Green light for a better environment

Reducing Greenhouse Gas Emission with ITS in Japan and The Netherlands

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Preface

This report is based on a research done in an internship at Toyota InfoTechnology Center Co., Ltd. for Bachelor thesis in Civil Engineering at University of Twente. This research was focused on the attitude towards current Green ITS of Japanese and Dutch drivers and a proposal of a design for a new in-car system in Green ITS. To measure the attitude of these drivers, a web survey has been deployed. Based on the results a new system of Green ITS has been designed. The survey and proposal of Green ITS was the main focus of this research.

I would like to thank several people who have contributed in this research. First of all, I would like to thank Professor Bart van Arem (University of Twente) for giving me this great opportunity to do my research at Toyota InfoTechnology Center Co., Ltd. Special thanks for my supervisors Sachi Mizobuchi and Jing Bie for their great help during my research. I would like to thank Naiwala Chandrasiri, Izuru Nogaito and Professor Saito for their great inspiration and discussions during my research and Maiko Tanaka for the Japanese translations. Onur Altintas, Yuko Tomoe and Ellen van Oosterzee-Nooteboom, I would like to thank them for the perfect arrangements of my stay at Toyota InfoTechnology Co., Ltd. And last but not least, I would like to thank all the participants of the survey!

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Summary

Traffic is one of the biggest contributions to global warming. Environmental changes are caused by greenhouse gas emission and energy consumption. To improve environment, several measures have been taken to reduce car use and emission, such as increasing tax rates and the promotion of public transport. A new development in the car industry is in-car Green Intelligent Transport Systems (Green ITS), systems which have the objective to improve environment by encouraging the driver to change into fuel efficient behavior.

The objective of this research is to propose a design of an in-car system in Green ITS for drivers in Japan and The Netherlands to improve the environment. To measure the opinion on Green ITS of Japanese and Dutch drivers, a web survey has been deployed. The purpose of this survey was to find out the following aspects

- Type of preferred information to motivate the change into fuel efficient behavior
- Influence of personal characteristics on the type of preferred information
- Attitude towards Green ITS

The results of this survey show that Japanese and Dutch drivers will be most motivated to change their driving behavior by the fact of knowing how much money they would save with fuel efficient driving behavior. The second most preferred information is about fuel consumption. Even though the objective of Green ITS is to improve environment, information about CO_2 emission and contribution to the environment is least preferred by drivers.

According to the results personal character, experience with ITS and attitude towards environment don't have influence on the preference of information, but correlation has been found in the driving style of the respondents. Although, the majority of respondents chose money related information as their greatest motivation, drivers with frequent car use and high mileage are more aware of their impact on environment and as a result also prefer information about their contribution to the environment.

The information provided by Green ITS was positively received by drivers from both countries. The majority of the drivers stated that the information is highly relevant to motivate them in changing to fuel efficient behavior. This positive attitude towards Green ITS means that drivers are willing to use these systems and as a result improvement of environment will be achieved.

Based on the results of the survey and knowledge of current Green ITS, a design of in-car Green ITS is proposed. Next to the desires of the drivers, this system is based on the demands of impact on the environment, safety, level of support and comfort. The proposed in-car system consists of an onboard screen which is suitable and implementable in every vehicle. During trips, the system will collect data of driving behavior and compare these results with fuel efficient behavior. Based on this comparison the driver will receive information of personal advice to develop fuel efficient behavior. After the trip, trends of driving behavior will be shown and the driver will see his progress. Next to information about driving

behavior, other factors of motivation will be provided by the system. These triggers are indications of fuel consumption, expenses of the trips and impact on environment.

1 Introduction

Nowadays, environment is becoming more and more important to us, because of the remarkable weather conditions and climate change. Instead of watching the change, people should be encouraged to act upon it to create a better environment for the future. Recycling, efficient use of energy and water, and walking instead of driving are just typical known actions that are easy to adopt.

Traffic is one of producers of excessive Greenhouse Gas emission, such as CO_2 emission. Diminishing the car use would decrease this production, but this is quite difficult to achieve in this modern world. Therefore changing the current behavior of drivers to a fuel efficient behavior might be the solution to improve the environment. High speeds, heavy acceleration and the lack of anticipation in traffic are the cause of excessive production of emissions. With improving these driving skills to a more environment friendly behavior, fuel consumption, expenses and production of emission will decrease. With fuel efficiency the environment as well as the driver will benefit.

Changing current driving behavior by adopting new skills is difficult for most drivers. To help the driver in changing his behavior, several in-car systems in Green Intelligent Transport Systems (Green ITS) are currently in development. These systems have the objective to achieve fuel efficient behavior and therefore will provide the driver with information on his driving behavior, of advice and data of fuel consumption or costs. This way, the driver gets directions of how to change his behavior while being encouraged with direct feedback of his progression.

Green ITS systems are just recently released and unfortunately the experiences of these haven't been reported yet. To promote and improve these systems, the design and use should satisfy the desires of the user. By measuring the attitude of drivers towards Green ITS, designers will be aware of the needs and preferences of these drivers.

For this research the focus will be on measuring the attitude of drivers in The Netherlands and in Japan on Green ITS by the deployment of a web survey. After analysis on data of the survey, a new in-car system in Green ITS will be proposed for both countries. This proposal defines the design of the system in order to change the behaviors of Dutch and Japanese drivers to improve environment.

1.1 Objective

The objective of this research is to give a proposal of a new in-car system of Green ITS for Japan and The Netherlands after measuring the attitude towards Green ITS among Japanese and Dutch drivers by the deployment of a web survey.

1.2 Research questions

To achieve this objective, this research can be guided in research questions. Investigation on the topics of the sub questions will lead to the answer of the main research question.

Main research question

What kind of in-car system of Green ITS can be proposed to Japanese and Dutch drivers to achieve fuel efficient behavior?

Sub research questions

- What kind of in-car Green ITS are currently available?
- What kind of information is preferred to receive by Japanese and Dutch drivers to motivate them to change into fuel efficient behavior?
- How is the preference of information influenced by the personal characteristics of the drivers in Japan and The Netherlands?
- What is the attitude towards Green ITS in Japan and The Netherlands?

1.3 Approach

1.3.1 Literature research

Investigation on current in-car Green ITS gives an impression of the methodology and the available information. In this part of the research certain Green ITS measures will be examined and criticized on their impact on the environment, level of support, safety and comfort.

1.3.2 Research on preferred information

Because of the novelty of most of the Green ITS technologies, drivers are not aware of these systems. By measuring what motivates these drivers to change their behavior into fuel efficient behavior, the proposed system should be designed by the preferences of these drivers. To attract the drivers to use this system, it is important to know what kind of information motivates them to change and what they think about Green ITS. Also correlation between the personal characteristics of the driver and the preferred information will be investigated. Therefore a survey on Dutch and Japanese drivers will be deployed in this stage of research.

1.3.3 Proposal for Green ITS

Preference of information and attitude towards Green ITS will be clear after analysis on the results of the survey. With this knowledge and understanding of the current methodology, a new system of in-car Green ITS can be designed. The proposed system will be designed from the desires from the drivers and his adaptability on Green ITS.

1.4 Risks

Measuring the attitude towards Green ITS by deployment of a survey involves risks. It is necessary that the risks are known before research and analysis of results and most importantly should not be underestimated. For this research, the most important risks are the following

1.4.1 Impact of proposed Green ITS

In the literature study several existing and new technologies are going to be examined. Most of the existing technologies have been tested and the results are clear. The new technologies have not been tested yet and still they need to be examined on advantages and effects. It is possible to predict the effects of these new systems, but there is no evidence. The risk will be that the predicted impact will not match the reality.

1.4.2 Driver's attitude

Drivers are individuals with own experiences and driving styles. By measuring the attitude of a group of drivers, the attitude can differ in a wide range. To design a system in Green ITS to accommodate the majority of the drivers, it is important to generalize the drivers. The risk is that after generalization the system does not satisfy the desires of the majority of these drivers and as a result the system does not attract the driver to use it.

1.4.3 Deployment of the survey

The survey is designed to measure the opinion of drivers by different levels of questions. The interpretation of these questions can differ between drivers. Also the choice for answering and space for personal opinions is limited. These restrictions can result in errors during the analysis of the results. These errors can cause difference between the measured attitude and the real attitude of Japanese and Dutch drivers.

This report of the research on Green ITS contains the chapters Background, Approach, Analysis and Results, Discussion, Proposal Green ITS and Conclusion. The chapter Background will present the general topic of global warming caused by traffic, past cases of measures to reduce emission and current available in-car systems of Green ITS . In the Approach the concept of measuring the attitude towards Green ITS, hypotheses for this research and the design of the survey will be explained. Results of this survey will be presented in the Analysis and Results chapter and these results will be further investigated in the Discussion part. Then the final proposal of Green ITS will be presented with an explanation of the choice of this particular system. At last the research will be concluded and a possible after study will be proposed.

2 Background

This chapter will present the concern of worldwide traffic emission and measures that have been taken in the past in the traffic sector to improve environment. And finally, an introduction of Green ITS will be given.

2.1 Global Warming and Greenhouse Gas emission

Today's extreme weather conditions are the result of climate change and global warming. Greenhouse Gas emissions (GHG), such as carbon dioxide, cause the temperature and sea level to rise. With these severe environmental changes the chances are bigger for natural disasters to occur. To prevent such disasters a rapid reduction of greenhouse gas emissions should be deployed.

In 1997 the United Nations Framework Convention on Climate Change (UNFCCC) in Kyoto, Japan adopted a treaty to prevent the change of the climate system by greenhouse gas emission. This Kyoto Protocol has the objective to encourage the 183 participating countries to stabilize their GHG emissions. The four greenhouse gases concerning this protocol are carbon dioxide, methane, nitrous oxide and sulfur hexafluoride. Most of them are caused by excessive energy consumption and traffic pollution. The goal is to reduce the GHG emission by 5% compared to year 1990: For Europe this will be 8% (The Netherlands 6%) and Japan 6% of reduction. In 2007 the European Commission announced to set the goal at 20% of reduction by 2020.

The following chart shows what the causes are for the greenhouse gas emissions in the world.

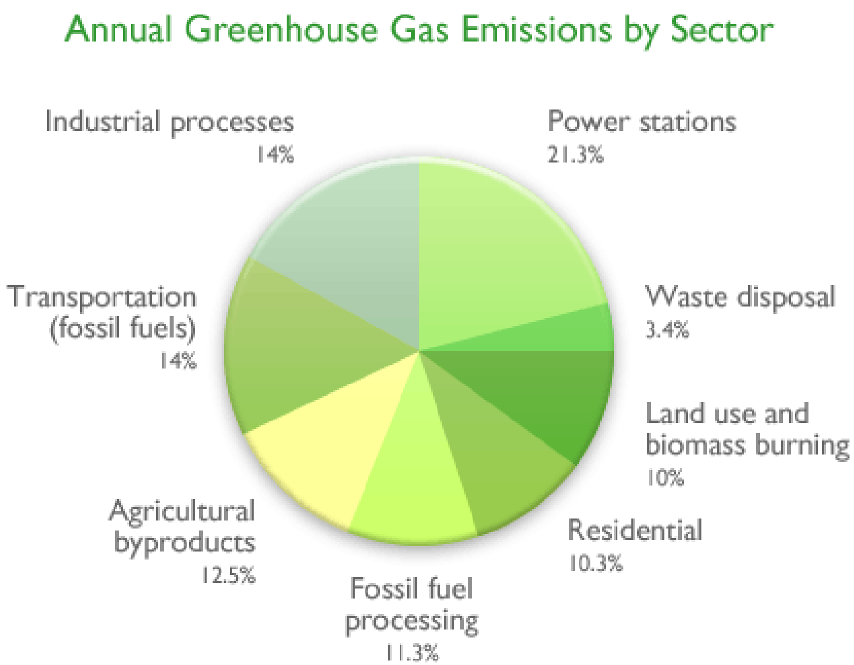


Figure 1: Chart of Greenhouse Gas emission per sector

According to this chart traffic emission is next to energy consumption one of the biggest contributions to climate change. These facts define the seriousness of the impact of traffic on the environment. Traffic contains conscious human activity, which means that a change in behavior can improve the environment. The use of private vehicles causes the most greenhouse gas emissions. To reduce these emissions, the frequency of car use should be diminished. In order to change behavior of drivers it's important to know what drives these people to use private vehicles and what the causes are of excessive pollution.

This chapter will present the measures that have been taken in the past in the traffic sector to improve environment. There after measures in Green ITS will be explained and discussed.

2.2 Past cases

In the past, several measures have been introduced to reduce greenhouse gas emissions and achieve sustainable mobility. Traditional measures like construction of extra lanes and tax rating on fuel are well known, but upcoming technology of hybrid cars and information technology systems have already been implemented. Some of these measures are successfully accepted by travelers while others have failed. These types of measures can be categorized as following

1. New car technology
   (e.g. hybrid cars, zero emission vehicles)
2. Policy measures
   (e.g. tax rates, penalties on speeding)
3. Infrastructural changes
   (e.g. extra lanes, roundabouts)
4. Modal shift
   (e.g. promotion of public transport)
5. Transport management
   (e.g. traffic signal control systems, traffic information systems)
6. Driving behavioral changes
   (e.g. promotion of low emission driving, route choice information)

A description of these categories will give a clear overview of the past measures that have been implemented. The main focus of this research will be on driving behavioral changes. These measures will be further analyzed in the next part.

2.2.1 New car technology

Most of the developments in the car industry involve reduction of fuel consumption. To minimize the consumption of fossil fuels, alternative fuels might be the solution. These include bio fuels, hybrid vehicles and zero-emission vehicles. The zero-emission vehicle doesn't produce emission nor pollution when stationary or in operation. These vehicles operate on electricity, fuel cells, compressed air or even solar cells.

Nowadays, hybrid cars are getting more popular and there have been some battery-powered electric vehicles tested. An example of those test vehicles were the electric microbuses in France. Unfortunately, this project failed due to the low operating speed. Although the emission caused by generation of these electric vehicles might be higher, these vehicles will contribute to improvement of the environment after further developments and tests.

2.2.2 Policy measures

Common policy measures concerning emission are tax rates, speed control and other pricing systems. The risk of pricing systems is that the impact is usually for a short term contribution. Shortly after the raise or charge the driver will consider reducing the use of the car. But if the conditions of other travel modes remain less convenient than car use, he will be willing to pay the price. Another fact is that for long term results punishing is less effective than encouraging the drivers. Instead of pointing out the flaws, with encouragement, the driver is positively approached and gets rewarded for that. As for pricing systems road pricing and vehicle emission tests are fair ways of charging drivers. With road pricing the driver will pay for the mileage he makes and with emission tests, the condition of the car will be examined and charged for the amount of emission it produces. In this way occasional drivers won't be equally charged as daily driver and the driver may consider modal shift or a more environment friendly vehicle.

Another option for reducing emission is calming traffic and homogenizing the flow. The homogenization of speed will improve the traffic flow and reduce the emission. This can be done by speed control like the trajectory control in The Netherlands. This trajectory control system measures the average speed in a certain distance and at a certain place. Unlike other speed control systems, the driver is unaware of where the measurement is taken and whether the measurement is on a distance of 100 meters or 500 meter.

Different from charging, accessibility measures such as in Italy (TNO 2008) have positive effects. In Genoa, Italy access control strategy has been implemented, which means that there is a fixed amount of vehicles allowed on the road. Drivers will be discouraged to either use this road or the car.

2.2.3 Infrastructural changes

Congestion is one of the main causes of emission. Accelerating and braking in the small movements of vehicles during congestion lead to excessive pollution. Increase of the capacity of roads improves the traffic flow. A traditional approach to increase the capacity is by building extra lanes or new roads. Replacement of traffic signal control systems with roundabouts is another measure to improve the traffic flow. The results of a research in The Netherlands stated that by improving the traffic flow with replacement of a roundabout improved the air quality on the cross intersection. (TNO 2008)

To encourage the use of public transport, the construction of priority bus lanes makes travelling by bus more attractive. These priority lanes are well received in Sweden. The buses will be able to avoid congestion and at traffic signals have priority on the bus lanes at cross intersections. The buses won't hold up regular traffic and passengers won't get delayed by congestion. The traffic flow will gain, travel time of drivers and passengers will be shorter and the air quality will be improved.

