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LIST OF ABBREVIATIONS

ABBREVIATION	DESCRIPTION
DFOT	Detailed Field Operational Test
DoW	Description of Work
FOT	Field Operational Test
LFOT	Large Scale Field Operational Test

ND	Nomadic Device
WP	Work Package

REVISION CHART AND HISTORY LOG

REV	DATE	AUTHOR(S)	REASON
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EXECUTIVE SUMMARY

This deliverable reports on the Usability activities undertaken in TeleFOT mainly within WPs 4.8 and 4.10. These planned to support the Sub-Project 4 of TeleFOT in Evaluation and Assessment of nomadic devices within the national Field Operational Tests (FOTs). The key objective of WP4.8 in this regard is to provide measurable data that allows comparing usability and user experience of different driver assistance services whilst the key objective of WP4.10 is to identify and define the target and actual technical performance metrics for the Nomadic Devices (NDs) used.

Two approaches are described in this Deliverable which have been utilised within TeleFOT for evaluating the usability of the nomadic and aftermarket devices tested within the TeleFOT FOTs. The first approach describes the feedback received from the TeleFOT participants with regard to their user experiences with the devices tested during the FOTs. To complement this information, each test site was asked to supply usability information specifically related to the time taken and the number of user interactions (aka button presses) to access certain functions within their ND. These included time and interactions to access the main menu and primary function, or adjust the volume, as well as to start up and shut down. The participants' opinions on the design of the device, user interface, initial reactions and benefits to the NDs were then recorded as were 'Other Issues' which related to participants' perceived usefulness, reliability and ease to interpret the information offered by the ND. This method allowed in-depth information to be captured surrounding issues which may have influenced the use of the ND during the FOT and/or common issues which arose.

The second approach involved expert evaluations undertaken by HMI analysts working at the test-sites on a number of devices that were tested within TeleFOT. Not all of the devices that were tested within TeleFOT were subjected to expert evaluations. However, the procedure for such evaluations is described along with the results.

1. INTRODUCTION

TeleFOT is a Large Scale Collaborative Project under the Seventh Framework Programme, co-funded by the European Commission DG Information Society and Media within the strategic objective "ICT for Co-operative Systems".

Officially started on June 1st 2008, TeleFOT aims to test the impacts of driver support functions on the driving task with large fleets of test drivers in real-life driving conditions.

In particular, TeleFOT assesses via Field operational Tests the impacts of functions provided by aftermarket and nomadic devices, including future interactive traffic services that will become part of driving environment systems within the next five years.

Field Operational Tests developed in TeleFOT aim at a comprehensive assessment of the efficiency, quality, robustness and user friendliness of in-vehicle systems, such as ICT, for smarter, safer and cleaner driving.

Any in-vehicle system that provides information to the driver (whether nomadic or integrated) has the potential to influence driving due to behaviour described by Regan et al (2011) as 'attention competition'. This is described as 'voluntary or involuntary diversion of attention away from activities critical for safe-driving toward a competing driving-related activity that is less safety-critical. To what extent this occurs may depend on the type of system (i.e. nomadic or integrated) and type of device (e.g. navigation, speed advice etc.)

However, distraction is only part of the story – drivers have different expectations as to how an information system will affect their driving performance and therefore drivers will report very different experiences with such systems. It can be argued that in order for any nomadic and aftermarket device to have any impact on any of the impact areas evaluated by TeleFOT (Safety, Mobility, Efficiency, Environment and User Uptake), it has to be used. This is discussed in more detail in the Impact Assessment Deliverables on user uptake (D4.7.2 and D4.7.3). However, one major pre-requisite for user acceptance, adoption and uptake is the usability of the device. The International Organisation for Standards ([ISO](#)) defines usability as "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use." Analysing the

definition it becomes clear that usability is not a property of the device alone, but is created in the use context. If one is to undertake benchmarking on usability one therefore has to consider not only the device on its own, but also in its intended context of use.

Feedback on the overall Usability of a system as experienced by users is an essential feature of a product life-cycle. If users have a negative perception and experience of a system, then the manufacturers of that system need to know something about these negative experiences in order to take corrective action and ultimately design and develop a more 'user-friendly' system.

Usability of a system is determined by a number of factors. For example, Mahatanankoon et al. (2006) concluded that perceived trust in service (service reliability) and the particular physical design characteristics of the mobile device (e.g. interface quality), play important roles in users' acceptance and hence usability of mobile devices. The Technology Acceptance Model for Mobile Services (TAMM) developed by Kaasinen (2005) extends the TAM model (proposed by Davis) by adding two factors; trust (perceived reliability of technology, perceived reliability of service provider, user's confidence of control over the service, privacy issues) and ease of adoption (which refers to taking the service into use, becoming aware of the services available etc.). Furthermore, TAMM redefines the factor usefulness as value to the users (the features that are appreciated by the individual users). Ease of use is a factor common in several models on user adoption of new technology but on the move, users can often only devote part of their attention to the device and the service which is why easy interaction and navigation are particularly important for nomadic devices. In addition, 'resumability' is an important feature - i.e. the possibility to start completing a task, and be able to resume after a disruption.

This IP Deliverable reports on the Usability activities that were undertaken in in WP4.8, Usability and Bench-marking and also WP 4.10 Technical Evaluations. In order to examine usability issues associated with the devices that were tested within TeleFOT, two approaches were taken. The first approach describes feedback that was received from the test-sites including information gathered from the TeleFOT participants with regard to their user experiences with the devices tested during the FOTs. This information was gathered through use of the User Uptake questionnaires that were administered throughout the TeleFOT

project. The participants' opinions on the design of the device, user interface, initial reactions and benefits to the NDs were then recorded as were 'Other Issues' which related to participants' perceived usefulness, reliability and ease to interpret the information offered by the ND. To complement this subjective information from the participants, each test site manager was asked to assess each of the devices in order to supply usability information specifically related to the time taken and the number of user interactions (aka button presses) to access certain functions within their ND. These included time and interactions to access the main menu and primary function, adjust the volume as well as start-up and shut down the device. Overall, this method allowed in-depth information to be captured surrounding issues which may have influenced the use of the ND during the FOT and/or common issues which arose.

