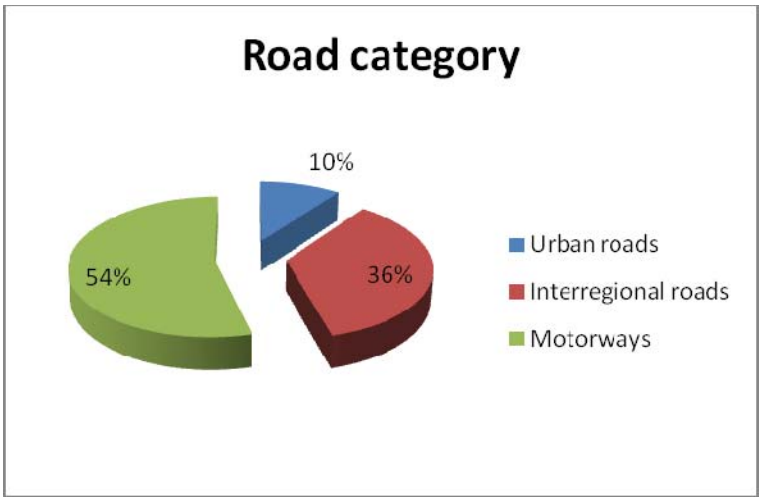

Figure 13: Road category on which drivers prefer to use the applications

4.3.3 Analysis of the acceptance of driving environment information applications

The acceptance of the application category depends on the applications themselves. But overall the applications of the driving environment category are accepted. The results can be seen in Figure 14. 62% of the respondents accept the driving environment information applications.

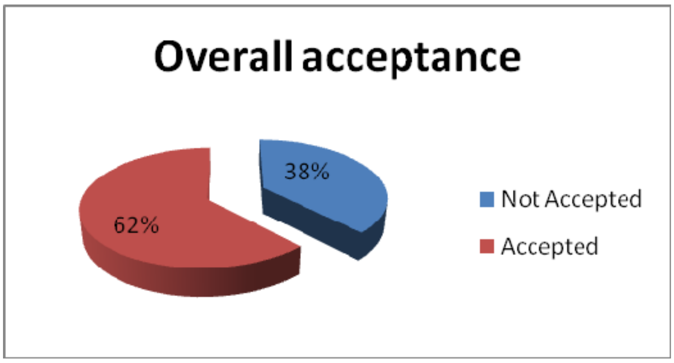

Figure 14: Overall acceptance of driving environment applications

The applications that could be rated on a scale from 1 through 5 got a rating of 3.2. These are the weather information, route choice, and the travel time applications. The other applications which the respondents could choose to be informed inside or outside their vehicle were accepted by 66% of the respondents. In Figure 15 it is shown where the respondents would like to receive driving environment information. It is clear that information has to be provided inside as well as outside vehicles.

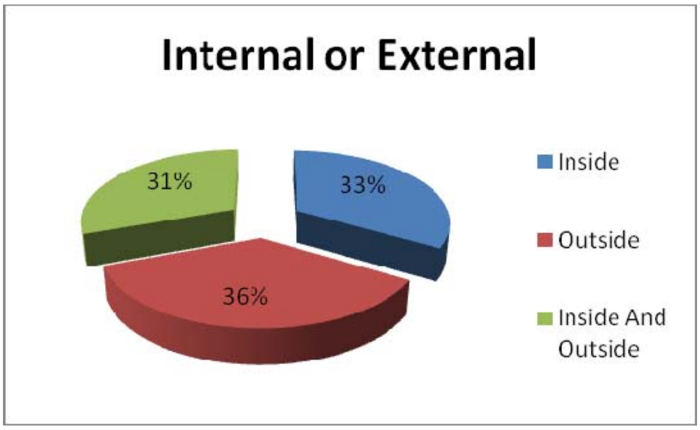

Figure 15: Where the drivers want information: Inside or outside the vehicle

The interface respondents would like to use is shown in Figure 16. Again there is no preference for a particular interface, so it is recommended to give the driver all the options and let him/her choose how he/she would like to perceive information or do further research in which the driver can practically experience in-vehicle systems.

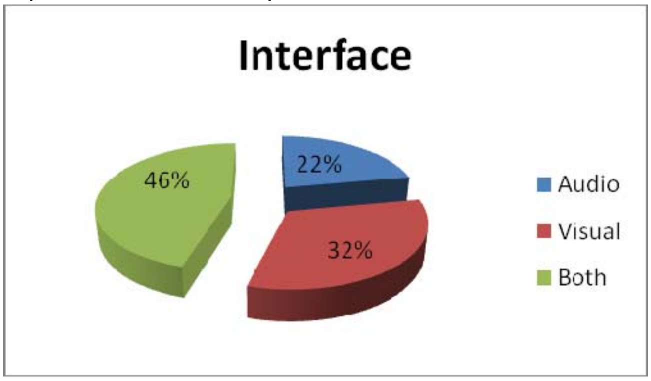

Figure 16: Type of information drivers would like to perceive

To give the driver the best route to his/her destination it is necessary to know what the driver calls the best route. This can be seen in Figure 17. Here it can be seen that 78% of the respondents describe the fastest route as the best route.

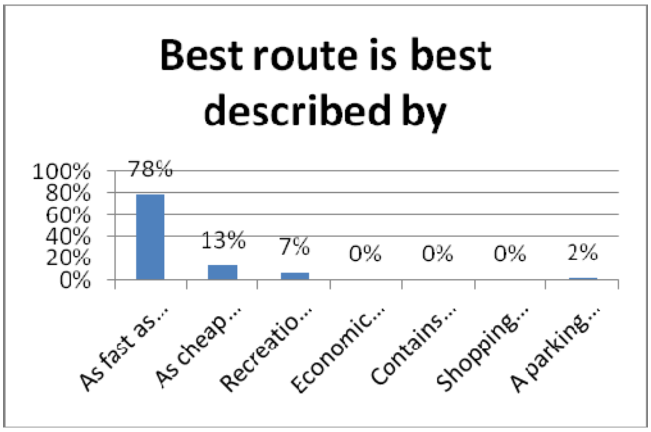

Figure 17: Description of the best route

Results from the survey show that regardless of the transportation motive, the fastest route is always seen as the best route. For businesslike or home-work motives over 80% of the respondents see the fastest route as the best route. If the motive of transportation is educational the cost is also considered important, while in case of shopping the recreational route is considered important. It is noticeable that people who have social-/ recreational activities as their primary motive prefer a fast and cheap route over a recreational route. People who have more driving experience have a different description of the best route.

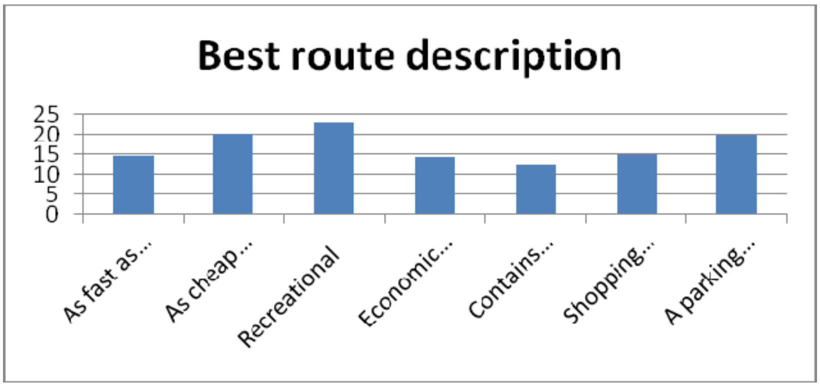

Figure 18: Best route description against average driving experience

In Figure 18 it is visible that people who have more driving experience are more concerned about getting a parking space and recreation than people with less driving experience. Because of the relationship between driving experience and age, the same conclusions can be drawn when age is put in relation with the description of the best route. People with more driving experience also prefer audio messages to other formats of information. The more experienced drivers are also the ones who always want information on trucks carrying dangerous goods and want information both inside and outside the vehicle.

If the influence of the general characteristics is considered, the following conclusions could be drawn:

- Gender does not have influence on the general acceptance of the driving environment information applications. It does however influence the way drivers want to receive information in their vehicle. Female drivers would like audio messages more often than the average driver.
- Age does not have much influence on the acceptance of applications. However, there is a difference in the way drivers want to perceive information. This varies with the age; there is no clear relation visible. Older people want to get more information on dangerous goods than younger people.
- Education level has its influence on the acceptance of driving environment information applications. Drivers with a lower education would not like to receive any more than the average driver. There is a significant* difference in the way the low educated driver wants to perceive information. The low educated driver wants more audio messages then the average driver.
- The income level has no significant influence at all on the overall acceptance of the applications. However it seems that people who earn more money have less interest in the presence of vehicles carrying dangerous goods.
- The primary motive of transportation has no significant influence on the acceptance of the driving environment information applications.
- The vehicle type the driver uses does not have any influence either on the acceptance of the driving environment information applications.