Another infrastructural change is removing parking spaces and constructing car free zones. Discouraging the drivers to use cars to cities decreases the inner city congestion and reduces emission. The car free zone will also improve the safety of the cities. In addition, Park & Ride stations can improve the accessibility toward inner cities and the efficient transport of passengers. Another positive result is that drivers don't have to search for free parking spaces anymore, which reduces the emission produced by searching.

2.2.4 Modal Shift

Cars produce the highest emission of all transportation modes. To encourage drivers to use other kinds of transportation the environment will improve. Collective passenger transportation is more efficient as from logistic and environmental point of view. Collective transportation, such as public transportation, has a higher capacity what means that the average fuel consumption and emission per passenger is low. A solution to attract drivers to use public transportation is simply making it cheaper, increase the frequency and improve connections. This is still not always possible due to infrastructural and governmental conditions and the fact that people don't like to be dependent on timetables and value their privacy. Priority lanes can make the travel time of public transport shorter, which makes it more attractive to use. A combination of public transport and cars is the Park & Ride system. The driver still can use his own car to the city, but the accessibility to the inner city will be more convenient by using the bus.

Carpooling is not a matter of modal shift but can reduce the car use and increase the traffic flow. This concept becomes more attractive by constructing special parking spaces for car sharing. A new development in Japan is that drivers without car possession can rent a fuel efficient car for a short limited time instead for the entire day. This reduces the amount of cars on the roads and decreases congestion.

The most environmental way of transportation is by bike or by walking. To attract cyclist in Bremen, Germany the streets have been converted from two way traffic to one way traffic allowing contra flow cycling. This successful measure also improves the safety on the streets.

One of the remarkable projects concerning modal shift was "I Kyoto" in Belgium. During four weeks the employees of a company had to collect as many CO_2- low kilometers by walking, cycling, carpooling or using public transport. In this period they saved 638 ton of CO_2 and 10% of the employees made a permanent changeover to a more sustainable commuting.

2.2.5 Traffic Management

The purpose of traffic management is to achieve efficient traffic flow by coordinating traffic situations and cooperation between traffic systems. Traffic systems such as traffic signal control systems have impact on the behavior of drivers. The optimization of traffic signal systems should achieve better traffic flow. Instead of optimizing each individual signal system, the cooperation of several systems in series is an advanced technique for generating big amounts of traffic. Several projects in The Netherlands involve the so-called "Green wave". This green wave is a series of cooperated traffic signal systems which will have the same light cycle on the same moment. By reduction of stops congestion will reduce and the air quality will improve. Another way to improve air quality, which has been implemented in Utrecht, The Netherlands, is opposite from the green wave. This measure was to let drivers avoid a highly polluted road by changing the light cycle. Green periods were shortened and red periods appeared more frequently. As a result traffic stopped taking the road and the air quality improved.

A clear measure of transport management is the Active Traffic Management from England. The objective of this plan is to improve the air quality by improving the traffic flow whilst maintaining safety (Rijkswaterstaat, 2005). The most important aspects of this plan include speed limiting, ramp metering, dedicated lanes for types of vehicles and use of the hard shoulder. By ramp metering with road signs speed limits will be displayed according to the amount of traffic and speed. During accidents on the road these road signs will also display alternative route choices. These systems cooperate to lead the driver as efficient as possible.

Communication in traffic management is one of the most important aspects. New developments allow communication between traffic centers, infrastructure and the vehicle. Traffic information detected at traffic systems, such as traffic signal control systems, will be send directly to the vehicle (infrastructure to vehicle or V2I). Another option is that traffic information gathered by vehicles will be send to other vehicles (vehicle to vehicle or V2V). By warning drivers for situations ahead, alternative routes can be calculated and traffic flow will improve. A step ahead would be that every vehicle and traffic system will function as radars by collecting information. Traffic systems will be controlled by this new, collected information and it will lead to a self-sufficient, cooperative communication system.

2.2.6 Driving behavioral changes

All of the past measures include bits of behavioral change; as it is for changing transport modes, changing route by road signs or buying a more fuel efficient car. But to address the driver directly by advice or information about his behavior is quite new. In-car systems that encourage the drivers to improve environment by developing a fuel efficient driving behavior are called Green Intelligent Transportation Systems. Green ITS provide drivers with information or advice based on collected data during trips. Information and advice can be displayed during or after driving by texts, graphs or intervention.

A currently existing example of in-car Green ITS is a system called ECOdrive (ecodrive.eu), which will intervene during driving when the driver exceeds the optimum speed or engine revolutions. It will lower the engine revolutions to the optimum revolutions or speed is reached. This optimum speed and optimum revolutions can be set by the user.

Other systems of Green ITS are continually released in the automobile industry. Because of the novelty of these systems, experiences of drivers using them have not been reported yet. Important aspects of testing Green ITS should be the impact on emission, safety, the level of support and comfort.

2.3 Current Green ITS

Past measures and new car developments, such as optimizing traffic signal control systems and alternative fuels, will reduce the greenhouse gas emission. But the driver is unaware of the impact, because these measures are not directly addressed to the driver and his behavior. Still the most important factor of saving fuel and reducing emission is the driver's foot. Personal advice on changing to a fuel efficient driving behavior would be more effective and long lasting. The car industry continuously releases new technologies to make the drivers aware of their behavior. These Green ITS are helping the driver to develop a fuel efficient driving behavior. With collecting data on the driver's behavior during trips, an analysis can be made and the driver receives advice on how to save fuel and money. By following the given advice, the driver can improve up to 15% of fuel efficiency (Fiat, 2008).

Current available in-car Green ITS is still very new and no results of impact on emission has been reported yet. To understand these systems, the next section will present the features of current in-car Green ITS.

2.3.1 Level of support in Green ITS

Excessive fuel consumption and CO_2 emission are the results of unnecessary idling of the car, high speeds and excessive acceleration and braking during driving. Driving smoothly by anticipating to the traffic and by avoiding high speeds, the driver will already reduce his fuel consumption. To help him doing so, Green ITS provides information of his driving behavior and optional advice for changing his behavior.

Information

The concept of collecting data on driving behavior and processing these into a personal advice is relatively new. A more basic approach in Green ITS is to give the driver small signs during the trip to indicate his fuel efficient behavior. Ecolamp is one of these small indications. This light is built in the dashboard and lights up when the driver is behaving fuel efficient. However, the driver gets no extra information and explanation on his behavior.

Another popular system is the gear shift indicator which is more and more often used by several car companies. This indicator shows the driver when to switch in a different gear to avoid excessive acceleration and thus unnecessary fuel consumption. A simple indication with lights is done in Mini cars. Three colors indicate the engine revolution status: green stands for fuel efficient, yellow for start changing gears and red for inefficient behavior. Instead of light, most car companies use numbers to indicate the gear shift moment based on engine revolutions in the dashboard display.

Figure 2: Gear shift indicator by BMW

Advice

Systems that provide the driver with information on his behavior and personal advice have just recently been released or are still in development. One of these advanced projects in Green ITS is EcoDrive from Fiat, which is already in use. Users download the software from the internet. By putting an USB-stick in the car, data of his driving style during the trip will be collected. This driving history will be shown in texts, graphs and numbers on a computer after the trip. After analysis of these data, the system will provide the driver with advice in order to save fuel. Advice will be given on four aspects of the driving behavior: speed, acceleration, deceleration and gear shift. The driver will see his behavior compared to the optimum fuel efficient behavior. By following the advice the driver can watch his progress and see how much CO_2 or money he saves. Additional information that can be provided is the fuel consumption and eco index.

Figure 3: Advice on gear shift and driving history by Fiat EcoDrive

Fiat's EcoDrive is similar to the Nissan ECO Drive Support Service, which hasn't been released yet. The difference between these two systems is that the ECO Drive Support Service can provide information during the trip on an onboard screen. This way the driver gets direct feedback and can follow up his advice immediately.

As for a more advanced display Honda introduced its Ecological Drive Assist System and Ford the SmartGauge and EcoGuide. Both systems provide information about fuel economy during trips on a built in dashboard display in hybrid cars. The system from Honda consists of four parts: ECON Mode button, Ambient meter, Eco guide and Eco information. Since ECON mode is about engine specifications and is not related to driving behavior, this will be not mentioned further.

The ambient meter changes in three different colors dependent on the driving style. Green for fuel efficient driving, blue green for moderate fuel efficient behavior and blue for excessive fuel consumption. The driver will get direct feedback on his behavior without difficult numbers or graphs.

Figure 4: Interface of Eco Guide by Honda

The Eco guide in the centre of the instrument panel is a display which presents the driving behavior during the last three trips. These data concern fuel-efficiency during the trips and it will be shown in 'leaves'. The more leaves means the more fuel-efficient the trip was. Also the cumulative lifetime results of driving behavior during trips are expressed in leaves.

With the addition of Honda HDD InterNaviSystem the driver can see his full history of results of driving behavior. This Eco information program also offers advice based on the drivers habits from the past to be more fuel efficient. The driver will see his improvement of practices on the display and in the future other tips for fuel efficient driving will be available on the internet.

Figure 5: Growing Leaves principle by Ford

A similar system to Honda's Eco Drive is Ford's SmartGauge and EcoGuide. This system also provides information about fuel economy during driving. The interface is more advanced and well designed, because the driver can switch between four different screens during driving. Three out of the four screens shows the driver specifications of the engine and battery status, which does not concern behavioral changes. As for the other screen, it shows the fuel consumed during the trip and by the "growing leaves and vines" principle the driver will see how fuel efficient he is. In this concept direct feedback is the key to efficient behavior: The more leaves and vines there are displayed, the more fuel efficient the driver is.

Intervention
Next to information supply, there are systems which control or correct the driver's behavior by intervention. An example of an existing controlling system is ECOdrive (ecodrive.eu), which is suitable for every car. The driver sets his optimum speed or engine revolutions before making his trips. By exceeding this speed or revolutions during the trip, the system will intervene and reduce the speed or revolutions to the preset criterions. Three different colors of led signals will warn the driver on his behavior. Green stands for the correct driving behavior, with yellow it's recommended to reduce speed or engine revolutions and by red the system will intervene. With this system the driver can never exceed any limits and practice heavy accelerations. New development of this system is the addition of GPS. With GPS the system can trace different road conditions on the route and adjust the limits to these conditions.

Nissan developed the ECO Pedal system which corrects the driver's behavior through the accelerator. Unnecessary fuel consumption is often caused by excessive pressure on the pedals during acceleration and deceleration. By correcting this behavior, the fuel efficiency will improve. The system collects data from fuel consumption and transmission efficiency during acceleration and cruising. It will calculate the optimum acceleration rate. A counter push-back control mechanism will be activated when the driver exerts the excess pressure on the pedal. To remind the driver of the fuel-efficiency driving behavior, an eco-lamp will be turned on when the driver accelerates too hard.

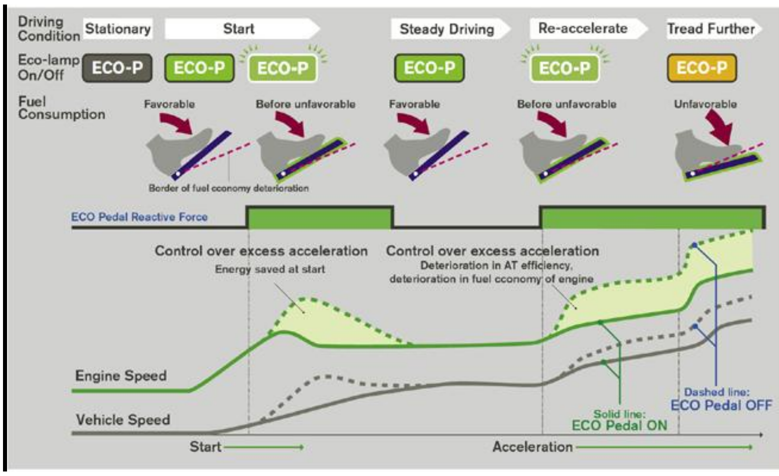


Figure 6: Concept of Eco Pedal system by Nissan

2.3.2 Case study Green ITS

Because of the novelty of Green ITS, the experiences of drivers using Green ITS haven't been reported yet. An analysis on the capabilities, effects and support of these systems might predict which systems are more likely to be used and which ones will have the most impact on the environment in the future. In this section the advantages and disadvantages will be presented, categorized in the factors of demands: impact on environment, safety, level of support and comfort. All of these factors are tightly connected to each other by the fact that the main purpose of these systems is to change behavior. Dependent on the driver's choice, the system that's most preferable to use, will have the most impact on the change of behavior and eventually the environment.

Impact on environment

The main objective of Green ITS is to develop systems which improve fuel efficiency. The improvement of each Green ITS on the environment is given in fuel efficiency in percentages. Most of the numbers being released are results from test drives, which could be doubtful. Only systems which are already in use for a while, such as Fiat's EcoDrive and ECOdrive (ecodrive.eu), have legitimate results on the impact on fuel economy. Although these results never come with an explanation. To diminish the expectations of new systems, some car companies won't even give test results on how much impact it will have on fuel efficiency. The next table shows the impact of Green ITS according to their manufacturers.

Green System	Improvement of fuel efficiency
Eco lamp *(Toyota)*	4%
ECO Pedal system *(Nissan)*	5-10%
Eco Drive Support Service *(Nissan)*	7,7%
ECOdrive *(ecodrive.eu)*	15%
EcoDrive *(Fiat)*	15%
Gear shift indicators	Not available
Ecological Drive Assist System *(Honda)*	Not available
SmartGauge & EcoGuide *(Ford)*	not available

Figure 7: Impact of current Green ITS on environment

According to these numbers, the Fiat and ECODrive (ecodrive.eu) have the biggest impact on the environment. This does not mean that these systems are better than others. Even though the numbers are impressing, other factors might be worse in these systems. Preference and the values of drivers in these systems decide the frequency of use. Although the Eco lamp does not improve much, with a positive experience and thus frequent use of this system, the impact on the environment can eventually exceed the impact of an uncomfortable, but more powerful system.

Safety

Safety is the most important aspect in designing systems. The use of systems should maintain or improve the current safety. These days, the driver cannot totally rely on the information given by the systems, no matter how advanced these are. Anticipation is the key for remaining safety of your own and other drivers. Aspects of safety include intervention, distraction and the trust in the system.

In car systems which control and correct drivers during trips are effective, but can lack in safety. There are certain levels of controlling and correcting, from cruise control to fully automatic parking. This is determined by the ratio of human-car influence. The two systems with intervention in Green ITS are ECO Pedal System from Nissan and ECODrive from ecodrive.eu. The Eco Pedal System gives a counter pushback when the system detects an excessive pressure on the pedals. With Ecodrive the speed or engine revolutions will be abruptly reduced to the pre set limits after exceeding these. In busy traffic situations on high-ways these systems might be dangerous: In some situations in safe passing of vehicles, excessive pressure for braking or accelerating is necessary to preserve the safety on the road. When the system blocks the driver from doing so, the following car may not be aware of abrupt the action and this can end up in collisions. Unlike the Eco Pedal control, ECODrive can unfortunately not be turned off.

Distraction during driving can also cause dangerous situations. Indicators, sounds and difficult interfaces can disturb the driver's concentration. It depends on the familiarity of the use with in-car systems whether the driver can easily adapt to the system. Different types of distraction will be further explained in the section "Comfort".

Next to physical safety, the feeling of being safe is very important too. Difficult interfaces might scare the driver and bad experiences with systems might keep them from using these. When the driver is feeling safe and trusts the system, stress won't distract him and accidents are less likely to happen. Therefore, accurate information supply should be reached.