The second approach involved expert evaluations undertaken by HMI analysts working at the test-sites on a number of devices that were tested within TeleFOT. Not all of the devices that were tested within TeleFOT were subjected to expert evaluations. However, the procedure for such evaluations is described along with the results of the respective evaluations.

2. USABILITY EVALUATIONS – FOT PARTICIPANT AND EXPERT ANALYSIS

2.1. Usability Characteristics as evaluated by Test-site Managers

This section defined the specific usability characteristics of the systems that were under evaluation within the TeleFOT project at each of the test-sites. It clarifies whether the system was truly nomadic (i.e. capable of being removed after each journey). It also defines whether the application was stand alone, or installed on a secondary device such as a Smartphone. It further identified where the device was mounted or located in the vehicle during the FOT. A section then defines which modalities of HMI display and feedback were available from the ND (either visual, audio or haptic) and which of these was the principal

mechanism. As the majority of devices offered visual feedback, the capabilities and format of the display screen is then defined. Next the physical and power characteristics of the ND are described (i.e. size, weight and battery performance). Finally the adjustability and user preference capabilities are assessed.

Host Device

- 83% (19/23) of the devices tested were truly nomadic, meaning they could be removed from the vehicle. Of these NDs 7 were hosted on and whose primary function was a 'Satnav' system and 11 on 'Smartphones'.
- The 4 remaining systems evaluated were 'Specific Systems' (e.g. data loggers or those developed specifically with a sole function in mind) and could not easily be removed from the vehicle or did not provide additional functionality for the user.

HMI Feedback

- Every system apart from one offered in-vehicle feedback to the driver, FILFOT4 gave feedback offline via a PC.
- The primary visual feedback from the NDs evaluated was 'Graphical' (in 14 cases), 'Both' graphical and text (7), only 'Text' in 1.
- The primary auditory feedback was 'Speech' (again in 14 cases), with 3 devices each either providing either 'Tones', 'Both' speech and tones, or 'No' audio.
- No systems offered 'Haptic' feedback to the driver.

Screen Specification

- The screen sizes of the Smartphone and Satnav host devices varied between 3.2" and 5.0" (8.1 and 12.7 cm; measured on the diagonal).
- All had 'Colour' screens, with all of the Smartphones principally being used in the 'Portrait' orientation, and Satnavs in 'Landscape'.
- 86% of the host devices utilised a 'Touchscreen', either with or without additional 'Hard' keys.

Unit Specification

- The battery life of the Satnavs and Smartphones ranged between 2 and 7 hours with usage. However, 5 (the 'Specific Systems') were powered directly from the vehicles 12v supply.

Adjustability

- Adjusting the volume of the host device for each evaluated systems was generally defined as 'Simple', but adjusting a more advanced screen feature such as the brightness of the screen was split 50-50 for complexity ('Simple' or 'Complex').

Usability – Timing and Interactions

The time taken to activate the ND system and application was evaluated. This includes the interval time to access the main system menu, the primary function, the primary application and provides a total time summary in seconds from start up to access the primary function. It also details time taken to adjust the function or HMI. Finally it details the de-activation and shut down timings. This is included since long times required for activation and accessing functions can often result in dissatisfaction or failure to use ND systems. This section defines the aspects of system performance related to the number of system interactions necessary to activate the ND system and application. This includes the interactions to access the main system menu, the primary function, the primary application and provides a total interaction summary from start up to access the primary function. It also details the number of interactions to adjust the function or HMI. Finally it details the de-activation and shut down interactions required. This is also included as complex interactions to activate and access functions can often result in dissatisfaction or failure to use ND systems.

- Of the responses received the total time cited by the test sites for the system from off to fully functional varied according to if the ND application evaluated was hosted on a Satnav or Smartphone system, at a mean time of 82.5 verses 69.6 seconds respectively.
- However the time to boot up and gain access to the main menu was faster with the Satnavs, at 29.5 verses 53.7 seconds respectively. Conversely the time from main menu to fully functional was shorter with the Smartphone at 18.1 verses 53.0 seconds respectively.

- The time taken for a Smartphone to boot up, so the main menu could be accessed, equated to over three quarters of the total time taken, this would be similar to that of booting a PC, and reflects that once booted applications on the Smartphone can be accessed quickly and effectively.
- The number of button presses (or interactions) to access the primary use of the system was relatively consistent across platforms, with between 2 and 6 interactions needed. Again little difference was observed in the number of interactions needed to change a function of the system or HMI, ranging between 3 and 9 interactions.
- The time taken to exit the system was again similar for both platforms (16.8 for Satnav and 13.3 seconds for Smartphone). The number of interactions to exit for the Satnav was between 1 and 3, and for the Smartphone between 2 and 4 (this increase is accounted for by the exiting of the application to the main menu, then the turning off of the Smartphone).
- As might be expected those systems evaluated which powered by the vehicle's 12v supply (the 'Specific Systems') were far quicker to start up (at an average of 8.5 seconds) and shut down (instantaneous at ignition off) compared the Satnav and Smartphone host devices.