*Pearson Chi Square test has been used to test if the observed data set is different from the expected data set (Goodness of Fit) at 0.05 level. This method has been applied in all categories to all general characteristics.

4.3.4 Acceptance of the Driver Comfort category applications

The overall acceptance of the driver comfort applications depends on the acceptance of the applications provided in the survey. These were applications concerning automatic control of the distance between vehicles in different traffic conditions. The results can be seen in Figure 19.

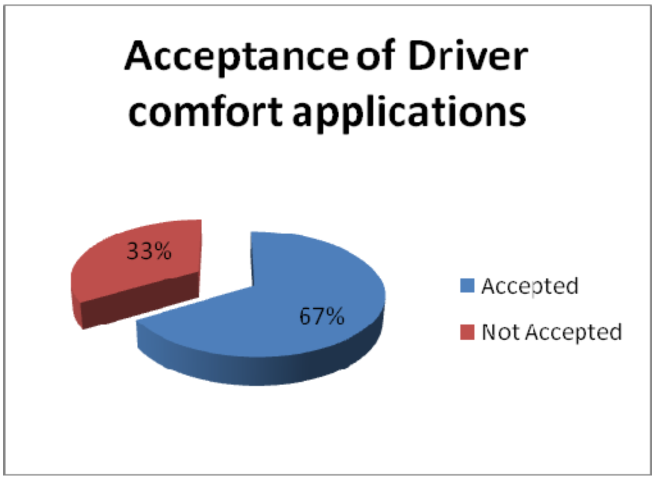

Figure 19: Overall acceptance of driver comfort applications

In this category the level of control has also been analyzed. The results (Figure 20) show that only 6 percent of the respondents want the driver comfort applications to be always on. 28 percent of the people do not want any automatic vehicle control at all; while 39 percent want to be able to switch the automatic control off. This means that 45 people want some form of automatic control.

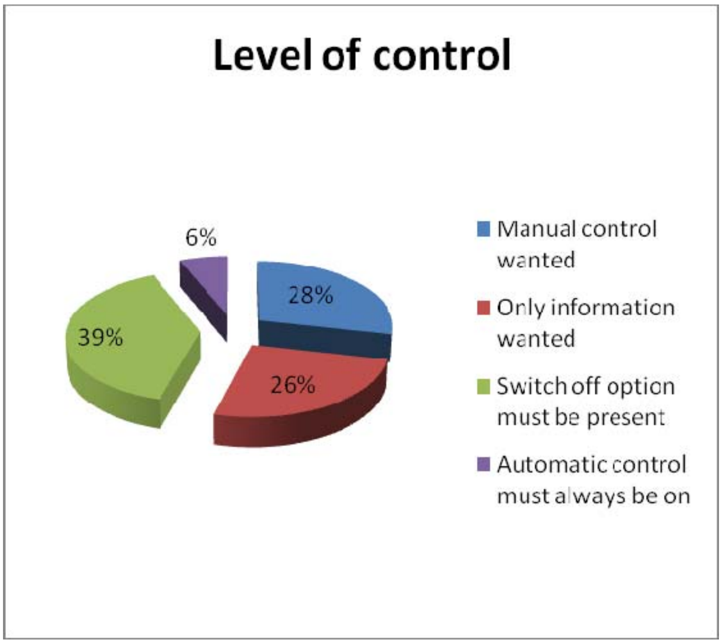

Figure 20: Preferred level of control

It is very remarkable that people with more driving experience want more automatic control of the vehicle (see Figure 21). Maybe this is because younger people are more anxious to drive than older ones. This is why people who accept the driving comfort applications overall have more driving experience (18 years) than those who do not accept them (15 years). There is no difference in the driving experience of the people who want to use the fully automated driving assistance and those who do not want to use this option.

Average driving time of the day will not be considered in this category because there is little variance between the driving time per day per level of control.

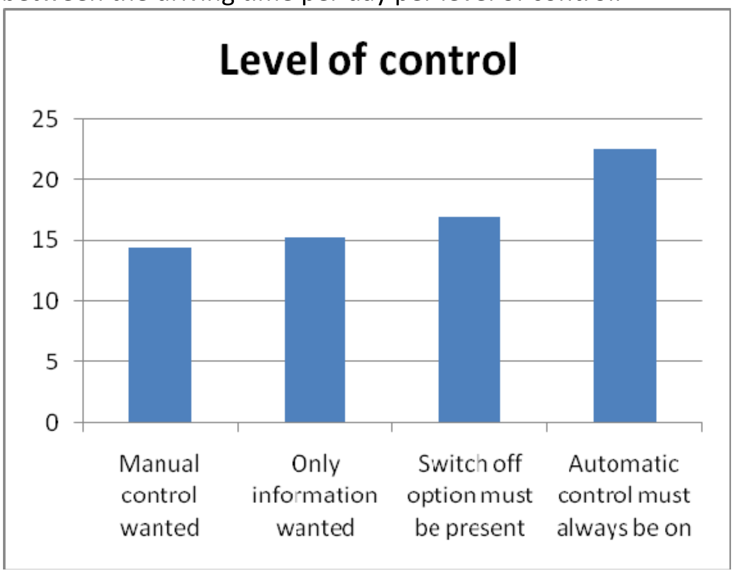

Figure 21: Level of control versus driving experience

The respondents were also given the opportunity to give their opinion on a fully automated congestion assistant. This is not like the congestion assistant presented in the work of Van Driel and Van Arem (2006), the difference is that this one takes over all driving tasks. The acceptance of this version of the congestion assistant can be seen in Figure 22.

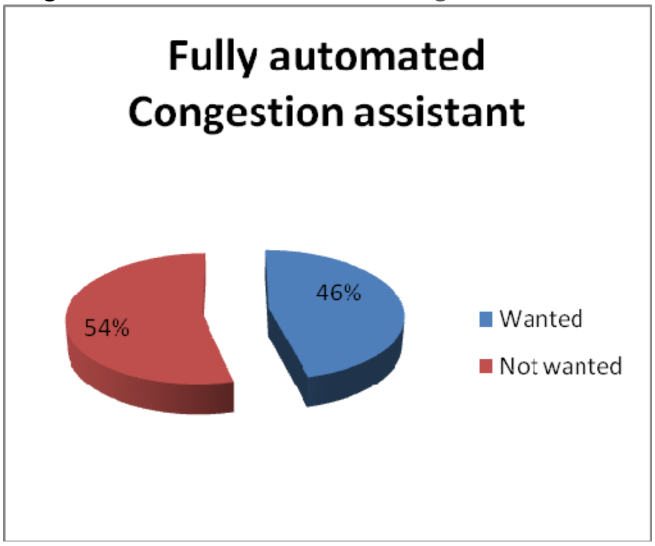

Figure 22: Acceptance of the fully automated congestion assistant.

After analysis of the effects of the general characteristics on the acceptance of the driver comfort applications the following conclusions were drawn:

- Gender does not make a difference in the overall acceptance of the driver comfort applications. But it does make a difference in the acceptance of the fully automated congestion assistant. The females seem to like the fully automated congestion assistant less than the male.
- As the age increases, people want more automated driving assistance. The relation is the same between age and level of control; as the age increases people want more automated control. There is no clear relationship between the acceptance of the fully automated congestion assistant and age.
- Increase in the education level also means increase in the acceptance of driver comfort applications. The high educated do accept the fully automated congestion assistant (51%). The acceptance by the lower educated is considerably lower than the acceptance by the higher educated (25%).
- The overall acceptance of the driver comfort application increases with the income level. This is the same with the acceptance of the fully automated driver assistant and the level of control of the applications.
- The motive of transportation seems to matter for the acceptance if it is education or businesslike. For these motives of transportation the overall acceptance is lower; 53% and 60% respectively, compared to 67% overall.
- Vehicle type also has its influence on the acceptance of the driver comfort applications. These applications are more accepted (+10%) under the respondents who drive vehicles of 2 axles. This is the same with the acceptance of the fully automated congestion assistant.

4.3.5 Acceptance of the services category applications

In general, drivers see a high risk in the use of the internet by the driver (4.1 on a scale from 1 to 5) compared to a medium-low risk (2.7) in the use of the internet by the passenger. The availability of games for the passenger is seen as a slightly negative influence on the driver (2.4). The people who see the availability of internet as a risk have on average more driving experience than people who see less risk in the availability of the internet. This is contrary to the view on the availability of games. People who have a negative view on games have less driving experience than those that have a positive view on the availability of games for the passenger. The question which services applications they would like to spend on, internet was the most selected one. The results can be seen in Figure 23. The age of the respondents has its influence on the risk perception of the respondent. Younger people are more interested in games and TV while older people are more interested in the in-vehicle availability of radio. The same relation is visible between the driving experience and the service preference: the more experienced drivers are more interested in radio, and the less experienced drivers more interested in games and TV. The general characteristics did not have an influence on the risk perception of the respondents.