Level of Support

Previously, three levels of support in Green ITS are mentioned: Information, Advice and Intervention. It is important to investigate which level of support in the system is preferable for the driver to have. By designing this support to the driver's desires, the driver is more willing to use the system and thus will result in a bigger impact on the environment.

The current information supply systems differ from each other by the type, the amount and time of information supply. Minor indications like the Eco lamp are very simple and easy to understand. But the user might wonder what it means and why it lights up. Systems, like for example Fiat's EcoDrive, provide the driver with information on his previous driving behavior, advice for fuel efficient behavior and progress trends after following up the advice. Next to this information, data about fuel consumption, CO_2 and money saved are displayed. The question is if all this information is wanted and motivates the driver to change his behavior. By overwhelming the driver with too much information, the system might get the driver scared of the difficulty and amount.

A perfect combination in the amount and type of information can be sought in the timing of the supply. Unlike Fiat, most of the systems are able to give information during and after driving. With direct feedback and advice during driving, the driver is more aware of his behavior and can immediately adapt his behavior. Advice given after the trip is most likely to be forgotten. On the other hand driving history, CO_2 and money saved can be displayed after the trip to avoid distraction.

Controlling the driver's behavior during a trip by intervention is very effective on changing the behavior, because the driver simply has no other choice than to follow. Although, the driver will be warned before intervention, the driver is still forced to change his behavior and will be punished if not doing so. This unpleasant feeling of being forced might change the driver's mind in using this system for long term. As for a long term use of this system the user will adapt his behavior to this system and has eventually developed a fuel efficient behavior.

Comfort

Comfort is from a driver's point of view most valuable. Without comfort in Green ITS, the driver won't be willing to adapt his behavior to this system. With the use of a system, his comfort during driving should be maintained or improved. Unfamiliarity is normal with the introduction of a new system, but the driver should be able to adapt to this system quick and easily. Otherwise, the driver will get stressful and cause danger for himself and other drivers. Aspects of Green ITS that might make the driver uncomfortable are lights, sounds, displays and interventions.

Stress and distraction are the results of displays with difficult numbers, texts, figures and loud, surprising sounds and lights. Also the amount of information during driving can cause decrease of concentration. The system should have the minimum of information supply and a simple display to easily adopt the advice. It's up to the preference of the driver in which way he wants to receive what kind of information. Some drivers may react better with sounds, while others prefer texts in the dashboard. Even though intervention can be dangerous, with a good description and explanation of the system, the driver won't be surprised and might find it comfortable.

The key of all systems is that it should leave the driver the choice of using it and the type of information supply. With an approach of helping the drivers rather than forcing them is more effective: Rewarding and a positive approach are more satisfying than punishing. Also letting the driver anticipate with the system shows the flexibility. Trends of progress motivate the driver to change and it's up to them if they want to follow the advice.

The opinion of the driver is most important factor in designing Green ITS. By adjusting the level of support of systems to his desires, while maintaining comfort and safety, improvement of environment will be achieved.

3 Approach

In the previous chapter currently available Green ITS technology has been introduced and described. These techniques are usually designed from a technical point of view, which means by modeling the behavior and desires of a driver. To attract drivers to use such kind of systems, the design of these systems should satisfy the desires of Japanese and Dutch drivers. By collecting the opinion on fuel efficiency and Green ITS directly by survey, a better approach of Green ITS for drivers and eventually improvement of the environment will be the result. This chapter of approach will explain which elements are expected to have influence on the driver's choice of Green ITS. The conceptual model presents the relation between elements on which the hypotheses are based. Further the set up for survey questions and the software used will be described.

3.1 Conceptual model

The purpose of this survey is to measure the attitude of drivers to Green ITS. Which information is preferred in these systems is based on certain elements. This conceptual model presents these elements and their connections to the preferred information.

Elements

- Personal Character
- Driving Style
- Experience with ITS
- Attitude towards Environment

These four elements are related to the driver's personality and behavior. By examining the relationship between these elements, it is possible to predict preferred type of information, which will trigger the driver to change his behavior. In this section the relationships between these elements will be explained.

Personal character contains the personality of the driver himself. Factors which characterize the type of driver are his driving experience and his personality in general. As for his driving style, this includes his average mileage, trip purposes, route choice and frequency of driving. These factors are related to his behavior when driving in daily life. The capability to adapt to Green ITS depends on experience with current ITS and interest in technology. Difficult systems are more likely to discourage drivers to use them. The attitude of drivers towards environment explains the sort of information which might encourage the driver for fuel efficiency. Information about CO_2 production will have more influence on drivers who do care about the environment than those who don't.

The relationships between the elements are shown in de following conceptual model.

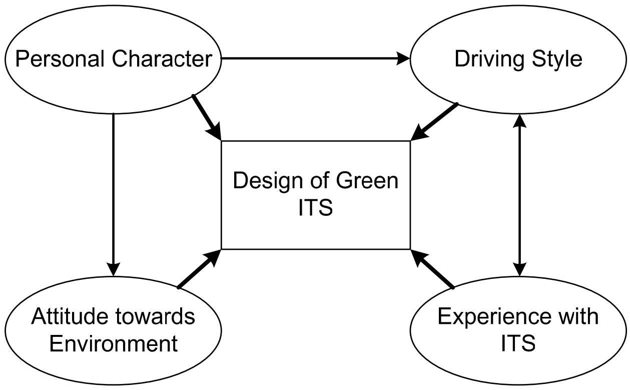


Figure 8: Conceptual model

Green ITS is the technology which can provide the driver with certain information about fuel efficient driving behavior. As mentioned in the previous chapter the systems can provide information about personal driving behavior and the results of it. Driving history, advice and progress on behavior are related to driving itself while information about fuel consumption, CO_2 production and money explain the results. Preferred type of information of the driver depends on the four elements.

The personal character is related to the driving style and the attitude towards environment. The driver develops a driving style which fits his personality. His attitude towards the environment in general and his knowledge about fuel efficient driving are also involved in this development. Besides personal character, the driving style is also influenced by the experience with use of ITS. ITS are designed to help the driver, but bad experiences could affect his choice of using them. By analyzing different types of characters, driving styles and attitudes it is possible to define which type of Green ITS and thus information supply suits which type of driver.

3.2 Hypotheses

Assumptions on characteristics of drivers, based on the conceptual model, lead to the expected preferable design of Green ITS. In these hypotheses the focus will be on the different types of drivers with their characteristics. By categorizing these different types of drivers based on their personality, driving behavior and attitudes towards environment and ITS, it is possible to predict which information is most likely to be received by these types.

Drivers who consider themselves ecological are more willing to improve their fuel efficiency than others who aren't aware of the increasing global warming. These ecological drivers can be characterized by their positive attitude towards the environment and their intentional ecological driving behavior. The expectation is that drivers will want information about their CO_2 production and other environmental factors.

Other drivers are encouraged by information about how much money they would save with changing their behavior. These drivers often have a high average mileage and where fuel prices have remarkable effect on their total expenditures when they change. Information which might trigger these types of drivers is about fuel consumption and the amount of money they would save.

Experience with current ITS might predict the attitude towards Green ITS. Drivers who are familiar and have a positive experience with current ITS are more likely to want to use Green ITS. These drivers have experience with information supply and are not afraid to receive many types of information. This means that they find different types of information relevant in Green ITS.

3.2.1 Differences in countries

The survey is targeted on Japanese and Dutch drivers. Differences in the results of both countries might affect the design of the proposed ITS. In this section hypotheses are made on the differences between the results of both countries.

Driving behavior

Japan is known for her highly developed and fast public transport system. Because of the conveniences of this system, the Japanese respondents might rather use public transport than car in their daily life. Especially in big cities such as Tokyo, public transport is much faster and cheaper than travelling by car. The Netherlands consists of a big network of roads and high ways. For this reason the Dutch respondents are more likely to use car in their ordinary life. The expectation is that Japanese drivers have a lower average mileage and use vehicles less frequently than Dutch users. Therefore it is expected that Japanese drivers will care less about money related information.

Experience ITS

The continuous development of new technology is a part of the Japanese culture. The Japanese car industry is well-known all over the world. For these reasons it is expected that Japanese drivers are more experienced with current ITS than Dutch drivers, because of their big interest in new technology. The expectation is that Japanese drivers are familiar with information supply and are more eager to receive information in Green ITS.

In this research the four elements of the conceptual model will be used to define types of drivers. The investigation of these types will estimate the preference of information in Green ITS.

3.3 Survey Design

The desires of the driver determines the design of Green ITS. Approaching the drivers directly is the most effective way to unveil the attitude of drivers on Green ITS. For this research it was chosen to deploy a survey. In this section the development and design of the survey will be further explained.

The survey “Green light for a better environment” consists of the following four parts

- General information: These questions concern personal information of the respondent, such as age, vehicle possession and features of the vehicle.
- Driving behavior & ITS experience: These questions are related to the driving habits of the respondent, such as trip purpose, average mileage and frequency and the experience of using ITS.

- Attitude towards environment: These questions contain the self-image of respondents with environmental behavior.
- Green ITS: These questions contain the preference of the driver on different types of information in Green ITS.

3.3.1 General information

This first section consists of questions on the personality of the respondent. With this information drivers can be categorized. Because of this traffic related subject, only respondents with a driving license participated in the survey. The questions are related to age, occupation, possession of different types of driving licenses, vehicle possession, most often used vehicle and the features of it. Factors such as driving experience and personality can be easily retrieved from this data.

3.3.2 Driving behavior

Investigating the respondents' driving behaviors reveals which driver has the most impact on the environment. And thus this driver needs the most support of Green ITS in order to change his behavior. Also the driver's experience with ITS will be reported. Familiarity with the use of technology in the vehicle has influence on the adaptability of the driver on Green ITS. This information is important in the design of Green ITS. Questions in this part are related to average mileage, driving frequency, trip purposes, route choice and the familiarity of several ITS technology.

3.3.3 Attitude towards Environment

By measuring the attitude of respondents towards environment it will be clear who has a positive attitude and is more willing to change his behavior. This means that the drivers who are not impressed by the environmental issues need other factors to encourage them to change. In this section the priorities of several kinds of information which will trigger the driver to change are asked. Other questions are related to the attitude towards environment in general and the self-image of the respondent.

3.3.4 Attitude towards Green ITS

The first three sections characterize the respondent's personality, behavior and attitude to fuel efficiency. To design a system that satisfies the desires of the driver, the attitude to Green ITS should be measured. Because of the novelty of in-car Green ITS, many drivers are not familiar with these systems. To measure what their attitude is to such kind of systems, examples are provided to give the respondent an impression of in-car Green ITS. Respondents will be asked on which kind of information is relevant to help them in changing their behavior. Also the timing of the information supply is important. The types of information are divided into four parts. The first part is about the supply of general information such as fuel consumption, costs and CO_2 emission. The second part consists of questions about the need for advice on driving behavior. After advice, the respondent will be asked if he is interested in an analysis of his previous driving behavior. At last, there are questions about the display of progress of driving behavior.

All in all, this survey consists of 34 questions. The survey gives the respondent an impression of Green ITS, but does not include the attributes of Green ITS. The results of this survey will show the willingness to use the system and the attitude towards Green ITS. By overwhelming the respondent with different kinds of attributes in Green ITS, such as the possibility of different interfaces, sounds and lights, creates confusion and the assumption that respondents already confirmed to want these systems.

3.4 Survey Method

In this research the attitude towards Green ITS will be measured in Japan as well as in The Netherlands. The research location is set in Japan, therefore a web survey is most preferable to receive data from the Dutch population. Other advantages of web surveys are the low cost, the flexibility in changing data, the ease of the use of internet, direct collection of digital data and accessibility of an enormous population by internet. The survey is set out on the internet for both countries in their own languages. The software used the target of population and the spread of the surveys are presented in this section.

3.4.1 Software

Several software packages to build web surveys are available. Because of the demands for a multi lingual survey, the software used for this survey should contain the ability to create Japanese characters. Based on this ability, the low costs and easy interface the software Limeservice is chosen. This software, which can be found on www.limeservice.com, is totally web based and is capable of managing collected data directly to statistical analysis programs. The final web survey can be found on the websites http://wingyan.limeask.com/index.php?sid=56984&lang=nl (Dutch version) and http://wingyan.limeask.com/index.php?sid=97472&lang=ja (Japanese version). The final set up of these surveys can be found in the Appendix.

3.4.2 Target of population & invitation

The target of this research is Dutch and Japanese owners of a driving license. Vehicle possession was not obliged for filling in the questionnaire, but was preferable. Gender and age did not matter, but it has been tried to attract as much drivers in different age groups. Especially professional drivers and drivers with high mileage were desired for this survey. These drivers have the greatest amount of emission and thus should be the main focus group for designing Green ITS.

In order to make a good analysis of the drivers from both countries, the aim is set on at least 100 respondents per country. The respondents were informed by an email which included information on the subject of the research and the importance of the survey. By clicking on the link to the website in the email, the respondent would be sent to the online questionnaire. In The Netherlands the questionnaire is spread out by a personal network, such as friends, family and sport clubs. These were asked to forward the questionnaire in their network. Also auto forums on the internet were informed about this research. In Japan the survey is spread over the Toyota InfoTechnology Center Co., Ltd. Thereby were the other sub companies of Toyota Motor Company informed and Universities related to Toyota InfoTechnology Center Co., Ltd. This snowball method is effective, because of quick email service and flexibility of a web survey.

4 Results & Analysis

This chapter contains the results of the survey “Green light for a better environment”. As is mentioned before, the purpose of this survey was to measure the attitude of drivers towards Green ITS. The results of Dutch as well as Japanese drivers are analyzed by SPSS and will be presented. First, general statistics of the respondent will be explained. After this section, the results of the data analysis based on the four elements of the hypotheses will be discussed. At last, there will be a presentation of the preferences of information supply in Green ITS.

4.1 General statistics of respondents

In the Netherlands 100 respondents filled in the survey and 98 respondents from Japan. To get an impression of population that filled in the survey, general data such as age, profession and mileage are generated from the survey.

Characteristics		**Dutch**	**Japanese**
Age	18-24	48%	40.6%
	25-39	36%	38.5%
	40-64	13%	19.8%
	65 and older	3%	1%
Profession	Student	39%	53.1%
	Office worker	28%	30.2%
	Professional driver	5%	0%
	Other	28%	16.7%
Car possession	None	32%	44.8%
	1	38%	45.8%
	2-3	28%	9.4%
	More than 3	2%	0%
Annual average mileage	0 - 1.000 km	11%	41.7%
	1.000 – 5.000 km	19%	29.2%
	5.000 - 10.000 km	13%	14.6%
	10.000 - 20.000 km	29%	12.5%
	20.000 - 30.000 km	13%	1%
	More than 30.000 km	15%	1%
Primary trip purpose	Commuting	41%	15.6%
	Work related	13%	3.1%
	Social Recreational	45%	56.3%
	Shopping	1%	25%

Figure 9: Characteristic of respondents

As for both countries the majority of the people responded are between the age of 18 and 39 and are student. No professional drivers have responded in Japan and the variety of the profession of respondents is higher in The Netherlands. Significant differences between respondents from both countries are car possession, annual average mileage and primary trip purpose. Dutch drivers have the luxury to possess more than one car, while Japanese just have a single car or no car. In the facts of annual mileage is shown that Japanese are likely to make shorter trips up to 5.000 km. Most of the Dutch drivers have a mileage from 10.000 – 20.000 kilometers. Using car to commute or for work is less popular in Japan than in The Netherlands. Japanese often use the car for more private purposes. Significant differences will further discussed in the next chapter.

The main objective for this research is to propose a preferable type of Green ITS to both countries in order to reduce emission. From this data can be analyzed what the main target of users is for future Green ITS. The main target is the driver who drives the most and has the highest mileage, because these produce the most emission. The proposed Green ITS has to suit the profile, needs and preferences of this type of driver.

