MARKET TRIAL REPORT

GINA

Prepared by: Denis Naberezhnykh (TRL), Dave Tindall (TRL), Veronica Uribe (CENIT), and Bruno Gonçalves (GMV)

Approved by: Dave Tindall, TRL

Authorized by: Richard Walker

Filename :	GINA_D3_4_v0_9.docx
Code :	GINA/D3.4 - Market trial report
Version:	V0.9
Date:	26 July 2011
WP:	WP3.2.3 - Trials evaluation and reporting
Category*:	PP Programme Participant
Customer:	GSA
Grant Agreement:	227725
Internal code:	TBC

* PU Public / PP Programme Participant / RE Restricted / CO Confidential

DOCUMENT STATUS SHEET

Version	Date	Pages	Changes
V0.1	21 July 2010		First draft of template
V0.2	8 August 2010		Template version sent to CENIT
V0.3	19 April 2011		Addition of CENIT sections and ASCENDI trials sections
V0.4	27 April 2011		Final review by DT
V0.5	25 May 2011		Amendments following GSA and EC comments
V0.6	26 May 2011		Changes from CENIT
V0.7	26 May 2011		Changes from CENIT
V0.8	7 June 2011		Review by TRL prior to GMV sending to client.
V0.9	26 July 2011		Client comments addressed. Final version

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

1. SUMMARY

During GINA End-to-End trials two sets of trials were carried out that provide a possible assessment of the market for national, GNSS based Road Pricing systems. In this case, the market trial report is looking into consumer acceptance of GNSS-based Road Pricing and the potential for Value Added Services (VAS). This report presents findings from two trials:

1. End-To-End trials – large scale, prolonged period trial using volunteers with pseudo charges and bills based on a realistic charging scheme.
2. VAS implementation trials - trial of using GNSS equipment by highway concessionaire (ASCENDI) and the possible benefit of VAS.

Although the anticipated level of participant feedback was not available from the End-to-end trials, a review of other recent Road Pricing trials in Europe and a consultation with key personnel who worked on the previously proposed Dutch National GPS-based Road Pricing scheme - ABvM, showed that the public could be receptive to the introduction of a Road Pricing scheme if it is perceived to be fair and transparent with regard to re-distribution of revenues. It also became apparent that participants acceptance of Road Pricing and charging schemes was dependant on the level of congestion they would experience in their everyday travel. Those exposed to more traffic and congestion saw a greater benefit in having a Road Pricing system. However, in order to be perceived as fair and allow users to avoid higher tariffs on certain roads during rush hours, alternatives routes should be made available.

Regarding the VAS implementation trial, a definition of the required features was made at the beginning of the trial. During the trial execution there were several technical problems with the central system and with the OBEs deployed. All these problems together, affect the credibility of the system and the end users never felt fully involved on the project. Due to lack of availability of ASCENDI personnel, there was insufficient communication between ASCENDI and the GINA project team.

In the absence of direct feedback from ASCENDI, general conclusions were made. The results presented at the end of the trial show that a highway concessionaire could benefit from using GNSS technologies on their daily activities. Their daily activities could be simplified, the management of the teams' active on the highway could be enhanced and new activity reports could be developed.

2. INTRODUCTION

GNSS (GPS) based Road Pricing schemes are being considered by a number of governments in Europe and the rest of the world as a possible method for reducing congestion levels, and potentially reducing pollution. One of the potential benefits of GNSS based Road Pricing is that it does not require a significant investment in additional roadside infrastructure, unlike tag and beacon (DSRC) based tolling schemes, for example.

GPS based Road Pricing schemes, such as the one proposed in the Netherlands, also have the benefit of being able to cover the entire road network and employ a “kilometre based charging” policy. However, in order to operate correctly, schemes such as this require positioning and distance data determined by the On-Board vehicle Unit (OBU) to be sufficiently accurate in order to bring down incorrect charging, especially overcharging, to an acceptable level.

The GINA project aims to demonstrate that by utilising EGNOS corrections to GPS (and in the future Galileo) signals, high enough position accuracy can be achieved in order to guarantee an acceptable level of overcharging. During the GINA project two sets of trials were carried out. In order to demonstrate the accuracy of the proposed technology, an exhaustive trial was carried out that aimed to test the technical capabilities of the OBU on routes specifically designed to be challenging for GPS receivers. In addition, an End–to-End trial was carried out that aimed to allow for an overall assessment of the capabilities of the system and involved up to 100 participating vehicles being equipped with OBUs and going about their normal business for a period of six months.

This report provides analysis and evaluation of and the full market trial carried out as part of the End-to-End and VAS implementation trials. Analysis carried out in this report is based on the trial methodology defined in GINA deliverable “D3.1 – Trials Plan”.

In this report, the results of ‘soft’ data analysis are presented. By ‘soft’ data it is meant data that was gathered through the use of questionnaires, user feedback and market research. Its main purpose is to inform GNSS Supervisory Authority (GSA) of user perception of the GINA Road Pricing system and market readiness for the exploitation of VAS in the context of Road Pricing. Whereas GINA deliverable “D3.3 – Trials data package, evaluation and results report”, addresses predominantly technical evaluation of EGNOS in a Road Pricing context through the analysis of data gathered during Exhaustive and End-to-End trials.

3. ACRONYMS

3.1.1. ACRONYMS

Acronyms used in this document and needing a definition are included in the following table:

Acronym	Definition
CAN bus	Controller Area Network bus – enables in-vehicle communication
DSRC	Dedicated Short Range Communications
EGNOS	European Geostationary Navigation Overlay Service – A system that uses a system of satellites and ground stations to analyse the quality of the GPS signal (GALILEO in future) and transmit this information to a user. This enables to improve the accuracy of the GPS signal.
GINA	GNSS for INovative road Applications
GMAR	GNSS Metering Association for Road User Charging
GNSS	Global Navigation Satellite System
GPS	Global Positioning System – a U.S. satellite navigation system
IVE	In-Vehicle Equipment
OBU	On-Board Unit
PVT	Position, Velocity and Time
RUC	Road User Charging
SISNeT	A system that makes EGNOS Signal-In-Space (SIS) available in real time via the internet. In particular it allows real time access to the wide area differential corrections and the integrity information provided by EGNOS.
TTFF	Time To First Fix: term used to describe how long it takes for a GPS receiver to acquire its position
VAS	Value Added Services

Table 1 – Acronyms

4. END-TO-END TRIALS

BACKGROUND

The purpose of the End-to-End trials was to demonstrate how a potential Road Pricing system could be implemented. This demonstration was carried out through a large scale trial lasting for 6 months and involving 100 participants in the Netherlands. The trial was designed to demonstrate the following:

1. Technical performance / reliability of the GINA equipment and back office systems over a prolonged period of time
    a. Generating invoices according to the requirements of the Netherlands ABvM
    b. Feasibility of using SISNeT as an efficient mechanism for transmitting integrity information
    c. To describe exhaustively the different problems occurred that serve as lessons learned for the ABvM implementation
    d. To systematically analyse availability of signals as potential identification of interferences and how could affect the ABvM
    e. Complexity of GINA OBU installation for different types of vehicles.
2. How various VAS could be implemented on the GINA platform.
3. User perception / acceptance of the Road Pricing system and VAS.

End-to-End trials begun in July 2010 and were scheduled to be completed in December 2010.

5. METHODOLOGY

PARTICPANTS

The methodology was based on that described in GINA deliverable "D3.1 – Trials Plan". Participants were selected by ARVAL and consisted largely of ARVAL employees and customers. When selecting participants the following demographics were used as guidelines:

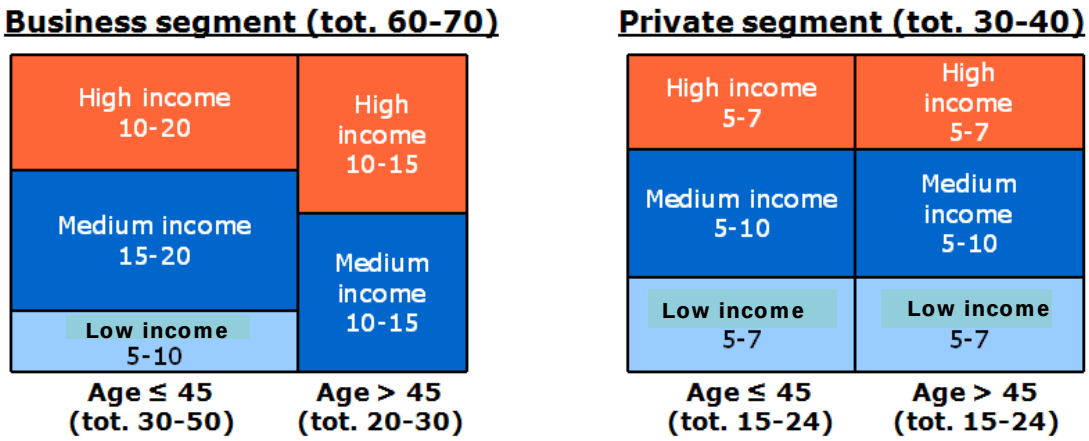


Figure 1: Estimated Participant demographics

The actual demographics of the participants are as shown in Table 2:

Table 2 - Demographics of participants

User Age	User Gender	User Nationality	User Education Level	User Occupation	User Income	# of cars at the home of the user
26-45	Male	NL	Master Degree	Company Executive	60k€-90k€	2
26-45	Male	Dutch	Master Degree	Company Employee	60k€-90k€	1
26-45	Male	NL	Master Degree	Company Employee	<30k€	2
18-25	Male	Dutch	Bachelor	Company Executive	<30k€	2
26-45	Male	Dutch	Bachelor	Company Executive	60k€-90k€	2
26-45	Male	Dutch	Bachelor	Company Employee	60k€-90k€	2
26-45	Male	NL	Bachelor	Company Employee	30k€-60k€	2
26-45	Male	Netherlands	Bachelor	Company Employee	<30k€	2
18-25	Male	Dutch	Bachelor	Company Employee	60k€-90k€	2
26-45	Male	NL	Master Degree	Company Employee	30k€-60k€	2
26-45	Male		Master Degree	Company Employee	<30k€	1
26-45	Male	Dutch	Bachelor	Company Employee	30k€-60k€	2
46-65	Male		Master Degree	Company Executive	60k€-90k€	2
26-45	Male	NL	Bachelor	Company Employee	30k€-60k€	2
46-65	Male	dutch	Master Degree	Company Executive	>90k€	3
26-45	Male		Master Degree	Company Executive	<30k€	1
46-65	Male	Dutch	Other	Company Employee	60k€-90k€	>3
46-65	Male	dutch	Bachelor	Company Executive	60k€-90k€	2
18-25	Male	Dutch	Master Degree	Company Employee	30k€-60k€	1
26-45	Male	Dutch	Bachelor	Company Employee	60k€-90k€	1
26-45	Male		Bachelor	Company Executive	60k€-90k€	2
26-45	Male	Dutch	Other	Company Employee	60k€-90k€	2
26-45	Male		Master Degree	Company Employee	60k€-90k€	3
26-45	Male		Master Degree	Company Executive	<30k€	1
46-65	Male	NL	Bachelor	Company Executive	>90k€	2
26-45	Male	NL	Master Degree	Company Employee	30k€-60k€	1
26-45	Male	Netherlands	Bachelor	Company Executive	60k€-90k€	2
46-65	Female	German	Bachelor	Company Employee	60k€-90k€	2
26-45	Male	nl	Master Degree	Company Employee	>90k€	2
26-45	Male	Dutch	Bachelor	Company Executive	30k€-60k€	3
26-45	Male	NL	Master Degree	Company Executive	<30k€	2

Table 2 gathers the different 31 profiles filled in by the volunteers during the duration of the end2end trials. Not all the volunteers (up to 91) completed the information due to the fact that all feedback provided was on a voluntary base. Different issues arose during the trial phase, for example serious privacy concerns in the Netherlands coupled with the scrapping of the ABvM proposed system due to political reasons. These led to a lack of interest from most of the volunteers even if GINA partners provided all the information and tried to encourage them to fill the required information.

A small number of garages were selected during the project to participate in assisting with the installation of the GINA equipment in participating vehicles. GINA OBU experts from GMV provided training in installation in vehicles and OBU operation to those who would be undertaking these tasks.

PSEUDO INVOICES

Pseudo Invoices were generated for each participant based on the travelling that was undertaken during a set period. The invoices were calculated based on a set of defined tariffs and geo-objects and made available via an online tool; the different data available for the users to check was comprised of the following elements (more information in the appendix at the end of the document)

- Tariffs charged, including tariffs list, cost per kilometre, areas covered by each tariff and times of the day
- Defined charging zones, available through map polygons, with information of the tariffs applied each time of the day and each day of the week for a selected area
- A billing invoice that can be breakdown into daily invoices, per journey and per month

Participants were able to access and view their pseudo bills and charges but no actual monetary transactions took place. No actual payments were made by the participants in any way.

Based on their pseudo bills the participants were asked for feedback on the charges and how willing they would be to change their driving habits as a result, via a questionnaire.

USE OF EGNOS

All OBUs in participating vehicles were EGNOS enabled, as in the case of the exhaustive trials, EGNOs data was provided via SISNeT. Based on the data gathered, an assessment of the suitability of SISNeT as a platform for transmitting integrity information was made by analysing availability and reliability of the data

The use of EGNOS was evaluated in all the OBUs installed, by default configuration all OBUs were EGNOS enabled via SISNET, during the lifetime of the End-to-End trials the EGNOS feature in the OBUs was disabled gradually in all the units thus leading to a % of the raw data collected being EGNOS enabled and other set EGNOS not enabled, then the differences in accuracy, or distance evaluation could be analysed and compared.

VALUE ADDED SERVICES (VAS)

Questionnaires were produced to seek feedback from both end users (the participants) and providers, on various aspects of possible VAS tested during End-to-End trials. In particular:

1. Usefulness of services
2. Ease of use
3. Suggested improvements

GENERAL

Data from the OBUs was dumped automatically using Palview and the output data was then post-processed and made available for analysis.

A database was maintained which recorded the following information for each participant's OBU:

1. Trial-car ref number (Key field, other items below)
2. Firmware/Hardware version
3. OBU spec 2: EGNOS
4. Region/country
5. Vehicle stats 1: manufacturer
6. Vehicle stats 2: vehicle type
7. Vehicle stats 3: engine (power, fuel etc).

The Dutch privacy law is strict concerning recording of personal TDP data and the data recorded during GINA trials was fully compliant with the Dutch Law on privacy and data protection, therefore the type of data recorded and analysis that could be performed on the End-to-End data was limited. It is understood that it should not be possible to relate a user / participant with specific Position, Velocity and Time (PVT) data according to the Dutch law, therefore:

- Data was managed in an anonymous way
- For RUC purposes, individual PVT data was not used.

DATA ANALYSIS

In this report, the purpose of data analysis was to evaluate 'soft' data. Analysis of Time Distance Place (TDP) related data obtained from the GINA OBUs is undertaken and described in GINA deliverable "D3.3 – Trials data package, evaluation and results report".

Analysis of data in this report was carried out predominantly by CENIT and included analysing participants' responses to questionnaires about their perception of the GINA Road Pricing Platform and the concept of Road Pricing in general. The questionnaires used during the project are included in Appendix 1.

ROUTE DEFINITIONS

5.1.1. ROUTES

During the End-to-End trials, participants did not follow designated routes or schedules. Instead, each participant performed his or hers usual driving as part of their daily commute and travel. A set of geo-objects was defined that aimed to cover the municipalities where participants were likely to be travelling (see Figure 2) and an additional set of smaller geo-objects near the participants' work locations in order to enable the gathering of statistical data, as can be seen in Appendix 3. It was anticipated that having geo-objects in locations where a vehicle is likely to enter it regularly, such as near a workplace, would create a large number of repetitions.

Municipalities that were used as geo-objects are as follows:

- Utrecht
- Den Haag
- Rotterdam
- Nijmegen.

Figure 2 - End-to-End municipalities' geo-objects

5.1.2. CHARGING SCHEME ENVIRONMENT

In order to simulate a realistic charging scheme, a number of municipalities were defined as geo-objects, see Figure 2. Inside those cordon geo-objects, further, smaller, geo-objects were defined so that a set of overlapping geo-objects were created. Different combinations of tariffs applicable to the defined geo-objects were simulated by having higher charges during the rush-hour, workdays between 7:00-09:00 and 16:00 to 19:00. Doing so made it possible to see the effects of the pseudo-invoices on the driving behaviour of participants. A higher tariff was applied to the small geo-objects and a lower tariff to the cordon-based municipalities' geo-objects.