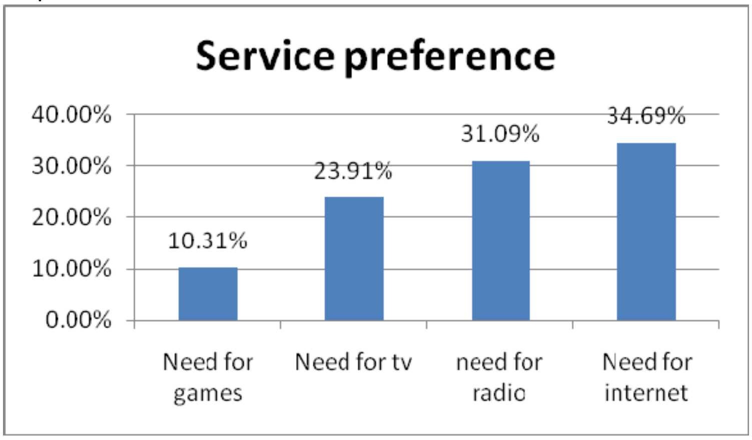

Figure 23: Preference of service under the respondents

Parking service was shown to users of vehicles that have more than two axles. It was mentioned that the service was not free of charge. Results are shown in Figure 24. Of the drivers that saw this question 77% of them were willing to use the parking service, and it heavily depended on the circumstances. 96% of the drivers do not want to use the service under normal circumstances. Because there were not that many respondents who got to fill in this question the influence of the general characteristics will not be considered.

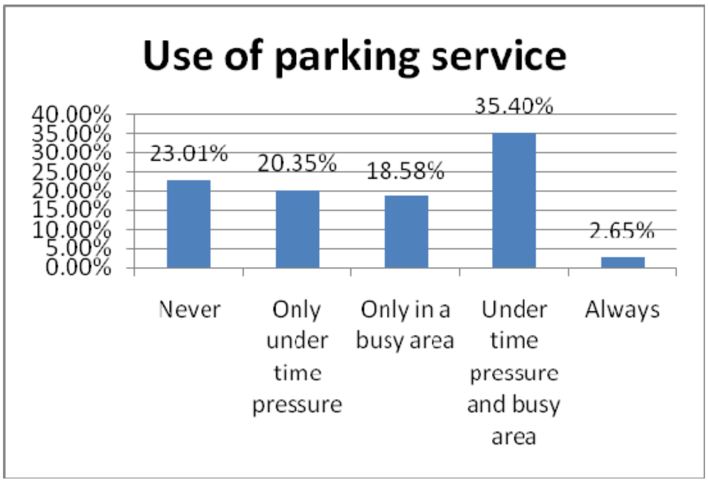

Figure 24: preferred use of parking service

4.3.6 Summary of the comments

The respondents are concerned about the distraction the applications will cause. They say that the driver already has enough distractions and that more devices will only lead to more distraction. Helping the driver too much will lead to dumber drivers in the future. Besides that some respondents say that they do not want any autopilot type of devices in their vehicle. They want to keep control of the vehicle, and if a device fails, people want to be able to fix this device without having to go to a garage. This will only lead to more costs according to the respondents. The respondents do not want to pay a monthly fee to get services. They also complain the current way of providing information. The variable messages are not reliable and there are too many traffic signs. The respondents are also concerned about the reliability of the future applications. If the current technologies encounter problems, more advanced technology will lead to more advanced problems.

There were also suggestions for improvement of applications. The first is the active gas pedal application. Here a respondent stated that some accidents can be prevented by driving faster. The active gas pedal would not allow this. In this scenario the active gas pedal will lead to an accident. The second proposal concerned an application where the vehicle maneuvers to the side of the road in case of an emergency.

There was also some criticism on the interface of Quaestio. These were similar to the comments received in the pilot test. Most of the respondents complained about the inability to enter decimals. They wanted to do this in the question on the average driving time per day.

The reliability of the applications seems to play an important role in the acceptance of the applications. This indicates that proof must be provided that the systems are reliable. It is also important that the driver can switch of the device. This way they still feel in charge of the vehicle which will lead to a higher acceptance percentage of the applications.

5 Conclusions and Recommendations

The goal of this assignment was to get an overview of the acceptance of some vehicle-vehicle/infrastructure communication based ITS. This was done by means of a survey, which was administered online during a 4 week period. A total of 460 valid responses were gathered that had to reveal the acceptance of a selected set of applications. First conclusions will be given on general characteristics of the respondents, general application characteristics, driving environment applications, driver comfort applications and service applications; followed by some recommendations.

In this research the following characteristics of the respondents have been considered: motive of transportation, driving experience, age, gender, income level, and education level. First the primary motive of transportation will be considered. In general the primary motive of transport is work, followed by social-recreational and businesslike activities. The relation between the transportation motive and the willingness to pay for the driving environment information applications are similar. This indicates that the applications in driving environment information can be focused on these three motives of transportation. This can be done by researching the traffic behavior of the people with these motives and providing them with options. E.g. for the social-recreational people a database can be created where social recreational activities are saved with information on its time and location. The social-recreational driver can then select what kind of activity he/she is wants to attend, in what area he/she wants to attend this activity, after which route information is given to the driver via vehicle-vehicle or vehicle-infrastructure communication.

Two general application characteristics were considered. The first one is willingness to pay (WTP). The WTP for the services and the driver comfort category are different. Here people who have education as their motive of transportation are more willing to pay than others. These people are mostly between the ages of 20-24 and have a low income. This means that an eye must be kept on the price tag of these applications.

The second application characteristic that was considered was the road type on which drivers prefer to use the provided applications. The road type on which drivers prefer to use the provided applications is the motorway followed by the interregional and the urban roads. Motorways are used for longer distances of travel. This means that the driving environment information, driver comfort and services applications are used when driving longer distances and longer period of time. This means that it is better to make the applications available on motorways and interregional roads only, especially in the early stage. Maybe after drivers have some practical experience with the applications they have a different idea on where they would like to use the applications.

Now the application categories follow, of which driving environment information is the first. The applications in this category were accepted by 62 percent of the respondents. 69% of the drivers would like to receive information outside the vehicle and at the same time 64 percent would like to receive information inside the vehicle. This means that information has to be provided both inside and outside the vehicle, where the information that is provided inside the vehicle is more personalized. The information could then be adapted to the motive of transportation or the vehicle type. Since the drivers would like information within their vehicle, it is important to know which kind of interface they would like. 66% percent of the drivers would like audio messages while 78% of the drivers would like visual messages. This indicates that both audio and visual messages have to be made available with an option to switch off the audio or the visual part of the message. When information is given on a route, the people who give information must know what the driver calls the best route from origin to destination. Results show that, no matter what motive of transportation, drivers always want to get to their destination as fast as possible. This means that the resistance of the roads must be calculated at several times of the day and the route with optimum resistance and length must be selected so the driver can get as quickly as possible from origin to destination. 52 percent of the drivers want some kind of information on dangerous goods. Giving the drivers information on dangerous goods can have a negative impact on the traffic flow. If a driver knows that the truck driving in front is carrying dangerous goods it might change its behavior by increasing the distance between the vehicles. This has a negative impact on the roadway capacity.

The second application category is the driver comfort category. The driver comfort category offers applications in which the vehicle has a certain degree of autonomous control of the vehicle. Only 6 percent of the drivers want the control to be on in all situations without the possibility to switch the device off. Unfortunately this is the system that has the most positive influence on traffic flow, because this option leads to the lowest variation in travel speeds which means more optimal road usage. 26 percent of the drivers would only like information instead of physical control of the vehicle. This could be done by giving the driver information on the optimum distance between the vehicles. This can be achieved through vehicle to vehicle communication. The problem with this option is that the driver needs to pay a lot of attention to the information given and must be able to react quickly on the messages. This adds pressure to the drivers cognitive capacity which might make using this application unsafe than when drivers are not using this application. This is why it is recommended to provide the driver comfort applications with a switch-off option which will have a greater acceptance and a more positive impact on the traffic flow. The overall acceptance in this category is 67%, while the acceptance for the fully automated congestion assistant is 46%. This is close to the rate mentioned in the research of Van Driel and Van Arem (2006) which is 43%.

The last application category that was presented in the survey is the services category. Services applications are applications that provide the driver with entertainment, information and reservation services. The major issue of the services category concerned the distraction of the driver. The drivers have a different risk perception on the availability of the services for the driver and the passenger. They see a high risk in the availability of services for the driver while the risk when the service is available for the passenger is perceived as relatively lower. Drivers with more driving experience are more aware of the of in-vehicle services. There is preference for the availability of the internet and radio over the availability of TV and games. These services must be made available without demanding much interaction from the driver. The parking service that was provided for drivers of vehicles with more than two axles is wanted by 77 percent of the drivers under time pressure, in a busy area, both or always. Because the number people who always want to be able to reserve a parking space is low, it is not a good idea to always make the parking service available. It would be best to do this during peak hours and in big cities.

In the following paragraphs a few recommendations will be given. The first is on the reliability of the applications. This seems to play an important role in the acceptance of the applications. This indicates that proof must be provided that the systems are reliable. It is also important that the driver can switch of the device. This way they still feel in charge of the vehicle which will lead to a higher acceptance percentage of the applications.