4.2 Analysis by elements

Instead of categorizing types of drivers and examine what kind of information is important to each type, this analysis has been done in reverse. The results of the question about the type of preferred information, which will motivate to change driving behavior, will be the point of reference in this analysis. This priority of information defines the respondent's character and attitude towards environment. By correlating this character to his driving style and experience with ITS, suitable Green ITS based on this preferred information can be designed.

In the previous chapter, four elements of the conceptual model have been explained. The hypothesis is that these four elements define the type of driver with his preferred type of information. The survey is designed by these elements: Personal character, Driving style, Experience with ITS and the Attitude towards environment. Several key factors in these elements will be chosen for investigation and the relation between them.

4.2.1 Priority information

The respondents were asked to choose the most relevant information to receive in order to change their behavior. They had to rank these types of information to the priority of preference and motivation.

Priority of information	Dutch	Japanese
Fuel consumption	17%	34.4%
Money saving	64%	56.3%
CO_2 emission	11%	2.1%
Contribution to environment	8%	7.3%

Figure 10: Frequency of the highest priority of respondents

As for both countries, money related information is of most importance to drivers. The second most preferable information is about fuel consumption. This information is more preferable among drivers in Japan than among Dutch drivers. Remarkable is the difference in importance of CO_2 emission.

Because of the fact that the majority is motivated by money related information, the main target of Green ITS is this type of driver. Several key factors have been chosen to find correlation between the preferred information and the character of the driver. The four elements will be the guideline for this analysis.

4.2.2 Personal character

To define the personal character of the driver, three key factors have been analyzed: Age, profession and car possession. Age and profession tells something about the daily life of the driver. Generally, office workers drive or commute more with the car than students, which makes them a more important target for the research. The possession of the car reveals that the driver needs a car or wants to drive. These factors were compared with the preference of information.

Characteristics of Dutch respondents		**Fuel Consumption**	**Money saving**	**CO_2 emission**	**Contribution Environment**	**Cumulative Population**
Age	18-24	4%	40%	2%	2%	48%
	25-39	11%	17%	6%	2%	36%
	40-64	2%	6%	2%	3%	13%
	65 and older	0%	1%	1%	1%	3%
Profession	Student	3%	31%	3%	2%	39%
	Office worker	9%	15%	3%	1%	28%
	Professional driver	1%	4%	0%	0%	5%
	Other	4%	14%	5%	5%	28%
Car possession	None	5%	24%	2%	1%	32%
	1	8%	19%	7%	4%	38%
	2-3	4%	19%	2%	3%	28%
	More than 3	0%	2%	0%	0%	2%
Total		**17%**	**64%**	**11%**	**8%**	**100%**

Figure 11: Personal characteristics of Dutch respondents

Characteristics of Japanese respondents		**Fuel Consumption**	**Money saving**	**CO_2 emission**	**Contribution Environment**	**Cumulative Population**
Age	18-24	15%	20%	1%	4%	40.6%
	25-39	10%	24%	1%	3%	38.5%
	40-64	8%	11%	0%	0%	19.8%
	65 and older	1%	0%	0%	0%	1%
Profession	Student	19%	29%	1%	4%	53.1%
	Office worker	10%	17%	1%	2%	30.2%
	Other	5%	10%	0%	1%	16.7%
Car possession	None	16%	19%	2%	6%	44.8%
	1	13%	32%	0%	1%	45.8%
	2	4%	5%	0%	0%	9.4%
Total		**34%**	**56%**	**2%**	**7%**	**100%**

Figure 12: Personal characteristics of Japanese respondents

The difference between the importance of information on fuel consumption and money saving is remarkable in The Netherlands, but this ratio is smaller in Japan. Interesting fact is that in Dutch drivers between the age 18 and 24 or students or drivers with no car possession are much more interested in money related information than the older drivers or who have a car. The fact that office workers are forced to use the car and usually can declare their expenses to the company explains the importance of fuel consumption instead of expenses. And drivers who possess a car are more aware and prepared to pay the extra expenses, such as tax or fuel costs.

4.2.3 Driving style

The driving style shows the driving behavior in ordinary life. The annual average mileage and frequency gives information about the car use. More frequent drivers often have a higher average mileage, which means that they produce more emission. The purpose of the trip reveals the familiarity of the routes. Commuting is often the same route, which means that the driver is familiar with it and drives more smoothly. This causes less emission than when the driver has different routes all the time and has to learn its conditions.

Characteristics of Dutch respondents		**Fuel Consumption**	**Money saving**	**CO_2 emission**	**Contribution Environment**	**Cumulative Population**
Annual average mileage	0 - 1.000 km	2%	7%	1%	1%	11%
	1.000 – 5.000 km	3%	15%	1%	0%	19%
	5.000 - 10.000 km	3%	9%	0%	1%	13%
	10.000 - 20.000 km	5%	17%	3%	4%	29%
	20.000 - 30.000 km	2%	8%	2%	1%	13%
	More than 30.000 km	2%	8%	4%	1%	15%
Frequency	(Almost) Always	8%	30%	7%	4%	49%
	3-4 times per week	5%	9%	3%	3%	20%
	1-2 times per week	0%	7%	0%	0%	7%
	1-3 times per month	1%	17%	0%	0%	18%
	Some times per year	3%	1%	1%	1%	6%
Primary trip purpose	Commuting	5%	27%	7%	2%	41%
	Work related	4%	6%	2%	1%	13%
	Private	8%	31%	2%	5%	46%

Figure 13: Driving style to the priority of Dutch respondents

Characteristics of Japanese respondents		Fuel Consumption	Money saving	CO_2 emission	Contribution Environment	Cumulative Population
Annual average mileage	0 - 1.000 km	14%	20%	2%	4%	41.7%
	1.000 – 5.000 km	9%	17%	0%	2%	29.2%
	5.000 - 10.000 km	3%	10%	0%	1%	14.6%
	10.000 - 20.000 km	5%	7%	0%	0%	12.5%
	20.000 - 30.000 km	1%	0%	0%	0%	1%
	More than 30.000 km	1%	0%	0%	0%	1%
Frequency	(Almost) Always	4%	7%	0%	0%	11.5%
	3-4 times per week	5%	8%	0%	0%	13.5%
	1-2 times per week	7%	13%	0%	3%	24%
	1-3 times per month	7%	13%	0%	1%	21.9%
	Some times per year	8%	10%	2%	0%	20.8%
	Never	2%	3%	0%	3%	8.3%
Primary trip purpose	Commuting	6%	8%	0%	1%	15.6%
	Work related	0%	2%	0%	1%	3.1%
	Social Recreational	19%	29%	2%	4%	56.3%
	Shopping	8%	15%	0%	1%	25%

Figure 14: Driving style to the priority of Japanese respondents

All factors are significantly different in both countries. Dutch drivers have a high average mileage, frequent use of the car and are more likely to commute by car. On the contrary, Japanese users have a low average mileage, use the car occasionally and the main purpose of using the car is for private situations. Although the majority from both countries chose money information as their priority, these differences may be noticeable in the designs. Dutch drivers should be more concerned about their fuel efficiency, because of their frequent driving behavior.

Next to these factors also subjective questions about self image have been asked the driver. They were asked to state their level of experience. Experienced drivers usually have a higher mileage, which means more CO_2 emission. But these drivers are also better anticipators in traffic, which might conclude they drive more smoothly and fuel efficient than beginners.

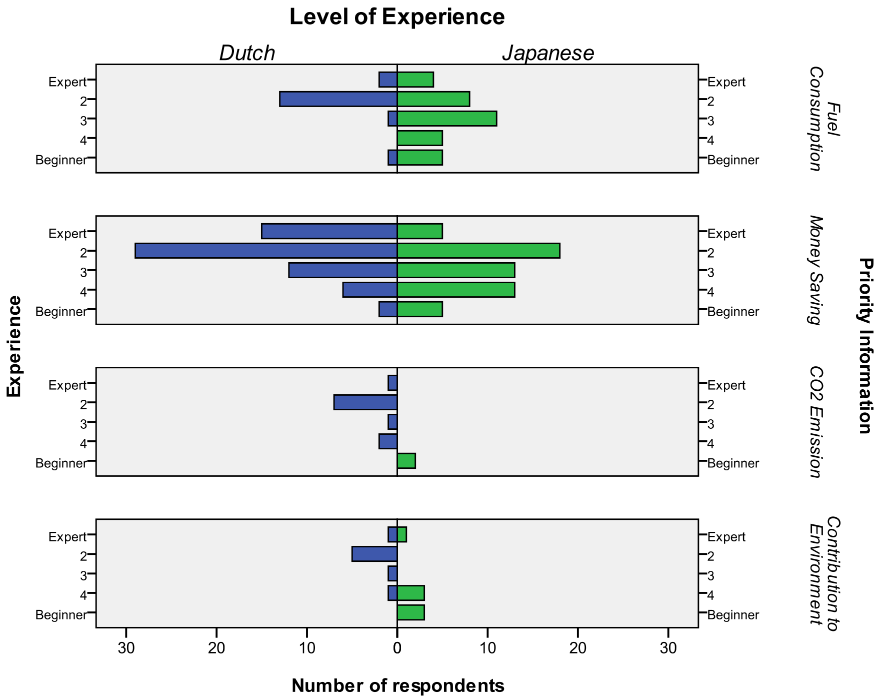


Figure 15: Level of Experience of Dutch and Japanese respondents (SPSS)

Dutch drivers consider themselves more experienced, based on the high response on level "good" and "expert". Interesting fact is that a higher level equals more interest in information of CO_2 emission and contribution to environment. This is in contrast with the Japanese responses. Environment related information is more wanted by 'moderate' and 'beginner' levels of experience.

4.2.4 Experience with ITS

Green ITS is a new development in the current ITS technology. The experience with ITS tells whether the driver is familiar with in-car systems or not and is capable to adapt to these systems. In this survey, the experience of ITS among the Dutch and Japanese respondents is measured. The familiarity was asked for the cruise control, navigation systems, adaptive cruise control, lane departure warning and intelligent information systems. Frequent drivers are more likely to use ITS and to design comprehensible Green ITS it is important to know with what kind of systems the driver is familiar with.

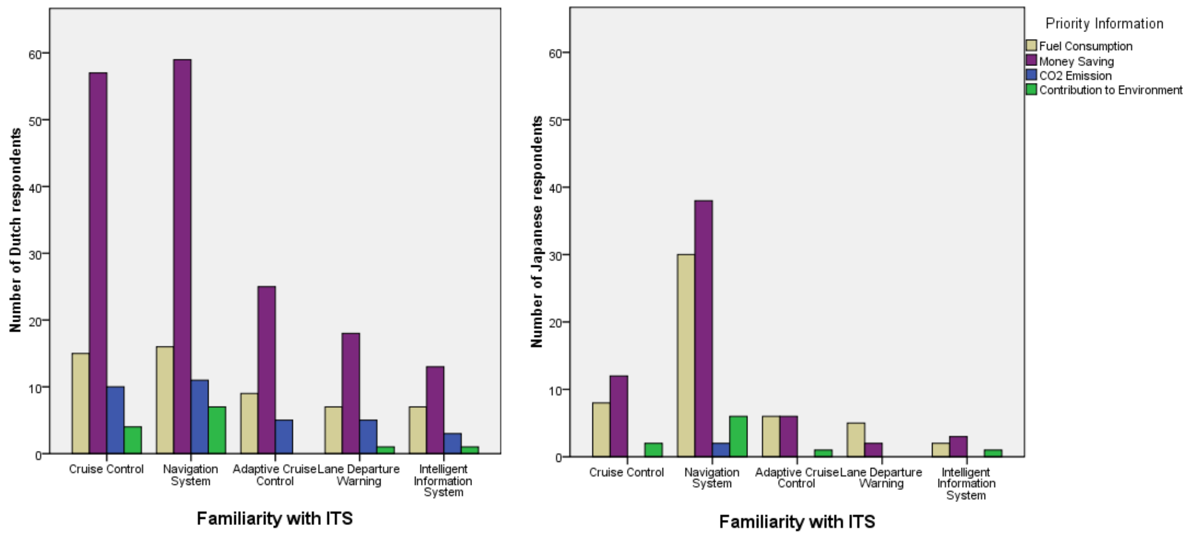


Figure 16: Experience with ITS of Dutch and Japanese respondents (SPSS)

The striking difference between the two countries is that the group of Japanese respondents which are familiar with the current ITS is significant lower than the group of Dutch respondents. As for a country with well developed technology, the result is quite remarkable. For both countries cruise control and navigation systems are most used. A comprehensible new system should have the same level of adaptability as these systems. Possibly, some interface aspects of the current systems can be copied to keep the familiarity of the system and to avoid wrong usage of the system. Especially, the results from The Netherlands show that the preference of information is not related to the experience with ITS. The same ratio of interest in types of information concludes that experience in ITS has no relation with the preferred information, which is in contradiction with the hypotheses.

4.2.5 Attitude towards environment

In the survey several subjective questions have been asked about the concern of the respondent on environment in general. These respondents were asked to reflect their self image of their attitude towards environment. Respondents, who care about global warming, prefer to receive information about CO_2 emission or contribution to the environment. Also other questions about the fuel efficient behavior and fuel price show their attitude and behavior.

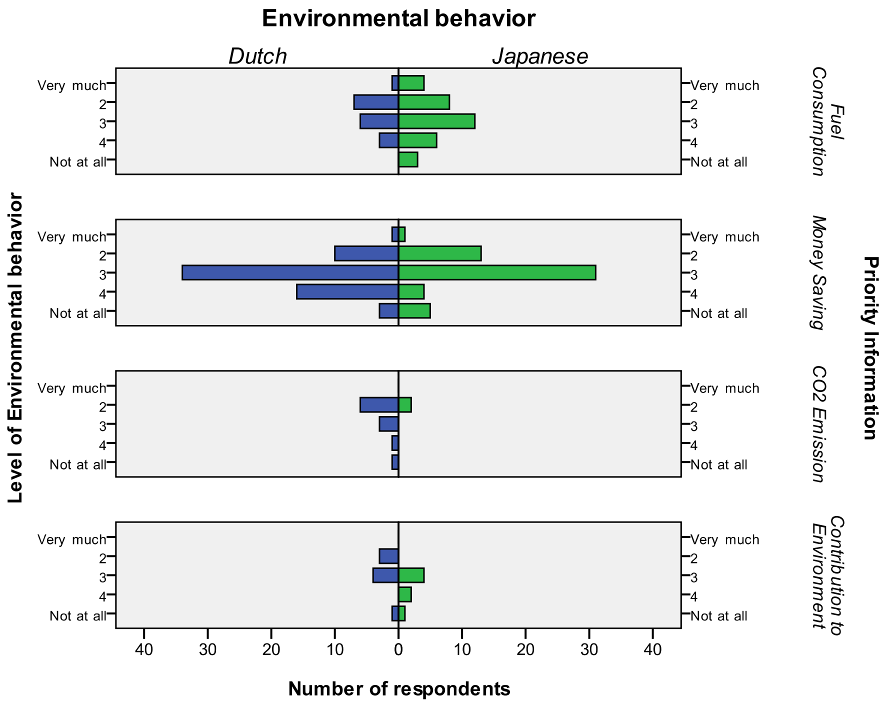


Figure 17: Self-image of environmental behavior of Dutch and Japanese respondents (SPSS)

Environmental behavior concerns actions that people take to improve the environment, such as recycling or low energy use. Most of the respondents hesitate to call themselves very environmental and reflect themselves to have an average environmental personality. Dutch respondents who have environmental information as their priority do think they are more environmental, while on the contrary Japanese respondents who are interested in contribution to environment refer themselves as not environmental.