Tariffs used in GINA End-to-End trials were based on the surcharges proposed by the Dutch Government:

A. 0.085 €/km

B. 0.105 €/km

C. 0.125 €/km

D. 0.145 €/km

In addition to the charges proposed for distance driven in geo-objects, a baseline charge was implemented for all distance driven as follows:

A. 0.065€/km - during weekdays on all roads in the Netherlands (as far as these kilometers are out of geo-objects and not driven during rush hours)

B. 0.03 €/km - during weekends on all roads in the Netherlands at any time.

By combining the tariffs above, it was possible to generate varying bills based on the amount of distance driven, time of driving and location. Participants' opinions regarding

their pseudo bills and how willing they would be to change their driving habits based on those pseudo-bills was gathered and analysed.

6. CHANGES TO ASSESSMENT METHOD

The initial project programme included a demonstration of GNSS-based road pricing and VAS in the Netherlands. During this trial, the engaged vehicles were equipped with OBUs which provided location based data to be collected as the vehicles were driven. In turn, this permitted the capabilities of a given End-to-End charging scheme to be assessed. It was anticipated, as described in GINA deliverable D3.1, that participant feedback would be sought by asking them to complete an online questionnaire during and after the trials completion. Unfortunately, the feedback received from users was statistically inadequate to properly assess behavioural changes resulting from the GINA Road Pricing scheme and their perception of a possible real implementation.

Owing to the lack of data, an alternative approach has been used in this report. In order to assess driver's reaction to a Road Pricing scheme, the analysis was focused on a literature review of results from other trials and interviews with experts from Transportation Departments within the Dutch Ministry.

This information makes it is possible to have a well defined general framework to account for users reaction to Road Pricing schemes.

7. INTERVIEWS WITH EXPERTS

Although requests for interview were sent out to a number of experts who have worked on the national road pricing scheme which was, until recently, under development in Netherlands Ministry of Transport, Public Works and Water Management, only one candidate responded. An open interview via email was conducted with Stefan Eisses, who worked in the project team, in order to obtain information related with the implementation of road charging in this country and specifically if he had any data or information about projects addressed to the "possible perception of the users in the Netherlands on the road pricing". During this contact the interviewee provided information about the ABvM project and focused on the Netherlands market has been collected in this report. Although the ABvM project was not implemented in the Netherlands due to a political decision at the time, the scheme remains a valid reference in terms of demanding specifications, performance and price constraints. The feedback received from those involved in ABvM scheme is therefore, considered to be valuable.

It must be noted that the ABvM project raised a fierce political debate that was widely covered by national and international media, and finally culminated in the project withdrawal after the formation of the new, Dutch coalition government. It is possible that public opinion on the distance-based Road Pricing was driven by emotions, rather than facts, as most inhabitants have little or no experience of road charging. However, it has to be noted, as stated by research evidence described below, that a shift in public opinion often appears once the scheme is implemented and users can perceive the benefits. Examples of this can be seen in the works of Zmud & Arce (2008) [RD.1], Glaister (2007) [RD.3] and Hugosson (2007) [RD.4], as in the Stockholm referendum results.

A large enquiry was held by the motorist organization ABvM, with 350,000 respondents answering a variety of questions on the proposed road pricing system†. The survey results suggested that more than 68% of respondents were actually in favour of paying per kilometre for using their vehicle, instead of the current fixed taxes as they see it fairer to pay for vehicle usage rather than by vehicle ownership. This survey also showed that even though a 20% (within the 68% of supporters) of participants strongly supported the toll, another 20% (of the remaining 32%) were firmly opposed.

In the analysis of the response to the different measures it also appeared that the idea of charging higher tolls during peak hours was more difficult to gain the public acceptance from the general public, despite it being an effective measure to cut congestion. People tend to think that this is unfair due to the lack of travel alternatives and its perceived ineffectiveness. This is presented here as a qualitative statement as the complete quantitative data was not available.

This survey also shows that the OBU installation is a major concern for an extensive proportion of participants, as it is perceived as expensive and raises privacy issues. In addition, it is not well perceived as its installation is not done in a volunteer basis and users don't know much about its characteristics and implications. This attitude was also observed in a recent mobility project where motorists were rewarded for changing their behaviour with respect to car use: a few euro's for each peak hour trip they avoid (on a given trajectory). Quite a few of the volunteers withdrew when they finally understood that equipment (OBU) were to be mounted in their vehicle. On the other hand, the people that finally participated in trials and other mobility projects did not find the equipment a problem at all.

There was also criticism by the respondents of the ABvM project about the transitional period in which the purchase tax (BPM) on a car would have been phased out and become the Motor vehicle tax (MRB) to be paid each quarter. Chief Executive Officer of ABvM Guido

† ABvM survey: pay for car use

van Woerkom revealed that the reduction in the BPM, programmed for the Netherlands Tax Plan 2011, would lead to a significant increase in the MRB, which was perceived to be unfair by the poll. The reduction in the BPM by 1 January 2011 was subsequently withdrawn.

On the subject of Road Pricing the director of the RAI Association (de Nederlandsche Vereniging de Rijwiel- en Automobiel Industrie) Peter Janssen, strongly believes that people find it logical to pay for the use of the car as a better option than buying one. According to Janssen this confirms the results of the ABvM enquiry that a system of Road Pricing "is unavoidable for the future''.

8. LITERATURE REVIEW

A review of the available literature related with the user's reaction to the implementation of road charging was made in order to gather two representative studies with similar technical approach to the one used in the End-to-End trials, this allows the inclusion in this document of a framework with guidelines of what to expect with the implementation of this type of charges. Two scientific articles were used, *Public acceptability change of urban road pricing schemes*, by Tina Gelhert, et al., [RD. 2] paper based on the results of a test carried out with residents of Copenhagen and the article *Acceptability of urban transport pricing strategies*, by Jens Schade and Bernhard Schlag [RD. 6] who used the data gather from a survey carried out in four European cities about the acceptability of road pricing.

8.1. PUBLIC ACCEPTABILITY CHANGE OF URBAN ROAD PRICING SCHEMES

The work by Gelhert et al. (2008), based on data from the AKTA road pricing trial in Copenhagen [RD. 2], established changes in public acceptability, and reduction in use of private car in relation to the introduction of urban road pricing. The relevance of the information in this scientific article leads to the inclusion of it in the present section.

The methodology implemented used a sample of 517 users (reduced to 252 for data analysis due to problems with the GPS technology and lack of usable data form users)[‡] recruited by phone with telephone numbers picked at random. All participants who took part in the trial had to belong to one-car households, be the most frequent user of the car, be residents and/or having their workplace within the Road Pricing area and have the need for daily travel.

Public acceptability of four different Road Pricing schemes (as shown below) was measured through two questionnaires, with the same questions, completed by all the participants, one before the trial and other after the trial ended. The schemes include three types of urban road pricing, where charges depend on the kilometres driven, and one tax-based charge that is a way of pricing in which the user has to pay a fee if he wants to use the road network. All four were considered to be possible Road-Pricing Schemes and are detailed below:

1. Increase of up to 180% in the car registration tax and 25% in value-added tax (VAT) when buying a car, and in addition an annual tax of about €400 depending on car type.
2. Urban road pricing.
3. A rush hour charge in the morning and evening rush hour as implemented in the AKTA field trial.
4. A package solution consisting of road pricing and the revenues used as participants would prefer it. [§]

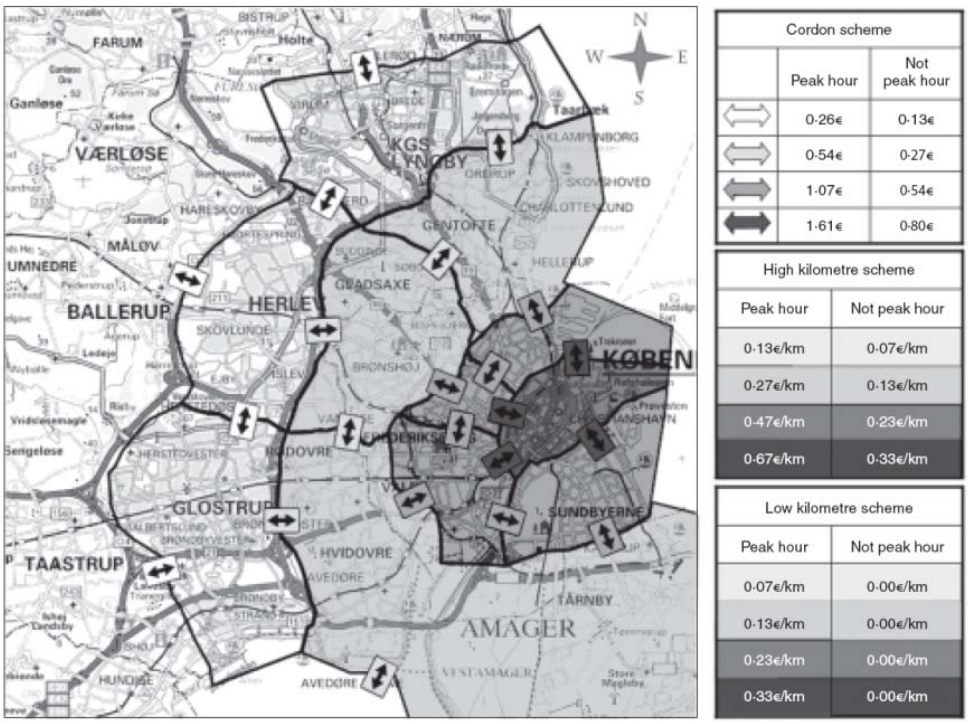
The urban road pricing scheme implemented, covering the metropolitan region, divided Copenhagen into 4 pricing zones with different price levels that increased closer to the city

[‡] See Nielsen et al. (2003) for details [RD.7]

[§] The original article [RD.7] didn't have this information, therefore, it was necessary to use the new article by the same author [RD.2] in which packaged solution is explained in more detail. In the AKTA road pricing experiment the preferred revenue use was measured with two items, one focused on revenue use for the general public where participants had to choose between local traffic improvements, national traffic improvements, local tax reduction, national tax reduction or others; the second item focused on the transport system in which participants could choose three out of seven options: extension of the road network, extension of parking space in the city centre, improvement of traffic safety, extension of Park & Ride facilities outside the city centre, extension of public transport, reduction of public transport fares, or others.

centre and differentiated between rush and non-rush hours. Under these conditions, three urban road pricing schemes were established (cordon, high kilometre scheme, and low kilometre scheme the two latter referring to charges higher or lower as shown in Figure 3).

Figure 3 - Design of the virtual road pricing scheme in Copenhagen



Cordon scheme		
	Peak hour	Not peak hour
⟷	0·26€	0·13€
⟷	0·54€	0·27€
⟷	1·07€	0·54€
⟷	1·61€	0·80€

High kilometre scheme	
Peak hour	Not peak hour
0·13€/km	0·07€/km
0·27€/km	0·13€/km
0·47€/km	0·23€/km
0·67€/km	0·33€/km

Low kilometre scheme	
Peak hour	Not peak hour
0·07€/km	0·00€/km
0·13€/km	0·00€/km
0·23€/km	0·00€/km
0·33€/km	0·00€/km

The measurements of the impacts of the pricing schemes include a comparison of the driver behaviour in an additional control period with no pricing (namely no toll scenario) during which, devices installed in the cars (OBUs) did log the movements but did not show any pricing information to the drivers.

The motivational strategy used to encourage the participants to reduce their car use was to give them the charges they saved, calculated as the difference between the sum of road user charges under the no-toll scenario and the road pricing scenario[**]. In addition, each participant received an allowance to compensate for the time and effort related to the trial.

The percentage of drivers who were positive about the four proposed road pricing schemes before the trial was conducted, are described below:

- Car tax scheme, which has very high fixed taxes on car ownership: 20%
- Urban road pricing: 72%
- Additional rush hour charge for the morning and evening rush hours as implemented in AKTA: 62%.
- Package solution combining road pricing with the preferred revenue: 44%

[**] People were incentivized to get save money in their trips. The more they saved the bigger allowance they got. People participating in the trial spent a period with and without virtual charges for which they got some money (bonus + savings), then people who reduced more their travels, got more money.

Table 3 - Change in acceptability of road pricing schemes after the trial (frequency in %)

	Negative change (−2; −1)	No change (0)	Positive change (+2; +1)	Difference between pricing schemes $\chi^2(df = 2)$, *P*	*N*
Current Danish car tax system	23·8	51·4	24·9	0·54, n.s.	294
Urban road pricing	13·1	61·0	26·1	0·69, n.s.	292
Peak hour charge	11·9	59·9	28·2	4·37, n.s.	294
Package solution	16·7	57·4	25·8	4·52, n.s.	283

n.s., Not statistically significant.

The results in Table 3 show that the majority of respondents did not change their attitude concerning the different road pricing measures after the trial. The biggest change of attitude was found for the current Danish car tax scheme, where 48.7% (rounded) of respondents changed their attitude in almost equal shares in a positive and negative direction. Concerning the road user charging schemes the proportion of participants changing their attitude ranged from 39.0% for road pricing to 42.6% for the package solution. Statistical analysis, made especially for the study of Gelhert et al. (2008) [RD 2], showed that changes in attitude observed cannot be attributed to the experience of the three different pricing schemes, since the chi-square test χ^2 resulted in values under 4.605 given a degree of freedom of 2 and a p-value of 0.1, as results cannot be considered statistically significant and no relation can be found between the charge scheme and the change in the users' perception.

Table 4 presents the results of average daily car use under the control period (first column of each scheme) and the road pricing condition (second column) and the differences between them (third column). For instance in the case of the Cordon scheme, when the *trip distance* was assessed, the sample tested made 32.72 km during the control period and only 30.54 km when the cordon pricing scheme was implemented, ending in a reduction of 2.18 km. It is noted that there is a decrease in almost all car use indicators apart from a small increase in the average trip speed.

Table 4 - Descriptive car use reductions in response to urban road pricing

	Overall			Cordon			High			Low		
	Control	Pricing	+/−	Control	Pricing	+/−	Control	Pricing	+/−	Control	Pricing	+/−
Number of trips	4·60	4·28	−0·32	4·22	4·24	+0·02	4·58	4·13	−0·45	4·87	4·59	−0·28
Trip distance: km	36·43	33·86	−2·57	32·72	30·54	−2·18	35·03	32·01	−3·02	41·49	39·69	−1·90
Trip duration: min	54·16	49·44	−4·72	49·92	47·48	−2·44	52·58	45·95	−6·63	60·00	57·75	−2·25
Trip cost[a]: €	3·19	2·74	−0·45	2·63	2·27	−0·36	4·18	3·49	−0·69	1·53	1·48	−0·05
Trip speed: km/h	39·84	40·56	+0·72	38·77	38·97	+0·15	39·59	41·14	+1·55	41·03	40·40	−0·63

[a]Calculated according to the relevant pricing scheme.

The analysis of changes in car use was made using a two-way analysis of variance (Anova) and aimed to determine the difference between scores of the car use indicators under

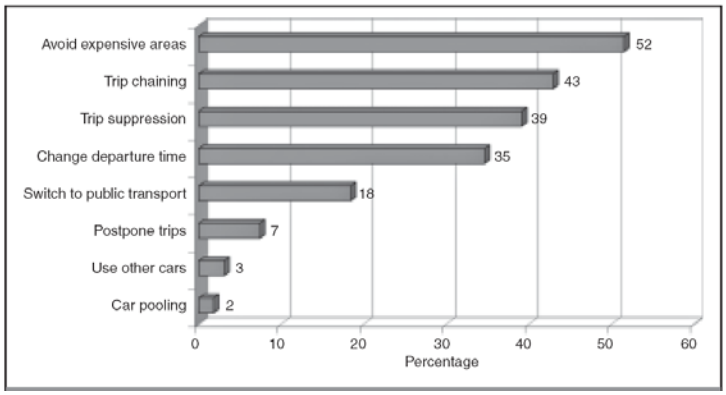
control and road pricing condition. The two-way Anova analysis reflects a significant treatment effect for the number of trips, the trip distance, the trip duration and trip costs but not for the trip speed, which means that the implementation of pricing as such, led to significant reductions in these car use indicators but not to a change in individual driving behaviour, such as, driving speed.