Another recommendation is to combine features of the applications in a way that they fit the motive of transportation. E.g. People with a businesslike motive of transportation prefer the driving environment information over driver comfort applications. This means that an application set for people with a businesslike motive of transportation has to contain more driving environment information applications than driver comfort applications to guarantee a higher acceptance. For more information on the motives of transportation see 4.3.1.

There are also some recommendations based on the comments of the respondents. The first recommendation concerns the active gas pedal. Maybe this application should include technology that automatically switches of the active gas pedal in case of danger. This could also be done with inter-vehicle communication. If one vehicle approaches another vehicle and enters a circle with a predefined radius, the speed of the approaching vehicle can be compared with the maximum speed that a vehicle can stop within that range without causing an accident. If the speed is higher, the approaching vehicle sends a message to the other vehicle to inform that it is not able to stop on time which automatically switches off the active gas pedal. This will allow the driver to do anything that he/she wants to prevent the accident.

The second proposal is to enable the vehicle to move to the side of the road automatically is a very complicated one. This requires both inter-vehicle as vehicle-infrastructure communication. Inter vehicle communication is required to determine if there are other vehicles between the vehicle and the side of the road. Vehicle-infrastructure communication is required for the navigation from a lane to the side of the road. This application requires the use of some kind of coordinates or the continuous measuring of the distance between the vehicle and the side of the road or communication nodes.

Further research is recommended on the acceptance of the VRU and Collision warning applications. The acceptance of these applications may differ from the ones that have been researched in this assignment because their safety applications. According to Figure 2 safety is at the core of the consumers needs. This is why higher acceptance is expected for these applications. It is also recommended to do research where the end-users can practically experience the ITS applications of vehicle-vehicle and vehicle-infrastructure communications.

Overall the ITS applications that inter-vehicle communication generate are accepted by the majority of the drivers. It is important that the driver feels in charge of the vehicle, by enabling the driver to make choices between options and switch off the system. Furthermore driver distraction has to be taken in consideration: the informed driver might be a better driver, but the cognitive overloaded driver is the unattended driver.

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Appendices

5.1 Applications not researched in surveys

5.1.1 Vulnerable road user applications

Vulnerable road users (VRU) are the road users that move at lower speeds e.g. by bike or by foot. There are two applications for vulnerable road users. The first application concerns vulnerable road users that are crossing the road. Here one vehicle informs the other one on the presence of vulnerable road user that is out of the line of site of the second vehicle via inter-vehicle communication.

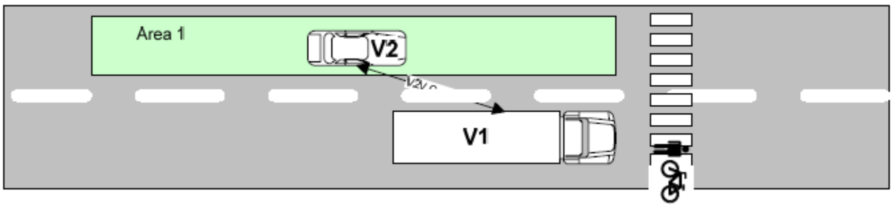

Figure 25 : VRU crossing application (Vivo, 2006)

The second VRU application is vulnerable units in a blind spot: Here the driver is warned on when to make a right turn in the presence of a VRU (Vivo, 2006).

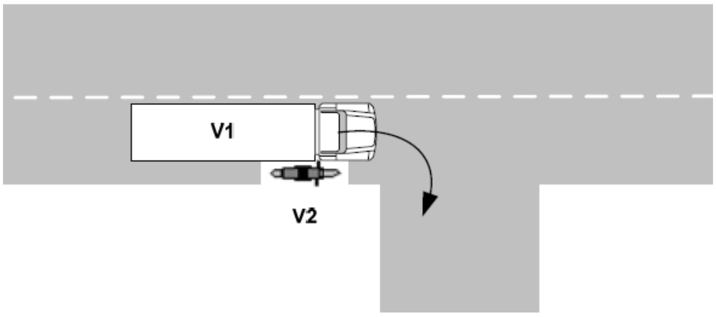

Figure 26: VRU application (Vivo, 2006)

5.1.2 Collision warning applications

Collision warning messages can serve as a tool to reduce the amount of human errors in the driving task. As was cited in the introduction, approximately 90% of accidents occur due to human errors. This section will provide information on general collision warning, followed by lane change maneuver options, then longitudinal collision warning, rear-collision warning, and applications to improve intersection safety.

The first sub-category that will be presented here is general collision warning. A first alternative is vehicle-to-vehicle unicast urgent exchange. When a collision is nearly unavoidable vehicles establish a unicast “connection” to share more vehicle information at a faster rate. The vehicle attempts to avoid or prepares for the crash (Meitzner, 2007). Another possibility is multiple collision avoidance. Here the inter-vehicle communication enables transmission of the information on obstacles or incidents detected by a preceding vehicle to the following vehicles. The obstacles include objects, parked vehicles and low-speed vehicles (Kato, Minobe, & Tsugawa, 2003) (Misener, 2007)(Meitzner, 2007). Vehicles could also be warned for static objects in a tunnel or they could be warned for abnormal vehicle behavior in front (Vivo, 2006). Abnormal vehicle behavior is also a part of the assisted transportation case of the HIDENETS project.

Now several lane change maneuver options will be presented. When merging at an interchange or on lane changing the inter-vehicle communications will provide the localization and speed data of each vehicle to all vehicles at the interchange. Each vehicle on the through traffic may enlarge the gap to accept the merging vehicle (Kato, Minobe, & Tsugawa, 2003).

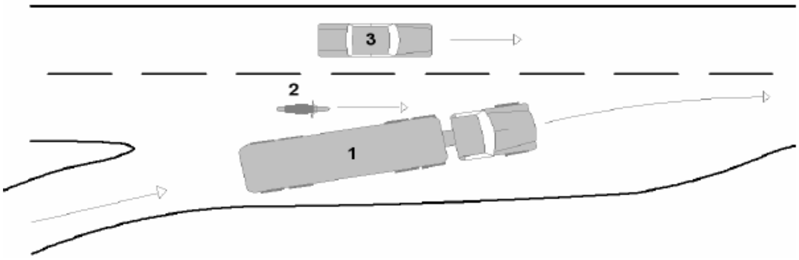

Figure 27: Lane changing options (Vivo, 2006)

Other possibilities concern motorcycles overtaking a left turning vehicle and lane change maneuvers for trucks with blind spots. In the IEEE Intelligent vehicle conference in 2002 several options have been presented for lane recognition. This information could be used to advice the driver of lane departure and the other drivers that lane departure is taking place. This could be done through inter-vehicle communication. Overtaking collision warning is also a part of the assisted transportation use-casein the HIDENETS project.

The third sub –category of collision warning is longitudinal collision warning. In this paragraph two possibilities of longitudinal collision warning are presented. The first is head on collision warning due to hazardous overtaking attempt (Vivo, 2006). The purpose of this application is to warn the first vehicle coming from the adjacent lane. As illustrated in Figure 28 vehicle 2 then warns vehicle 1 for the crash risk.

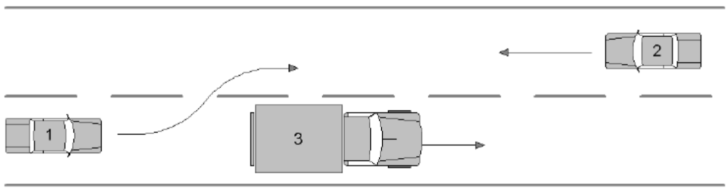

Figure 28: Hazardous overtaking (Vivo, 2006)

The second option of longitudinal collision warning presented here is a head on collision warning due to an autobus or similar vehicle climbing down on a hairpin curve. Here the vehicle that is coming will be warned by the autobus (Vivo, 2006).

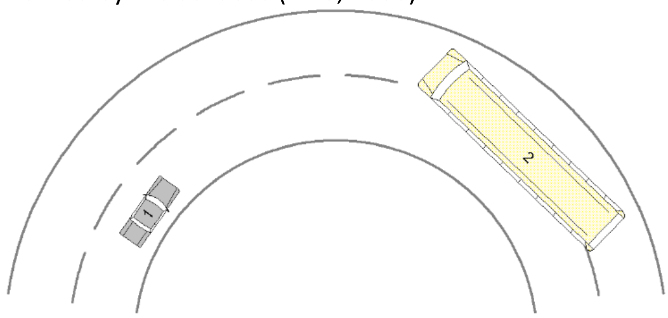

Figure 29: Bus in hairpin curve (Vivo, 2006)

The fourth sub-category of this category is the rear-end collision application. Rear-end collisions can occur several ways. One way is a slow heavy vehicle that is climbing up trough a hairpin curve. A solution is to warn the slow vehicle about the approaching danger situation (Vivo, 2006).This can happen through vehicle-vehicle communication. A second possibility on a rear-end collision is a slow vehicle at the end of a hilly road segment. Here the proposed solution is also to warn the slow vehicle about the danger situation (Vivo, 2006).