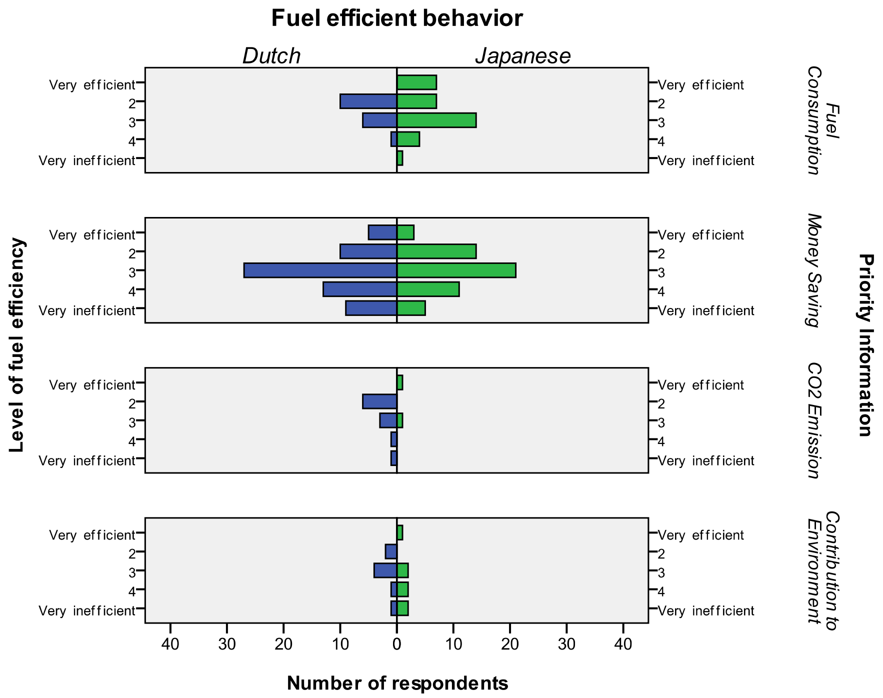


Figure 18: Self-image of fuel efficient behavior of Dutch and Japanese respondents (SPSS)

In this question the respondents were asked to give their impression of their fuel behavior during driving. It is expected that respondents who care about the environment should know that fossil fuels are running out and excessive use affect the environment. Therefore these respondents should drive more fuel efficient, which is not the case for the Japanese respondents in this survey. Another outstanding result is that fuel efficient drivers still care about their fuel consumption, which might mean that they really want to reduce their fuel consumption to the minimum.

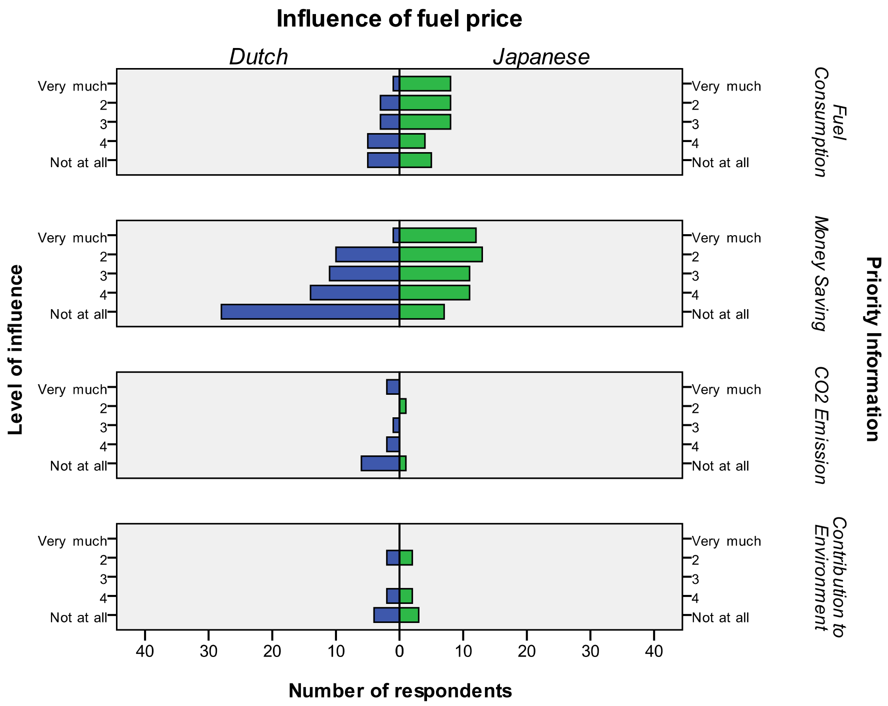


Figure 19: Influence of fuel price on Dutch and Japanese respondents (SPSS)

The intention of raising the fuel price is to reduce the consumption of it. Therefore it is expected that respondents with money related information or fuel consumption as their priority are influenced by this price. The results on these types of respondents in Japan tell that the priority of information has no influence on their behavior. The amount of respondents who answered that fuel price has influence is almost the same as the amount of respondents who say is has no influence. A more significant result that the majority of Dutch respondents who preferred money related information think that fuel price has no influence at all on their behavior. A possible explanation could be that these drivers are dependent on their car and cannot reduce their frequency because of commuting.

All in all, it can be concluded that the attitude towards environment is not related to the preferred information in Green ITS. Respondents with care for environment don't find themselves more fuel efficient than drivers with money information as their priority and these money focused drivers are not always influenced by the fuel price. These results contradict with the hypotheses.

4.2.6 Attitude towards Green ITS

The attitude of a driver towards Green ITS is the willingness to use Green ITS. In the survey, respondents were asked to give their opinion on several aspects of Green ITS information supply, such as advice and history of driving behavior. A high relevancy of this information equals a willingness to use Green ITS and a big influence on the change of driving behavior. Therefore, the information which resulted in the highest relevancy will be the most preferable for drivers to receive. Next to the type of information, the respondents were asked to give their timing of information. In this section these results will be presented.

Type of information in Green ITS

The majority of drivers chose money related information as their most important motive to change behavior. These drivers also include the most frequent drivers which produce the most emission. To improve environment, Green ITS should be designed to satisfy the desires of this type of driver.

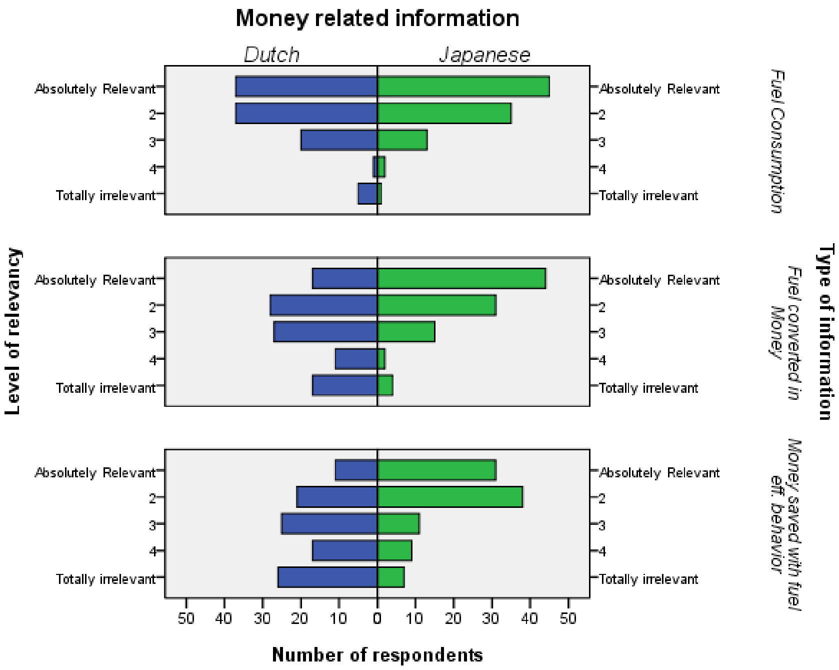


Figure 20: Level of relevancy in money related information of Dutch and Japanese respondents (SPSS)

According to the chart, information directly or indirectly related to money is likely to be received. This information concern fuel consumption, money converted from fuel consumption and the amount of money saved with fuel efficient behavior. Although more Dutch respondents chose money related information as their priority than Japanese, this money related information is significantly more relevant for Japanese drivers.

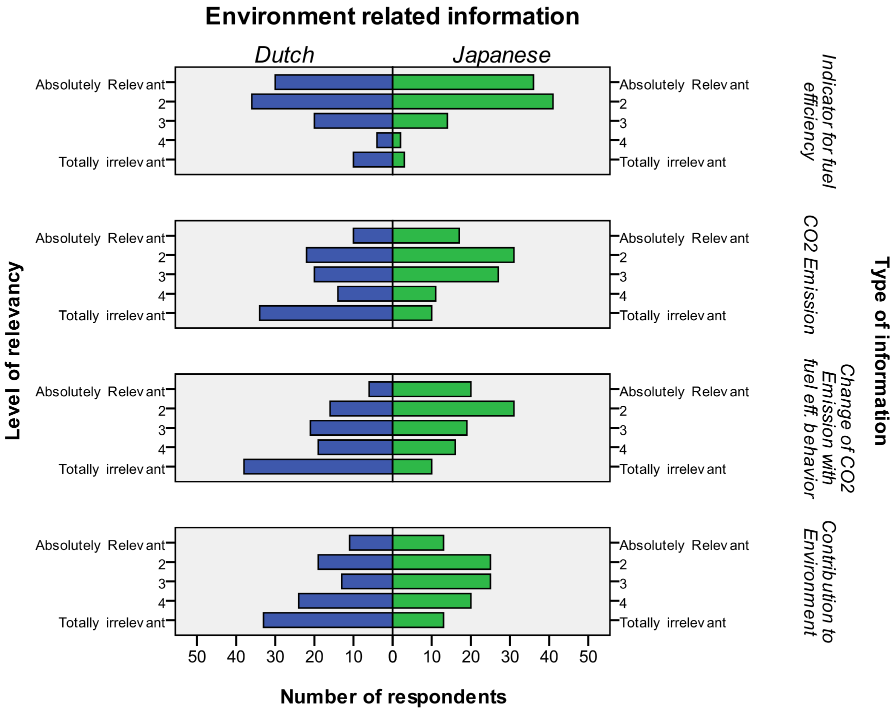
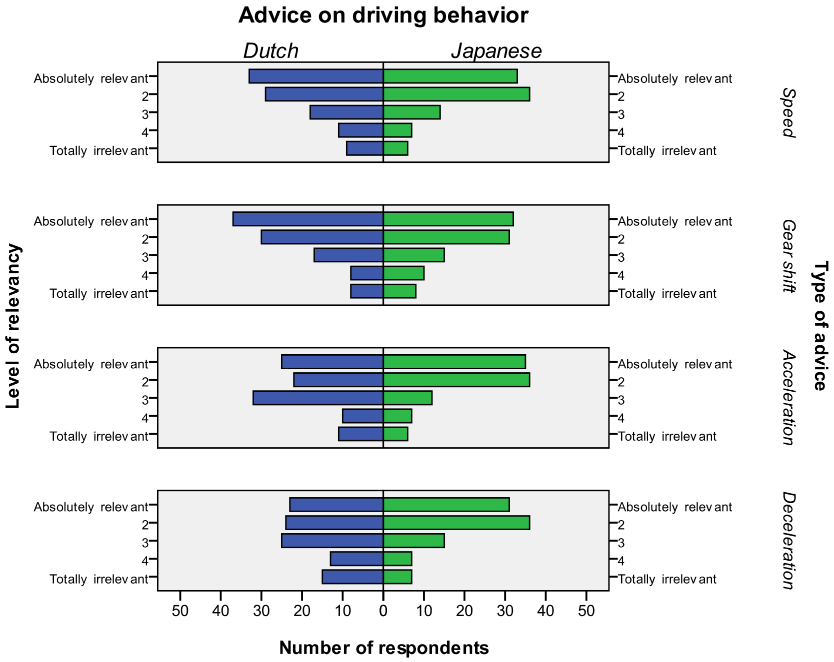
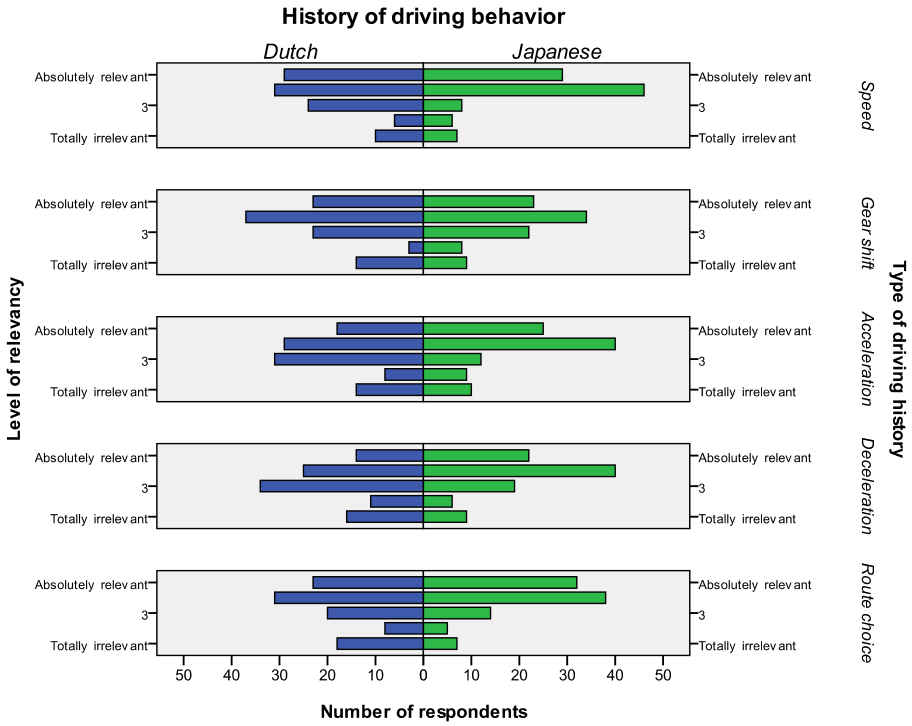


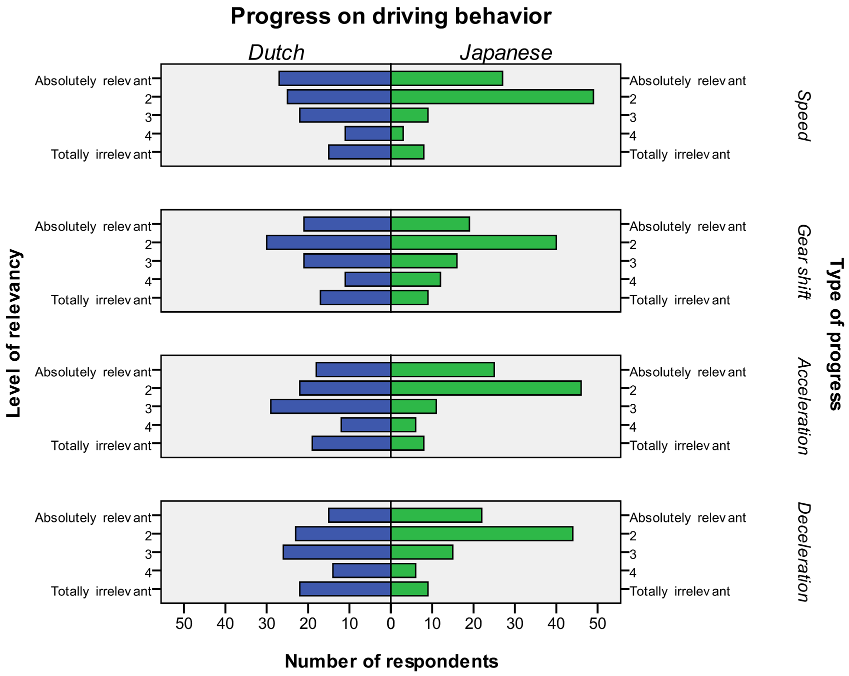
Figure 21: Level of relevancy in environment related information of Dutch and Japanese respondents (SPSS)

As for environment related information the indicator for fuel efficient behavior is very popular. For Dutch drivers environment related information is over all irrelevant, but the results are not negligible to exclude this information from Green ITS. From these graphs it is clear that Japanese respondents find environment related information more relevant and are more willing to receive this type of information than the Dutch respondents. A possible cause could be the eagerness to use new technology and receive all kinds of information.

