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Vulnerable Road User needs towards ITS

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ABSTRACT: *Due to fast development of new technologies in the field of Intelligent Transport Systems (ITS) a number of new research topics arise, especially in view of vulnerable road users (VRUs). While most advancements in the ITS sector are primarily targeting motorised transport with focus on safety and ecological aspects of transport, there is still a lack of both research and innovation considering VRUs. The vulnerable road users and ITS (VRUITS) project, co-funded by the European Commission, aims at actively integrating the "human" element into the ITS approach. The focus of this paper is on the mixed methods approach applied in the project to assess both actual user needs and expert opinions on perceived barriers and necessary adaptations on technological, societal and behavioural levels for a successful and sustainable deployment of new technologies.*

KEYWORDS: *ITS, vulnerable road users, focus group discussions, expert interviews*

1. INTRODUCTION

In recent years Intelligent Transport Systems (ITS) have become a ubiquitously used term and field of activity in transport research as well as traffic system development. From infrastructural systems which intelligently activate traffic lighting and adapt it to actual traffic flow, to in vehicle technologies such as Advanced Driver Assistance Systems (ADAS) these developments focussed on motorised road traffic (Brookhuis et al. 2001), while vulnerable road users (VRUs) were rather seen as obstacles that were difficult to consider appropriately in the system architecture. More recently, international research and development projects approach this short-coming by assessing actual ITS potential based on VRU needs and expectations (Methorst, 2010) in the frame of experimental field trials (Pécheux et al. 2009). The EC co-funded project VRUITS (Vulnerable Road Users and ITS) aimed at assessing societal impacts of selected ITS. The goal was to provide recommendations for policy and industry regarding already available and future ITS in order to improve the safety and mobility of VRUs. The main focus of the VRUITS approach was to demonstrate how VRU safety, mobility, and comfort, can be considered appropriately in connection with the development of ITS, and how HMI (human machine interface) design can be adapted to the needs of the heterogeneous groups of VRUs.

To achieve a first summary insight, experts from the fields of traffic and spatial planning, public transport (PT) service providers, policy makers, etc. where involved in the course of expert interviews. This proved to be an essential step, as the following arguments will show (Feypell, et al. 2010). Data from the Community database on Accidents on the Roads in Europe (CARE) and additional national accident data sets, including information on the micro-level [i.e. the SafetyNet, PENDANT and MAIDS Databases] are available. However, subjective input on traffic safety and comfort is lacking and comparability of data across borders is not sufficient. Data on exposure, especially across borders is limited. National travel surveys vary significantly in methodologies, sampling and periodicity (Methorst et al. 2010). Involving experts and road users hence promised to provide a more holistic and reflected input. This paper focuses on the respective part of the work in VRUITS addressing experts' and road users' views and opinions.

2. METHODS

An exploratory approach allowed for producing qualitative data in four countries representing four geographic regions of Europe. Focus group discussions with road users and expert interviews were carried out to this end. Firstly, in order to integrate the actual target groups into the research process and to assess current issues, needs and attitudes towards ITS, rep-

Table 1: Sampling process of focus group participants

	Focus Group #1 "Older road users"	Focus Group #2 "Adolescents"	Focus Group #3 "Parents"	Focus Group #4 "Adults"	Focus Group #5 "PTWs"
Gender	Half male/female	Half male/female	male/female	Half male/female	male/female
Age (groups)	60+	16–19	20+	20+	18+
Transport Mode (main mode of transport)	Pedestrians Bicycle (2 at least) PTWs	Scooter (2 at least) Bicycle (2 at least) Pedestrians	Bicycle (2 at least) Pedestrians	Bicycle (2 at least) Pedestrians	PTWs
Impairment (sensory/motor)	2 persons at least with sensory or motor impairment				
Other characteristics	–	–	Parents of children under 16 years	–	PTW riders

resentatives of different vulnerable road user groups were involved in Focus group discussions. In this way relevant differences within the potential user groups can be identified and thus the heterogeneity of groups can be considered appropriately, before advancing with the development process of prototypes and HMI design. Secondly, in order to sketch possible future developments, technology potentials and future issues relating to deployment and responsibilities in the fields of ITS and VRUs, experts from the tangent fields of infrastructure development, traffic planning, ITS, policy, etc., were interviewed.