The fifth sub-category to be presented is intersection safety. The first application of intersection safety is left (in most western countries) turn collision avoidance and crossing collision avoidance. The system offers the driver information on approaching vehicles at blind crossings such as the localization, the speed and the behavior intention (Kato, 2003). It is possible to provide the information services, warnings or braking control to the driver depending on the level of danger.
The second intersection safety option concerns the accident intersection application (Vivo, 2006), where drivers approaching an intersection are warned about the accident at the intersection. This is also a part of multiple collision avoidance (Kato, Minobe, & Tsugawa, 2003) (Misener, 2007)(Meitzner, 2007). A third application of intersection safety is obstructed view at intersection. In this scenario one vehicle is warned about the presence of other vehicles at the intersection. The system warns in particular the drivers of the vehicles that could be masked by other vehicles. Here it is assumed that all vehicles are SAFESPOT vehicles.

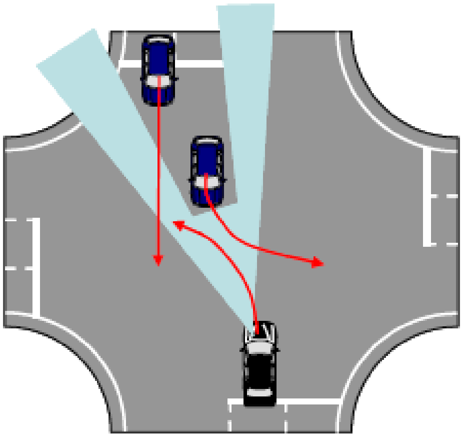

Figure 30: Masking of vehicles at intersections (Vivo, 2006)

Another possibility is permission denial to go-ahead. The driver waiting at an intersection is not allowed to cross if a dangerous situation is detected, even if he has right of way. In this case the vehicle detects an oncoming intersection, then the system detects if a danger situation can occur independent of the right of way rules (Vivo, 2006) . A fifth option is providing the driver with details on defect traffic lights. When a traffic light gives false information both drivers will think they have right of way which will lead to an accident. The system will warn the driver if he/she has to stop or not (Vivo, 2006). The driver could also be warned if the vehicle approaches the traffic light too fast and there is a danger that the vehicle cannot be stopped on time, or if the vehicle is approaching a traffic light that is going to change (Schulze, Nöcker, & Böhm, 2004). The next alternative is when a vehicle brakes hard due to red light. The purpose of this application is to avoid accidents coming from an unforeseen emergency braking vehicle. The system then informs the driver of the occurring situation (Vivo, 2006). The last option that will be mentioned here is the approaching emergency vehicles warning. In this scenario the emergency broadcasts its presence as it nears an intersection. Here it is assumed that all the vehicles are SAFESPOT type (Vivo, 2006). SAFESPOT type vehicles are vehicles that are equipped with technology that makes inter-vehicle/vehicle-infrastructure communication possible as presented in the SAFESPOT project. The objective of this project is to produce a breakthrough for road safety.

Appendix of the literature study on survey methods

Survey Design Quality criteria
Supports multiple platforms and browsers/e-mail clients (Yun & Trumbo,2000)
Controls for browser settings (Yun & Trumbo, 2000)
Detects multiple submissions automatically (Yun & Trumbo, 2000)
Presents questions in a logical or adaptive manner (Kehoe & Pitkow, 1996; Norman, Friedman, Norman& Stevenson, 2001)
Allows saving responses before completion (Smith, 1997)
Collects open-ended or quantified-option responses (Bachmann & Elfrink, 1996; Kiesler & Sproull, 1986; Loke & Gilbert, 1995, Schaefer & Dillman, 1998; Yun& Trumbo, 2000)
Provides automatic feedback with completion (Smith, 1997)
Uses paper questionnaire design principles (Dillman, 2000; Oppenheim, 1992, Preece, Rogers & Sharp, 2002; Witmer, Colman, & Katzman, 1999)
Prevents survey alteration (Witmer et al. 1999)
Provides response control and economical displays (Preece et al., 2002; Stanton, 1998)
Provides for links to definitions, menus, button and check box options, animation, sound, graphics options, and so forth (Preece et al. 2002; Yun & Trumbo,2000)
Does not require familiarity with survey presentation software (Sheehan & Hoy, 1999)
Displays appear quickly to participant (Couper,Traugott& Lamias, 2001)
Tracks response source of response failure (Paolo, Bonamino, Gibson, Patridge, & Kallai, 2000)

Table 13: Survey design quality criteria (Andrews, Nonnecke, & Preece, 2003)

*These recommendations should be applied considering the survey goals.

Privacy and confidentiality Quality Criteria
Participants can designate conditions of release, use, retention and disposal of personal data data
Sample only from public e-mail lists, online communities and automated mailing lists
Send invitations and surveys separately
Collect data through Web pages
Provide multiple response options
Use “re-mailers” to ensure anonymity
Do not troll through observation
Do not use “cookies”
Do not use links from personalized sites
Provide disclosures
Provide third party privacy certification
Use credible domains
Use encryption for sensitive material
Use hypertext links for long disclosures
Disclose sampling procedures
Obtain community leader consent
Provide survey results to respondents
Use self-selected user identifications and passwords (option)
Provide “rather not say” response option (Kehoe & Pitkow, 1996)
Allow people to “opt-in” (Yun & Trumbo, 2000)
Establish credibility quickly through subject lines and opening statements (Yun & Trumbo, 2000)

Guarantee that no one will see one's personal data, not anonymity as researchers will know who the participants are, and explain the method for maintaining confidentiality (Sheehan & Hoy, 1999)

Table 14: Privacy and confidentiality Quality Criteria (Andrews, Nonnecke, & Preece, 2003)

*These recommendations should be applied considering the survey goals.

Principles for constructing web surveys

1. Introduce the web questionnaire with a welcome screen that is motivational, emphasizes the ease of responding, and instructs respondents on the action needed for proceeding to the next page.
2. Begin the web questionnaire with a question that is fully visible on the first screen of the questionnaire, and will be easily comprehended and answered by all respondents.
3. Present each question in a conventional format similar to that normally used on paper questionnaires.
4. Limit line length to decrease the likelihood of a long line of prose being allowed to extend across the screen of the respondent's browser.
5. Provide specific instructions on how to take each necessary computer action for responding to the questionnaire.
6. Provide computer operation instructions as part of each question where the action is to be taken, not in a separate section prior to the beginning of the questionnaire
7. Do not require respondents to provide an answer to each question before being allowed to answer any subsequent ones. This can lead to premature terminations
8. Construct web questionnaires so that they scroll from question to question unless order effects are a major concern, large numbers of questions must be skipped, and/or a mixed-mode survey is being done for which telephone interview and web results will be combined.
9. When the number of answer choices exceeds the number that can be displayed on one screen, consider double-banking with appropriate navigational instructions being added.
10. Use graphical symbols or words that convey a sense of where the respondent is in the completion progress, but avoid ones that require advanced programming.
11. Be cautious about using question structures that have known measurement problems on paper questionnaires, e.g. check-all-that apply and open-ended questions.

(Dillman, Tortora, & Bowker, 1999)

Setting up the survey.

Questionnaire

Text in this color will be displayed with use of clarification features.
Questions in this color will be displayed depending on the answer on the related question.

Inleiding (Rijden naar de toekomst)

Wilt u weten wat u als bestuurder in de toekomst te wachten staat? Wilt u zelf nog de gevaren op de weg waarnemen, of laat u dit over aan uw voertuig? Wilt u zelf remmen, of wilt u dat uw voertuig zich automatisch aanpast aan de snelheid van het voorliggend voertuig? Vindt u dat u in uw auto een hotel moet kunnen reserveren of moet dit thuis gebeuren?

Er zijn diverse Europese projecten gelanceerd die gericht zijn op het creëren van nieuwe mogelijkheden voor de bestuurder. Laat weten hoe u over deze mogelijkheden denkt door deze vragenlijst in te vullen! U bent er hoogstens 10 minuten mee kwijt en krijgt door het invullen gelijk ook een idee van moderne opties die de toekomstige bestuurder kunnen worden geboden.

U kunt door de vragenlijst navigeren door van de grijze knoppen links gebruik te maken.

Dit is een onderzoek in opdracht van de Universiteit Twente en Twente Institute for Wireless Mobile Communications in het kader van een Bachelor Eindopdracht.

Klik op de button **Volgende vraag** om met de vragenlijst te beginnen. Met dezelfde button gaat u naar een volgende pagina in de enquête. Voor het terugbladeren naar een vorige vraag klikt u op de button **Vorige vraag**.

Gebruik tijdens het invullen van de vragenlijst niet de knoppen Vorige (Back) en Volgende (Forward) van de browser. Als dit per ongeluk toch gebeurt, kunt u de vragenlijst terughalen via de knop Vernieuwen (Refresh). Volg de instructies op het scherm.