For the analysis on information related to the personal driving behavior of the respondents, the following charts of advice, history and progress in driving behavior will be presented. These charts display the relevancy of this type of information supply.


Advice on driving behavior
Dutch
Japanese
Absolutely relevant
2
3
4
Totally irrelevant
Speed
Gear shift
Acceleration
Deceleration
Type of advice
Level of relevancy
50 40 30 20 10 0 10 20 30 40 50
Number of respondents

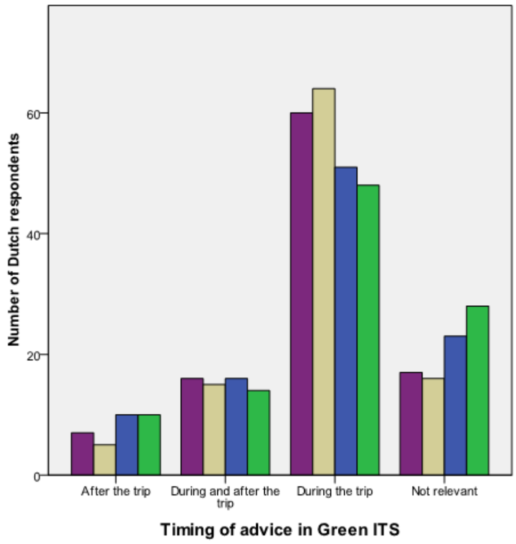

History of driving behavior
Dutch
Japanese
Absolutely relevant
3
Totally irrelevant
Speed
Gear shift
Acceleration
Deceleration
Route choice
Type of driving history
Level of relevancy
50 40 30 20 10 0 10 20 30 40 50
Number of respondents

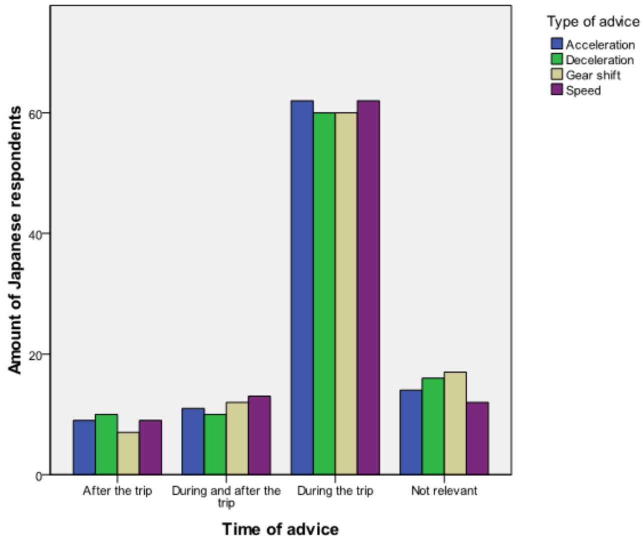


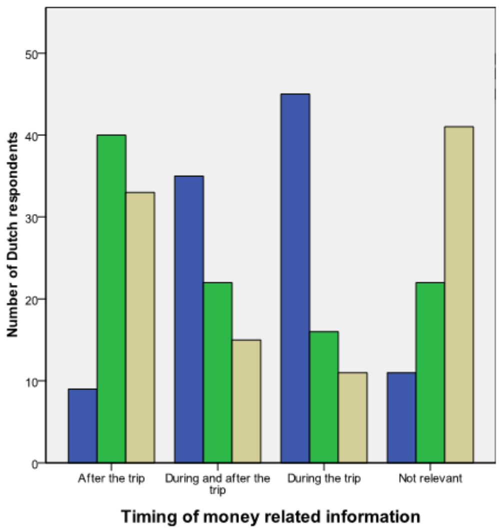
Advice, progress and driving history are based on the personal driving behavior. The respondents were asked which information they would find relevant for helping changing their behavior. Dutch drivers find advice on their behavior very relevant to receive. Compared to this information, driving history and progress are less relevant. Japanese respondents are steadily keen on receiving new information from Green ITS. Each type of information is equally relevant. A remarkable result is that Japanese respondents find advice the least relevant while Dutch drivers find it the most important type of information. Over all, the relevancy and interest of information is high, which stands for a positive attitude towards the use of Green ITS.

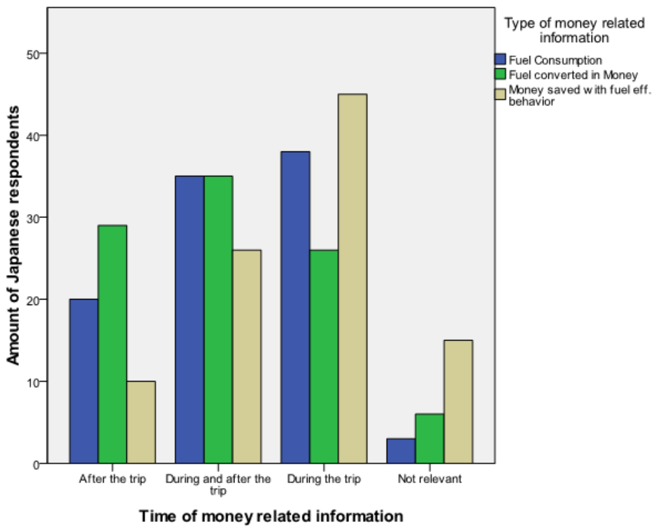
Timing of information in Green ITS

In the design of Green ITS the timing of information supply is very important. Wrong timing of information can reduce the impact on driving behavior, for example when advice on behavior will only be given after trips. After trips, drivers usually don't care about their behavior anymore and for the next trip they are more likely to have forgotten the advice. A few of the charts in analysis on timing of information will be presented.









Japanese drivers prefer to receive advice on their behavior during the trips and environment related information after the trip. For the rest of the information, such as history, progress and money related information, they don't have any preference of timing. Dutch drivers have more variety in their choice of timing. Advice, history of speed and gear shift and fuel consumption is preferred to receive during the trip. Progress, information in money value and environmental information is according to them more of use after the trips.

5 Discussion

The proposals on Green ITS for Japan and The Netherlands are based on the results of the survey. These results should be first analyzed on their credibility and plausibility. In this chapter, the results will be discussed on their contribution to the final proposals for both countries.

5.1 Attitude towards Green ITS

Measuring the attitude towards Green ITS in Japan and The Netherlands was the main focus of this survey. A positive attitude means that the respondent is willing to use Green ITS, finds the generated information in the system relevant and will change his behavior because of the system. In this survey this information is measured by the relevancy of information for changing behavior and relevancy of available information in current Green ITS.

As for both countries the drivers responded positively on these types of questions. Especially on the question which information motivates the respondent the most to change his behavior, the relevancy of information was well received. Further in the survey after a short explanation of Green ITS, the respondents were asked again about the relevancy of information in Green ITS. The unchanged positive reaction shows the willingness to receive this information and use of Green ITS.

5.2 Preference of Information

The most preferable and encouraging information to change to fuel efficient driving behavior is money related information. Respondents from both countries prefer to receive information on how much money they save with fuel efficient behavior and how much fuel costs they make during trips. Their second priority of information is the fuel consumption. The results of the survey show that next to money related information drivers with high mileage and frequency are more interested in fuel consumption. The reason could be the declaration of fuel consumption instead of money to their company.

Environment related information, such as CO_2 emission and contribution to the environment is significantly not preferred by the majority of drivers, even though one of the purposes of Green ITS is to make drivers aware of the impact of their driving behavior on the environment. An explanation for this disinterest could be that drivers don't see a direct clear link between their behavior and the impact on environment. The amount of emission produced is nothing but a meaningless number, because they cannot compare this number to anything. Converting these numbers into ordinary impacts of environment, for example the reduction of trees, the driver is more able to visualize the effects of his driving behavior. Therefore it is up to the Green ITS to make these drivers aware of effects by a certain display of information.

The conceptual model and the survey are based on the four elements. In the hypotheses these four elements were assumed to have influence on the preferred information in Green ITS. In the analysis on the results of the survey correlations between the preferred information and the type of driver were investigated and these are presented in the order of the four elements.

5.2.1 Personal character

Since the majority of the respondents chose money related information as their priority for Green ITS, it was difficult to find correlations between different types of personalities and the information. For defining the personal character, three key factors have been chosen, age, profession and car possession. The results show that this personal character does have influence on the choice of information. After analysis two clear types of drivers can be found. One is the driver up to the age of 24, generally the student and with no car possession and the other is the older employee from the age of 25 with car possession. Although money related information is still most preferable among all types of drivers, the older driver finds information such as fuel consumption and environmental related more important than the younger driver. This is noticeable in the ratio of other types of information compared to the money factor. An explanation could be that employees and car owners are more aware of the fact that cars have expenses. By buying a car the owner is willing to pay for the fuel, the maintenance and taxes. This can lead to more interest in fuel consumption during trips. This interest can also be caused by the declaration of expenses of the employee to his company. Usually, employees are asked to declare their travelling expenses in fuel consumption instead of the expenses in money. The greater interest of these drivers in environmental issues can be that car owners use cars more frequently, which makes them aware of the pollution they make by driving.

5.2.2 Driving style

For the driving style of the respondent three key factors are analyzed: annual average mileage, frequency and primary trip purpose. Significant is that the two countries are very different from each other. To start with, the primary purpose is in The Netherlands commuting and in Japan private related. This also explains the frequency and mileage of each country. Commuting is done at every working day and therefore very frequent and this causes a high mileage, while Japanese drivers have a lower mileage because of private trips which are usually less frequent. In The Netherlands, there is a remarkable difference in priority of information for commuters, high mileage drivers and frequent drivers, which are interrelated. A possible explanation could be that these drivers have no choice than to commute by car. Therefore they are willing to pay the price and accept the fuel consumption. Because of the fact that these drivers are conscious of the frequent car use, they are more concerned of how much emission they produce and how they affect the environment. They are more conscious about their behavior, because it usually is the same route. On the contrary Japanese drivers are more likely to have different kinds of routes, distances and frequency, which makes them less aware of their driving behavior and less interested in environmental information.

5.2.3 Experience with ITS

As shown in the previous chapter, the familiarity with existing and new ITS were asked. The result was that cruise control and navigation systems were most well-known among the Dutch and Japanese drivers. Remarkable was the difference between the familiarities in both countries. This difference will be further discussed in the section of difference between countries.

Analysis on experience with ITS and the relevancy of different types of information did not conclude that ITS experienced drivers wanted more information than the drivers with less experience. There is no correlation found between the relevancy of different types of information and the experience with current ITS, this aspect is important for the design of Green ITS. Drivers would rather adapt to a system with a similar interface as their current systems. Totally new systems and interfaces are more difficult to understand and it will take time for drivers to get used to them. By knowing their experiences with current ITS, Green ITS can be designed with the same usability in order to change the driving behavior as quick as possible.

5.2.4 Attitude towards environment

To measure the attitude towards environment several subjective questions were asked about environmental behavior in general, fuel efficient behavior and the impact of fuel prices on their behavior. For both countries the results did not confirm the hypotheses, which mean that preferred information is not related to a certain type of driver. Environmental behavior or fuel efficiency does not equal the greater interest in environmental information. The preferences of information are randomly spread over the different attitudes and this concludes that the attitude towards environment is not related to preferred information.

From this analysis it can be concluded that driving behavior has the greatest correlation with the preference of information. Experience in ITS and attitude towards environment does not define which information motivates the respondent to change into fuel efficient behavior.

5.2.5 Attitude Green ITS

For the design of Green ITS is important to know the relevancy of certain kinds of information. Respondents were asked to mark their level of relevancy on information of driving behavior, money related and environment related information. The relevancy of money related information is clearly higher than the relevancy of environment related information. Analysis resulted that there is no correlation found between the preference of information on driving behavior and the priority information to change behavior. In other words, respondents with money related information as their priority to change behavior could have chosen advice as relevant or as irrelevant with the same probability.

Results from these questions show that every type of information is almost equally preferred by the driver. Some types of information stand out more, but the difference in relevancy is minimal. From the result is hard to decide whether which kind of information should be implemented, because of high average relevancy. An explanation for this high relevancy could be real interest in Green ITS or that every respondent can relate the information to fuel efficiency.

The amount of supply of information does not have to be reduced, but the timing should be discussed. As for the respondents, advice and fuel consumption are most likely to be received during the trip. Other information about driving behavior, money and environment are preferred to receive after the trip. Apparently, the respondents find it unnecessary to receive such kind of information during the trip to motivate them to change behavior.

5.3 Differences between countries

During the analysis of the results significant differences between Dutch and Japanese drivers have been found. These differences should be considered to include in the design of Green ITS. In the chapter of Approach assumptions of differences in results of these countries have been made. These hypotheses will be discussed in this section.

One of the differences between the both respondents is the frequency and mileage. Japanese do not use the car as often as Dutch drivers. This confirms the hypotheses where the explanation could be the difference in public transport system. Most of the Japanese respondents live in Tokyo, which has a very dynamic public transport system. The Japanese people are not encouraged to commute by car, which is different in The Netherlands where commuting by car is quite common.

The most remarkable difference between both countries is the familiarity with current ITS. In the previous section on experience of ITS has been mentioned that the familiarity with current ITS is remarkable. Surprisingly, Dutch drivers were more familiar than the Japanese respondents even though Japan is known for its high technical development. Difference in car possession, purpose and infrastructure might be an explanation. In The Netherlands it is common to have more than one car, commute by car and make long distances. The majority of Japanese respondents live in Tokyo where the public transport system is more convenient than using a car. And because of the short distances they make, systems such as cruise control are not relevant.

As for information supply in Green ITS, Japanese respondents found almost every available information relevant to receive, while Dutch respondents were more critical. An explanation for this difference could be more genuine interest in Green ITS or randomly answered questions by Japanese respondents. Also the interest and eagerness of Japanese drivers in using new technology could be greater than the Dutch drivers. Even though the Japanese respondents might not have as much experience with ITS as the Dutch, this fact and the technology focused Japanese culture might be the reason of having more interest in Green ITS.

The question is whether these differences affect the proposed Green ITS for both countries. Apparently differences in personalities has no influence on the preference of information in Green ITS. The main focus group of drivers of both countries is the driver with the most frequent car use. This type of driver in both countries prefers money related information and are willing to receive information about their driving behavior. The relevancy of this information might vary between the countries but none of the information is negligible in Green ITS. Also the difference in experience of ITS does not mean that Dutch drivers should get more advanced systems, when simple systems can achieve the same effects.

5.4 Design of Proposed in-car Green ITS

After analysis of the results of the survey, the attitude towards Green ITS for Dutch and Japanese drivers is clear. This attitude is mainly positive and preferred information in the system is money related. Personal character and driving style of the driver has influence on the preference of information. In order to reduce the Greenhouse Gas emission in both countries, the main focus is on drivers with the most pollution. This type of driver can be defined as an employee with car possession and a driving style depended on the nationality of the driver.

The following factors should be included in the design of Green ITS.

- Type of relevant information in Green ITS
- Timing of reception of relevant information in Green ITS
- Interface and display of Green ITS

A proposal for the design of new Green ITS based on these factors will be presented in the next chapter.

6 Green ITS proposal

Green ITS can help drivers to develop a fuel efficient driving behavior to improve environment. Based on the results of the survey on the attitude towards Green ITS and preference of information from Dutch and Japanese drivers, new systems in Green ITS for both Dutch and Japanese drivers has been developed. These systems will not be built in car systems, but are suitable for every kind of vehicle and can be easily installed. In this chapter these new systems will be proposed, based on the type of information supply, timing of information supply and display of information in the system. Further in this chapter an explanation on the background of this proposal will be given.