The impact of the amount of the charge was also analyzed. The initial hypothesis was that there would be a different effect on driver acceptance of the schemes based on the amount of the charge. However, the analysis showed that there is no significant difference between the participant acceptance of low charge per kilometre pricing scheme and the high charge per kilometre pricing scheme.

A detailed analysis of the number of trips and the trip costs show that participants who drove under road pricing condition first reduced their number of trips and their trips cost less in comparison with those driving under the control condition first. The magnitude of effect of all statistically significant reductions in car use can be classified as small.

Regarding the strategies used to reduce car use, the participants mostly tried to avoid expensive areas or to organize their car use more efficiently. A statistical analysis shows no significant differences in the car-use reduction strategies applied by participants under different road pricing schemes. This would suggest that the type of road pricing scheme did not influence participant's choice of car use reduction strategies.

Figure 4 - Car use reduction strategies in response to urban road pricing



In this case switching to public transport was not an important reduction strategy as it could be in other cities, which could come from the fact that this specific trial was implemented only for a few weeks and therefore the car users may not have been motivated enough to make such radical changes in their travel behaviour.

An analysis of the acceptability after the trial shows that in general it has no relation with the attitude prior to the trial or behavioural response during the trial, with two exceptions, the current Danish car tax scheme and the rush hour charges, they were significantly predicted by the acceptability before the trial and the reductions in trip costs. That means that the analysis of two elements, the attitude prior to the trial and the reductions in trip costs during the trial, can lead to a good prediction of the public acceptability of the proposed charging scheme, in this case, the current Danish car tax scheme and the rush hour charges.

Only a few statistically significant relationships were found between change in acceptability of road pricing schemes and stated car use reduction strategies. This means in most cases there was no change in attitude even if the acceptability prior to the trial was inconsistent with the behavioural response during the trial.

Participants who exhibited behaviour that was conforming to their attitude prior to the trial did not show attitude change. Nevertheless, this result is not regarded as support for a relation between attitude and behaviour change, rather it is attributed to the main effect that most participants did not change their attitude in the first place.

Although such trials are thought to be valuable, it is important to emphasize that these kinds of trials lack certain important components of a full road pricing implementation. For instance, changes in congestion and improvements on traffic as well as the political debate and media coverage around the issue, can have an impact on public acceptance of road pricing schemes.

8.2. ACCEPTABILITY OF URBAN TRANSPORT PRICING STRATEGIES

With a similar approach to the one described in the first article, the work of Schade & Schlag (2003) [RD.6] analyzes different possible road pricing acceptability strategies to address two main questions. Firstly, the current public acceptability level of different urban transport pricing strategies, and secondly, if the factors outlined in a predicted acceptability model explain the level of current acceptability.

A survey of motorists (from December 1998 to January 1999) in Athens (Greece), Como (Italy), Dresden (Germany) and Oslo (Norway) was conducted, with a total of 952 motorists who filled a questionnaire send by mail. The participants were recruited by phone, and demographic criteria with regards to age, gender, occupation and place of residence were considered in order to ensure representative sampling. Two pricing strategies were presented in the surveys, as shown in Table 5.

Table 6 summarizes the results (mean values) for the evaluation of the two pricing strategies by survey respondents. As can be seen for the total sample, the subjective knowledge levels for both strategies are very low. This is not surprising because the strategies were very new at the time the survey was made.

Table 5 - Package Strategy

	A: “best practice second best” so-called strong package	B: “acceptable” so-called weak package
Charge motorists	Toll cordon with charges of 2 EUR during the morning peak (7.00–9.00 a.m.) and 0.5 € thereafter	Toll cordon charges of 1 € at all times (including nights and weekends)
	Parking charges increased by 0.5 €/h	Parking charges increased by 0.25 €/h
	Fuel taxes increased by 0.5 €/l	Fuel taxes increased by 0.125 €/l
Use of the revenues	2/3 to lower labour taxes	1/3 to lower fixed vehicle taxes
	1/3 to invest in capacity expansion of known road traffic bottlenecks’	1/3 to invest in capacity expansion of known road traffic bottlenecks and/or to improve parking facilities
		1/3 to improve the quality of public transport’’

Table 6 - Overall evaluation of strategies A and B

	Strategy	Knowledge	Perceived effectiveness	Personal outcome expectations (equity)	Acceptability
Total sample	A	1.50	2.39	−.21	1.80**
	B	1.48	2.34	−.16	2.22
Athens	A	1.70	2.51	.07*	1.96**
	B	1.69	2.56	.30	2.29
Como	A	1.92**	2.23*	−.39*	1.80**
	B	1.72	2.38	−.28	2.17
Dresden	A	1.32	2.37	−.60	1.65**
	B	1.39	2.37	−.37	2.07
Oslo	A	1.23	2.50**	.16**	1.85**
	B	1.27	2.15	−.11	2.38

All mean values can vary from 1 (e.g. know nothing at all, absolutely unacceptable) to 4 (know a lot, totally acceptable) with the exception of personal outcome expectations (equity) where values can vary from −1 (expected disadvantages) to +1 (expected advantages).
Wilcoxon signed ranks test:
*Difference between strategies A and B is significant at the .05 level.
**Difference between strategies A and B is significant at the .01 level.

Knowledge about options: very little in Dresden and Oslo and rather little in Athens and Como. There are two possible reasons for this gap, the fact that in Oslo the question referred to the objective knowledge because of an already existing pricing scheme and that in Dresden as part of a former socialist country, the knowledge about road pricing instruments is generally low, according to the article author's opinion.

Perceived Effectiveness: the perception of the effectiveness for reduction of inner city traffic for both strategies is much higher than the knowledge level. Thus, respondents may believe that the demand management could successfully address transport problems, and as a result, this suggests that the public is prepared to trust these measures even if they are new and unknown. Athens, Como and Dresden showed a perceived effectiveness of strategy B higher or equal to strategy A, Oslo did not. Again, this could be because the Oslo sample has experience with an existing pricing scheme, allowing a more realistic evaluation of the effects than in the other cities.

Personal outcome expectations (equity): The majority of respondents tend to expect disadvantages from the introduction of the two strategies. In Athens, Como and Dresden respondents expect less disadvantages from strategy B than from strategy A. In Athens the expectations tend to be rather positive with even a majority expecting advantages of the ''acceptable'' strategy. Only Oslo respondents expect more personal advantages of strategy A than of strategy B.

Acceptability: In general, both strategies are not fully acceptable for the respondents (see Table 7). Although acceptance of B is better than A, neither is accepted by a majority. In Dresden like in Como attitudes towards both pricing strategies are very negative compared with Oslo and Athens.

Table 7 – Acceptability (% who rated the strategy as rather or totally acceptable)

Strategies	Support in %				
	Total	Athens	Oslo	Dresden	Como
A	20	25	24	17	15
		Oslo	Athens	Como	Dresden
B	39	48	43	34	31

To analyze the relations between the different variables, further statistical investigations on a multivariate basis were necessary. Then a two-step procedure was adopted, first the extensive data was reduced to an appropriate minimum by factor analysis. Factors like problem perception, important aims to reach and the internal attribution of responsibility are based on a multitude of items. The results of the factor analyses are presented in Table 8.

Table 8 - Factor analysis values (means)

Factor	Number of items	Alpha Cronbach	Mean	Total variance explained
Problem perception (traffic)	2	.58	3.18	60.83%
Problem perception (environment)	4	.72	3.01	
Social aims	5	.60	3.30	44.97%
Personal aims	4	.58	2.84	
Internal attribution of responsibility	2	.74	2.48	56.37%
External attribution of responsibility	4	.53	3.21	

In a second step regression analyses were applied to investigate which factors contribute to the explanation of acceptability, factors like the perception of problems resulting from traffic, the valuation of common social aims, the level of subjective knowledge and the perceived effectiveness.

In this study linear stepwise analyses were carried out, which terminate when no new variable is able to improve the prediction of the dependent variable. First, the predictive power of the independent variables which were examined in direct relation to the two pricing strategies was analyzed.

Table 9 shows, in the analysis of strategy A, that three significant variables accounted for nearly 30% of the criterion variance. A high acceptability of strategy A is to be expected if social pressure to accept such a strategy is regarded as high, if the impact of strategy A to reduce inner city traffic is perceived as effective or if personal advantages following the introduction of strategy A are expected. The subjective level of knowledge does not improve the equation, although it is significant. The surprising result is that social norm has the most predictive value of all factors. Besides the influence of social norm only cost–benefit evaluations predict acceptability of the strategy.

The regression analysis for strategy B, shown in Table 9, is consistent with results of strategy A. In this case, the three variables account for 38% of the criterion variance, which is slightly higher than for strategy A. Again, social norm, perceived effectiveness and personal outcome expectations were significant, with social norm having the strongest predictive power. The subjective level of knowledge does not get significant any more.

Lastly, the remaining background variables, problem perception, important mobility aims and responsibility attribution were integrated to the previous variables analyzed into a general model. An arithmetic mean for all variables was calculated combining the two strategies A and B. All analyses were carried out for the total sample. Results are shown in Table 10.

Table 9 - Stepwise multiple regression analysis of the acceptability of strategy A and Strategy B

Predictor variables	Strategy A			Strategy B		
	R^2	B	β	R^2	B	β
Social norm	0,215	0,355**	0,354	0,301	0,364**	0,378
Perceived effectiveness	0,262	0,189**	0,207	0,347	0,206**	0,207
Personal outcome expectations	0,299	0,227**	0,203	0,381	0,224**	0,214
Knowledge	0,303	0,074*	0,066	-	0,522**	-

Constant	-	0,152	-	-	-
	F total=100.829**; *df* = 4/926			*F* total=189.816**; *df* = 3/924	
	*0,01 < *p* < 0,05;**p* <0,01.			*0,01 < *p* < 0,05; **p* < 0,01.	

R^2: coefficient of determination (fit)

B: regression coefficient (estimate of the change in the dependent variable that can be attributed to a change of one unit in the independent variable)

β: standardized regression coefficient.

Table 10 - multiple stepwise regression analysis for acceptability of strategies A and B

Predictor variables	R^2	*B*	β
Social norm	.236	.269**	.274
Personal outcome expectations	.317	.296**	.270
Perceived effectiveness	.343	.164**	.170
Traffic-related problem perception	.359	−.179*	−.123
General (societal) important aims to reach	.369	.113**	.083
Internal attribution of responsibility	.376	.078**	.088
Knowledge	.380	.068**	.065
Constant		.320	
F total = 80.34**; *df* = 7/918			

*.01 < *p* < .05; **p < .01.

The variables examined reveal again the highest predictive power. Social norm is the most influential predictor and also personal outcome expectations prove to be an influential predictor of acceptability.

The effectiveness evaluation of a strategy also appears to be a variable with high predictive power. This can be related to Rienstra et al. (1999) [RD.5], who suggests that “strategic responses on perceived effectiveness may occur when respondents try to justify their rejection of painful policy by claiming that they perceive them as ineffective”. It is possible to prove this by including the variable personal outcome expectations.

Although there is a relation between the expectation of disadvantages and an as low evaluated effectiveness (r =0.18**), this correlation is considerably lower than the correlation between outcome expectation and acceptability (r =0.47**) and between effectiveness and acceptability (r =0.32**).

If a partial correlation is carried out, with the impact of acceptability excluded then for the correlation between outcome expectations and effectiveness, a coefficient of r =0.05 (n.s.) is obtained. That is, the relation between the expectation of advantages or disadvantages from road pricing and the acceptability of the strategies is not statistically related to the effectiveness evaluation of the strategies. Thus, these findings point out that in this study strategic responses are not likely.

Regarding the background variables, besides problem awareness, especially the general important aims to reach qualify as predictor for acceptability. This means, respondents perceiving socially important aims, like rights for cyclists or improvements in urban living conditions, significantly clearer approve of the strategies. Concerning problem awareness, a perception of traffic related problems like traffic congestion or lack of parking space actually appears to hinder the acceptability of road pricing.

9. SURVEY E2E TRIAL ANALYSIS

The following is an analysis of the online survey answered by some of the participants of the E2E trials at the end of their participation in the project (view the full survey text in **¡Error! No se encuentra el origen de la referencia.**). Notice that the accuracy of the results obtained cannot be considered as statistically significant since the sample is very small. The data gathered only reflects the answers of 15 users (out of the 91 who participated in the project) regarding the characteristics and elements related to GINA. Most of the survey respondents are males among 26 to 45 years old (73%), in particular they are company executives (91%) with a Master degree (55%) and incomes over 30.000 € per year (82%) (View descriptive figures of respondents on **¡Error! No se encuentra el origen de la referencia.**).

In spite of the simplicity of the implemented methodology, this analysis allows the identification of some "potential tendencies" that explain the way that people see the different questioned issues and give an added value to this information.

In the methodology implemented two types of data behaviour were identified, one with unanimity in the responses by more than 50% of the participating sample, and the other, where the users had a similar distribution of the different options. In the first case, the coincidence in the answers can suggest a tendency of users to agree on the subject questioned, while in the second it is difficult to know if a bigger sample could give a clear conclusion.

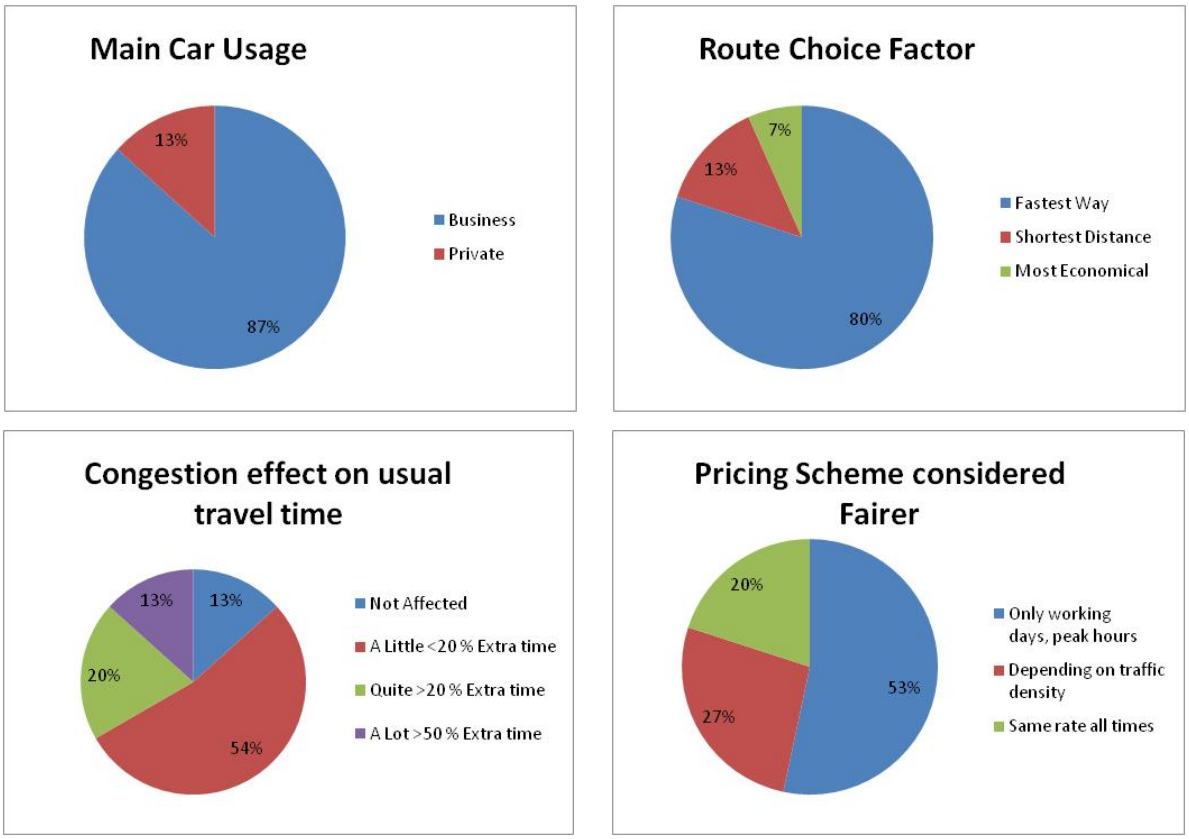
> **Important:** It should also be noted that this assessment is not aimed at participants' reaction to Road Pricing systems or the policy of Road Pricing but rather, at participants' response to the GINA Road Pricing tool in the context of the End-to-End trials.

