Displaying infrastructure-based information in the car – results from Austria's field operational test on cooperative I2V services

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ABSTRACT:

This research paper on the presentation and evaluation of mobile ITS services in vehicles covers a wide area of topics and includes a theoretical framework of user acceptance and at the same time first conclusions of the different aspects in the discussion section. Research on human machine interfaces has often been piggy-packed onto technology research activities as an add on both onEuropean scale Field Operational Test´s as well as with national testbeds and lighthouse projects. Public authorities want answers to crucial questions in terms of technical feasibility and scalability in the medium term time scale resolved, because this is the rationale for co-funding large scale research and development projects. At the same time user involvement and testing with users in real-world situations is expected; but often the challenges and short term dynamics of large-scale industry projects with competing technological approaches and yet emerging international harmonization and standardization have very limited degrees of freedom and design options for real world testing with end users. And the end user involvement relies on a series of limiting conditions from a technology point of view of the mobile devices including HMI design and layout topic.This paper presents results from one of these Field operational Test´s – the Austrian Testfeld Telematik; with valuable user reactions during a large-scale demonstration involving several dozen cars during the ITS world conference in 2012, and from the necessary activities to enable a comparison of user generated mobile data from 65 drivers with different mobile devices under real world traffic situations on public roads.

1. Introduction

This paper presents a brief overview of different stakeholders' expectations into research approaches and research results on in-vehicle driver assistance services. Then we link our approach (in tracking drivers' acceptance of in-vehicle invormation on nomadic devices) to different

research traditions and corresponding research questions. We elaborate briefly on the extended technology acceptance model which we have used in 16 European Commission RTD projects for assessing driver acceptance and unveil some of our preparatory studies necessary to be able to perform the ITS service assessment. After first results, that have not been presented elsewhere we discuss implications and give an outlook into next steps.

The widespread deployment of in-vehicle driver information systems and the emergence of advanced driver assistance systems are profoundly transforming road transport. Through these Intelligent Transport Systems, a range of services is offered to the driver with the objective of facilitating the driving task and improving travel safety. Nevertheless, these developments raise questions about acceptance and possible effects and their impact on drivers' behaviour and attitudes. All this encourages a Human Centred Design approach, in which ITS are designed according to driver needs and are not driven by technological capabilities and available options. This issue is at the core of our paper, has been at the core of our project design challenge and is at the core of many similar research and development projects. For this reasonswe are looking forward to discuss our lessons learnt with colleagues from other r&d areas and projects in a session at the conference in Vienna. We know that our research on using the extended technology acceptance model brings into the discussion the most widely used approach in assessing technology acceptance – even when this research tradition is only one of a vast diversity in European ITS evaluation method. This was one result in our study assignment of comparing European practices in ITS evaluation within the 2DECIDE project.

2 Different stakeholders' expectations into research approaches and research results

Research on human machine interfaces has often been piggy-packed onto technology research activities as an add on both on European scale Field Operational Test´s as well as with national testbeds and lighthouse projects. Public authorities want answers to crucial questions in terms of technical feasibility and scalability resolved in the medium time scale of 3 to 5 years; because this is the rationale for co-funding large scale research and development projects and programs. At the same time user involvement and testing with users in real-world situations is expected; but often the

challenges and short term dynamics of large-scale industry projects with competing technological approaches and yet emerging international harmonization and standardization have severly reduced degrees of freedom and design options for real world testing with direct end user involvement.
The section lists different stakeholders' expectations into research approaches and research results on in-vehicle driver assistance services:

- External validity (project results are valid also for all cultural contexts in all European Union member states and sometimes even beyond). (c.f [1]).
- Clear answers to deployment decisions (c.f [2]).
- Robust results converging with results from similar ITS research
- Measurement quality / reliability (not just single item questions but sound measurement instruments – even if this easily reaches the limits of what users are ready to answer / administer.
- Academic career promotion or completion of PhD work
- Widespread use of mobile devices and smartphones by end users, which influences directly the exspectations of the delivered ITS services, the used services and the experiences made, and therefore the overall acceptance by the users linked to it.

3 Project context determines research opportunities

From our experience in 16 similar European commission telematics (ICT) projects we present some of the lessons learnt how project context determines research opportunities. Our experience was validated within the study on ITS evaluation in Europe [10] (project 2DECIDE – ITS toolkit under EC's strategic activity 6.2 (ITS Action Plan)).
In the US (DoT / RITA) it has become good practice that evaluation groups are entirely independent from research and development groups. Contracts are given to experts on the condition that they use robust, comparable tools and frameworks. In Europe we have seen not only vast differences in research cultures (path dependency) into drivers' acceptance. We even find that many projects make reference to FESTA methodology or state of the art

in general terms without adhering to this state of the art within the "tailor-made" research approach of the single project.

Within the 2DECIDE project we analysed more than 400 ITS evaluation studies and found that convergence of methodologies or tools to be the rather rare exception. Comparability of data and results between different projects was not found.

4 Rather different research traditions and research questions

We link our approach (in tracking drivers' acceptance of in-vehicle information on nomadic devices) to different research traditions and single research questions. The issue at stake is nicely demonstrated in the conference programme in the aspects:

- Methodologies
- Human Factors
- HMI & Designs
- Safety
- Ecomobility

All these research branches seem to have their own good practice and their own tools for their single aspects of work. This increases the overall design challenge: Do you adhere to a specific research community or answer the general question of R&D result users: Are these mobile ITS services under analysis ready for deployment or not?