6.1 Proposal for Green ITS in The Netherlands and Japan

The Dutch system of Green ITS is capable to generate the following information

- History and progress of driving behavior
- Advice based on current driving behavior
- Money related information
- Environment related information

6.1.1 Type of information supply in Green ITS

History, progress and advice are based on the factors speed, gear shift, acceleration and deceleration of the driver's personal behavior. During the trip data of these factors will be collected and will be shown as the driving history. These results will be compared with the optimum fuel efficient behavior, such as optimum speed and optimum gear shift moments. Based on this comparison, advice will be given to develop a more fuel efficient behavior. After following the advice, drivers are able to see their progress in fuel efficiency.

Next to information of personal driving behavior, other information will be displayed to encourage fuel efficient behavior. These triggers are money or environment related. Money related information contains the fuel consumption of trips in liters per kilometer, fuel consumption calculated in the value of money and how much money is saved by progress. Environment related information is the amount of CO_2 emission during trips and the reduction of CO_2 emission by progress. Drivers will be encouraged to be more fuel efficient by making them conscious of their consumption and production. By giving information about their progress, drivers will be challenged to reduce consumption and production.

6.1.2 Timing of information supply in Green ITS

The use of Green ITS should not affect the driver's safety. To avoid stress, distraction and confusion, only the essential information directly involved with their driving behavior can be chosen during driving. It is up to the driver to display this information or not. Other information about driving behavior will be displayed before or after the trip.

Information that will have directly effect on the driving behavior is advice for fuel efficient behavior. Unlike information about progress and driving history, advice can directly be adapted by the driver. The driver has the choice to display advice for his speed, gear shifts, acceleration and deceleration. Extra encouragement to drive fuel efficient is to display the progress compared with previous behavior during driving. During the trips, only the factors speed and gear shift of progress will be available for display. History, progress and also advice will be displayed before or after the trip to avoid confusion during driving. The user is able to see what his previous behavior is and will be challenged to improve this behavior.

As for money related information, only fuel consumption will be displayed during the trip. Because of the changing fuel prices, information in the value of money is not able to be accurate at all times and therefore will only be displayed before or after the trip. All environment related information will be available after the trip.

6.1.3 Display of information in Green ITS

Display of information of Green ITS will be shown on an on board screen, which can be installed in every car. This screen can be attached next to the dashboard to keep it in sight during driving. During the trip the information displayed should be easily understandable without any difficulty or distraction. Inefficient gear shift, excessive acceleration and deceleration are all related to sudden changes in engine revolutions. By inefficient behavior, such as excessive pedal pressure or gear shift at high revolutions, the screen will slowly turn red. The brighter the color, the more inefficient the behavior is. With fuel efficient behavior the display will turn soft green.

For advice on speed, the extra speedometer on screen will show two pointers. One green pointer will fluctuate on the optimum driving speed and one red pointer will indicate the current speed. The closer the red pointer will get to the green one, the more fuel efficient the behavior is. As for fuel consumption a simple meter with bars indicates with how much fuel the trip is started. The disappearance of full bars equals the fuel consumed. At the end of the trip the fuel consumed in numbers of liter per kilometer will be displayed.

The factors speed, gear shift, acceleration and deceleration will be displayed in trends on screen. Trends will show the optimum behavior with the actual behavior. With dots on these trends the right timing and actual timing of gear shift is explained.

Graphs, displayed after the trip, will define the differences between actual fuel consumption, actual money spend on fuel and fuel consumption and expenses with fuel efficient behavior. Calculations explain how much excessive fuel has been used and how much money could have been saved with fuel efficient behavior. This concept will also be used with the environment related information. Differences between actual CO_2 emission and emission with optimum behavior will show how much CO_2 emission could have been spared.

Figure 22: Impression of proposed Green ITS

6.2 Explanation of proposal Green ITS

In previous chapters is mentioned that the main focus should be on the drivers with most frequent car use. From the results of the survey it can be concluded that most frequent Dutch drivers are middle aged, have an average annual mileage to 20.000 km, possess a car and have commuting as their main trip purpose. Frequent Japanese drivers are also middle aged and own a car, but have a lower annual average mileage and use most often for social recreational trip purposes. Although, the differences between these types of drivers are significant, their interest in information in Green ITS is the same. Respondents from both countries answered money related information as their greatest motivation to change to a fuel efficient driving behavior. As second motivation, they both answered information about fuel consumption, which is slightly more preferred by Japanese drivers than the Dutch.

Respondents were also asked to give their experience with current ITS. Dutch drivers were familiar with cruise control and navigation systems, while Japanese respondents only have experience with navigation systems. The adaptability to new technology might be advantage for Dutch drivers, but out of the results could be concluded that Japanese drivers find information provided by Green ITS more relevant. The respondents from both countries had a positive attitude towards Green ITS.

Next to the preference of information of drivers, this proposal was designed with the following aspects of demands:

- Impact on environment
- Safety
- Level of support
- Comfort

To improve environment, this new system should be easy adaptable for users to achieve fuel efficiency in short term. By making the system too difficult to use, no positive impact on environment will be reached. Therefore it is better to design an attractive system with little bits of improvement on environment than a system with big improvements, but won't be preferred by drivers to use.

The use of Green ITS should not affect the safety of the driver. Distraction, confusion and stress by using systems will cause danger for the driver and others. Easy understandable and adaptable systems avoid these dangers. Trust in a system provides the user a feeling of safety. Panic and stress will be reduced when information is accurate.

There are three levels of support: providing information, giving advice and correct the driver if necessary. Each level of support has advantages and disadvantages. For this design, intervention of the system is not included. This will be further explained in this chapter. Most important of the support in the system is that this can be turned off when wanted and drivers should maintain their anticipation in traffic.

Comfort in the system encourages the driver to use it. Comfort has many aspects, such as the usability, trust and the feeling of safety. Uncomfortable feelings such as panic, stress and distraction should be avoided. Therefore the system should be designed to the adaptability in order to achieve improvement of the environment.

6.2.1 Type of information supply in Green ITS

The majority of the respondents from both countries chose history, progress and advice on their driving behavior as relevant. Japanese respondents were more eager to learn about this information than Dutch drivers, but the majority of Dutch drivers still find these types of information relevant. As for the money and environment related information, both countries responded with almost the same enthusiasm. Although the results from the survey show that money related information is most preferred in Green ITS, less relevant information, such as environment related information are still included in the proposed system. This has been done to give the user the option to see his behavior from another aspect. The possibility to see environment related information in Green ITS makes the driver curious and aware of the impact of their behavior in the environment. The intension of including these kinds of environmental information in the system is to make drivers conscious of the environment and therefore to encourage to change their behavior.

6.2.2 Timing of information supply in Green ITS

The new system is designed to only display all factors of advice and the progress of speed and gear shift during the trip. An explanation for this concept is to maintain the safety and comfort of the driver. Too much information and difficult displays can cause stress, distraction and panic during driving. To avoid these effects, the amount of information based on the personal driving behavior is reduced. After the trip information history and progress will be displayed. With these types of information current and previous driving behavior will be compared. It is unnecessary to display behavior of previous trips during the next trip, but to encourage the driver to change his behavior information on his progress might help. The user will be challenged to improve his behavior which is compared to his previous behavior. Speed and gear shifts are the most understandable factors for experienced drivers. For this reason, information on progress of acceleration and deceleration are left out.

As for information not directly related to driving behavior, only fuel consumption will be available for display during the trip. Information in money value won't be accurate according to the last fuel prices. These values should be frequently uploaded to calculate the expenses. Therefore this type of information will be shown before or after the trip.

All environment related information will be displayed after the trip, because these types of information are not as easy to understand as speed or gear shift. Special attention to this information can cause distraction during the trip. And information such as CO_2 emission is easier to understand when being compared to the emission with optimum behavior, which can only be done after trips. Thereby, this information was not preferred by the majority of respondents. By overwhelming these drivers with unwanted information, these drivers will hesitate and be scared to use this system. Leaving the option open to display this information before or after the trip won't scare them, but also make them curious and aware of the impact on environment.

6.2.3 Display of information in Green ITS

To make this system suitable for every type of car, it is chosen to display information by an on board screen which can be easily installed next to the dashboard. By keeping this screen in sight of the driver during driving, the safety will be preserved. The most important aspect of this system is that when the driver feels uncomfortable with information or the system, it is always possible to turn it off.

During the trip, it is important to keep the information displayed as simple as possible. And the driver should not feel to be forced to change his behavior. Comfort and safety are the main focus of the display. Numbers and difficult graphs demands extra thinking during driving, therefore the design is based on the experience of the driver with different types of technology. The advice on speed will be given on a speedometer, which is familiar to the driver. Fuel consumption will be displayed by bars, which is quite similar to bars for battery display.

Advice on the behavior of gear shift, acceleration and deceleration will be displayed by colors. These behavioral factors are more difficult to understand than speed, but have more effect on the environment. These factors are all related to the amount of engine revolutions and therefore are simplified and combined to one indicator with two colors. The introduction of adding colors to the display is new to most of the drivers. For this type of 'emotional engineering' the colors were chosen from bright red to soft green. The color red is likely to be known as energy or wrong. The brighter the color, the more nervous the user gets and is triggered to change behavior. For fuel efficient behavior is chosen for the color green. Green stands for right, environment and is more calming. Not to distract or trigger the user to change, the green color will ultimately turn to soft green instead of bright green.

Indications on behavior by sounds are left out on purpose. Although respondents from both countries are familiar with navigation systems, which usually have sounds, the use of sounds in advice adds no extra value to the behavior. The driver is already exposed to simple indications and a new indicator by colors, which needs extra attention in the beginning. By adding sounds, the user might get distracted or annoyed and as a result he won’t be using the system. Also the variety of possible sounds in advice is small, which is easy to adapt but will create boredom.

After the trip, the complexity of information may increase to a certain understandable level. Trends and animations are easy to understand. By showing trend lines of fuel efficient behavior and the driver’s personal behavior, the user will see differences by one simple glance on the screen. The user can choose to receive texts and numbers for extra information on advice or progress.

Next to information supply and advice on behavior, intervention is another level of support. With correcting driver’s behavior during trips, the driver is forced to change his behavior and improvement of environment will certainly be achieved. For this proposed system, controlling and correcting driver’s behavior is not included. The reason for leaving this out is the effects on safety and trust in the system. Drivers have developed their own driving style and enjoy driving. It is important to anticipate in traffic and being aware of the surrounding traffic. Systems in these days are not well developed yet to detect every type of traffic situation and therefore information won’t always be accurate. Therefore drivers should never be totally dependent on technology. By correcting behavior due to inaccurate information, dangerous situations can result in great accidents. Another disadvantage of intervention in systems is that the driver is forced to change. It is known that greater results have been achieved by rewarding than by punishing. Drivers are less willing to use systems which punish them for incorrect behavior. By creating a freedom of choice to develop another behavior, the driver is more attracted to use the system.

7 Conclusion

In this chapter the conclusions of this research will be presented. These conclusions are based on the guidelines of the research questions. Nowadays, systems in Green ITS are in high development and being improved continuously. At last an after study will be proposed for further research on current Green ITS.

7.1 Conclusions

Green ITS is a new concept of ITS with the objective to reduce emission and improve environment by ITS measures. In-car systems of Green ITS are designed in order to make driver's behavior more fuel efficient. These systems can be divided in three levels of support: Information supply, advice on driving behavior and intervention during driving. Systems with information supply show the driver different indications on his behavior by a display during driving. Examples of indications are fuel consumption and speed behavior. More developed systems collect data from previous trips and compare these with optimum fuel efficient behavior. Based on this analysis, personal advice on the driver's behavior can be given. Other systems correct the current driving behavior to a more fuel efficient behavior. The system will intervene when inefficient behavior is practiced.

By the deployment of a survey the respondents in Japan and The Netherlands were asked to give their preference of information to change into a fuel efficient behavior. The greatest motivation to change their behavior was providing drivers of information on how much money they would save with fuel efficient behavior. Next to this information, drivers were also interested in the fuel consumption during their trips. The least preferred information is about impact on environment, such as CO_2 emission.

According to the results, personal character, experience with ITS and attitude towards environment don't have influence on the preference of information. Correlations were found between the preference of information and the driving style of the Japanese and Dutch drivers. The majority of the respondents preferred money related information over environmental information. Next to money related information, drivers with frequent car use, high mileage and with commuting as primary trip purpose were significantly more interested in other types of information, such as the contribution to the environment by using the car.

Types of information in current in-car systems in Green ITS were positively received by respondents. The majority of the respondents think the provided information is relevant and are willing to use this type of system. This positive attitude towards Green ITS can lead to acceptance and frequent use of Green ITS.

The design of the proposed in-car Green ITS is based on the desires and motivations of drivers to have fuel efficient behavior and the demands of impact on environment, safety, level of support and comfort. This design consists of the type of information supply, timing of the information supply and the mode of display of information. Information of driving behavior, expenses and fuel consumption and environment will be provided. During the trip, advice and fuel consumption will be displayed with simple indications on an on board screen. After the trip other information will be presented with trends, numbers and texts.

7.2 After study

The design of a new system in Green ITS is a proposal for Japan and The Netherlands. Because of the fact that Green ITS is new and experiences have not been reported yet, improvement of systems is difficult. Therefore, these systems should be implemented, promoted and experiences with Green ITS should be gathered. By analyzing these experiences, likes and dislikes of users will be known and space for improvement will be available. This improvement will be based on the type of information supply, the timing of information supply and the display of information. Different types of information or modes of display might have other or stronger effects on the driving behavior.

Out of this research can be concluded that drivers are more interested in money than in the impact on the environment by their car use. Providing the driver with information on money does not change their attitude towards the environment. The cause of this disinterest could be that drivers don't see a direct relation between their car use and the impact of it on the environment. To make these drivers aware of their impact and motivate them to improve environment instead of saving money, a direct, understandable and imaginable relation should be found between the impact and their behavior. An example could be the comparison between the amount of emission and the impact on reduction of trees. Further study on this subject might change the vision of the driver on environment. A better imagination of impact on environment might motivate the driver even more to change his behavior.

Another after study can be done on the relation between driving experience and fuel efficiency. Although an experienced driver has a great mileage, this driver is capable to estimate the abilities of a car and knows how to operate in certain situations. These facts make the experienced driver more capable of smooth driving and anticipation in traffic, which characterizes a fuel efficient driver. The beginner hasn't developed his own driving style yet and is not familiar with the abilities of a car. Besides, a beginner is not capable yet of smooth driving as in acceleration or braking. With Green ITS the driver will be helped by certain advice on their driving behavior. It is difficult to say whether an experienced driver is more likely to change his behavior than a beginner. The beginner could be taught when he's still developing his own driving style, while an experienced driver already has his own style which might be harder to change. The topic of this after study is on which the type of driver Green ITS should be addressed to. Experienced drivers might produce less emission even though they have a higher mileage.

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Appendix

Survey

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Groen licht voor beter milieu

Het is bekend dat de wereld dagelijks wordt bevuild met uitlaatgassen van auto's met als gevolg het broeikaseffect. Onbewust nemen mensen regelmatig de auto wanneer het uitkomt. Maar wat men vaak niet weet is dat door het aanpassen van het rijgedrag al een steentje bij kan dragen aan een beter milieu. Gepaard met de campagne "Het nieuwe rijden" worden tegenwoordig steeds meer nieuwe systemen uitgebracht die de bestuurder helpen om een zuiniger rijgedrag te ontwikkelen. Dit is niet alleen in het voordeel voor het milieu, maar ook voor de portemonnee.
Het doel van deze enquête is om te onderzoeken welke factoren u als bestuurder kunnen beinvloeden en stimuleren om het gedrag aan te passen tot een zuiniger rijgedrag. Door deze factoren samen te nemen in de nieuwe in car systemen kunnen bestuurders tijdens en na het rijden worden geholpen om een milieuvriendelijker rijgedrag te ontwikkelen en hiermee het milieu te verbeteren.