2.2. Usability Characteristics as evaluated by the Participants

In general participants taking part in the different FOTs within TeleFOT stated that they were initially positive (80%) about the systems and functions being evaluated at the beginning of the FOT, the remaining 20% were neutral, with no test site reporting participants as being negative towards the functions being evaluated at the beginning of the FOT.

Following the completion of the LFOTs participants were generally more negative towards the systems evaluated then when they started - this was thought to be mainly due to Usability and Reliability issues.

Benefits

Post FOT participants generally rated the benefit of having access to the system as Moderate (10/22), with 6 suggesting a large benefit and 4 a small benefit (2 no data).

Trust

Trust that the system would provide the user with accurate information was generally rated by participants as being Moderate-to-Large for the NSS and GDS functions, but very varied for SI/SA with Greek participants rating trust in the information as large, with UK and Sweden rating as low.

Future Use

The average amount that participants suggested that they would be prepared to pay to purchase the systems that they have been using throughout the duration of the FOT was approximately €20 as a one-off payment, with 5 test sites reporting that participants in general were not prepared to pay anything.

Usability

In general users' responses to the information being offered by the various systems was rated as being easy to interpret, with the exception of two FOTs using a specific NNS (GEDFOT1 and UKLFOT1).

In general the ease to amend driving style based on the advice given was rated as moderate to high, as was the system responsiveness.

Reliability

In general the truly NDs (Satnavs and Smartphones) were reported as being less reliable than 'Specific Systems' which were powered from the vehicle 12v supply.

Considering if the system would rarely crash or freeze six of the systems were rated on the lower end of the scale for reliability, 4 towards the upper and 10 in the middle of the range. However the systems evaluated would usually start up first time, with half (10/20) always starting up first time and the other half generally starting up (2 no data).

Trust

When responding to 'Users would followed the advice given' and 'Systems would generally give good advice' again this was generally positive with the exception of two FOTs using a specific NNS (GEDFOT1 and ESLFOT1).

Usefulness

A contradictory view was generally expressed by participants who used systems with SI/SA. This was that the general concept of providing speed limit information for the current road was deemed the most useful aspect of such systems, but the least useful aspect was that these features were often out of date or inaccurate.

Comments from the participants

Comments were obtained from all participants in relation to their assessment of the usability of the functions tested within TeleFOT. These are shown in table 1 of Appendix 1.

As can be seen from table 1 above, there were some positive aspects of the devices tested within the FOTs but also some negative aspects. These varied from test-site to test-site.

At the German test-site (testing SatNav), some frustrations were evident – participants commented that the display was small and the resolution was not very good and that the device was quite slow utilising a complicated and unattractive design. Also, setting of a destination required several button-presses. Frustrations were also seen with late advice on navigation and speed limit databases incorrect.

At the Italian LFOT test-site, (testing SatNav on a smartphone), some users found the display too small even though the device itself was convenient and portable. The Italian DFOT test-site (testing SatNav) found that the participants were generally positive about the functions but some reported irritations regarding audio information. Trust in the information given was not especially high and even decreased after the tests due to difficulty interpreting the information given and also the fact that the maps were in some cases out of date.

At the Spanish LFOT test-site (testing SatNav), there was general satisfaction with the device but participants found it difficult and time-consuming to locate satellites which was the main frustration. At the UKLFOT1 test-site (testing SatNav), reliability was perceived as being 'good overall' but many users were aware of the device not performing as well as the market leader which led to a reduction in use overall. In the UKDFOT2 (testing Green Driving/Lane-positioning advice on a Smartphone), participants were generally very positive about the functionality of the Foot-Lite system but some participants were irritated by the lane-position feedback. In UKDFOT3 (testing Forward Collision Warning/Lane-keeping advice), many participants found the feedback about forward headway too intrusive and irritating whilst the Lane-keeping advisory system was thought to be not accurate enough overall. At the Greek LFOT1 test-site (testing navigation on a smartphone), most participants seemed to be generally satisfied with the function although minor fixation and display issues were reported. The same issues were reported at the Greek LFOT2 test-site (testing navigation and speed limit information). At the Greek LFOT3 test-site (testing navigation and traffic information), issues regarding delays in information provision and size of display were reported whilst at the Greek LFOT4 test-site (testing navigation and speed alert), issues regarding delays in information provision were also reported as were reliability issues with regard to speed limits. At the GreekDFOT1 test-site (testing SatNav and collision avoidance), some irritations with the device was reported including annoyance at the warning given during lane-departure events, the sudden appearance of a 'window' during device interaction and delays in timing of the voice commands. The Greek DFOT2 (testing Speed Limit information, Collision Avoidance Warning and Lane Departure Warning), participants also reported being annoyed by the warning sound given by the Lane Departure Warning and also inaccuracies in the Speed Limit information. At the GreekDFOT3 (testing Speed Alert, Collision Avoidance and Lane Departure Warning), the same frustrations were reported as with GDFOT2. At the Finnish LFOT2 test-site (testing Navigation, Traffic Information, Green Driving Advisory system and Speed Limit information), users were not very positive about the services provided – the traffic information was seen to be irrelevant to the route travelled and also somewhat out-dated. Furthermore, the participants found themselves disagreeing with the advice given by the Green Driving Advisory system whilst some participants reported that the speed limit information provided was inaccurate in

winter months. Therefore, overall many participants reported various frustrations with the devices tested but interestingly despite these frustrations, there were few reports that the participants had no intentions of using the system tested, or a suitable alternative in the future.