The goals of this approach were to identify issues and hazards that potentially affect road safety, mobility and comfort in general and for vulnerable road users in particular. This should provide a baseline for the development of scenarios reflecting the possible functions of most relevant on-market technologies with respect to assisting upcoming advancements in this field. As both procedures were defined as strictly exploratory no hypotheses were defined beforehand. The collected results therefore should establish a user-centred qualitative founding for the subsequent tasks and work packages of the VRUITS project.

2.1 Focus Group Discussions with VRU groups

The focus group discussion is a method of qualitative sociological research. It is characterized as a moderated discussion structured by a guideline which aims at covering defined research questions by guiding the participants along this guideline (Merton 1987). A specifically trained moderator steers the communication process, but interferes only in order to support discussion flow and to make sure that all defined contents are taken up. Discussion contents are recorded as notes by an assistant, with a recording back-up, for later data analysis. Usually 5 to 15 discussants are involved. A discussion round ranges from two to three hours starting out with a short briefing and communication between the participants.

The actual sampling of participants for the discussion rounds in VRUITS took the high level of heterogeneity of the target population of vulnerable road users into consideration, also including characteristics like affinity for technology, mobility impairments (sensory, cognitive and motor) and main mode of transportation (pedestrians, bicyclists, PTWs [powered two-wheelers]) for everyday mobility tasks. The following sampling process (table 1), including the "usual suspects" age and gender (Morgan 1997), was defined for all discussion rounds in the four partner countries involved in this task.

Each of the focus group discussions followed the same structured guideline distributed to the discussion leaders in the respective country language. This tool not only specified a list of predefined questions to introduce to the participants, including main and sub-questions, but also the roles of the involved personnel (moderator, assistants), the venue, documentation and schedule of the process. The collected results (transcripts from audio recordings of the whole sessions), were translated back into English. Based on a manual content analysis with the open source tool weftQDA, the transcribed data was first summarised and then structured according to the dimensions of interest in table 2:

Table 2: Main dimensions of interest for summarising data

2	Traffic and Mobility as a VRU	*What are the general experiences of VRUs in traffic?*
3	General Safety issues of VRUs	*What are general safety issues related to subjective safety in traffic?*
4	VRU's and ITS	*Experiences made both actively and passively with current systems? General knowledge about these ITS?*
5	Using ITS / Experiences	*Actual usage and usability of ITS. What are general expectations and perceptions?*
6	Problems and Barriers related ITS	*Identification of potential problems and barriers experienced and perceived in relation to ITS*
7	Safety issues related to ITS	*Perception of safety in relation to ITS. What issues are associated with ITS? What is the safety related potential of ITS for VRUs?*
8	Future prospects and potential of ITS	*What are future developments and possible improvements?*
9	General observations made by the Moderators/assistants in course of the discussion sessions	*Conflicts, Disagreements, Discrepancies, etc.*

Table 3: Actual participants of focus group discussions

	FG1 – Adolescents		FG2 – PTWs		FG3 – Adults		FG4 – Older road users		FG5 – Parents	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Austria										
Sample	8	6	4	5	3	3	1	3	4	3
	14		9		6		4		7	
Netherlands										
Sample	6	1	3	5	4	4	4	4	6	3
	7		8		8		8		9	
Finland										
Sample	0	3	1	9	9	10	2	6	4	2
	3		10		19		8		6	
Spain										
Sample	1	3	1	4	3	2	0	4	0	5
	4		5		5		4		5	

In total, 143 participants from the participating partner countries were involved in 20 focus-group discussions (table 3). They represented the following groups: adults, parents, adolescents, older road users, cyclists and PTWs.