Laat met deze vragenlijst weten hoe u als bestuurder over het zuinig rijden denkt en wat uw rijgedrag kan beinvloeden. De vragenlijst zal ongeveer 10 tot 15 minuten duren en geen antwoord is goed of fout. Vergeet niet aan het eind van deze enquete op "Versturen" te drukken. Wanneer u deze enquete vroegtijdig wilt afbreken druk dan op "Hervat later".
Verzamelde gegevens zullen uitsluitend voor dit onderzoek worden gebruikt en niet worden overgeleverd aan derden. Dit onderzoek is in opdracht van Universtiteit Twente in samenwerking met Toyota InfoTechnology Center Co., Ltd. in het kader van een bachelor eindopdracht.

Er zijn 34 vragen in deze vragenlijst.

Een opmerking over uw privacy
Deze vragenlijst is anoniem.
Privacy statement: Deze vragenlijst is anoniem. De bewaarde antwoorden bevatten geen identiteitsgegevens tenzij u deze bij een bepaalde vraag hebt ingevuld. Indien u via een toegangscode deelneemt kunnen wij u verzekeren dat deze niet wordt bewaard in combinatie met uw antwoorden maar wel is opgeslagen in een aparte tabel. De tabel met toegangscodes wordt gebruikt om na te kijken of een vragenlijst reeds voor de betreffende toegangscode is ingevuld. Er is geen enkele manier om de codes te koppelen aan de antwoorden.

Laad onvoltooide vragenlijst | Volgende >>

[Afbreken en antwoorden verwijderen]

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Algemene vragen

*Wat is uw leeftijd?

Kies één van de volgende antwoorden

Selecteer..

*Wat is uw beroep?

(bijv. student, manager, onderzoeker, consultant, etc.)

*Bent u in het bezit van een rijbewijs?

- Ja
- Nee

Wanneer u geen rijbewijs heeft, zal het verder invullen van deze enquete niet van toepassing zijn.
Daarbij bedank ik u voor uw aandacht.

*Zo ja, welk type rijbewijzen bezit u?

Selecteer de toepasselijke opties

- Motorfiets
- Auto
- Aanhangwagen
- Vrachtwagen
- Bus

*Hoe lang bezit u over deze rijbewijzen? (in jaren)

En hoe vaak maakt u gebruik van deze rijbewijzen wanneer u rijdt?

Vul n.v.t. in wanneer u dit rijbewijs niet bezit

	0 - 1	1	2	3	4	5	6 - 10	11 - 15	>15	n.v.t.	Altijd	Erg vaak	Soms	Zelden	Nooit	n.v.t.
Motorfiets																
Auto																
Aanhangwagen																
Vrachtwagen																

Bus

*Hoeveel auto's bezit u?

Kies één van de volgende antwoorden

- Geen
- 1
- 2
- 3
- Meer dan 3

*Bezit u over een lease auto?

- Ja
- Nee

*

In welk type motorvoertuig rijdt u het meest in het dagelijks leven?
(hoeft niet perse in uw eigen bezit te zijn)

Kies één van de volgende antwoorden

- Klein voertuig (mini, stadsauto)
- Middelgroot voertuig (middenklasser, kleine multipurpose vehicle)
- Groot voertuig (topklasse, grote mpv, terreinwagen)
- Motorfiets / Brommer
- Vrachtwagen / Bus (als bestuurder)
- Anders

*Welk energielabel heeft dit voertuig?

Kies één van de volgende antwoorden

- A
- B
- C
- D
- E
- F
- G
- Geen idee

Via de site http://www.anwb.nl/auto/dagwaarde/zoek/zoek_uitgebreid.jsf kunt u uw auto terugvinden met het energielabel

*Op welke soort brandstof rijdt dit voertuig?

Kies één van de volgende antwoorden

- Diesel
- Benzine
- LPG
- Hybride
- Elektriciteit

*Hoeveel brandstof verbruikt dit voertuig?

[ ] Km/L

In dit veld kunnen alleen cijfers worden ingevoerd

*Wat is de transmissie van dit voertuig?

Kies één van de volgende antwoorden

- Automatisch
- Handmatig

Hervat later | << Vorige | Volgende >>

[Afbreken en antwoorden verwijderen]

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Vragen betreft het rijgedrag

*Hoeveel kilometers rijdt u gemiddeld per jaar?

Kies één van de volgende antwoorden

- 0 - 1.000 km
- 1.000 - 5.000 km
- 5.000 - 10.000 km
- 10.000 - 20.000 km
- 20.000 - 30.000 km
- Meer dan 30.000 km

*Hoe vaak gebruikt u gemiddeld de auto? (of het voertuig waar u het vaakst mee rijdt)

Kies één van de volgende antwoorden

- (Bijna) elke dag
- 3 - 4 keer per week
- 1 - 2 keer per week
- 1 - 3 keer per maand
- Enkele keren per jaar
- Nooit

*Waarvoor gebruikt u de auto het meest?

Kies één van de volgende antwoorden

- Voor woon werk verkeer (van thuis naar werk en andersom)
- Voor werk gerelateerde doeleinden (geen woon-werk verkeer)
- Voor sociaal-recreatieve doeleinden
- Voor winkelen
- Anders

*Waarvoor gebruikt u de auto nog meer?

Selecteer de toepasselijke opties

- Voor woon-werk verkeer (van thuis naar werk en andersom)
- Voor werk gerelateerde doeleinden (geen woon-werk verkeer)
- Voor sociaal-recreatieve doeleinden
- Voor winkelen
- Anders:

(meerdere antwoorden mogelijk)

Als u voor uw werk gerelateerde doeleinden rijdt, beschrijf voor welke activiteiten u de auto gebruikt (bijv. afspraken afgaan, bezorging, etc.)

*Staat u regelmatig in de file? (meer dan 3 keer per week)

- Ja
- Nee

*

Geef aan hoe vaak u met deze motieven rijdt door de volgende zin af te maken
In het dagelijks leven rij ik

	Altijd	Erg vaak	Soms	Zelden	Nooit
Dezelfde bekende, gebruikelijke route	○	○	○	○	○
Een route die onbekend is, maar de bestemming is wel bekend	○	○	○	○	○
Een route die onbekend is en de bestemming ook onbekend is	○	○	○	○	○

*Geef aan welke in car systemen u bezit en wat u relatie is tot deze systemen

	In bezit	Niet in bezit	Ik gebruik het nu	Ik ben er bekend mee	Ik heb er van gehoord	Ik heb er nooit van gehoord
Cruise control	○	○	○	○	○	○
Navigatie systeem	○	○	○	○	○	○
Adaptive Cruise Control	○	○	○	○	○	○
Lane Departure Warning	○	○	○	○	○	○
Intelligent informatie						

systeem ○ ○ ○ ○ ○ ○

Indien u gebruik maakt van een navigatie systeem, in welke situaties gebruikt u dit systeem?

Selecteer de toepasselijke opties

- ☐ Voor het vinden van nieuwe routes
- ☐ Voor woon-werk verkeer
- ☐ Voor verkeersinformatie (bijv. vermijden van files, omleidingen, etc.)
- ☐ Voor het vinden van faciliteiten (bijv. parkeerplaatsen, benzine stations, etc.)
- ☐ Bijna elke situatie

(meerdere antwoorden mogelijk)

Hervat later | << Vorige | Volgende >>

[Afbreken en antwoorden verwijderen]

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Vragen betreft milieubewustheid

*Houdt u van auto rijden?

Ik ben er dol op				Ik haat het
○	○	○	○	○

*Vindt u uzelf een ervaren bestuurder?

Expert				Beginner
○	○	○	○	○

*Vindt u dat uzelf milieubewust leeft?

Zeer milieubewust				Milieu interesseert me niet
○	○	○	○	○

*Op welke manieren leeft u milieubewust?

Selecteer de toepasselijke opties

- ☐ Door bewust watergebruik
- ☐ Door energiebesparing (bijv. spaarlampen)
- ☐ Door gebruik van openbaar vervoer in plaats van de auto
- ☐ Door recycling
- ☐ Anders: ________

(meerdere antwoorden mogelijk)

*Vindt u uzelf een zuinige bestuurder?

Zeer zuinig				Totaal niet zuinig
○	○	○	○	○

*Beinvloeden brandstofprijzen uw autogebruik? (Minder autogebruik wanneer de brandstofprijzen hoog zijn)

Zeer veel invloed				Geen invloed
○	○	○	○	○

*Geef van de volgende factoren aan hoeveel invloed zij hebben op uw gedrag door volgende zin aan te vullen

Ik zou mijn autogebruik en/of rijgedrag aanpassen tot een milieuvriendelijker gedrag als ik wist

	Zeer veel invloed				Geen invloed
Hoeveel brandstof ik kan besparen	○	○	○	○	○
Hoeveel geld ik kan besparen	○	○	○	○	○
Hoeveel CO2 uitstoot ik kan verminderen	○	○	○	○	○
Hoeveel ik bij kan dragen aan het broeikaseffect (individuele uitstoot t.o.v. Nederland)	○	○	○	○	○

*Geef de prioriteit voor de volgende informatie aan door de volgende vraag te beantwoorden

Welke soort informatie zal het meeste invloed op u hebben om uw rijgedrag aan te passen tot een zuiniger rijgedrag?

Selecteer een optie op de lijst aan de linkerzijde, beginnend met de meest toepasselijke optie doorgaand tot de minst toepasselijke optie.

Uw keuzes:

- Brandstof besparing
- Geld besparing
- Vermindering van CO2 uitstoot
- Invloed op broeikaseffect

Uw rangschikking:

1:
2:
3:
4:

Klik op de schaar naast elk item om de laatst ingevoerde gegevens te verwijderen.

Hervat later | << Vorige | Volgende >>

[Afbreken en antwoorden verwijderen]

LimeSurvey

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Vragen betreft green ITS

Overmatig brandstofgebruik en CO2 uitstoot zijn het gevolg van onnodig de motor laten draaien, hoge snelheden en hard optrekken en remmen tijdens het rijden. Om een zuiniger rijgedrag te ontwikkelen zijn er tegenwoordig veel nieuwe systemen in ontwikkeling die u informatie geven over uw rijgedrag. Deze systemen kunnen uitgerust worden met verschillende soorten informatie tijdens en na de rit. Tijdens het rijden verzamelt het systeem gegevens over uw schakelmomenten, snelheden en optrek- en remgedrag. Met deze gegevens kunt u uw rijgeschiedenis bekijken (diagrammen, grafieken, cijfers) en wordt dit vergeleken met het optimale rijgedrag. Op basis van deze data geeft het systeem een analyse en advies uit voor een milieuvriendelijker rijgedrag. Het systeem zal u waarschuwen, adviseren of ingrijpen bij onzuinig rijgedrag. Naarmate u het persoonlijke advies opvolgt kunt u uw progressie terugbekijken en zien hoeveel brandstof u heeft bespaart en/of hoeveel uitstoot u heeft verminderd.
Laat de met de volgende vragen weten welke soort informatie u zou willen ontvangen tijdens en na het rijden.

***Geef aan wanneer en welke informatie u wilt ontvangen en hoe relevant deze informatie voor u is voor het ontwikkelen van een zuiniger rijgedrag**

	Tijdens het rijden	Na het rijden	Tijdens en na het rijden	Wil ik niet ontvangen	Absoluut relevant				Totaal niet relevant
Indicatie van zuinig rijgedrag*	○	○	○	○	○	○	○	○	○
Brandstof verbruik (L/100Km)	○	○	○	○	○	○	○	○	○
CO2 uitstoot (gram per km)	○	○	○	○	○	○	○	○	○
Brandstof verbruik omgezet in geld (Euro's)	○	○	○	○	○	○	○	○	○
Kosten bij optimaal rijgedrag vergelijkend met huidge kosten (Euro's)	○	○	○	○	○	○	○	○	○
Geldbesparing ten opzichte van de vorige ritten (Euro's)	○	○	○	○	○	○	○	○	○
Verandering van CO2 uitstoot ten opzichte van vorige ritten (gram per km)	○	○	○	○	○	○	○	○	○
Bijdrage aan het milieu door zuiniger rijgedrag (individuele uitstoot t.o.v. uitstoot	○	○	○	○	○	○	○	○	○

in Nederland)

*Indicatie door bijv. een groen licht op uw dashboard wanneer u een zuinig rijgedrag beoefent, zonder enige verklaring.

***Na analyse van uw rijgedrag kan er advies worden uitgebracht om uw rijgedrag te verbeteren tot een optimaal, zuinig rijgedrag.**

Geef aan wanneer en welke advies u wilt ontvangen en hoe relevant deze informatie voor u is voor het ontwikkelen van een zuiniger rijgedrag

	Tijdens het rijden	Na het rijden	Tijdens en na het rijden	Wil ik niet ontvangen	Absoluut relevant				Totaal niet relevant
Optimale snelheid									
Optimale schakelmomenten									
Optimaal optrek gedrag (optimale pedaaldruk*)									
Optimaal rem gedrag (optimale pedaaldruk*)									

* Pedaaldruk: Bij overmatige druk op het gas/rem pedaal kan er advies gegeven worden om de druk te verminderen of ingegrepen worden door een tegendruk op het pedaal

---

***Tijdens het rijden verzamelt het systeem gegevens over uw rijgedrag. Deze gegevens kunnen op verschillende manieren worden weergegeven, in bijv. grafieken, diagrammen, cijfers, tekst, trends etc.**

Geef aan wanneer en welke gegevens uit uw rijgeschiedenis u wilt ontvangen en hoe relevant deze informatie voor u is voor het ontwikkelen van een zuiniger rijgedrag

	Tijdens het rijden	Na het rijden	Tijdens en na het rijden	Wil ik niet ontvangen	Absoluut relevant				Totaal niet relevant
Snelheid									
Schakelmomenten									
Optrek gedrag (optrektijden, pedaaldruk*)									
Rem gedrag (remtijden, pedaaldruk*)									
Routekeuze									

* Pedaaldruk: Overmatige druk op het gas/rem pedaal kan worden geanalyseerd

---

***Het systeem zal na analyse van uw rijgeschiedenis een advies uitbrengen. Wanneer u dit advies opvolgt kunt u zien wat uw progressie is ten opzichte van uw vorige rijgedrag.**

Geef aan wanneer en welke gegevens van uw progressie u wilt ontvangen en hoe relevant deze informatie voor u is voor het ontwikkelen van een zuiniger rijgedrag

	Tijdens het rijden	Na het rijden	Tijdens en na het rijden	Wil ik niet ontvangen	Absoluut relevant				Totaal niet relevant
Snelheid	○	○	○	○	○	○	○	○	○
Schakelmomenten	○	○	○	○	○	○	○	○	○
Optrek gedrag (pedaaldruk*)	○	○	○	○	○	○	○	○	○
Rem gedrag (pedaaldruk*)	○	○	○	○	○	○	○	○	○

* Pedaaldruk: Overmatige druk op het gas/rem pedaal kan worden geanalyseerd. Dit gedrag wordt vergeleken met vorige ritten.

Vergeet niet op de volgende pagina op "VERSTUREN" te drukken!

Naast de informatie uit de vorige vragen zijn er natuurlijk ook andere soorten informatie die gegeven kunnen worden. Heeft u suggesties voor andere systemen en informatiemogelijkheden die de bestuurder helpen om een zuiniger rijgedrag te ontwikkelen, vul deze suggesties dan hier in:

Hervat later | << Vorige | Volgende >>

[Afbreken en antwoorden verwijderen]

LimeSurvey

0% 100%

Bedankt

Bedankt voor het invullen van deze enquête!

Sluit nu de enquete af door op "VERSTUREN" te drukken.

Wanneer u vragen heeft over deze enquête of dit onderzoek, dan kunt u contact opnemen via e-mail.
Het e-mailadres is wing-yan.man@jp.toyota-itc.com

Hervat later | << Vorige | Versturen

[Afbreken en antwoorden verwijderen]