2.3. TeleFOT Expert Usability Evaluations of Nomadic and Aftermarket Devices

In addition to the user experiences as shown above, specific Usability evaluations were also conducted by expert analysts at each of the test-sites. To complete this task, TeleFOT has used an "In-Vehicle Information Systems Electronic Checklist" developed by the UK Transport Research Laboratory (TRL - available for download at www.trl.co.uk). The checklist covers Installation, Information presentation, Interaction with displays and controls, System Behaviour, and Information about the system. It provides guidelines for design referring to the European Statement of Principles (ESoP), International Standards, Statement of Principles and Regulations. The checklist is made up by 57 question areas with one or several sub-questions to be answered, followed by an assessment of severity and a comments box. The checklist then provides a summary of all issues that the analyst has found in some way problematic. The focus of the checklist is clearly on safety and usability issues, mostly on an interaction level. The inclusion of user and the use situation are very much up to the analyst. As stated earlier, four devices have been evaluated using the checklist, the Blom navigator used in the Italian LFOT, Spanish LFOT1, and UK LFOT; the FootLITE device used in one of the UK DFOTs; the LATIS mobile application used in the Finnish LFOT; and the Garmin navigator used in the Swedish LFOT2.

2.3.1. LATIS

LATIS™ (provided by Logica), is a Location aware traffic information solution for drivers. It is based on Logica's Enterprise Mobility framework. The function provides traffic & road weather information as well as speed limit information and speed alerts. The TRAFFIC and

road weather information are provided by Mediamobile Nordic. LATIS™ utilizes a built-in speech synthesizer to read aloud announcements of nearby incidents or other relevant info. On-line map service is used to display the user's position and the exact location of the incident. Current speed and speed limit are also displayed for users equipped with GPS. The current speed is read aloud, if it exceeds the speed limit. As the information exchange in LATIS™ works both ways by nature, all users produce advanced FCD information. Manual "one button" reporting of traffic incidents enables even a limited number of users to effectively provide traffic information. LATIS™ mobile phone application works also on the background, enabling a simultaneous use of navigator software. The nomadic device, on which the user interface of the applications is implemented, is the user's own mobile phone. The applications support Nokia Symbian phones (N and E series phones, as well as Nokia 6210 Navigator).

Installation

Due to the system being installed on a mobile phone, all questions regarding installation of the physical device are dependent on the participants' phones and therefore not possible to evaluate. The installation of the software on the phone on the other hand, was quite difficult and it was considered that this could not be undertaken without special skills. For this reason, a help desk was installed. Reports from the help desk indicated that with such a variety of mobile phones, the help desk people sometimes had problems supporting the installation.

Information Presentation

A serious concern was that Traffic information messages are shown both as a symbol and as texts. On the map view, symbols sometimes overlap each other rendering them unreadable. Another serious concern was that general icons are used for the messages. These icons may not always cover the specific content.

A minor concern was that the mobile phone brightness on most of the phones in the test does not change in function of the surrounding light. There was also no special "Night mode"

in the software. Another minor concern was that traffic info icons are super-imposed on a map display, obscuring part of the map.

Another minor concern was the audio messages. These are based on text messages that are read through speech synthesis. Text messages related to traffic information are long texts and therefore sometimes difficult to grasp when presented as speech. Audio messages related to speed limit, however, are short and clear. During the test, the service was only available in Finnish, but this was not considered a problem as all participants in the FOT spoke Finnish. Another part of the checklist concerned the loudness of the auditory information. This is, of course, dependent on the phone used, but it was noted that there generally was no connection between the vehicle infotainment system and the phone so e.g. the radio wasn't muted when traffic info was read by the device.

During the FOT it was noted that messages, e.g. on road works may be out-dated, when the end of an event has not been registered by the traffic info server. Also, the correctness of speed limits depends on the accuracy at the server, e.g. if speed limits are changed at the correct time between summer/winter.

Interaction with Displays and Controls

There is very little interaction with LATIS. The only menu interaction is for controlling the settings, which should not be done while driving. It was noted that since the software was running on standard Symbian phones, all interaction had to be done through the numeric keypad. This is not always easy or intuitive.

System Behaviour

Normally the driver does not have to interact with the service during driving. The only input possible is traffic events reported by the user.

Information about the System

Installation instructions and first use are rather complex. After that it is simple. Enter of traffic info events is not self-explanatory. The guidelines state that program should not be used when driving.

2.3.2. BLOM Ndrive Touch XL SE 'TeleFOT Release'

The NDrive G800 is a personal navigation solution based on GPS technology. It provides navigation through visual and voice instructions, which includes names of roads and locations, door-to-door navigation and detailed information about points of interest.

Installation

The device was mounted on the windscreen with the help of a suction cup. In the test vehicle used for the evaluation, the device was difficult to reach when the driver had their seatbelt on. This restricted their ability to interact with the device for necessary tasks such as adjusting the volume. In real life the installation of course is dependent on the car model. As the device is mounted on the windscreen, the device impaired some of the 'swept windscreen area', reducing the driver's view of the road.

Information Presentation

The 'main menu' button's function was not obvious from its appearance and was, therefore, easy to overlook. The icons at the top right of the map screen were also not intuitively obvious as to what their functions were and were quite cluttered and close together. Furthermore, the interface when giving directions didn't inform the driver which road he/she was heading onto e.g. "take the A6".

To adjust the volume from the map screen required clicking on the 'battery and GPS' logo which was not at all intuitive, followed by requiring a further button press to make the slider controls appear to allow adjustment of the volume. This would likely be a common interaction with the device and was seen as being unintuitive and overly complex.

It was suggested that presenting auditory information, on which road to enter, would add clarification and allow the driver to match audio instructions to the road signs observed.