5 The extended technology acceptance model in user studies and transport research studies (TAM – Model)

We elaborate only briefly on the extended technology acceptance model which we have used in 16 European Commission RTD projects for assessing driver acceptance. The extended technology acceptance model has been used and described in hundreds of papers and projects (c.f [3]). Some sources see it as the most widely used model and tool. Our team has used this approach since 1997 in most of our user-related research. Basically the model sees driver acceptance defined by ease of use and perceived usefulness. The model consists of pre-drive questionnaires about user exspectations combined with after drive questions about the user experiences and answers and changes between the two are compared

statistically. If these aspects of work are combined with short feedbacks to single services (realized as so called event triggered pop-up questions on a mobile device) than the overall picture of user reactions covers even more aspects and details of user acceptance.

6 Our preparatory studies

Mobility and driver context is rather different due to prior experience with assistance systems. Therefore we re-used lessons learnt from European Commission's flagship project COOPERS (on infrastructure to car cooperative services) [4] as well as results from 12 focus groups, participant observation, results from projects Telefot, Eurofot and Fot-Net. For the Field Operational Test (FoT) – TTA extensive work has been started in order to analyse the basic technical operating conditions for the selection and the characteristics for acceptable end user consumer devices from an evaluation point of view. The technical aspects are the correctness of background maps and views in the FoT geographic area as well as the positioning accuracy and set update frequency of the mobile device in the area in the south of Vienna. Please relate to [5] for further details of these aspects. This resulted first in a list of acceptable devices for participating users and secondly in a set of recommended user settings for devices used by participants of the FoT TTA.

7 First results of the FoT - TTA

A part from the selection of the suited mobile devices the Austrian Field Operational Test investigated necessary development steps for bringing cooperative infrastructure-to-vehicle (I2V) services to a deployment-ready stage; the simplified research question was: ‘Do cooperative I2V services work already sufficiently well for the next deployment steps?’. Based on the FP6-IP COOPERS and the FESTA methodology the authors developed a multi-method, assessment methodology to identify early end-user acceptance indicators for the different cooperative services, and adapted this to various mobile devices of lead users

During the 2012 ITS world congress Vienna a common demonstration of the

TTA consortium and the Car- to-Car-Communication-Consortium (C2C-CC) showed first very promising results in setting-up end user services based on I2V technology. Services like ‘in-vehicle-signage’ or ‘road-works warning’ were shown on different end-user devices (smart phones, tablets, and in vehicle integrated devices from different manufacturers).

The assessment methodology of the FoT had to be adapted due to technical development changes as well as time constraints for the real-world testing period.A sample of 65 friendly users tested the TT services during a period of two months (October to November 2013). Collected user feedback consisted of:

(1) A mobility behaviour questionnaire before starting the test drives,

(2) An evaluation questionnaire after the test period as well as

(3) Pop-up questions directly on the end-user device to be completed after every test ride and concerning the experienced services only.

All test drive data as well as GPS-tracks have been evaluated by an independent international evaluation group together with the sensor traffic counting on the ASFINAG network on the motorway A4. (University Graz: Prof. Fellendorf, University Munich: Prof. Busch etc).

First results show:

(1) Cooperative services are valuable for most of the users;

(2) The shown services were mostly perceived as correct and in-time;

(3) 25% of the test users reduced their speed due to cooperative-services;(4) Most of the users are willing to use the services in future.

8 Limitations of these results

Limitations arise mainly from the trade-off between individual research traditions' good practices and deployment authorities' expectations. The main limitations are due to:

- Methodological issues especially for road safety aspects
- Measurement issues and comparability
- Complementing Simulation studies
- Distress and distraction measurement and Video data

9 Discussion

We have elaborated that an FoT with a variety of end user devices is feasible, but the effort to make user data related to ITS services comparable

for the assessment is very high. There is an indication that current in vehicle devices have an influence on driver behaviour.
According to the involved numbers of users in FoT´s and the related sizes of user groups for the comparative assessment of results between projects the approach needs to be improved and intensified much beyond sharing data. The combinations of this direct assessment methods with traffic simulations of street segments and motorway cooridors will be discussed in the workshop.

10 Outlook / next steps

All data as well as GPS-profiles of the test rides have been evaluated by an independent international evaluation group. We are looking forward to discussing our early results and lessons learnt with collegues at the Humanist conference in Vienna.

11 Conclusions

It is quite obvious – there is room for improvement. We feel there should be an exchange on various research traditions beyond the sharing of data or a common basic principle like the FESTA handbook. The combinations of real user involvement with parallel simulations and calculations are necessary to determine scaling up of cooperative its solutions from local to (urban) context and corridor level. Somehow this confirms conclusions from several European inititatives [6], [7], [8], [9] that have tried to stimulate convergence in research and evaluation on intelligent transport. And the most important finding for future R&D projects and scientists related to user acceptance aspects: user are accustomed to state of the art mobile devices and GUI´s, therefore do not present them anything below in R&D context´s.

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