9.1. ANSWERS WITH MAJORITY RESPONSES

The following are the concepts that share a majority in the answers, classified according to the type of information that can be obtained from their analysis.

Users characterization: Considers issues about the behaviour and characteristics of the users like the mainly motivation to use the car, the factor with most influence on the route choice and the user's perceived congestion effect on travel time.

Figure 5: Issues referred to the user habits and characteristics



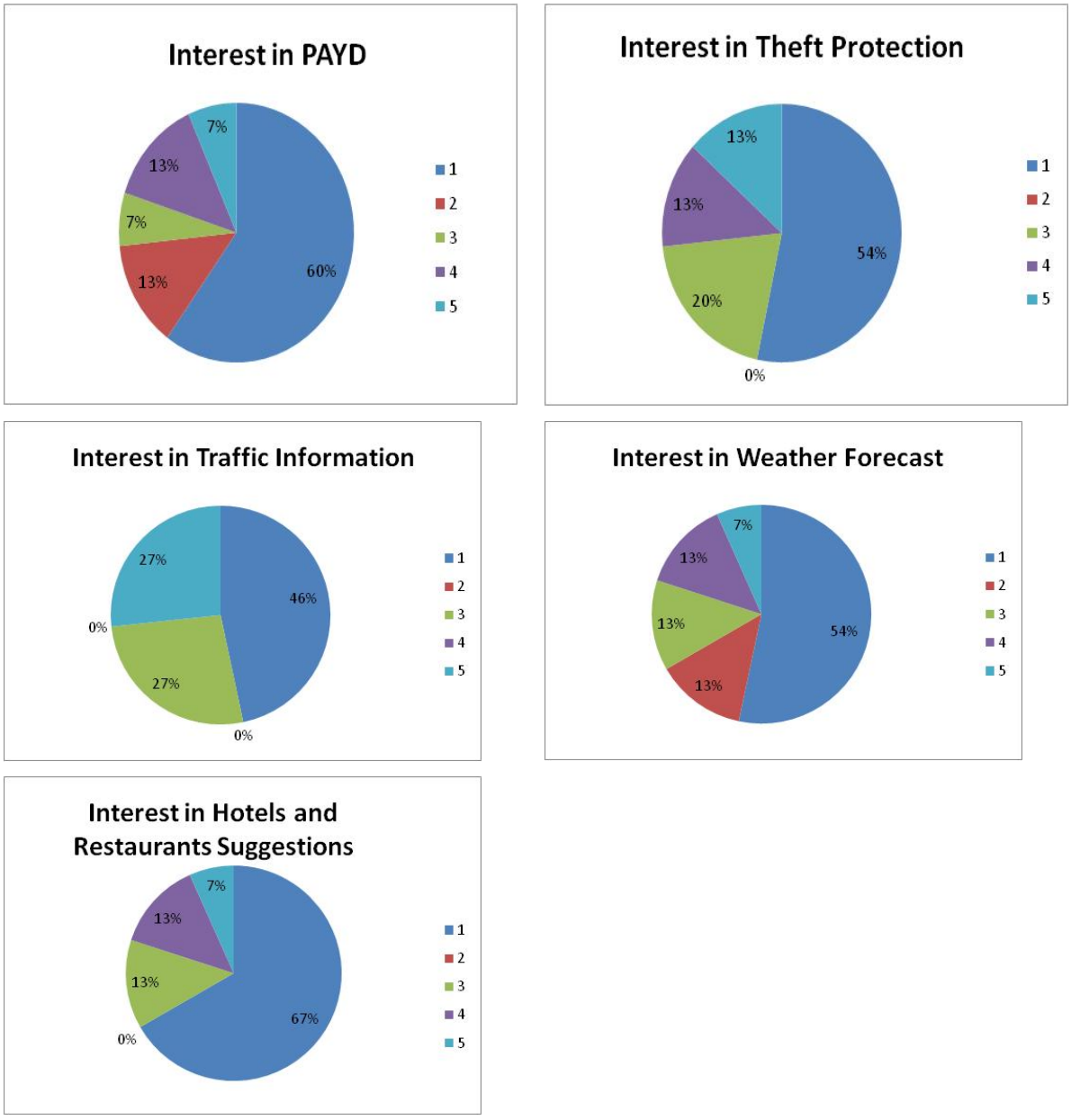
The fact that most of the respondent uses the vehicle for business proposes may have an effect over his perception of some other issues like the value of travel time. This is supported by the fact that most respondents chose their route mainly by the fastest way, as it is the major factor affecting their travel cost.

The fact that most respondent answer that congestion does affect their journey, may suggest that travel time reliability could be a major concern as it has a major effect on route choice, as stated before.

If the majority sees that the fairer pricing is the one that charges only during peak hours instead of variable charges according with density or a flat charge all the time, this strengthens the idea that user do really need an structured pricing framework in order to evaluate their travel options. If variable pricing is meant to be applied it may have some pricing boundaries to avoid user's aversion to uncertainty.

Users' interest: Specific questions were made about interest of users on issues like the implementation of PAYD (Pay As You Drive) scheme or services like providing protection against thefts, information about weather or restaurants and hotels.

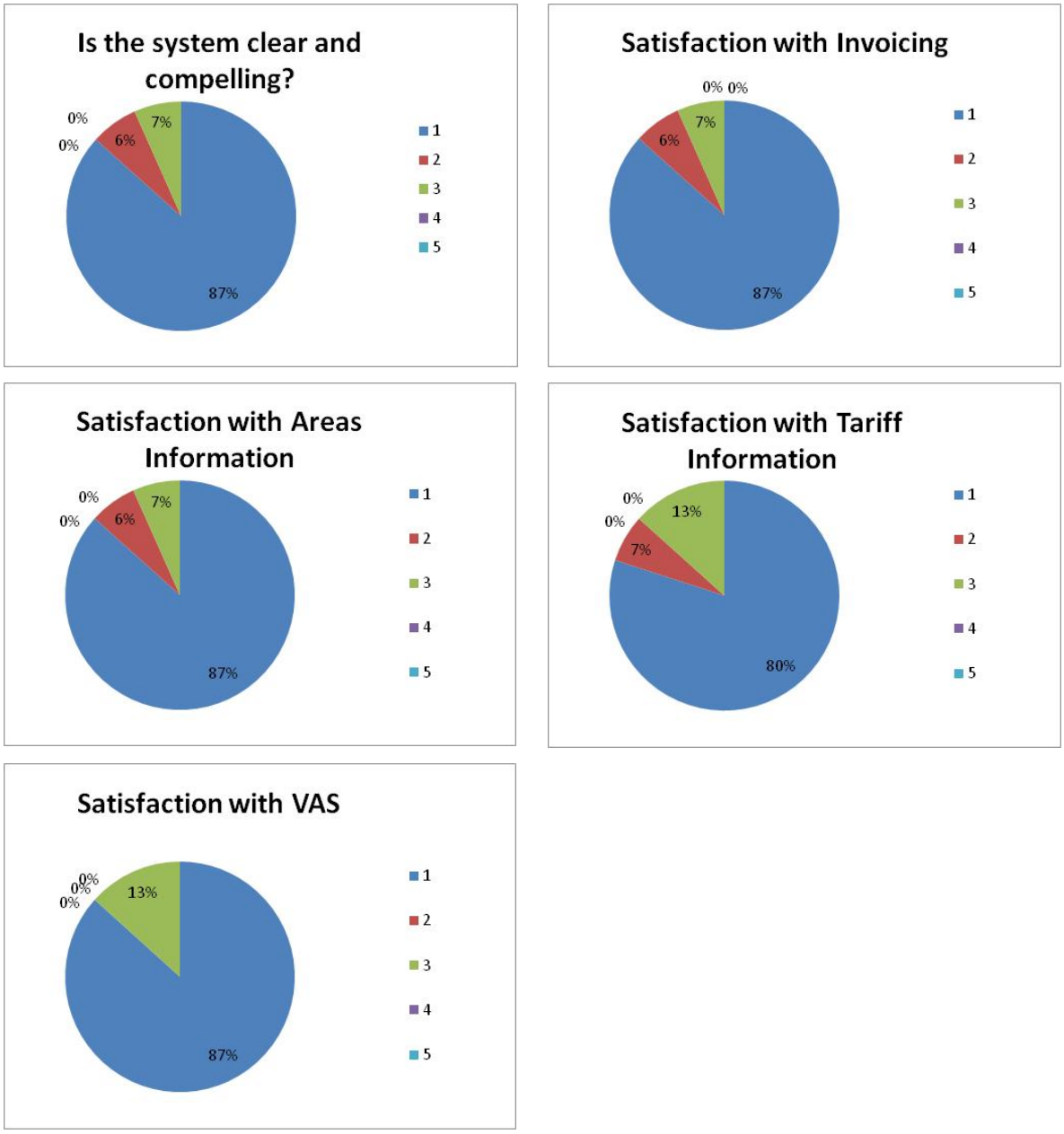
Figure 6: Issues referred to the user interest (1 as least interest and 5 as highest interest)



It can be stated that there seems to be no general interest for services with an added value, although such answers could be because the users already obtain those services by other means than the ones proposed. The interest of information about traffic was included even though the maximal percentage doesn't reach 50% but it does show a tendency, which could be reasonable taking into account that users already have this free information available before journey departure through the internet or mobile phones. Any value added service may be correctly perceived as worthwhile in order to be correctly evaluated.

Users' GINA system perception: Questions made about the experience of the respondents with the system tested should be a good indicator about the users' impression after the trial.

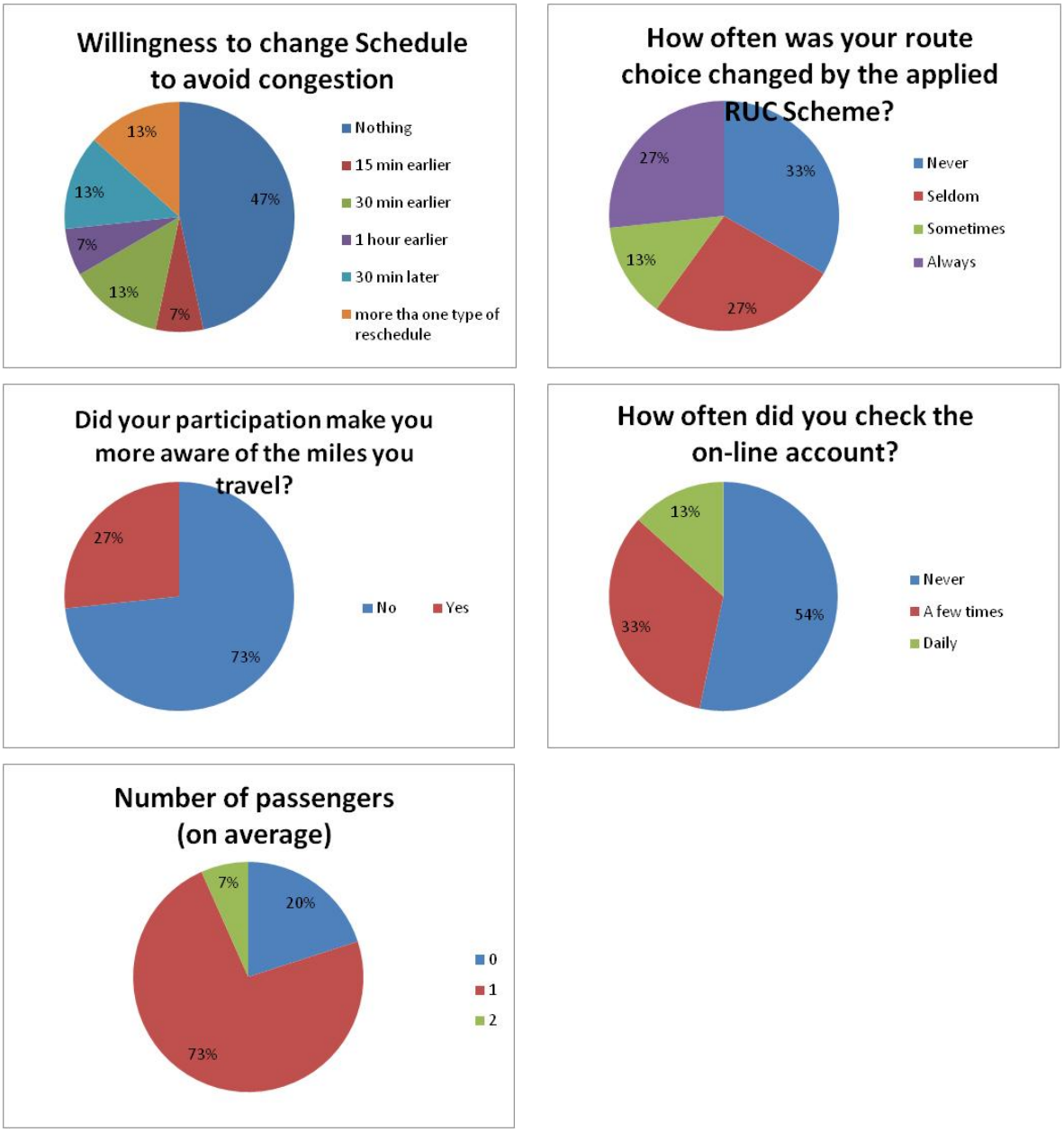
Figure 7: Issues on the perception of the system of pricing scheme tested (1 as lowest value and 5 as highest value)



These results could be justified due to the fact that the volunteers were only asked to provide their feedback at the end of the trial period (even if there were some attempts to get interim feedback) for organizational reasons in the project. This could have lead to an interpretation of the information a posteriori, with the observed effect. To this situation, it is necessary to add the possible loss of interest in the trial on the volunteers' side (also observed by the withdrawal of part of the drivers) which could be influenced by the different changes occurred in the Netherlands with respect to the deployment of the ABvM scheme.

Behavioural changes: The users were also inquired about theirs consume changes due to his participation on the trial.

Figure 8: Issues referred to the users' habits and perception changes



With a closer look into the responses about the frequency of changes in the route caused by the implementation of the GINA system (40% made route changes at least sometimes) and the willingness to change schedule (more than half of the users think that they could make changes in their schedules) are not as low as expected, taking into account that there was not a real strong incentive to modify road driving behaviour. But of course this conclusion is based on the opinion of only 15 participants of the trial who were interested enough in the trial to answer the survey, and therefore maybe they are a little more sensitive about this kind of issues.

The responses about of the number of passengers shows that the majority (73%) travels with an extra passenger, this may have some effect in the fact that almost half of the respondents (47%) has no willingness to change their travel schedule. The flexibility of the users' habits is constrained when the changes affect more than one person, trend that could be even more pronounced by the fact that business is the main use of the vehicle.

In the results about of the change in the awareness of the users' consumes and how often the user check the online account are consistent, since a reduced knowledge of the consume leads to a low impact in the awareness.