Interaction with Displays and Controls

A small number of the turning instructions were observed to be a little late in their presentation when coming off a dual carriageway and onto a roundabout. There was also no easy way to ask the device to repeat a missed audio instruction, leading to a greater reliance on information displayed on the screen and more eyes off road time than necessary. Furthermore, the icons on the map display were quite small and therefore it was difficult not to inadvertently activate another control. It was also not possible to locate the controls non-visually due to the interface being a touch screen, meaning the buttons weren't differentiable by texture or relief.

System Behaviour

A serious concern was raised as the device didn't inform the user that the driver shouldn't interact with the device whilst the vehicle was in motion. It also doesn't inform them that they take responsibility for their own actions when interacting with the device. The user manual also lacks a statement to inform the driver that they retain responsibility for complying with traffic regulations.

Although the instruction manual informed users not to attempt to use the system whilst in motion the device was still fully operational whilst the vehicle was moving, perhaps offering a temptation to interact with the device.

Overall assessment and Recommendations

Overall the device didn't perform as well as many of the class leaders but was generally usable and navigated the researchers from point A to B with only very minimal confusion caused. It should be acknowledged that the device was still in prototype form and it is likely that the only serious concerns raised by the assessment, that the device itself did not inform users not to interact with it whilst in motion, would likely have been addressed in the

finished product. The interface design was concluded to not have any major criticisms which limit its usage or lead to confounded results in the studies for which it was used.

2.3.3. Foot-Lite

Very few concerns were raised about the Foot-Lite system by the analysts.

System Behaviour

It was suggested by the analysts that adjusting any of the system's settings, apart from volume, should be made impossible once the vehicle is in motion. Furthermore, they concluded that if the volume is switched off or turned down low then this information should be made displayed to the user. Also if the system crashes or stops working then it should be made obvious to the user that the system is no longer functioning.

Overall assessment and Recommendations

Overall there were only a small number of minor concerns with the design. This was aided by the fact that the system requires no interaction once it has been launched, which itself could be carried out while the vehicle was stationary before setting off. A lot of thought has obviously been put into the interface design, which it was believed showed clear and intuitive graphics. There was a slight concern of the use of green and red colours together; however issues with this were mostly overcome by the graphics in question being distinguished by positioning as well as colour. Overall the design was intuitive, believed to cause minimal distraction and effectively communicated greener driving as well as improved driver safety practices.

There were a few design recommendations. The first has already mentioned in the report above, namely to make it impossible to interact with the device's settings while the vehicle is in motion as well as displaying if the volume is turned down low or turned off. The graphic informing where the gearshift information is displayed currently uses the word 'gearchange' this was found to be difficult to read due to the font being vertical. It is suggested this is replaced with a simple image of a gearbox to alleviate this. Under very exceptional situations

the display can become a little overloaded, such as when overtaking on single carriageway, where lane departure, acceleration and headway warnings were all shown simultaneously. Prioritizing and reducing the information displayed in these circumstances would improve the design.

2.3.4. Garmin Nüvi 205WT

Installation

The device is mounted on the windscreen with a suction cup; power is fed from the cigarette lighter socket. No problems regarding installation could be conceived.

Information Presentation

One concern regarding information presentation was that many common settings are hidden in the menu structure and it is not obvious how to access e.g. Traffic information. Another concern was that "take the third exit to the right" is used as a way to say "turn left in the roundabout". This may take some time to get used to. During the test it was apparent that Traffic info often is late and only covers some traffic info, or even worse is irrelevant. Furthermore when traffic info is available, the traffic info sign changes colour, which isn't very obvious. Green driving advice is presented as a number from 1-100 and although quite easy to see and interpret was seldom considered relevant as an indication of green driving.

Interaction with Displays and Controls

Some things, such as traffic info requires lots of button pressing in order to see what type of problem there is and exactly where it is located.

System Behaviour

Although the instruction manual informed users not to attempt to use the system whilst in motion the device was still fully operational whilst the vehicle was moving, some functions (TI) require interaction while driving. The display of regulatory messages on start-up infers on the usability criteria "efficiency", and may lead to people starting driving and then entering information as the car is moving.

Information about the System

The manual did not include information on "ECOROUTE" the simple green driving support function included in the device. These instructions were in a supplement only available in English

3. DISCUSSION AND CONCLUSIONS

This Deliverable has outlined the Usability of the TeleFOT Nomadic and Aftermarket devices. Two approaches have been used – gathering data from the user experiences and test-site managers during the actual FOTs at each European test-site and also expert evaluations of the devices by human factors 'analysts' also at the test-sites.

For the first approach, each test site was asked to supply usability information specifically related to the time taken and the number of user interactions (aka button presses) to access certain functions within their ND. These included time and interactions to access the main menu and primary function, or adjust the volume, as well as to start up and shut down. Whilst this 'technical' data was being collated from the test site (which was the principal aim of the Usability WPs) other 'User Uptake' issues were also summarised in order to further assist those partners answering the SP4 research questions. These questions were derived from the Standard User Uptake TeleFOT questionnaire and related to opinions on the design of the device and user interface, initial reactions and benefits to the NDs to name a few. In addition 'Other Issues' which relate to participants' perceived usefulness, reliability and ease

to interpret the information offered by the ND were also collected. Towards the end of the FOTs, a section of free text was included for test site managers to comment on the practical use of the device during the FOT. This allowed more in-depth information to be captured surrounding issues which may have influenced the use of the ND during the FOT or common issues which arose.

The conclusion of the first approach is that TeleFOT nomadic and aftermarket devices could be described as fairly typical for category of products and services that they represent. There were some usability issues noted, but nothing that would render the devices unusable.

In the second approach, the expert evaluations of the devices tested were relatively positive although some minor design concerns were highlighted by the analysts.