Tenzij anders vermeld is bij iedere vraag maar één antwoord mogelijk.

Algemene vragen (Filtervragen)

De opties in dit onderzoek worden gepresenteerd in drie categorieën. Voordat er op deze categorieën wordt ingegaan worden er enkele algemene vragen aan u voorgelegd. U wordt niet gevraagd om zich te identificeren: Deze vragenlijst is anoniem. Alles wat u ons aan informatie verschaft wordt vertrouwelijk behandeld.

A1. Wat is uw geslacht?

a) Mannelijk
b) Vrouwelijk

A2. Wat is uw leeftijd?

a) 18-19
b) 20-24
c) 25-29
d) 30-39
e) 40-49
f) 50-59
g) 60-64
h) 65-74
i) 75+

A3. Wat is uw hoogst genoten opleidingsniveau?

a) Lager onderwijs
b) Lager beroepsonderwijs
c) Mavo/VMBO theoretische leerweg
d) VMBO overig
e) Middelbaar beroepsonderwijs
f) Havo/Vwo
g) Hoger beroepsonderwijs
h) Wetenschappelijk onderwijs

A4. Wat is uw jaarlijkse inkomensniveau (netto in €)?

a. <11.000
b. 11.000-16.000
c. 16.000-20.000
d. 20.000-25.000
e. 25.000-32.000
f. 32.000-45.000
g. 45.000-70.000
h. 70.000-100.000
i. >100.000

A5. In wat voor voertuig rijdt u wel eens? (Er zijn meerdere keuzes mogelijk)

a) Voertuigen met 2 assen (bijvoorbeeld auto's, bestelbussen)
b) Voertuigen met meer dan 2 assen (bijvoorbeeld vrachtwagens)

A6. Wat is het *primaire* doeleinde waarom u gebruik maakt van een voertuig?

a) Onderwijs (om naar een onderwijsinstelling te gaan)
b) Zakelijk (transport in verband met werk)
c) Winkelen
d) Woon-werk (om van thuis naar werk te gaan of omgekeerd)
e) Sociaal-recreatief (om naar vrienden/familie te gaan of voor recreatieve doeleinden)

A7. Voor welke doeleinden maakt u gebruik van een voertuig? Selecteer hier *alle* doeleinden waarvoor u gebruik maakt van een voertuig.

a) Onderwijs
b) Zakelijk
c) Winkelen
d) Woon-werk
e) Sociaal-recreatief

A8. Hoeveel jaren heeft u al een rijbewijs? Vul in het onderstaand vakje het aantal jaren in.

A9. Hoeveel uren bent u gemiddeld per dag in uw voertuig onderweg? Vul in het onderstaand vakje het aantal uren in.

Meer informatie op de weg over uw omgeving (Vragen over gewenst onderwerp)

De eerste categorie vragen gaat over systemen die u bij het rijden meer informatie over de omgeving zullen aanbieden.

Stel dat u op een weg rijdt. Er zijn verschillende soorten informatie over uw omgeving die wij u binnen en/of buiten uw voertuig kunnen aanbieden. Ook kan er een prijskaartje aan deze mogelijkheden hangen. Hieronder volgt een serie vragen over deze mogelijkheden.

B1. Heeft u behoefte aan informatie over de weersomstandigheden tijdens het rijden?

a) 1 (Geen behoefte)
b) 2
c) 3
d) 4
e) 5 (Veel behoefte)

B2. Wilt u weten hoe lang het duurt om van A naar B te gaan?

a) 1 (Nooit)
b) 2
c) 3
d) 4
e) 5 (Altijd)

B3. Op welke wegcategorie wilt u dit weten? (Er zijn meerdere antwoorden mogelijk)

a) Op stedelijke wegen
b) Op provinciale wegen (N-wegen)
c) Op snelwegen (A-wegen)

B4. Zou u het belangrijk vinden om te weten welke route u het beste zal uitkomen?

a) 1 (Niet belangrijk)
b) 2
c) 3
d) 4
e) 5 (Heel belangrijk)

B5. Welke route ziet u als beste route om uw primaire doeleinde te bereiken (doeleinde zoals gekozen bij de vraag over uw primaire reismotief?

a) Een snelle route (zo snel mogelijk van herkomst naar bestemming)
b) Een goedkope route (met zo laag mogelijke transportkosten)
c) Een recreatieve route (bezienswaardigheden, natuur & landschap, hotels, uitgaansgelegenheden, restaurants)
d) Een economische route (langs bedrijven- en industrie terreinen)
e) Een OV knooppunten route (langs trein- bus- en tramstations)
f) Een winkelroute (langs winkelcentra)
g) Een parkeer route (langs beschikbare parkeerplaatsen)

B6. Heeft u behoefte aan extra informatie binnen uw voertuig over de geldende verkeersregels op de plek waar u zich bevindt?

a) Ik heb geen behoefte hieraan
b) Ik wil binnen het voertuig informatie hierover ontvangen
c) Ik wil via informatiepanelen buiten het voertuig informatie ontvangen
d) Ik wil zowel binnen het voertuig als via informatiepanelen buiten het voertuig informatie ontvangen

B7. Stel dat u bij het rijden door een bocht heen moet. Vindt u het van belang om te weten met welke snelheid dat maximaal kan?

a) Ik wil geen informatie hierover
b) Ik wil binnen het voertuig informatie hierover ontvangen
c) Ik wil via informatiepanelen buiten het voertuig informatie ontvangen
d) Ik wil zowel binnen het voertuig als via informatiepanelen buiten het voertuig informatie ontvangen

B8. Stelt u eens voor dat u voor een bepaalde route kiest, en er een onregelmatige gebeurtenis (voorbeelden: spookrijders, evenementen, uitzonderlijk vervoer, stremmingen, ongelukken) heeft plaatsgevonden. Zou u informatie hierover willen hebben?

a) Ik wil geen informatie over onregelmatige gebeurtenissen
b) Ik wil binnen het voertuig informatie over onregelmatige gebeurtenissen
c) Ik wil via informatiepanelen buiten het voertuig informatie over onregelmatige gebeurtenissen
d) Ik wil zowel binnen het voertuig als via informatiepanelen buiten het voertuig informatie over onregelmatige gebeurtenissen

B9. Wilt u van binnen uw voertuig informatie hebben over uw verkeersomstandigheden?

a) Ik wil geen informatie over verkeersomstandigheden
b) Ik wil binnen het voertuig informatie over verkeersomstandigheden
c) Ik wil via informatiepanelen buiten het voertuig informatie over verkeersomstandigheden
d) Zowel binnen het voertuig als via informatiepanelen buiten het voertuig informatie over onregelmatige gebeurtenissen

B10. Er bevindt zich een voertuig met gevaarlijke stoffen in uw nabijheid. Wilt dit weten?

a) Altijd
b) Af en toe
c) Hangt van het type gevaarlijke stof af
d) Nooit

B11. Hoe ontvangt u liever informatie binnen uw auto?

a) Door middel van geluid
b) Visueel (voorbeelden zijn waarschuwingslampjes, schermen)
c) Beide

B12. Hoeveel bent u bereid uit te geven om het ontvangen van informatie mogelijk te maken? Vul hier onder het aanschafbedrag in euro's in.

Moet u of het voertuig zich inspannen?

De tweede categorie vragen gaat over systemen die u zullen helpen zodat u meer op uw gemak kunt rijden. Hieronder volgen enkele vragen over de manieren waarop de techniek het mogelijk maakt om veilig te rijden met minder inspanning.

C1. Stel dat u in een zone terechtkomt waar het snelheidsmaximum lager of hoger is dan de zone waarin u zich eerder bevond. Er bestaat de mogelijkheid om het voertuig zich automatisch aan dit geldende snelheidsmaximum te laten houden. Op welke manier wilt u dat het voertuig ingrijpt:

a) Ik wil niet dat het voertuig ingrijpt
b) Ik wil alleen informatie over het geldende snelheidsmaximum ontvangen
c) Ik wil dat het voertuig alleen ingrijpt als ik het systeem vooraf inschakel
d) Het voertuig moet het snelheidsmaximum altijd beperken

C2. Er bestaat ook de mogelijkheid om uw voertuig automatisch de afstand tot het voertuig voor u te laten beheersen. Dit is een geavanceerde vorm van cruise control. Zou u dit systeem willen inschakelen?

a) Ik zou het systeem niet willen inschakelen
b) Ik wil alleen een waarschuwing indien ik het voertuig te dicht nader
c) Ik moet de mogelijkheid hebben om het systeem uit te schakelen
d) Het systeem moet altijd ingeschakeld zijn

C3. Waar zou u dit systeem willen inschakelen? (Er zijn meerdere antwoorden mogelijk)

a) Op stedelijke wegen
b) Op provinciale wegen (N-wegen)
c) Op snelwegen (A-wegen)

C4. Zou u deze functie willen hebben voor het houden van een veilige afstand tot een vrachtwagen met gevaarlijke stoffen?

a) Ik zou het systeem niet willen inschakelen
b) Ik wil alleen een waarschuwing indien ik het voertuig te dicht nader
c) Ik moet de mogelijkheid hebben om het systeem uit te schakelen
d) Het systeem moet altijd ingeschakeld zijn

C5. Waar zou u dit systeem willen gebruiken? (Er zijn meerdere antwoorden mogelijk)

a) Op stedelijke wegen
b) Op provinciale wegen (N-wegen)
c) Op snelwegen (A-wegen)

C6. Zou u willen dat uw voertuig zichzelf volledig bestuurt wanneer u zich in een file bevindt?

a) Ja
b) Nee

C7. Waar zou u dit systeem willen gebruiken? (Er zijn meerdere antwoorden mogelijk)

a) Op stedelijke wegen
b) Op provinciale wegen (N-wegen)
c) Op snelwegen (A-wegen)

C8. Hoeveel bent u bereid om uit te geven om comfortabeler te kunnen rijden? Voer in het onderstaande vakje het aanschafbedrag in euro’s in.