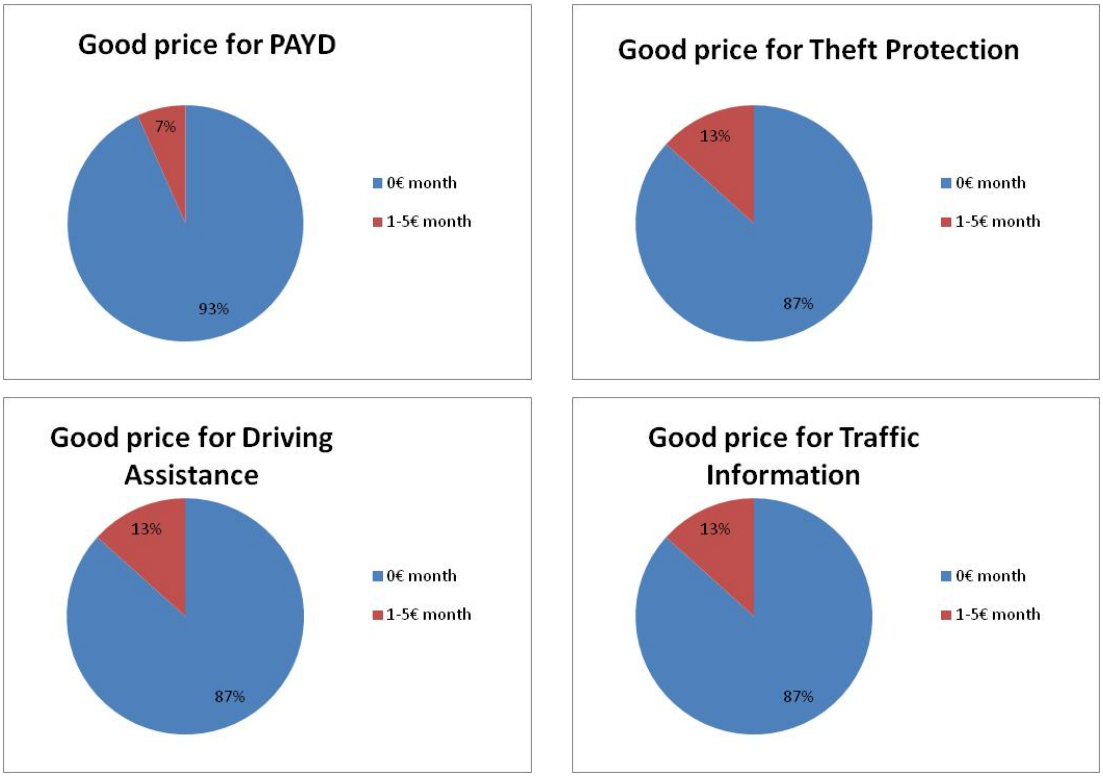
The general low impact of the trial agrees with the organizational issues and contextual situation in the Netherlands with respect to the ABvM together with privacy concerns and laws that are quite high in the Netherlands compared to other EU countries, which could justify part of the users' perception of the system, as explained before as well as the behaviour observed on their side, as presented in this section.

These results are consistent with the previous analysis on users' satisfaction about issues like information or invoicing, in accordance with conclusions about the serious impact of the lack of feedback with users. But of course, we must remember that all of the conclusions mentioned in this chapter are simply potential trends that could be obtained with a sample with a size more appropriate for this type of analysis.

The diverse answers about number of passengers may indicate that there is a possible willingness to accept a model in which the users share the vehicle at least with one passenger.

Good price: The evaluation of the user's willingness to pay for different GINA services provides information about how people feel about these issues.

Figure 9: Issues on the adequate price for the GINA system services

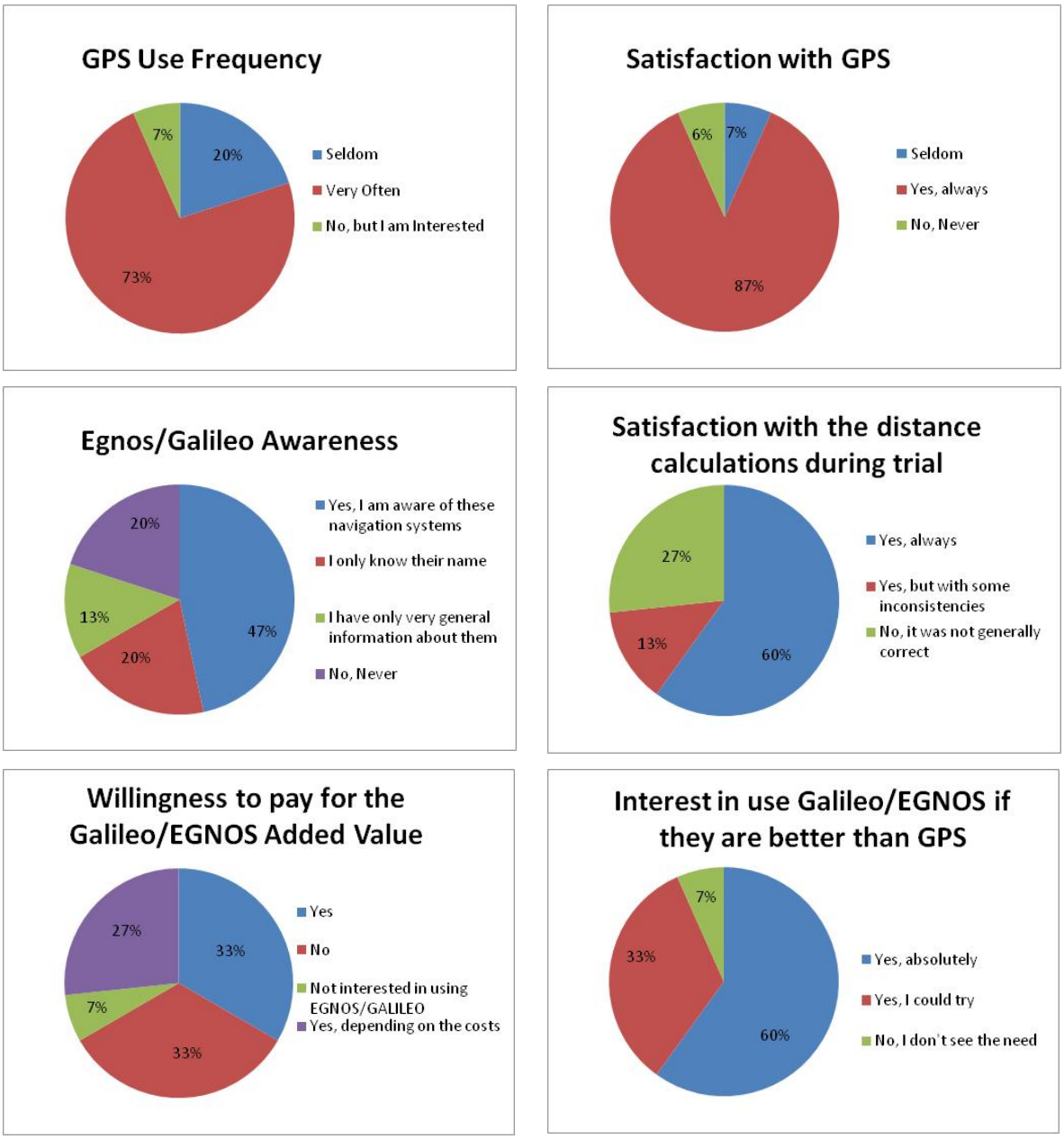


The figures show no willingness to pay for the PAYD scheme or any of the services mentioned in the survey like the theft protection, driving assistance or information about traffic and weather forecast. This result should not be taken as conclusive especially in the case of services related to information, as it is a common response to the right value for information, since people are used to paying for goods or services but so far, it is not really common to pay for information.

Considering that the volunteers were only asked to provide their feedback at the end of the trial period (even if there were some attempts to get interim feedback) for organizational reasons in the project, the low willingness to pay for services could be related to the decoupling of the provisioning of the answers and the trial period itself. This could have lead to an interpretation of the information a posteriori, with the observed effect. To this situation, it is necessary to add the possible loss of interest in the trial on the volunteers' side (also observed by the withdrawal of part of the drivers) which could be influenced by the different changes occurred in the Netherlands with respect to the deployment of the ABvM scheme. The information on the different services was at the volunteers' disposal and some of the questions included in the survey were related to the volunteers' interest in some services not necessarily tested as part of the trial, so it is not possible to relate directly their willingness to pay with their perception of the trial itself.

GPS and Galileo/EGNOS technology: The analysis of the user' perception of the existing GPS technology and their willingness to change to a new one has great importance for this project.

Figure 10: Issues on the GPS and EGNOS service perception



In general the figures indicate that users are used to satellite navigation technology (at least 73% uses GPS frequently) and that they seem very positive towards its utilization (87% is satisfied with GPS), even about Galileo/EGNOS project (at least 67% has any information about EGNOS, 93% is willing to try it and even 50% is willing to pay for their value added services), which could be a common response in a country like the Netherlands, where navigation technology has been in the market for a long period and where is possible to buy such an equipment in many stores.

There even is a willingness to pay for the VAS (Value Added Services) since at least 60% of the users were positive to this question, which is very interesting to future developments proposed by GINA project.

There is an important percentage of people (27%) who answered that distance calculation is not generally correct which could be due to the fact that the user's perception of the

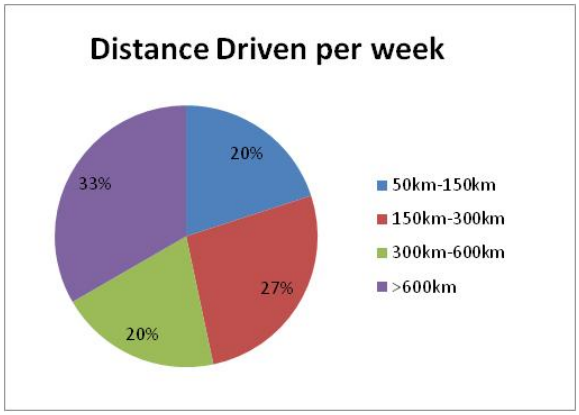
distance travelled does not necessarily include all kilometres driven. Most of the time people tend to have a more general view of the trip seeing it as the exact distance between origin and destination ignoring things like lane changes, the use of service lanes and further incorporations to main roads, etc. which might lead to some kind of misinterpretation of the real distance driven.

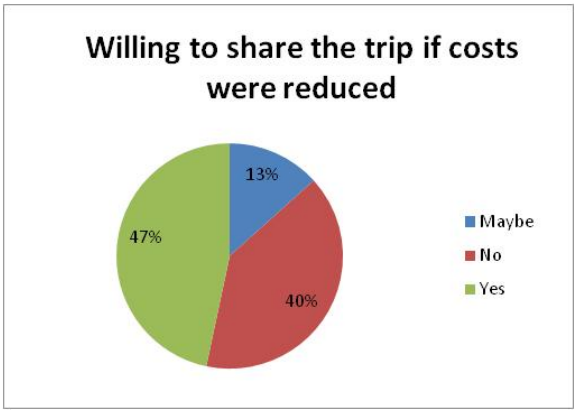
9.2. ANSWERS WITH DIVERSE RESPONSES

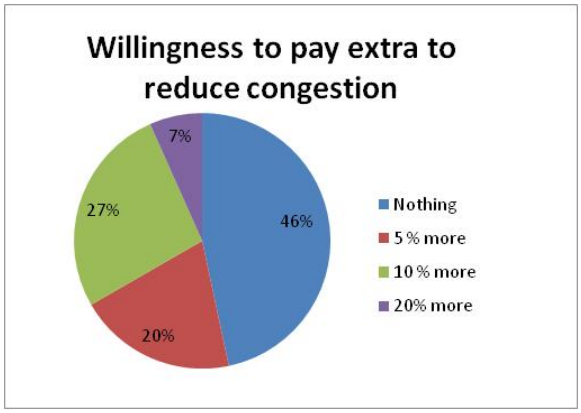
As mentioned before, there is a group of questions where the answer's diversification makes the analysis difficult. A bigger sample could show clear tendencies impossible to detect in this case.

It is worth pointing out that there are some evaluations in which the sample analysis is related not to a unique answer but to a multiple answer, in those cases the percentage associated to each option reflects the percentage of respondents that think that this particular choice is at least one of the possible answers to the question. For instance, in Figure 10, on the issue *Statements regarding adoption of a Road Charging Scheme* 28% of the respondents think that *Time Saving* could be one of his statements.

Figure 11: Issues with diverse answers about users' characteristics



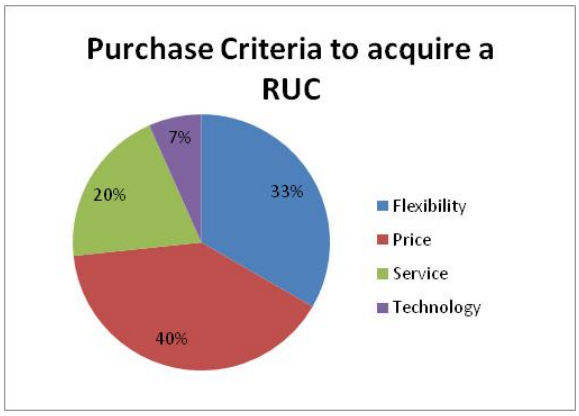


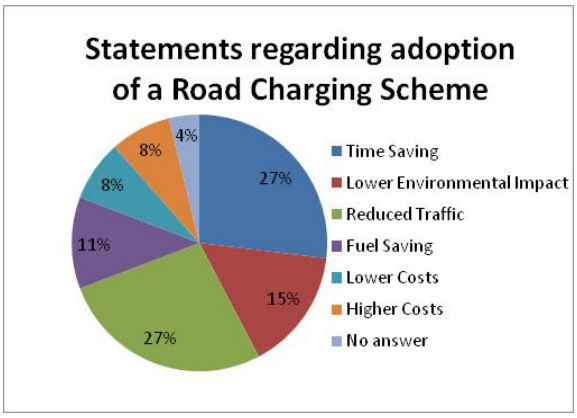


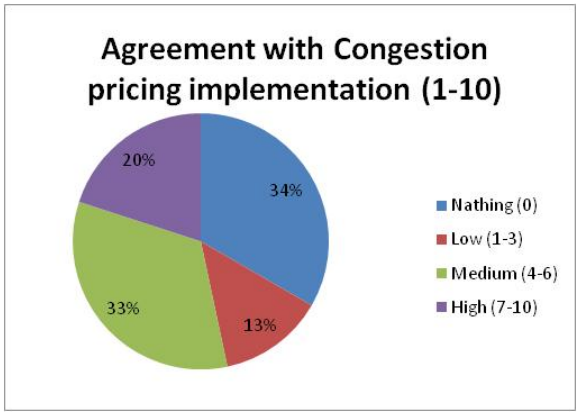
The finding that at least 60% of users may think about sharing their vehicle, convey to think that there seems to be no preference for travelling alone, and thus pricing differentiation by car occupancy could be well accepted.

Although responses about the willingness to pay to reduce congestion were diverse, the 54% of users that stated they would pay some amount in order to use less congested roads seems to give room for some kind of pricing schemes.

Figure 12: Issues with diverse answers about the implementation of charging schemes





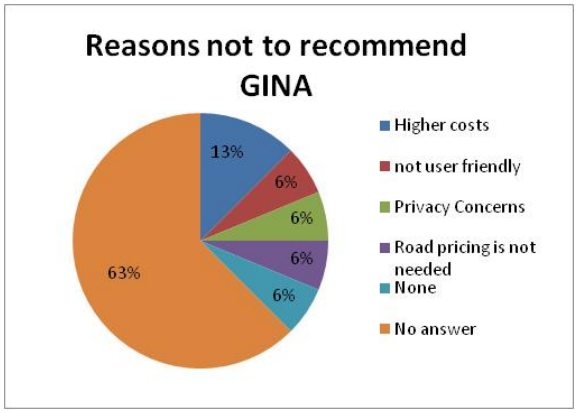


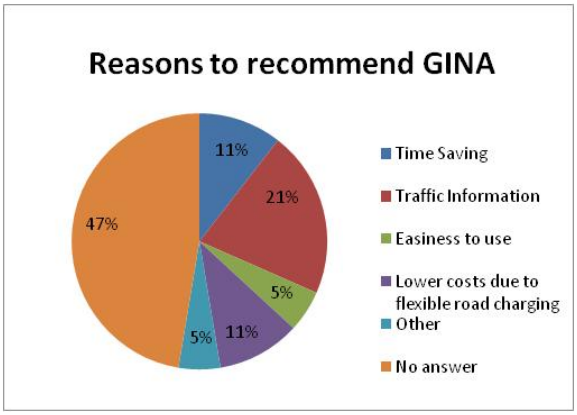
In general, the principal criteria for user's acceptance of RUC scheme are both, flexibility and price level.

Diverse answers were registered on the impact of the implementation of a road charging scheme which may be caused by the knowledge of the impact of similar measurements in other places.

The interpretation about the agreement with congestion pricing allow us to say that in this particular sample on this particular trial conditions with no monetary benefits for the participants, only a low percentage of people feel very positive towards the implementation of this type of scheme. This is also reasonable given the fact that a charging policy like this could easily perceived as negative if there is not a previous awareness of the possible advantages that its implementation could bring.

Figure 13: Issues with diverse answers about reasons to recommend GINA or not





The data evaluation on the two issues, made by a multiple answer analysis, includes a percentage marked with the option “No answer” that represents the respondents that did not choose any option at all. The analysis made it clear that the interpretation of this percentage is not related to a tendency to recommend or not the GINA scheme since, in every case but one, the people who did not answer the first question did not answers the second one either.