For the LATIS™ traffic information system, the installation of the software on the phone on was quite difficult and it was considered that this could not be undertaken without special skills. Also a serious concern was that Traffic information messages are shown both as a symbol and as texts. Another serious concern was that general icons are used for the messages. A minor concern was the audio messages which are based on text messages for traffic information are long texts whereas audio messages related to speed limit are short and clear. One further concern was that Installation instructions and first use are rather complex.

For the Blom NDrive device, the analysts were concerned that the device didn't inform the user that the driver shouldn't interact with the device whilst the vehicle was in motion. It also doesn't inform them that they take responsibility for their own actions when interacting with the device. Overall it was suggested that the NDrive device does not perform as well as many of the class leaders but was generally usable and navigated the researchers from point A to B with only very minimal confusion caused. The interface design was concluded to not have any major criticisms which limit its usage or lead to confounded results in the studies for which it was used.

There were very few concerns about the Footlite device - the interface design was thought to be very good showing clear and intuitive graphics. There was a slight concern of the use of green and red colours together but this was largely overcome by the graphics being distinguished by positioning as well as colour. Overall the design was intuitive, believed to

cause minimal distraction and effectively communicated greener driving as well as improved driver safety practices.

For the Garmin device, there was a slight concern regarding information presentation in that many common settings are hidden in the menu structure. Another minor concern was that "take the third exit to the right" is used as a way to say "turn left in the roundabout" which was thought to be misleading. Also it became clear that Traffic info is often late and only covers some traffic info, or even worse is irrelevant. Furthermore Green Driving advice is presented as a number from 1-100 and although quite easy to see and interpret was seldom considered relevant as an indication of green driving.

One conclusion is that Usability testing is much more reliable than check lists, and that it could be that many more usability problems are likely to surface when using this method. However, whilst many heuristic usability evaluation methods such as Cognitive Walkthrough and Predictive Human Error Analyses have been criticised for over-reporting usability problems, the TRL check list used in TeleFOT clearly under reports instead. One can argue that this necessarily isn't the case for all check-list, but clearly is so for the TRL "In-Vehicle Information Systems Electronic Checklist v.1.01". One reason for the checklist to under report on usability related problems is that it focuses on only some aspects of usability (interaction), and that it has a strong focus on safety related issues, rather than is the user actually can use the device in a real use context. The lesson is that one has to be very careful when choosing which checklist to use.

Another finding is that the analysts completing the checklist can affect the result to a large extent. For instance, the analysts who completed check list concerning the Blom device thought that the most severe issue with the device was that the device didn't clearly warn the user not to interact with the device while driving, while the analyst completing the check list for the Garmin Nüvi commented that the warning that is shown every time the device is started lowers the efficiency and can lead to the driver starting the trip and then interacting with the device. It suggests that the analysts appraising the Blom device analyses have high concerns about safety, whilst the analysts examining the Garmin device analyses focus more on use.

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4. Appendix 1

Table 1; User Comments concerning ND Experiences within the TeleFOT FOTs

FOT Code and main function of device tested	Please indicate here any comments you have regarding the Host Device	Please indicate here any comments you have regarding the User experience and potential uptake	Please indicate here any comments you have regarding Other issues - specifically reliability, usability and trust	Please indicate here any comments you have regarding Timings and Number	
GDFOT1 SatNav	Software not state of the art, bad graphical visualisation	Small display, bad resolution, slow, entering a destination quite complicated, unattractive design	Advices are very late (sometimes too late), navigation with coordinates not handy, speed limit database sometimes wrong	Very slow device, touch screen very slow, setting a destination by coordinates needs lots of button presses, difficult to shut down the device (sometimes no reaction)	
ITLFOT1 Smartphone	Some users found the device very convenient and handy, some that the screen was too small for navigation; some found the connection to external Bluetooth antenna tricky.				
ITDFOT2 SatNav	The device was designed in 2008 while test were made end of 2011, beginning 2012. For this reason the device was necessarily not in line with most recent PNDs. As this was a DFOT no assumption can be made as to if participants would turn the system on for all journeys.	Participants were generally positive about the three functions proposed. The green driving support function was still at prototype stage and, in general, it was remarked that a link to contextual traffic situation would be greatly beneficial for the function itself. Moreover a number of participants remarked that the audio suggestion about gear selection or braking	As this was a DFOT the examiner controlled the system (start-up/shut down). Some failures of the acquisition system late discovered (during the analysis) implied to repeat a		On the Magneti Marelli PND the Navigation support and Traffic info were associated function, while green driving support was an alternative function. Similar weather conditions were present through the trials

		was irritating.	second time the test. In order to avoid a pre-knowledge effect, new participants were selected. In general, this is rather surprising, the trust about information is not high and it slightly decreased after the test. This was due to some difficulty to interpret some indications and maps not totally updated in one point of the route.		
SPLFOT1 SatNav	Sometimes it was difficult to fix satellites and the process can take up too many minutes to make the first GPS fix.	In general, the menus are easy to learn and to use	In some cases, reliability has been questioned due to signal issues (positioning problems)		
UKLFOT1 SatNav	The device was chosen so as to be unfamiliar to the trial participants – this precluded the use of Garmin or TomTom type devices. Unfortunately the device did not perform like a market leader and as such low use was recorded throughout the trial period.	User uptake will be low – most participants used the device to record day to day behaviour (turning the device on) but few used it regularly to navigate – commonly 1 to 2 times per month.	Reliability was generally good with only ~3 devices failing completely (some due to being dropped etc)		
UKDFOT2 Smartphone	Participants liked the fact that the Foot-LITE system was hosted on a Smartphone as there was no need to carry another device into the car. As this was a DFOT no assumption can be made as to if participants would turn the system on for all journeys.	Whilst participants were generally positive about the Foot-LITE system in the DFOTs some participants were irritated by the 'Lane positioning feedback' which was deemed too frequent and sensitive, this reduced user acceptance and future use.	As this was a DFOT the examiner controlled the system (start-up/shut down) and would reboot the system if it crashed or froze - which occurred to some	Again as this was a DFOT the examiner controlled the system so there was no participant interaction.	Foot-LITE was seen as a safety device first and foremost, with eco driving information an added value.