Wilt u in uw voertuig van diensten genieten?

De laatste categorie vragen gaat over diensten waarvan u en/of uw reisgenoten van binnen uw voertuig gebruik kunnen maken.

D1. In Nederland is door gebrek aan ruimte het aantal parkeerplaatsen beperkt. Daarvoor is er een systeem ontwikkeld waarbij u vooraf een parkeerplaats kan reserveren (alleen beschikbaar voor commercieel vervoer). Zou u tegen betaling gebruik willen maken van een dergelijke dienst?

a) Nooit
b) Alleen bij hoge tijdsdruk
c) Alleen in drukke omgevingen
d) Bij hoge tijdsdruk en in drukke omgevingen
e) Altijd

D2. Internet is in korte tijd zeer populair geworden. Binnenkort zal het ook mogelijk zijn om binnen uw voertuig gebruik te maken van het internet. Dit kan zowel door u als uw medereiziger(s) gebruikt worden. Stel dat het internet voor u als bestuurder beschikbaar is. Ziet u de beschikbaarheid van het internet als risico voor uw aandacht op de weg?

a) 1 Geen risico
b) 2
c) 3
d) 4
e) 5 Risicovol

D3. Stel dat het internet alleen voor uw medereiziger(s) beschikbaar is. Ziet u de beschikbaarheid van het internet als risico voor uw aandacht op de weg?

a) 1 Geen risico
b) 2
c) 3
d) 4
e) 5 Risicovol

D4. Het internet maakt het verder mogelijk voor uw medereizigers om spellen te spelen tijdens uw rit. Wat vindt u van het effect dat dit op u als bestuurder kan hebben?

a) 1 Negatief
b) 2
c) 3
d) 4
e) 5 Positief

D5. Het is ook mogelijk om via internetverbinding geluid en beeld te ontvangen. Deze zijn dan voor uw medereizigers beschikbaar. Aan welke van de onderstaande mogelijkheden bent u bereid om geld uit te geven? (Er zijn meerdere antwoorden mogelijk)

a) Spellen
b) TV
c) Radio
d) Internet (hier wordt standaard internet bedoeld voor het surfen)

D6. Hoeveel bent u bereid om maandelijks uit te geven voor deze diensten? Voer in het onderstaande vakje het bedrag in euro’s in.

Uw mening is belangrijk! (opmerking van de respondent)
O1. Heeft u verder nog opmerkingen, plaats deze dan in het onderstaande vakje.

Afsluiting

Indien u de resultaten wenst van deze studie, vul dan in het onderstaande vakje uw e-mailadres in.

Bedankt!
Dit is het einde van de vragenlijst.

Klik op de knop **Sluiten** om de vragenlijst te bevestigen en te versturen.

N.B. Er verschijnt geen mededeling op het scherm dat uw antwoorden verstuurd zijn.

Hartelijk dank voor het invullen!

Quaestio interface

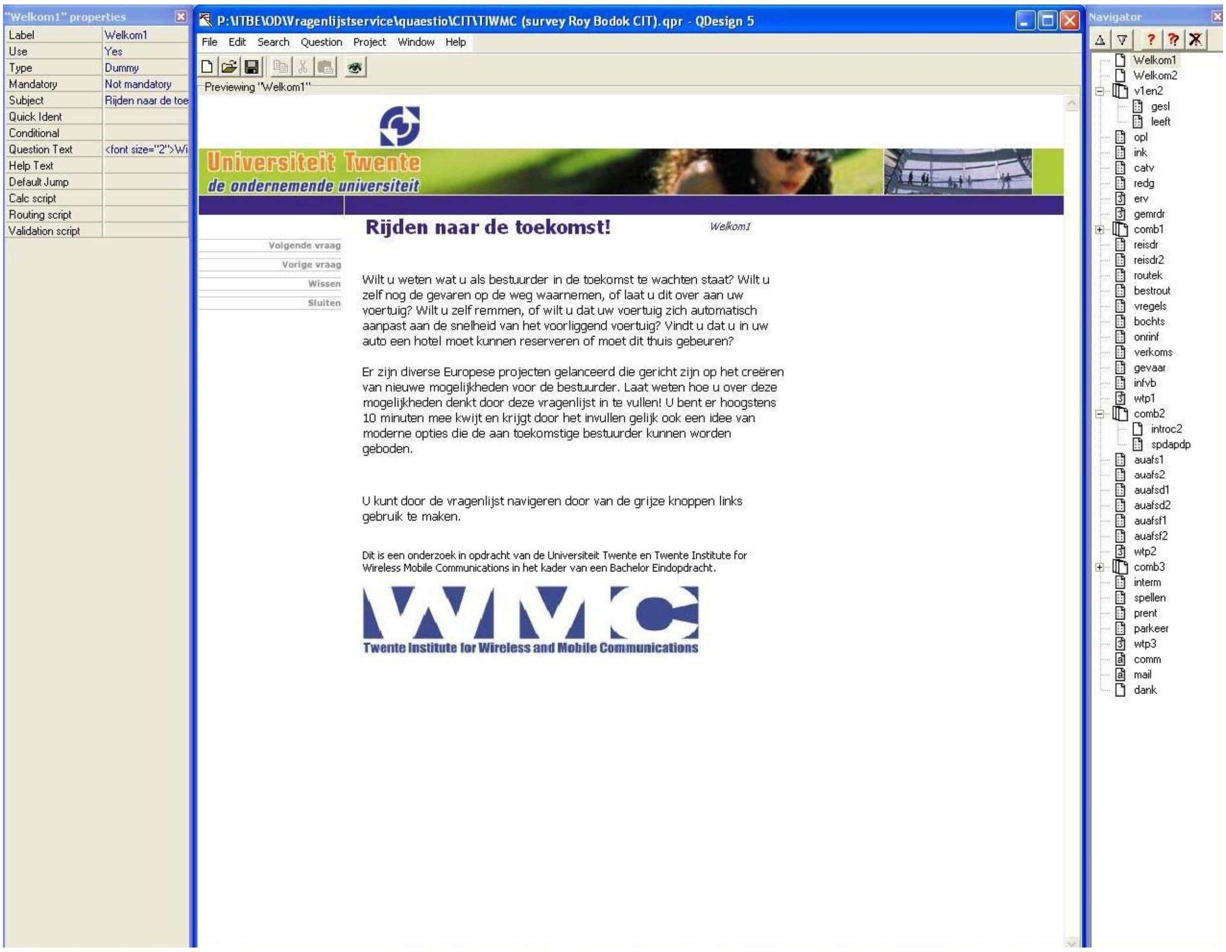

Figure 31: Quaestio interface

Code book

The variables have been coded to secure an efficient data analysis process. In this assignment each question has been coded prior to entering them in Quaestio. This way the data was easily entered in Quaestio without needing to write down the used codes. However, when the data is exported to SPSS the variable labels might change. Here a number could be added to the label. This means that only editing the label will be necessary. The code book is visible in Table 15.

VRAAGNR stands for the number used in the questionnaire
VRAAGCODE stands for the number that probably will be assigned to the variable in SPSS
VAR is the variable label that was used in Quaestio
NAAM VAR is the full name of the variable
OMSCHRIJVING is a description of the variable

Multiple answers can be selected when the questions are in this color. The answer categories are then converted into separate yes/no questions. This probably is the way how these questions will be processed in SPSS. The answer(s) on questions in this color lead to other questions depending on the answer.

When plain text is used as a description respondents are only able to read text.
When insertion text is used as a description the respondents are able to fill in text.
When number is used as a description the respondents are able to fill in numbers as answers.