About the reasons not to recommend GINA, although the opinions were divided, notice that the bigger percentage, from the people that actually answer the question, thinks that with the measurements implemented under GINA scheme there will be a cost increment for users. Then it is of great importance to take this on account during phase of the implantation of GINA in order to make the public aware that there is a way to avoid a cost raise and that is by modifying driving behaviour.

In general is remarkable the low response on these two questions, no more than 6 respondents choose one or more option on these subjects, which reduces even more the reliability of any conclusion related with the analysis this data.

10. CONCLUSIONS AND RECOMMENDATIONS

The feedback from trial participants required to obtain any information related with users' perceptions of the implementation of GINA road pricing measurements, as the ones considered with GINA, was not as initially expected. Organizational reasons related with the project led to a collection of information about the participants' perceptions, gather when the tested period was over, this combined to a reduced sample size of respondents volunteers, carried some difficulties in the analysis, allowing an interpretation of potential trends that cannot be considered as statistically significant. This situation was a combination of factors present in the Netherlands and the volunteers, such as the current frozen state of the Dutch fee collecting system together with privacy laws that had an impact in the volunteers' willingness to the use the online tools for feedback retrieval. The fact that no direct links or incentives were present with the volunteers led to several attempts to encourage them to fill the required data but always in a voluntary basis thus leading to the final status where no statistical significant sample could be obtained. Future test campaigns should consider this outcome in order to provide more benefits for users testing the system in order to encourage a greater involvement from their side.

Therefore, an alternative approach was implemented in this document. The compilation of literature about trials with some resemblance to the demonstration programmed in the GINA project made it possible to assess user's likely reactions and behavioural change due to this type of scheme implementation.

As stated by the existing literature, road pricing acceptability can be mainly defined by a few facets that must be correctly accounted in order to promote the scheme implementation. In short, those can be listed as: congestion severity, freedom of choice, perceived effectiveness, revenue allocation and equity impacts. While users travel behavioural response depend on the specific pricing implementations, as the variable priced (distance, rush-hour and car occupancy), the tolls locations (area, cordon and zones) and the particular travel patterns due to job/residence location.

In terms of acceptability, the severity of traffic problems increases user's awareness of the impact of car usage on congestion and city environmental quality, in order to establish a positive framework towards a transportation policy change from the status quo. Then to assure a good implementation of a system like GINA promoting user's awareness by a communication campaign, informing broad population about the congestion impacts and how effective travel demand management initiatives could be, is essential.

Also, to achieving certain level of acceptability, it is important to establish enough travel alternatives to give users a certain degree of choice adapting their behaviour by their own preferences under the pricing scheme. It must be noted that different users value travel options in very different ways, thus the objective must be to set a non excessive coercive framework assuring that travel options does not differ much on service level and generalized cost, allowing users to choose under their personal attitudes.

Perceived effectiveness is a subjective perception of congestion reduction and network performance in relation to their personal outcome from the pricing scheme. Thus it is important to assure that pricing scheme reaches a certain congestion reduction threshold, as it must be easily noticed by users without additional communication campaigns, which objective must be only to reinforce the evidences.

As stated by research, the revenue allocation is a major concern for scheme acceptability as it has a huge impact on fairness perception and equity. The use of the revenues raised by the pricing scheme should be devoted to increase travel options (public transport and network improvements), reduce regressive impacts on low income groups and disadvantages among territories due to higher travel costs.

Besides the information gathered from the literature review, the present document also includes a basic analysis of the survey answered by some of the participants of the E2E trials. As mentioned before, these results must be considered as preliminary conclusions since the lack of statistical significance given from the analysis of only 15 respondents. However, the analysis of this information allows us to indicate possible trends in user's behaviour.

With the methodology implemented, cases in which the users had an important coincidence in their response were identified as this allowed to suspect a potential trend and not a simple coincidence.

A general analysis of the answers given by the respondents suggests that not very frequent communication between users and operator –as this was not conceived as a commercial service but as a pilot- had an impact in users' perception, leading them to an apparent lack of motivation about some of the services (and especially about the payment for them). Although, it is also important to mention that a standard user will prefer the best conditions and services for free and that a direct question about any payment would probably lead to a negative response.

The general low impact of the trial agrees with the organizational issues and contextual situation in the Netherlands with respect to the ABvM, which could justify part of the users' perception of the system, as explained before as well as the behaviour observed on their side.

The evaluation of the fairer pricing reinforces the idea that user need an structured pricing framework in order to evaluate their travel options in advance then if variable pricing is meant to be applied it may have some pricing boundaries to avoid user's aversion to uncertainty.

Despite willingness to pay for the value added services initially stated by the users in a general question, on a subsequent evaluation on each of the possible GINA services based on a specific payment there is an apparent lack of interest, possibly motivated by the fact that users already have this free information available before journey departure through the internet or mobile phones. Taking this into account to assure the best possible scenario, when this type of services go on the market, the operator should send a clear message to the user of the benefits of these services compared to other sources of information.

In the design of the particular conditions of GINA RUC scheme, special consideration should be given to characteristics of demand, as the indicator of the vehicles occupancy and the willingness of the users to increase the value of this indicator if there is a reduction of the costs, since it seems to be a relation between price, the number of passengers and the flexibility to change route or travel schedule.

The demand elasticity evaluation, with a quality limitation given by the characteristics of the sample, indicates a certain tendency to a willingness to pay an extra small amount of the travel expenses in order to use less congested roads (slightly more than half of respondents agree to pay at least 5%). Although this information is important in the design of the RUC scheme, it is clear that a stronger analysis with an adequate statistical significance should be done, bound to a complete study of the potential impact of the charges on the congestion.

The conclusions regarding the navigation technology implemented for the system indicates that the user is in general satisfied with the service of the existing technology and there is a general acceptance towards the use of equipment using information provided by Galileo/EGNOS but only if there is not a reduction in the quality of the service.

Given the low response about the users' opinion on the reasons to recommend or not GINA charging scheme, is clear that is not possible to conclude something on this issue and therefore the overall impression that GINA can create on the public should be define with a different approach.

Finally the consolidation of the information from both, the literature reviewed and the End-to-End final survey, allows us to say that there are reasons to believe that a successful experience in the implementation of a charging scheme (like the one analyzed in the GINA project) requires to take good care of the relation with users with real incentives to keep them involved and strategic measures that guarantee a regular contact with the users and an appropriate and constant feedback from them, allowing an easy access to high quality information.

11. VAS IMPLEMENTATION TRIALS

The VAS IMPLEMENTATION trial with ASCENDI was added to the GINA project as an extra trial with the objective to evaluate the usage of GNSS systems on a different environment. With the end-to-end trial it is expected to evaluate the usage of GNSS systems from a national authority's point of view by way of Road User Charging (RUC) mechanisms and from the end user's perspective by using VAS.

On the VAS IMPLEMENTATION trial the idea was to evaluate the benefits of using GNSS technology from the perspective of a highway concessionaire.

The initial expectations for the trial were that ASCENDI, as an operator with a big highway network and several control centres, could determine whether GNSS could assist them in solving some of the difficulties that affect their daily activity. The main idea was that some new features could be developed to help in ASCENDI daily activities.

Since the beginning, 3 potential areas have been identified where GNSS could be applied:

1. Maintenance vehicle tracking
2. Legal obligations compliance
3. DSRC RUC versus GNSS RUC Comparison.

Because ASCENDI had some vehicles that are always monitoring the highway, the first obvious idea was to equip the vehicles with OBUs, thereby monitor the vehicle locations and use that information to increase the capacity to manage the teams on the field. To accomplish this task it was necessary to create an application which included map information so that vehicle locations over the highway network could be easily identified by personnel at the control centre.

During the highway monitoring, the teams on the field need to report to the control centre the moment they pass by pre-defined check points. This task is currently performed via radio and manually stored on a database at the control centre. The information collected manually is used later by ASCENDI to prove to the national authorities that the highway monitoring is compliant with the legal obligation. Based on this requirement, the second application to be implemented for the VAS IMPLEMENTATION trial was to try to automate this task by automatically detecting passage of the check points, using the GNSS locations reported by the OBU, and counting at the end of the day the number of times each check point has been visited by the patrols. With the usage of an automatic system it was expected to have a reliable system able to give accurate values of the vehicle activities, and thus provide a valid proof of vehicle activities, supported by GNSS, instead of a manual registry.

This trial used GPS-only antennas, which were sufficient to demonstrate that contractual obligations could be enforced. On a real system, GPS-only is not enough, since GPS is not compliant with safety and liability critical systems. With the introduction of EGNOS / Galileo with better measurement accuracy and availability, contractual obligations can be proved since these are compliant with liability critical systems, such as PAYD, RUC, or in this case, patrol routes verification.

Another idea discussed with ASCENDI at the beginning of the trial was the possibility to identify the exact location, time to arrive and assistance time of the incidents that happened on the highway, by analysing the position and vehicle velocity reported by the OBU. The objective was to compare the time and position reported manually with the automatically calculated positions.

The last objective expected from the VAS IMPLEMENTATION trial was the possibility to make a comparison between the tolling system methods that are used in all Portuguese highways named Via Verde based on DSRC technology with a possible usage of GNSS technologies for the same purpose.

At the end of the trial, it was expected to collect the opinion from ASCENDI to understand the benefits that the developed functionalities had brought to them.

Due to some reasons that are explained in the next chapters, not all the initial ideas proposed to the trial were possible to execute. In addition, ASCENDI personnel were not available at the end of the trial to provide any feedback about the developed functionalities. Therefore, all the considerations and conclusions present on this document are provided by GMV-SKYSOFT based on system installation, regular monitoring of the developed tools and some contacts with the ASCENDI persons during the project time frame.

It is also important to note here that this trail was proposed as an additional trial and was not integrated as a GINA project core activity. For that reason, the resources devoted to this trial have been reduced compared to other GINA key activities.

TRIAL ANALYSIS

11.1.1. OPERATIONAL SYSTEM

The purpose of this functionality was to create an application to be installed in one of ASCENDI control centres to be used by the operators to monitor the ASCENDI vehicle locations over the highway network. The main benefit of this feature by ASCENDI was the possibility to monitor the location of their teams in the field in real time. In addition, the application developed was also displaying the street name for the vehicle position and the actual velocity. We must emphasize here that the real-time vehicle velocity information was highly appreciated by the responsible personnel at the control centre. During the highway monitoring activities, the vehicles should not exceed the velocity of 80km/h and the application gave them the opportunity to have some control on this point. Having access to the velocity information, it was also very easy to identify if a vehicle was stopped. That condition could be used as a trigger to a contact via radio with the team on the field to identify if there was any problem or to identify a case where the team was giving some help to an accident.

In the cases where an accident was reported by a highway user via phone, for example, it was also simple to identify which was the vehicle that was closer to that point and allocate the right team for the assistance.

During the trial period some technical problems happened on the central system that did not allow the application installed on the ASCENDI control centre to present the real time vehicle location. In addition, one of the OBUs had a problem on the communication module.

After the corrections of these technical problems, that include the installation of a new software version on the control centre and the replacement of the OBU, the trial was restarted.

All the problems that happened during the first phase affected the credibility of the system and we think that the ASCENDI operators on the control centre loosed the confidence and the interest on the application. During the second phase that started in October all the systems performed well but, despite several attempts, it was not possible to collect any reaction or feedback for the usage of the developed application.

REPORTING SYSTEM

The purpose of this functionality was to automate the task that today is made manually by an operator on the ASCENDI control centre. With the OBUs installed on the ASCENDI vehicles, reporting their location on a regular basis, the developed system is automatically storing all the positions on a central database. At the end of the day an automatic task was started to compare the vehicle positions with some predefined areas. These areas were defined to match the check point locations that are used today by the vehicle drivers to manually report their passage to the control centre.

Using the result of the location analysis, a web page was implemented to give to the ASCENDI control centre responsible personnel a way to analyse the highway monitoring coverage. For a time period specified by the user, the number of times a check point has been visited by all the vehicles is presented, highlighting the cases in which the minimum contractual value was not reached.

The second step for this functionality was to compare both, the manual and new automatic method, by importing the file that is manually built by the operators at the control centre into the system and comparing the entries with the automatic registration made by the newly developed system. The result is also presented on a web page allowing the ASCENDI personnel to easily compare the values.

At the end of the development of these functionalities, in spite our efforts; there was no availability from ASCENDI to comment or give any feedback on the usage of these reports. Using the information available on the web page, we expect that ASCENDI has made 2 types of analysis.

First it was possible to evaluate the highway monitoring coverage. In most of the cases, we confirm that the minimum number of visits to each check point was reached, proving that ASCENDI is being compliant with the legal contractual obligations.

The second analysis was to compare the automatic counting of passages with the manual report. In this case we can check that the values are always very similar and in some cases the values automatically extracted from the GNSS system exceed the manual entries. This result should give confidence to ASCENDI that the actual way the report is being made is giving correct values. The vehicle drivers and the persons at the control centre are not making big mistakes with the manual registration apart from the accurate registration time. For example, some discrepancies have been noted on the reported time with an error of a few minutes that do not affect the passage counts. In some cases the automatic system had some extra passages that were identified has passages after the end of the inspection period. This result also shows that clearly this task could be automated using an application similar to the one developed for this trial instead of using a person to make the manual registration of the highway inspection.

11.1.2. DSRC RUC VERSUS GNSS RUC COMPARISON

At the beginning of the trial, ASCENDI has demonstrated interest in the comparison of the actual highway tolling method based on DSRC with a possible method based on OBUs installed on the vehicles reporting their locations.

It was discussed that it should be possible to calculate the highway tolling based on the effective distance covered by the vehicle or by the usage of geo-referenced gateways on each highway entrance with a predefined tariff between them.

On a second meeting with ASCENDI staff responsible for the Control Centre and maintenance vehicles we found that on the daily inspection activities there are cases where the vehicles are not passing on the “Via Verde” tolling system. The vehicles are using

service roads to enter and to exit the highway meaning that there are not so much registrations of the ASCENDI vehicles in the “Via Verde” system. With this information, ASCENDI decided that it was not so relevant to do this comparison and the feature development was abandoned.

CONCLUSION

At the beginning of the trial, the definition of the required features was made with the ASCENDI staff responsible. The communication with the end user did not happen and the necessity of an information/training session was never evaluated during the trial. In addition, during the trial execution there were several technical problems on the central system and on the OBUs. All these problems together, affect the credibility of the system and the end users never felt fully involved on the project. In addition, this trial was considered as an add-on to the main trail executed on the GINA project, meaning that the development was made with the involvement of limited resources what could have also a reason for less contact with the end user and their subsequent lack of interest.

As a result of this lack of involvement, at the end of the trial there is no feedback available to fully evaluate the result of the trial and to make a critical analysis of the results.

At the end of the trial we were expecting to validate the following points for the developed features:

Using the operational system the control centre operators should be able to improve the management and monitoring activities of the teams on the ASCENDI vehicles.

With the report system, the ASCENDI responsible personnel should have a new way to control and evaluate the highway monitoring tasks based on a system that is automatic and do not need human intervention that could introduce registration errors.

Even without a real feedback from ASCENDI, as a general conclusion, the results presented at the end of the trial show that a highway concessionaire could benefit from using GNSS technologies on their daily activities.

The daily activities can be simplified, the management of the teams spread on the highway could be enhanced and new activity reports could be developed.