			extent on about 25% of journeys. This would not be tolerated by participants in an LFOT who would probably just not use the system in the future.		
UKDFOT3 ADAS	The device is fixed semi-permanently to the vehicle so it has not been possible to take weight measurements of Mobileye. It is also not possible to report a battery time since Mobileye runs off the vehicle and has no battery of its own. It should also be noted that whilst the user interface input has been described as 'hard key' the user during the trials has no need to touch the device.	The majority of participants who tested Mobileye would definitely change the sensitivity of different settings on the device, namely the headway warning threshold. A lot of people found Mobileye too intrusive and the sound too irritating; this might inhibit future user uptake.	The Lane Deviation Warning occasionally rang for the wrong side of the road when a participant was close to leaving lane. This rarely occurred but shook the drivers' trust in the device when it did. People also thought that the Lane Deviation Warning was not accurate enough and did not always alert them when they were close.	System is automatically activated and deactivated via the ignition, but should the user wish to do this manually e.g. turn it off whilst the engine is running, this takes approximately 1-2 seconds and one button press. To turn it on: 1-2 seconds, 1 button press. However it would only be used manually or manually adjusted by an examiner before or after a trial session.	
GRLFOT1 Smartphone	The size of the device was adequate for presenting navigation information even in larger vehicles that participated in the study (for which the cabin is bigger and therefore the distance between the driver and the device is larger comparing to normal cars).	Most participants would use the navigation system if it was for navigation support in unfamiliar places. However due to their participation in the TeleFOT study, some of the participants used it also for their common trips.	Sometimes the information presentation was delayed comparing to the actual situation. The users reported that they learned the way that the information was presented with time (learning by exposure).	In some cases participants reported delays in first GPS fix. For all of these cases the device was repaired. Participants also reported that after a loss of GPS the device was able to fix it again quite fast (e.g. when passing under a bridge or in heavily dense areas).	Participants were satisfied in general by the navigation functionality. They would like to have the opportunity to scroll over the map and see the remaining route (this option was not provided by the specific navigation s/w).

<p>GRLFOT2 Smartphone</p>	<p>The size of the device was adequate for presenting navigation information and speed limit information even in larger vehicles that participated in the study (for which the cabin is bigger and therefore the distance between the driver and the device is larger comparing to normal cars).</p>	<p>Most participants would use the navigation and the speed limit information function if it was for navigation support in unfamiliar places or in larger trips. However due to their participation in the TeleFOT study, most of the participants used it also for their common trips.</p>	<p>Sometimes the information presentation was delayed comparing to the actual situation. The users reported that they learned the way that the information was presented with time (learning by exposure). Also in some cases the speed limits were not reliable; the users reported that they would like to have real time speed limits on their devices.</p>	<p>In some cases participants reported delays in first GPS fix. For all of these cases the device was repaired. Participants also reported that after a loss of GPS the device was able to fix it again quite fast (e.g. when passing under a bridge or in heavily dense areas).</p>	<p>Participants were satisfied in general by the navigation and the speed limit functionality. They would like to have the opportunity to scroll over the map and see the remaining route (this option was not provided by the specific navigation s/w) and they would like to receive real time speed limits.</p>
<p>GRLFOT3 Smartphone</p>	<p>The size of the device was adequate for presenting navigation information and the overview of the traffic information. However some of the participants reported that visuals of the en route traffic information could be larger.</p>	<p>Most participants would use the navigation and the traffic information function in unfamiliar places in the Attika region (the traffic information function was available only for the Attika region, meaning Athens and its suburbs). However due to their participation in the TeleFOT study, most of the participants used it also for most of their trips.</p>	<p>Sometimes the information presentation was delayed comparing to the actual situation. The users reported that they learned the way that the information was presented with time (learning by exposure). Also an improvement was proposed for the traffic information function, namely, to take into account the performed route and to provide only the relevant information to the driver and even alternative routes (dynamic navigation</p>	<p>In some cases participants reported delays in first GPS fix. For all of these cases the device was repaired. Participants also reported that after a loss of GPS the device was able to fix it again quite fast (e.g. when passing under a bridge or in heavily dense areas).</p>	<p>Overall, most of the participants would such as device but some of them mentioned that ADAS could be incorporated into one unified system in order to be more effective (e.g. same voice messages).</p>

			with traffic information).		
GRLFOT4 Smartphone	The size of the device was adequate for presenting navigation information even in larger vehicles that participated in the study (for which the cabin is bigger and therefore the distance between the driver and the device is larger comparing to normal cars). Speed alerts were considered useful and most participants enjoyed having access to this functionality even if not all the speed limits were accurate.	Most participants would use the navigation and the speed alert function even in common trips and especially if it was for support in unfamiliar places or in larger trips.	Sometimes the information presentation was delayed comparing to the actual situation. The users reported that they learned the way that the information was presented with time (learning by exposure). Also in some cases the speed limits were not reliable; the users reported that they would like to have real time speed limits on their devices, but even so they considered the function of high value	In some cases participants reported delays in first GPS fix. For all of these cases the device was repaired. Participants also reported that after a loss of GPS the device was able to fix it again quite fast (e.g. when passing under a bridge or in heavily dense areas).	