2.2 Expert Interviews

Ten semi-structured interviews with European level experts were conducted. The main aspects discussed during the interviews were assumed VRU mobility needs, critical scenarios in traffic and technology potential of available and future technologies in the transport and mobility sector. The expert interviews were also based on a guideline containing the interview questions and supporting interview materials. They specifically addressed the following aspects relevant to the VRUITS project:

- Current activities of the experts in relation to ITS and VRU transport
- State of the art of the technologies the experts are involved in
- Impact of ITS on VRU safety, mobility and comfort based on current work

- Barriers, problems, hazards and potential solutions to the development, market deployment and adaptation of ITS addressing VRUs
- Future developments and future prospects in the sphere of ITS

In the course of 10 semi structured interviews 10 European level experts from the fields of technology (including infrastructure, technology development and application), policy (structural aspects, legal issues, etc.) and interest groups of vulnerable road users qualitative input on technological aspects and user-oriented aspects of ITS was gathered (Creswell 2010). Their answers were electronically recorded. The gathered verbal data was analysed analogous to the focus group discussion, namely with the help of a content analysis of the transcriptions.

3. FINDINGS

Table 4 provides an overview of the summarized results of focus group discussions and expert interviews. Critical situations discussed in the focus groups are usually related to high car speeds, lack of respect of motorised road users, visibility problems, complexity and density of traffic, lack of communication between road users, bad weather conditions, and short comings of the (maintenance of) infrastructure. These factors are matched by the current traffic safety issues which should be addressed by innovative ITS solutions discussed in the expert interviews. Here, avoiding or mitigating visibility problems, especially in adverse lighting and weather conditions, counteracting critical infrastructure (e.g. where views are obstructed), were identified as ideal applications for ITS. However, experts stated that the lack of available data on VRU's accidents (especially single pedestrian accidents, etc.) was a major obstacle for effective ITS design and critical incident assessment.

The participants exhibited an overall high level of experiences with different existing systems; informing, intervening, warning. Examples mentioned refer to blind spot detection [BSD – detects and warns for VRUs and objects in the Blind Spot of the vehicle using sensor technology], speed adaptation [ISA – compares the current speed and the position of the vehicle with the current local speed limit and warns if the vehicle exceeds this limit], position definition [GPS], or Cruise Control. Also, systems where VRUs are detected by sensor technology were mentioned, like for instance Intersection Safety [INS – provides a warning to vehicles and VRUs at intersections if needed] or a VRU Beacon System [VBS – which warns of the risk of a collision with a VRU]. When systems are discussed based on experiences the verdicts are generally very positive (table 4).

For VRUs, navigation systems are of great interest. Systems which address subjective safety (feeling of being on the right track, travel more efficiently, with less stress) and support the individual sense of direction and individual orientation by providing location based information are generally expected to increase comfort. Personalized information (toilets, benches, parks, elevators, escalators, weather etc.) has the potential to improve and increase the general level of mobility especially for those road user groups who are facing challenges in public space (i.e. older road users).

When discussing the expected potentials of ITS for VRUs both VRUs and experts exhibit rather similar expectations, albeit with experts expecting more benefits on the system level, while rather individual benefits are discussed in the focus group discussions. Generally increasing the visibility of VRUs in traffic and improving comfort (short trajectories etc.) based on real-time data are mentioned among VRUs as well as improved traffic flow (also for VRU) and less fuel consumption. The experts see the main ITS impact in leading to a reduction of user errors of motorised road users (especially of novice and older drivers). Concerning VRUs new technologies are mainly associated with increased independence and comfort by decreasing uncertainty through dynamic "on-line" information.

On the other hand, focus group participants and experts were asked to identify potential hazards and adverse effects of these emerging technologies for VRUs. Negative consequences that were mentioned refer mainly to potential safety relevant impacts. Distraction (by sounds, visuals and visual stimuli and the reactions they require), overreliance or overconfidence in the technical equipment, and negative mid- and long-term effects concerning individual abilities (i.e.: decreasing spatial abilities and moving/driving skills, leading to prolonged reaction times if "manual" handling is needed) are shared reservations among experts and VRUs. While (potential) users are mainly mentioning expected costs as an obstacle for usage, experts are also referring to legal questions: responsibility in case of system failure or misuse, data privacy issues, etc.