12. REFERENCES

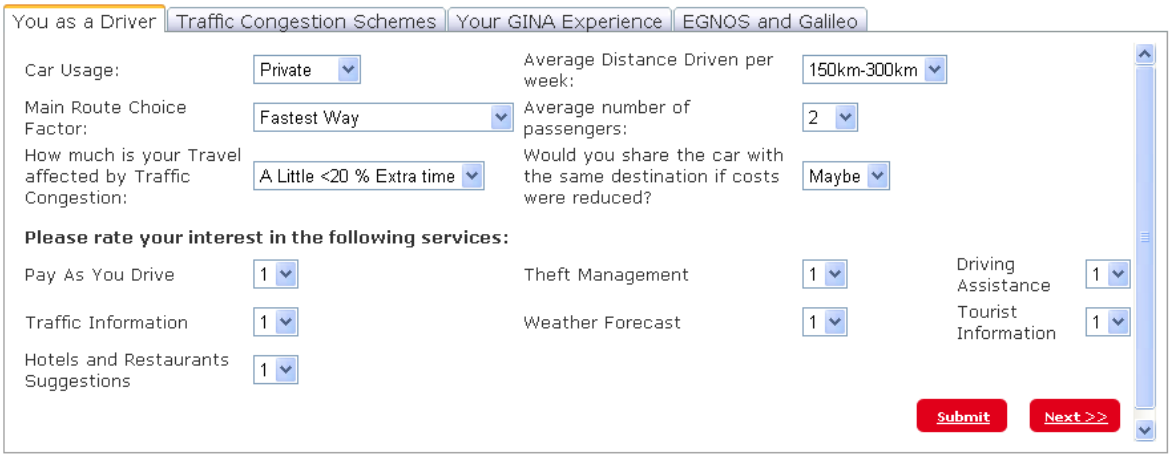
The following documents, although not part of this document, amplify or clarify its contents. Reference documents are those not applicable and referenced within this document. They are referenced in this document in the form [RD.X]:

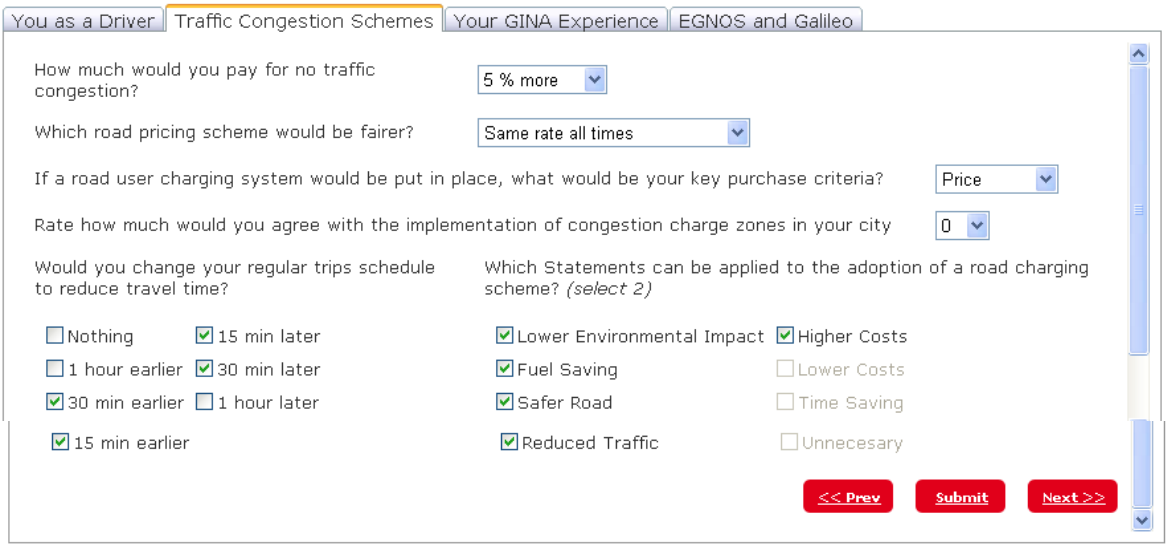
Ref.	Title	Authors	Version	Date
[RD.1]	Compilation of Public Opinion Data on Tolls and Road Pricing; *Transportation Science. 34(1), 37-49*	Zmud, J. & Arce, C.		2008
[RD.2]	Public acceptability change of urban road pricing schemes; *Proceedings of the Institution of Civil Engineers. Transport 161.*	Gelhert, S. et al		2008
[RD.3]	National Road Pricing: Policy Design and Public Acceptance; *International Trade Center–Co-Ordination of Urban Road-User Charging Organisational Issues*	Glaister, S		2007
[RD.4]	The Stockholm Trials: Congestion Charge in Stockholm; *Impact Workshop on Implementing Congestion Charging, Stockholm.*	Hugosson, M.B.		2007
[RD.5]	The social support for policy measures in passenger transport. A statistical analysis for the Netherlands; *Transportation Research D, 4 (3), 181-200.*	Rienstra, . et al		1999
[RD.6]	Acceptability of urban transport pricing strategies; *Transportation Research F, 6, 45-61.*	Schade, J. & Schlag, B.		2003
[RD.7]	The AKTA road pricing trial in Copenhagen; *10th International Conference on Travel Behaviour Research*	Nielsen, O.A. & Jovicic, G.		2003
[RD.8]	Acceptability of urban transport pricing; VATT Research reports (AFFORD project)	Schade, J. & Schlag, B.		2000

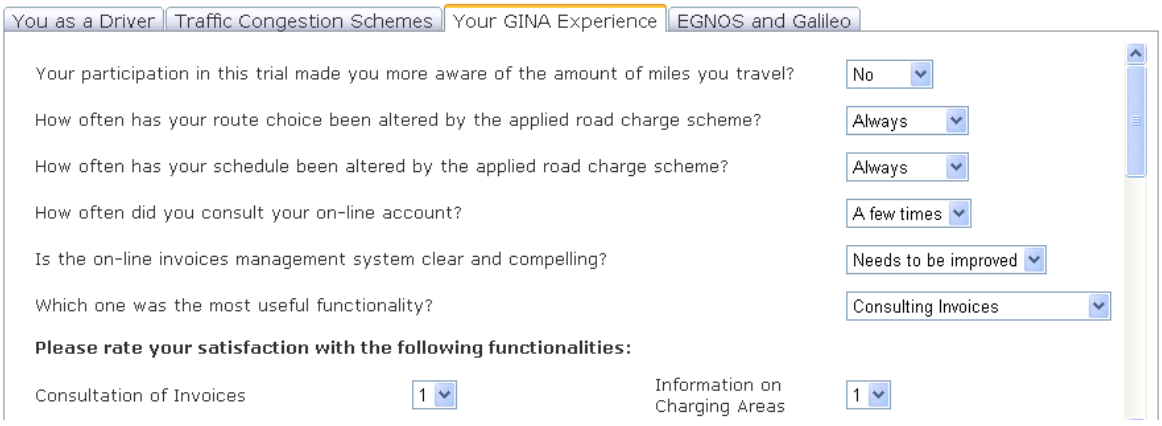
Table 11 - Reference Documents

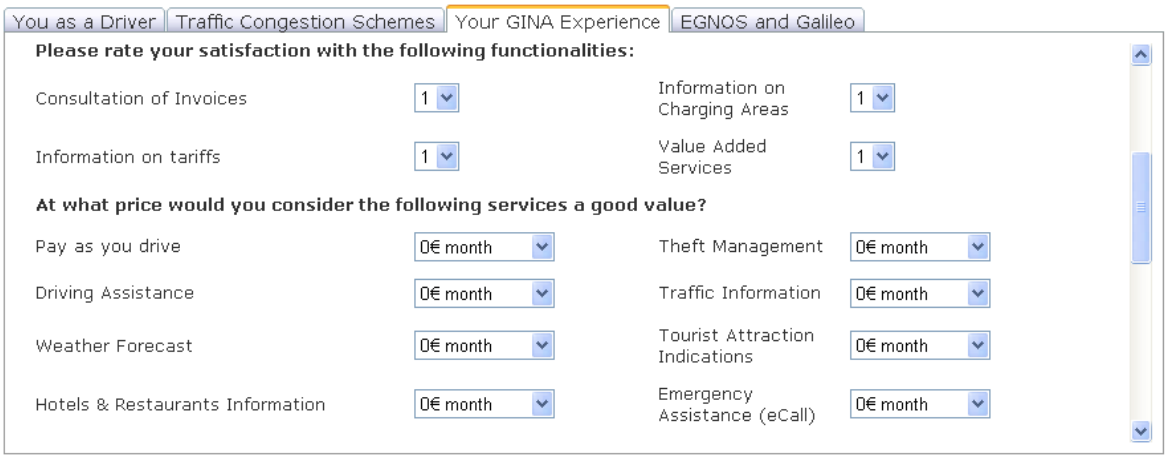
APPENDIX 1 – PARTICIPANT SURVEY

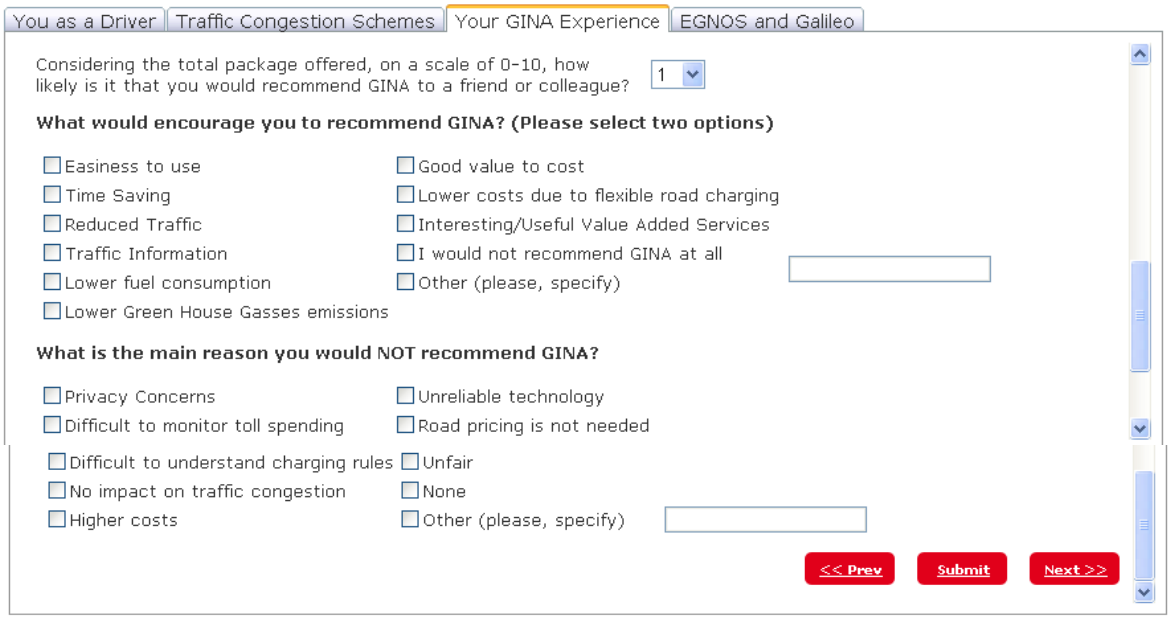
Screen shots of the survey from the E2E trial.

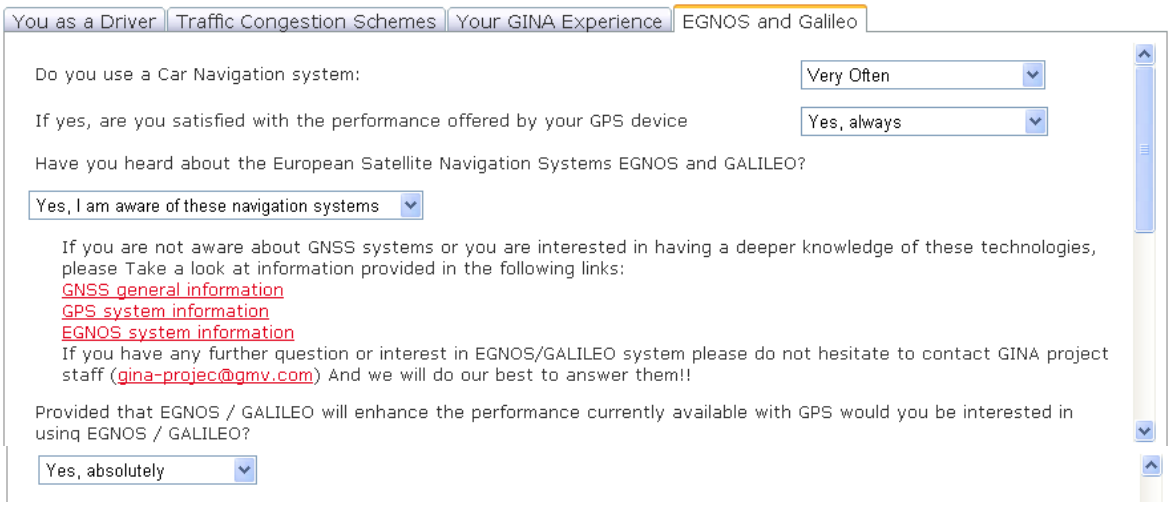






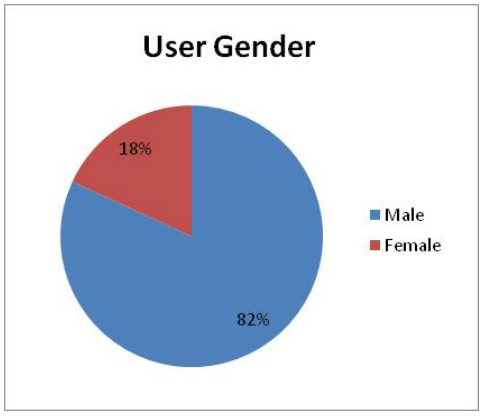

You as a Driver
Traffic Congestion Schemes
Your GINA Experience
EGNOS and Galileo
Please rate your satisfaction with the following functionalities:
Consultation of Invoices
1
Information on Charging Areas
1
Information on tariffs
1
Value Added Services
1
At what price would you consider the following services a good value?
Pay as you drive
0€ month
Theft Management
0€ month
Driving Assistance
0€ month
Traffic Information
0€ month
Weather Forecast
0€ month
Tourist Attraction Indications
0€ month
Hotels & Restaurants Information
0€ month
Emergency Assistance (eCall)
0€ month

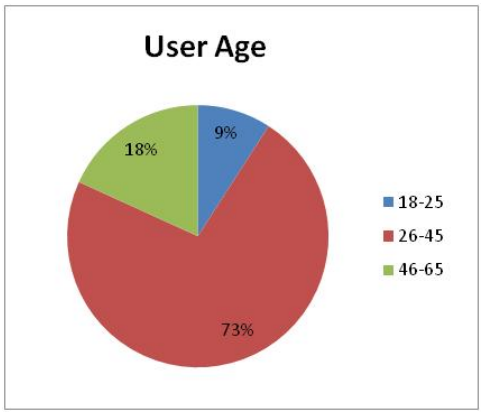

You as a Driver
Traffic Congestion Schemes
Your GINA Experience
EGNOS and Galileo
Considering the total package offered, on a scale of 0-10, how likely is it that you would recommend GINA to a friend or colleague?
1
What would encourage you to recommend GINA? (Please select two options)
Easiness to use
Good value to cost
Time Saving
Lower costs due to flexible road charging
Reduced Traffic
Interesting/Useful Value Added Services
Traffic Information
I would not recommend GINA at all
Lower fuel consumption
Other (please, specify)
Lower Green House Gasses emissions
What is the main reason you would NOT recommend GINA?
Privacy Concerns
Unreliable technology
Difficult to monitor toll spending
Road pricing is not needed
Difficult to understand charging rules
Unfair
No impact on traffic congestion
None
Higher costs
Other (please, specify)
<< Prev
Submit
Next >>

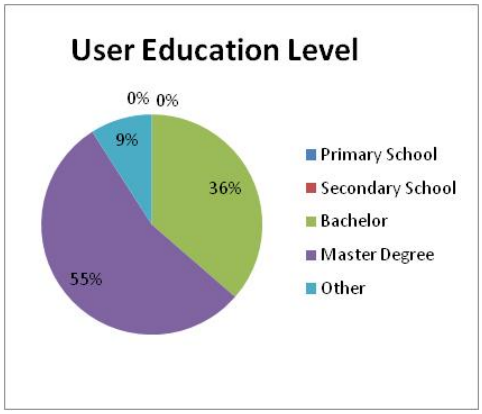

You as a Driver
Traffic Congestion Schemes
Your GINA Experience
EGNOS and Galileo
Do you use a Car Navigation system:
Very Often
If yes, are you satisfied with the performance offered by your GPS device
Yes, always
Have you heard about the European Satellite Navigation Systems EGNOS and GALILEO?
Yes, I am aware of these navigation systems
If you are not aware about GNSS systems or you are interested in having a deeper knowledge of these technologies, please Take a look at information provided in the following links:
GNSS general information
GPS system information
EGNOS system information
If you have any further question or interest in EGNOS/GALILEO system please do not hesitate to contact GINA project staff (gina-projec@gmv.com) And we will do our best to answer them!!
Provided that EGNOS / GALILEO will enhance the performance currently available with GPS would you be interested in using EGNOS / GALILEO?
Yes, absolutely

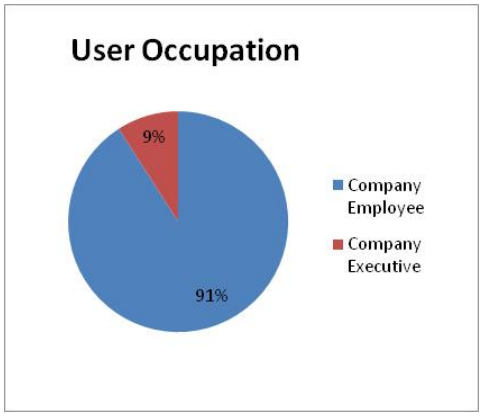
APPENDIX 2 – SAMPLE STATISTICS

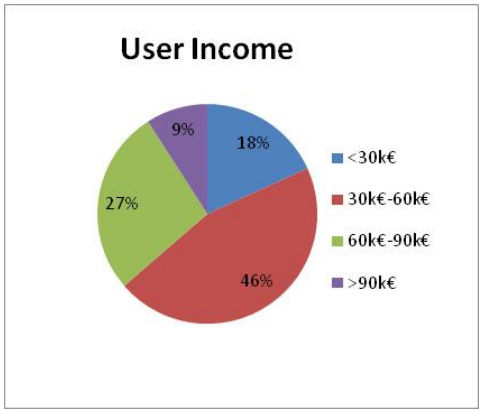
The following figures describe characterization of the sample.