<p>GRDFOT1 Smartphone</p>	<p>Participants followed the route suggested by the NAV as this was part of the testing procedure. Routes chosen by the NAV system were perceived as faster. Occasionally, participants had difficulty understanding what they were requested to do. For example, in some intersections they thought the advice to turn right or left was somewhat late (delayed) and others had difficulties to understand the suggested direction to follow in one roundabout was.</p>	<p>Audio should be further adapted in order to provide more precise info (for example, sometimes it advised users to stay on the right side when they had to go left in order to take a left turn). Provided really the fastest routes, sometimes it was surprisingly effective in this aspect. Most participants would use the navigation system if it was for navigation support in unfamiliar places. Collision Avoidance Warning was regarded as useful and they reported that it could be effective if used for longer period of time. However, the sound (not the haptic) for the lane departure warning (rubble strips sound) was a bit annoying and sometimes it was described as "off" (e.g. in curves with more than one lines).</p>	<p>Sometimes participants were annoyed by the sudden appearance of a window where they were asked if they wanted to close the application. They had to close the window in order to continue with the navigated journey. The TeleFOT application rarely crashed (2-3 times).</p>	<p>Sometimes timing of information (vocal) was a bit delayed for the participant to be able to change route or follow the suggested turn.</p>
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<p>GRDFOT2 Smartphone</p>	<p>Participants did notice the speed limits per road segment but some of them did not comply with the limit. Probably the greatest advantage is the increased awareness for certain speed limit signs and, consequently, regional limits. However, compliance would be more appropriately evaluated in a large scale effort for behavioural change/adaptation to able to be investigated.</p>	<p>Speed limit was viewed as a positive addition. Users mentioned that an added value would be to add vocal notification for speed limit and speed limit change. Comments for ADAS are the same across DFOTs. Collision Avoidance Warning was regarded as useful and they reported that it could be effective if used for longer period of time. However, the sound (not the haptic) for the lane departure warning (rubble strips sound) was a bit annoying and sometimes it was described as "off" (e.g. in curves with more than one line).</p>	<p>Participants noticed that there was wrong speed limit information for certain road segments and sometimes delays in speed info change were reported. For example, speed limit changed from 40 to 90 km/h and the speed limit provided was still 40 km/h. The fact that participants noticed every such deviation was a positive sign that they were paying attention to the messages provided by the TeleFOT application and this is an overall positive feedback.</p>	<p>Sometimes timing of information (vocal) was a bit delayed. Speed limit information changed later than the presented sign.</p>	
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<p>GRDFOT3 Smartphone</p>	<p>Speed alerts were effective in communicating speeding behaviour to participants. However, the small exclamation mark and the sound should be described beforehand in order participants to understand the meaning. In other words, all participants received the same information about the TeleFOT application but they had to be reminded about the way speed alert worked. It was not so intuitive and self-explainable.</p>	<p>Speed alert was an interesting and educative experience, as reported by participants. Users mentioned that an added value would be to add a more noticeable item (a red flashing circle, for example) for speed limit exceedances. Comments for ADAS are the same across DFOTs. Collision Avoidance Warning was regarded as useful and they reported that it could be effective if used for longer period of time. However, the sound (not the haptic) for the lane departure warning (rubble strips sound) was a bit annoying and sometimes it was described as "off" (e.g. in curves with more than one lines).</p>	<p>As some speed limits were wrong, speed alerts were wrong, as well. Sometimes, participants did not comply even if it was the right alert. This was not an effect of previous wrong messages but rather of idiosyncratic driving patterns.</p>	<p>Speed alert was a bit delayed for both onset and offset. In other words, sometimes the driver had exceeded the limit just for a while before it was shown on the screen and similarly the alert lasted a bit longer even if the driver had already decelerated.</p>	
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<p>FILFOT2 GDS</p>	<p>The applications (LATIS and DRIVECO) were installed on the test user's own Nokia Symbian S60 phone. In addition there is the DRIVECO module, which is attached to the vehicle's OBD-II interface. The LATIS is always in the background in the phone, and is activated when the phone detects through Bluetooth the DRIVECO module. Before the start of the pilot, the communication was optimised so that the energy consumption at the phone was as small as possible. However, due to the phone's logic, it was not possible to automatically activate the DRIVECO application, but the user had to confirm the connection. The FOT was characterised by a wide variety in phone and vehicle models, which made support difficult. Also, different telecom contracts or applications on the phone, could have an impact on the applications. Installation of the applications was – if the test user desired so – performed by VTT personnel. Due to the complexity of the setup and the wide variety in configurations, many users confronted problems during the test period.</p>	<p>In general, test users were not very positive about the services. Regarding traffic information, the information (which is similar to information transmitted over TMC), which is related to the region and not directly to the route travelled, is seen as irrelevant or could be out-dated (e.g. traffic jam is disappeared when the driver is at the location). Regarding green driving, the users did not always agree with the advices from the system, especially regarding hard braking. Other issues are related to motor braking (where system reports 0% motor braking, although user assures that he brakes on the motor). Regarding speed limit info, during the test period Nokia Maps came for free on newer models, and this application includes also a speed limit info/speed alert notification. Some users reported, especially during the start of the test, problems with the accuracy of winter speed limits.</p>	<p>See Previous</p>		
<p>FIDFOT4 Specific system</p>		<p>Driver feedback reporting benefits from having a reliable data logger and rich data collection. It depends on the test design and participants, whether fixed installation is a good option. When such option is available, it provides reliable data logging.</p>			

FIDFOT5 Specific system	The device (AC Panther) was installed in the public transport vehicle. The user interface is a touchscreen, but the only input needed by the driver is an identification code at the start of the trip				
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