VRAAGNR	VRAAGCODE	VAR	NAAM VAR	OMSCHRIJVING
	1	Respons0	Resp. code	Response code
	2	Ipaddre1	IP address	IP address of the computer used by the respondent
	3	atwdatum	Antwoord datum	Datum waarop de enquête werd gevuld.
	4	Questio1		
A1	5	Gesl	Geslacht	1= Man 2=Vrouw
A2	6	Leeft	Leeftijd	1=18-19 2=20-24 3=25-29 4=30-39 5=40-49 6=50-59 7=60-64 8=65-74 9=75+

A3	**7**	**Opl**	**Opleidingsniveau**	**1=Lager onderwijs** **2=Lager beroepsonderwijs** **3=Mavo/VMBO theoretische leerweg** **4=VMBO overig** **5=Middelbaar beroepsonderwijs** **6=Havo/vwo** **7=Hoger beroepsonderwijs** **8=Wetenschappelijk onderwijs** **9= Geen antwoord**
A4	8	Ink	Inkomensniveau	1=<11.000 2=11.000-16.000 3=16.000-20.000 4=20.000-25.000 5=25.000-32.000 6=32.000-45.000 7=45.000-70.000 8=70.000-100.000 9=>100.000
A5	9	Catv_00	Bezit van voertuig met 2 assen	0=Ja 1=Nee
	10	Catv_01	Bezit van voertuig met meer dan 2 assen.	0=Ja 1=Nee
	11	Predg	Primaire reden voor gebruik	1=Onderwijs 2=Zakelijk 3=Winkelen 4=woon-werk 5=sociaal-recreatief
A6	12	Redg_00	Reden voor het gebruiken van het voertuig= Onderwijs	0=Ja 1=Nee
	13	Redg_01	Reden voor het gebruiken van het voertuig=zakelijk	0=Ja 1=Nee
	14	Redg_02	Reden voor het gebruiken van het voertuig=Winkelen	0=Ja 1=Nee
	15	Redg_03	Reden voor het gebruiken van het voertuig=woon-werk	0=Ja 1=Nee
	16	Redg_04	Reden voor het gebruiken van het voertuig=sociaal-recreatief	0=Ja 1=Nee

A7	17	Erv	Aantal jaren met rijbewijsbezit	=nummer
A8	18	Gemrdr	Gemiddelde reisduur	=nummer
B1	19	Weer	Informatie over weersomstandigheden	1=Geen behoefte 2=0.25 behoefte 3=0.5 behoefte 4=0.75 behoefte 5=Totale behoefte
B2	20	Reisdr	Informatie over duur van de reis gewenst	1=Nooit 2=0.25 Altijd 3=0.5 Altijd 4=0.75 Altijd 5=Altijd
B3	21	Reisdr20	Informatie over duur van de reis is gewenst op stedelijke wegen	0=Ja 1=Nee
	22	Reisdr21	Informatie over de duur van de reis is gewenst op provinciale wegen	0=Ja 1=Nee
	23	Reisdr22	Informatie over de duur van de reis is gewenst op snelwegen	0=Ja 1=Nee
B4	24	Routek	Belang van routekeuze informatie	1=Niet belangrijk 2=0.25belangrijk 3=0.5 belangrijk 4=0.75 belangrijk 5=Heel belangrijk
B5	25	Bestrout	Beste omschrijving van beste route	1= Een snelle route 2=goedkope route 3=recreatieve route 4=economische route 5=OV knooppunten route 6=winkelroute 7=parkeerroute
B6	26	vregels	Behoefte aan informatie over geldige verkeersregels	1=Geen behoefte 2=Hangt van locatie af 3=Hangt van de tijdstip af 4=Hangt van de dag af
B7	27	Bochts	Maximum aanbevolen snelheid in een bocht	1=Geen informatie gewenst 2=Binnen het voertuig informatie over snelheidsmaximum in een bocht 3=Via informatiepanelen informatie over maximale snelheid in een bocht 4=zowel binnen als buiten informatie ontvangen

B8	**28**	**Onrinf**	**Informatie over onregelmatige gebeurtenissen**	**1=Geen informatie** **2=Binnen het voertuig informatie over onregelmatige gebeurtenissen.** **3=Via informatiepanelen informatie over onregelmatige gebeurtenissen.** **4=zowel binnen als buiten informatie over onregelmatige gebeurtenissen**
B9	29	Verkoms	Informatie over verkeersomstandigheden	1=Geen informatie 2=Binnen het voertuig informatie over omstandigheden 3=Via infopanelen 4=zowel binnen als buiten informatie voer verkeersomstandigheden.
B10	30	Gevaar	Informatie over gevaarlijke stoffen	1=Altijd 2=Af en toe 3= Hangt van de type gevaarlijke stof af 4=Nooit
B11	31	Infvb	Gewenste informatievorm binnen het voertuig	1=Geluid 2=Beeld
B12	32	Wtp1	Bereidheid om uit te geven voor meer informatie over de omgeving	=nummer
C1	33	spdadp	Automatische begrenzing van de snelheid	1=controle van het voertuig over de snelheid is niet gewenst. 2=informatie over snelheidsmax is gewenst. 3=ingrijpen moet controleerbaar zijn. 4= Voertuig moet snelheidsmaxima altijd controleren

C2	**34**	**Auafs1**	**Automatische afstandshandhaving tussen twee voertuigen gewenst**	**1=Ik zou het systeem niet willen inschakelen 2=ik wil alleen een waarschuwing indien ik het voertuig te dicht nader 3=Ik moet de mogelijkheid hebben om het systeem uit te schakelen 4=Het systeem moet altijd ingeschakeld zijn**
C3	35	Auafs233	Automatische afstandshandhaving tussen twee voertuigen op stedelijke wegen gewenst	0=Ja 1=Nee
	36	Auafs234	Automatische afstandshandhaving tussen twee voertuigen op provinciale wegen gewenst	0=Ja 1=Nee
	37	Auafs235	Automatische afstandshandhaving op snelwegen gewenst	0=Ja 1=Nee
C4	38	Auafsd1	Automatische afstandshandhaving tussen een normaal voertuig en een voertuig met gevaarlijke stoffen gewenst	1=Ik zou het systeem niet willen inschakelen 2=Ik wil alleen een waarschuwing indien ik het voertuig te dicht nader 3=Ik moet de mogelijkheid hebben om het systeem uit te schakelen 4=Het systeem moet altijd ingeschakeld zijn
C5	39	Auafsd37	Automatische afstandshandhaving tussen een normaal voertuig en een voertuig met gevaarlijke stoffen op stedelijke wegen gewenst	0=Ja 1=Nee
	40	Auafsd38	Automatische afstandshandhaving tussen een normaal oertuig en een voertuig met gevaarlijke stoffen op provinciale wegen	0=Ja 1=Nee

			gewenst	
	41	**Auafsd39**	**Automatische afstandshandhaving tussen een normaal voertuig en een voertuig met gevaarlijke stoffen op snelwegen gewenst**	**0=Ja** **1=Nee**
C6	42	Auafsf1	Automatische afstandshandhaving tussen twee voertuigen wanneer ze zich in een file bevinden gewenst	1=Ja 2=Nee
C7	43	Auafsf41	Automatische afstandshandhaving tussen twee voertuigen wanneer ze in een file bevinden is op stedelijke wegen gewenst	0=Ja 1=Nee
	44	Auafsf42	Automatische afstandshandhaving tussen twee voertuigen wanneer ze in een file bevinden is op provinciale wegen gewenst	0=Ja 1=Nee
	45	Auafsf43	Automatische afstandshandhaving tussen twee voertuigen wanneer ze in een file bevinden is op snelwegen gewenst	0=Ja 1=Nee
C8	46	Wtp2	Bereidheid om geld uit te geven voor "gemakkelijk rijden"	=nummer
D1	47	Interb	Het zien als het gebruik van het internet als risico wanneer het beschikbaar voor de bestuurder is	1= geen risico 2=0.25risico 3=0.5risico 4=0.75risico 5= risicovol
D2	48	Interm	Het zien van het gebruik van het internet als risico wanneer het beschikbaar voor de medereiziger is.	1= geen risico 2=0.25 risico 3=0.5 risico 4=0.75 risico 5= risicovol
D3	49	Spellen	Mening van de bestuurder op het gebruik van spelletjes door medereizigers.	1=Negatief 2=0.25 positief 3=0.5 positief 4=0.75 positief

				5= Positief
D4	50	Prent_00	Er is preferentie voor entertainment system spellen	0=Ja 1=Nee
	51	Prent_01	Er is preferentie voor entertainment system tv	0=Ja 1=Nee
	52	Prent_02	Er is preferentie voor entertainment system radio	0=Ja 1=Nee
	53	Prent_03	Er is preferentie voor entertainment system internet	0=Ja 1=Nee
D5	54	Parkeer	Bereidheid om van parkeerdienst gebruik te maken	1=Nooit 2=Alleen bij hoge tijdsdruk 3=Alleen in drukke omgevingen 4=Bij hoge tijdsdruk en in drukke omgevingen 5=Altijd
D6	55	Wtp3	Bereidheid om te betalen voor diensten	=nummer
O1	56	Comm	Commentaar over van alles wat	=insertion text
O2	57	Mail	Email adres van mensen die het resultaat willen	=emailadres
D1	58	Dank	Dankwoord	=Plain text

Table 15: The code book