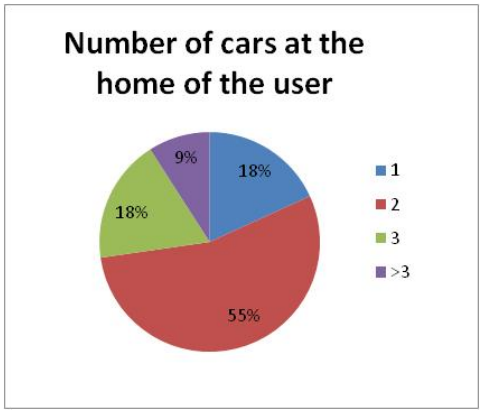












APPENDIX 3 – GEO OBJECTS

A corridor geo-object in the End-to-End trials is generally defined as four points of a rectangle surrounding an appropriate road segment as shown in **Figure 14**. The distance is then determined by measuring the length of the road segment (centre lane approximately) from one side of the geo-object to the other.

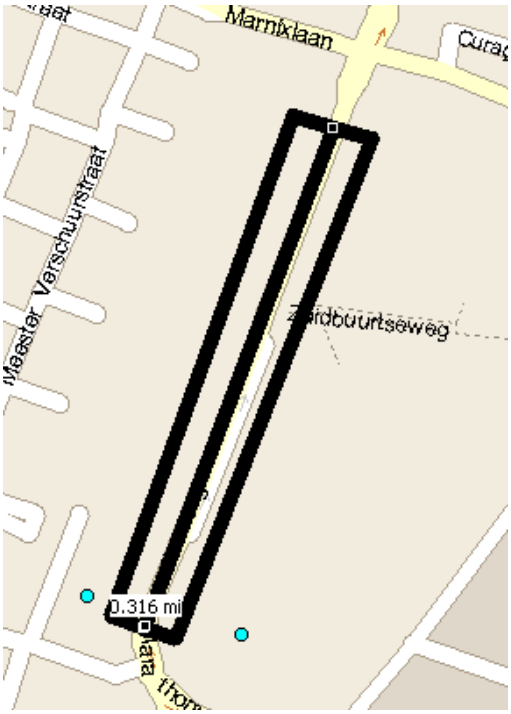


Figure 14: Example corridor geo-object

Name	Longitude	Latitude	Distance from map (km)
A325 1.1	5.87358	51.91396	0.671
A325 1.2	5.87442	51.91394	
A325 1.3	5.87259	51.90794	
A325 1.4	5.87335	51.90793	
A325 - N325 1.1	5.85783	51.88461	1.08
A325 - N325 1.2	5.8602	51.88463	
A325 - N325 1.3	5.8588	51.87489	
A325 - N325 1.4	5.85991	51.87487	
N325 bridge 1.1	5.86925	51.85331	0.504
N325 bridge 1.2	5.87083	51.85363	
N325 bridge 1.3	5.87157	51.84897	
N325 bridge 1.4	5.87329	51.8494	
Heyendaalseweg 1.1	5.86989	51.82726	0.147
Heyendaalseweg 1.2	5.86989	51.82707	
Heyendaalseweg 1.3	5.86835	51.82612	
Heyendaalseweg 1.4	5.86873	51.82595	

A20 1.1	4.34191	51.921	0.451
A20 1.2	4.34221	51.92051	
A20 1.3	4.33581	51.91949	
A20 1.4	4.33606	51.91897	
Marathonweg 1.1	4.32405	51.90836	0.509
Marathonweg 1.2	4.32514	51.90816	
Marathonweg 1.3	4.32153	51.90409	
Marathonweg 1.4	4.32241	51.90389	
Deltaweg 1.1	4.32376	51.90196	0.342
Deltaweg 1.2	4.32358	51.90162	
Deltaweg 1.3	4.32848	51.90104	
Deltaweg 1.4	4.32843	51.90081	
Jan Glijnisweg 1.1	4.85661	52.65771	0.856
Jan Glijnisweg 1.2	4.85782	52.65709	
Jan Glijnisweg 1.3	4.84721	52.65262	
Jan Glijnisweg 1.4	4.84845	52.65186	
De Staart 1.1	5.13352	52.02457	0.397
De Staart 1.2	5.13425	52.02523	
De Staart 1.3	5.1393	52.02387	
De Staart 1.4	5.13969	52.02452	
A27 1.1	5.12586	52.02047	0.5
A27 1.2	5.12667	52.02028	
A27 1.3	5.12946	52.02447	
A27 1.4	5.13021	52.02415	
A27 2.1	5.1161	52.00732	1.11
A27 2.2	5.11722	52.00722	
A27 2.3	5.11237	51.99762	
A27 2.4	5.11361	51.99749	
A27 3.1	5.1597	52.07986	1.13
A27 3.2	5.16081	52.07961	
A27 3.3	5.14989	52.07157	
A27 3.4	5.15176	52.071	
Rondweg 1.1	5.15741	52.01629	0.337
Rondweg 1.2	5.15851	52.01586	
Rondweg 1.3	5.16154	52.01812	
Rondweg 1.4	5.16201	52.01783	
Houtensewetering 1.1	5.16128	52.02035	0.21
Houtensewetering 1.2	5.16101	52.02014	
Houtensewetering 1.3	5.16357	52.01946	
Houtensewetering 1.4	5.16341	52.01929	
Houtensewetering 1.5	5.1629	52.01956	
Houtensewetering 1.6	5.16304	52.01951	
A4 1.1	4.32674	52.03039	0.652
A4 1.2	4.3277	52.03005	
A4 1.3	4.33325	52.03475	

A4 1.4	4.33385	52.03436	
Lange Kleiweg 1.1	4.3405	52.02647	0.595
Lange Kleiweg 1.2	4.34126	52.02681	
Lange Kleiweg 1.3	4.34661	52.02257	
Lange Kleiweg 1.4	4.34716	52.02292	
Lange Kleiweg 2.1	4.32462	52.03759	0.235
Lange Kleiweg 2.2	4.32409	52.03733	
Lange Kleiweg 2.3	4.32697	52.03603	
Lange Kleiweg 2.4	4.32644	52.03582	

APPENDIX 4 – USER BILLING ONLINE PLATFORM DETAILS

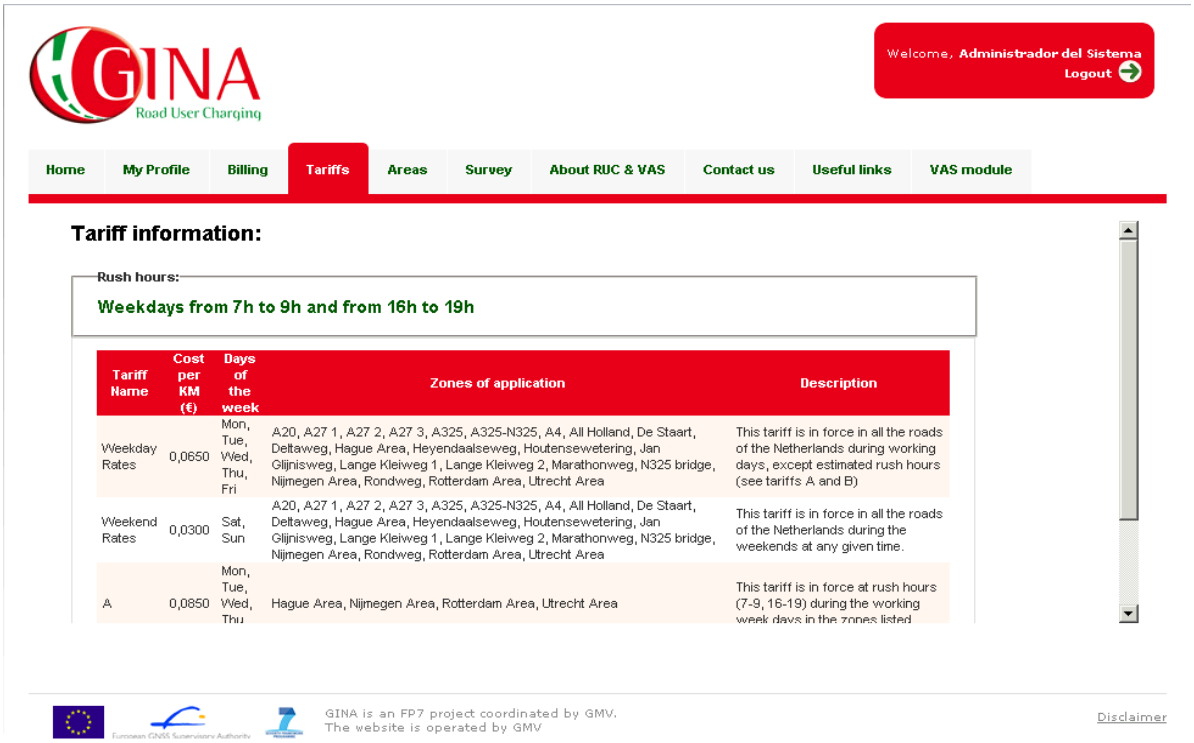


Figure 15 - User Tariffs definition & description

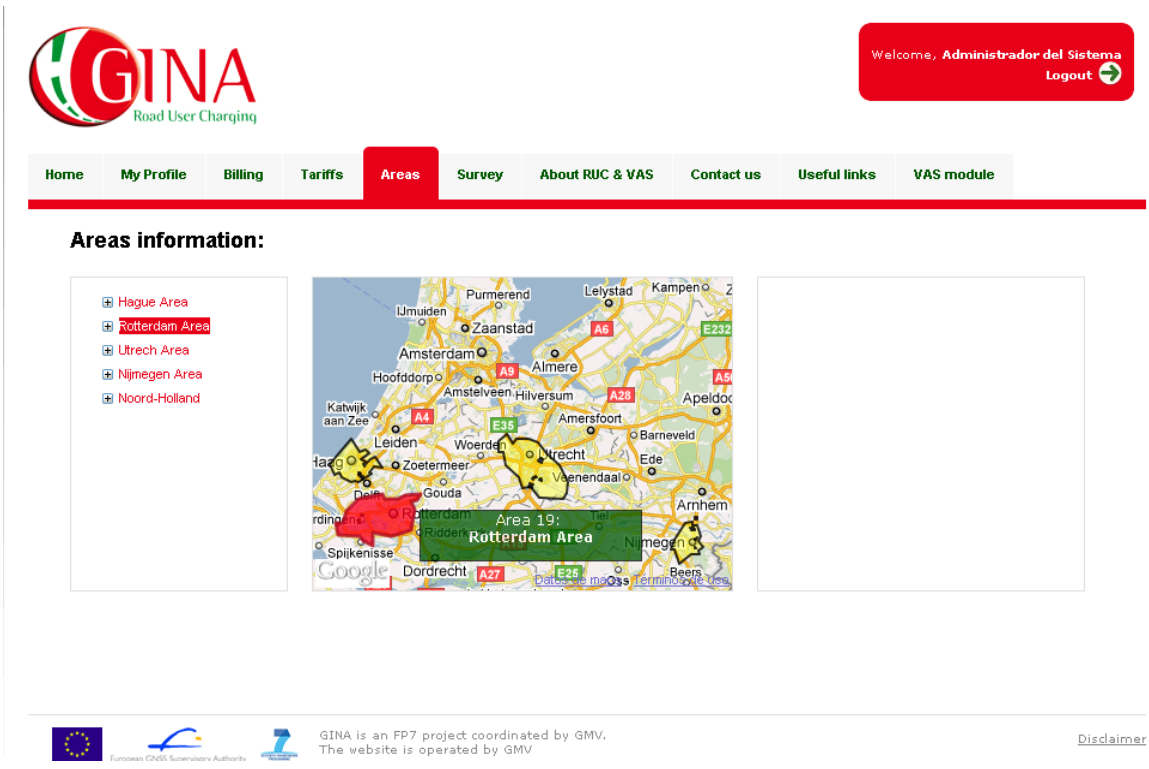


Figure 16 - Charging Zones information & description

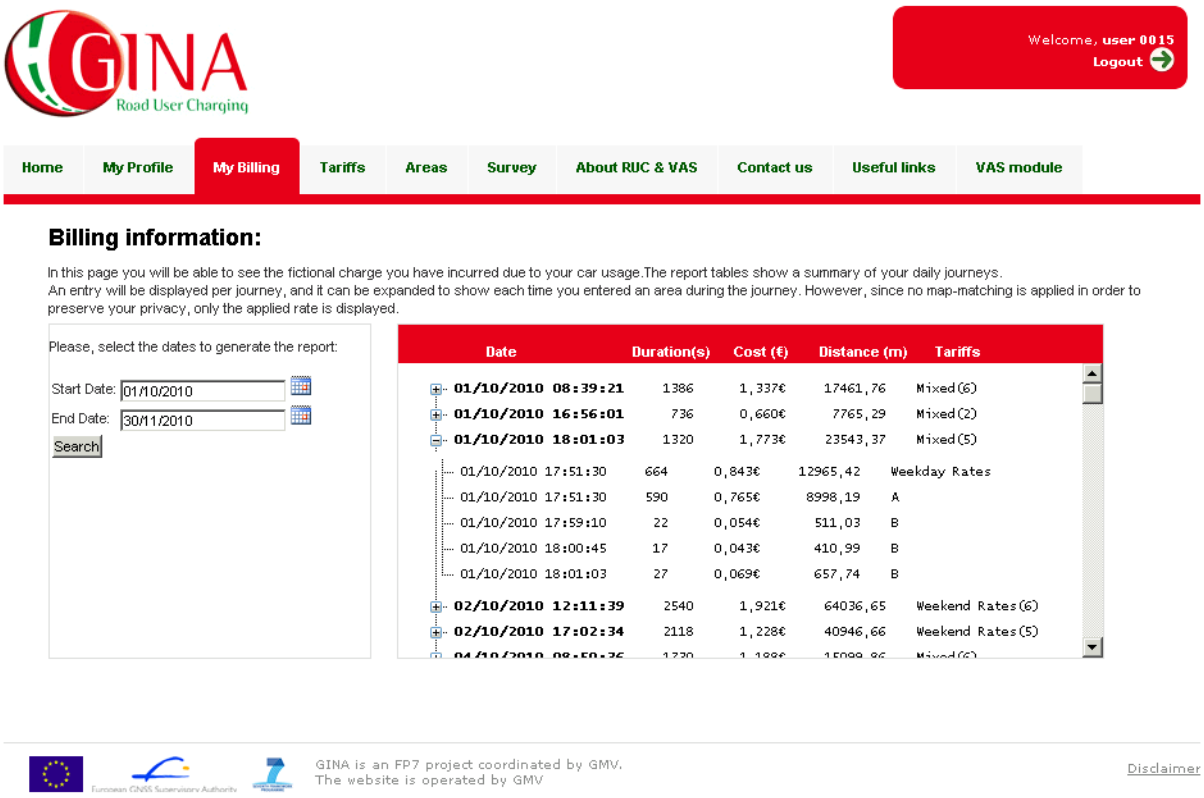


Figure 17 - User Billing Invoice details & breakdown

END OF DOCUMENT