Table 4: Summary of focus groups and expert interviews

		Focus Groups	Expert Interviews
Critical Situations		Problems for VRUs related to: • High (car) speeds • Complexity and density of traffic • Lack of communication between road users • Weather conditions/maintenance of infrastructure For car drivers: • Erratic behaviour of pedestrians For PTWs: • Lack of respect of car drivers • Visibility	• Visibility of VRUs • Infrastructure (space for VRUs) • Car Speeds • Education – training – awareness • Lack of data on VRU accidents (single pedestrian etc.)
ITS	Experiences	• Experiences on all levels of ITS (mobile applications, in-vehicle, infrastructure) and technologies (informing, intervening, warning) • High level of experiences among car drivers (BSD, ISA, GPS, Cruise Control, etc.) • Actual experiences with various systems very positive	
	Benefits/ Advantages (positive effects)	• Increased visibility of VRUs (communication, warning, intervention) • Increased overall traffic flow (automation) • Economic benefits (less fuel consumption) and ecological (less CO2 emissions) aspects • Increased comfort in traffic (information)	• Automation/support to reduce user errors (novice drivers, older road users, children) • Efficiency (traffic flow, fuel, CO2 emissions) • Distraction, fatigue • Independency (increased comfort and decreased uncertainty through information) • Education and training (via simulation and e-coaching)
	Hazards (adverse effects) / Barriers (Usability)	• Loss of autonomy • Distraction • Overreliance/overconfidence • Responsibility • Reliability (technical limitations) • Abilities (spatial ability / driving skills / reaction times)	• Distraction • Attention & risk assessment reduced • Delegation of responsibility • Privacy issues (who has/collects data?)
	Acceptance / Willingness to use / Relevant factors	• Affordability (systems too expensive) • Reliability (doubtful) • Usability (often difficult to use, lack of user-friendliness)	
Future Prospects			• Standardisation • Connection • User centred design

4. DISCUSSION

The chosen exploratory approach applied in the basic research phase of the VRUITS project aimed at providing qualitative input needed for both discussing attitudes, potential issues and barriers and market uptake of emerging ITS addressing VRUs. The results of this process provided in-depth insight into actual stakeholder needs and attitudes towards ITS by actively involving representatives of the target groups into the approach. Generally, the results collected in course of both expert interviews and focus group discussions with VRUs clearly indicate a high level of conformity between experts and potential

ITS users. This is not only true for the potential benefits, but also for the identified negative implications. Here HMI-design and usability need to be directly adapted to specific user groups by paying close attention to potential distraction and misuse. Marketing and communicating the actual benefits to potential user groups seems to be a reasonable approach for broad scale deployment as there is still a significant level of scepticism observable, e.g. concerning reliability of systems. The price – affordability – seems to be a topic not only experts in the field are aware of. The results showed that there is a high level of technology potential for addressing safety, mobility and comfort needs of certain road user groups. Generally user involvement is essential for a sustainable development of measures (especially in view of ITS), which underlines the need for qualitative research methods and participatory processes already in the development phase of new solutions. Therefore solutions not solely based on individual technical applications but also taking education and training should be fostered.

An important point has to be made with respect to data; while there is data available on actual user needs and attitudes more structured approaches are needed to identify individual user groups, develop specific use cases and assess characteristics relevant in the context of safety, mobility and comfort. As other tasks of the VRUITS project showed traffic accident data is available allowing for country comparisons on a European level, however there is still a lack of comparability on a micro-level, impeding the assessment of causal factors essential for critical scenario development. When it comes to mobility issues (= exposure), the data is simply poor, and with respect to the comfort of VRUs data is inexistent. Especially in this context qualitative approaches can support understanding and hypothesis-steered definition of critical scenarios for different user group segments, which is impossible when simply relying on existing statistical databases. Moreover, relevant input for HMI-design, prototype development, and the corresponding evaluation procedures can be derived in the frame of a user-centred approach, meaning that issues are discussed with VRUs and reflected by experts, both in the frame of interviews and of expert workshops.

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