INTRODUCTION

In the domain of road safety, Vulnerable Road Users (VRUs) have not benefited from the decrease in fatalities experienced by other categories of road users. While fatalities of all other categories are decreasing, fatalities among Vulnerable Road Users are stable or even increasing. According to the CARE (Citizens Consular Assistance Regulation in Europe) database 2009, inside European urban areas, pedestrian fatalities represent more than 35% of all fatalities. There is a national and European societal imperative to address the safety of Vulnerable Road Users. Mobility and comfort in traffic using a VRU-centric ITS approach combined with communication with vehicles or infrastructure can contribute to this.

THE PROJECT VRUITS

The Project VRUITS (Improving the Safety and Mobility of Vulnerable Road Users through ITS Applications) investigates how the safety and mobility of pedestrians, cyclists, Power-Two-Wheelers and elderly drivers can be improved with ITS applications. The research includes the improvement of the usability of different applications and the integration of VRUs in cooperative traffic systems. Selected applications will be demonstrated in the Netherlands (Helmond) and Spain (Valladolid).

Figure 1: A busy street crossing.
KEY OUTPUTS TO DATE

Researches, meetings, discussions and tests have been actively fulfilled in these first, productive months of the VRUITS projects. Such activities are summarized in Deliverable 2.2, which has been presented to the EU Commission and focuses on multiple objectives. Firstly, it aims to determine the most critical scenarios for different types of VRUs, starting from accident data analysis and attempting to compile a taxonomy of the major critical scenarios for vulnerable road users is derived providing essential input to the development of ITS aimed at VRU safety. Furthermore, it intends to examine the needs of the identified ITS-user groups, of national and European authorities, of infrastructure service providers and ITS related companies. Finally, it lists a prioritized inventory of existing and upcoming ITS services targeted to VRUs, and of ITS services, which may have a positive or negative impact on safety and mobility of VRUs.

By establishing links between the critical situations, road safety related tools and persons’ demands, user needs will be matched with the ITS applications, so that gaps of existing technology and potential for new ITS will be identified.

In this VRUITS newsletter, we would like to share with you what we have discovered and analyzed.

ACCIDENT SUMMARY FROM NATIONAL DATABASES

Analysis of a range of databases has been conducted to identify a number of scenarios for VRU’s. The CARE database (Community Road Accident Database) has been used as the most representative database for EU accidents and data from national databases from Austria, Finland, Spain, Sweden and the UK have been compared to the CARE data for consistency of results, and for potential additional information regarding accident situations.

**Pedestrians**

In all databases, including the CARE database, it was found that accidents were most likely to occur when the pedestrian was crossing the road at mid-block;

The accident analyses suggest that in most, if not all cases, the environmental conditions are not intuitively detrimental to road crossing. No consistency regarding the accident month was found either.

The accidents tended to occur in urban areas on roads with lower speed limits (50km/h).

Males are slightly over-represented in the CARE database whereas females are over-represented in some of the individual Member State databases;

In the majority of databases including CARE, a passenger car was the most frequent collision partner;

Some important parameters could not be determined. These include vehicle characteristics, vehicle speed pre-collision and pedestrian actions prior to collision.
Cyclist

In the analysis, the majority of cycling accidents were found to occur at junctions/intersections; one of the most common scenarios involved vehicles pulling out into the path of the on-coming cyclist;

CARE data suggests that the most common scenario involves both cyclist and vehicle heading in the same direction, but the vehicle then turns into the cyclist’s path;

Overall, males are over-represented;
The majority of the accidents occur in fine dry weather during daylight hours;
The majority occur in urban areas on roads with relatively low speed limits.

PTW

The most common scenario in the CARE accident analysis was found to be the PTW being hit by a vehicle, initially heading in the same direction and then turning across the PTW’s path;

This was not consistent with the national database analyses which suggest that the most common scenario involves vehicles pulling out from intersections into the path of the PTW;

Males were far more likely to be involved in PTW accidents compared to females;

Most accidents occurred within urban environments;

It is thought that he majority occurred on roads with low speed limits (50km/h);
The majority of accidents occurred in fine and dry weather conditions during daylight hours;
The majority occurred during the ‘summer months’ (May to September).

4 COUNTRIES, 20 DISCUSSION ROUNDS

The VRUITS project has performed 20 discussion rounds, with overall 143 participants from four different European countries (Austria, Finland, Spain, and The Netherlands), covering both general aspects of VRU mobility as well as ITS and corresponding experiences, needs and expectations. Within a high variety of engaged aspects, differences and similarities are mainly found between the different VRU groups not so much between the different countries.

In the following paragraphs, results arising from these group discussions are explained.

Mobility behavior

Generally, registered mobility behaviour matched the expectations. In fact, it resulted that parents and older road users utilize cars, particularly for longer trips and transporting children, groceries, etc. PTWs are predominantly used as a leisure time transport mode, with the car being used for everyday trips; public transport is mainly exploited by older road users, living in urban areas and no more able to drive a car on a regular basis. Cycling and walking proved to be very important for all different vulnerable road user groups, especially for the participants living in urban areas and for younger road users with limited access to other modes of individual transport.

Figure 3: Participants’ countries.
Critical situations

From all group discussions and among all the different interviewed VRU, the following four aspects associated to mobility critical situations emerged; moreover, these appeared to be particularly important for cyclists and pedestrians of all ages:

• High speeds of motorized traffic and high speeds of electronic vehicles with very low noise;
• High complexity and density of traffic situations, especially at intersections, roundabouts and crossings, where rules are often not clear or traffic is at high speed;
• Road lanes shared by different road user groups;
• Weather conditions and infrastructure maintenance, especially bicycle lanes that need to be kept clear of snow in winter. Information on road conditions should be provided in advance to avoid critical situations.

As discussed in most of the four PTW group discussions, a lack of respect, in conjunction with a driving behaviour often perceived as aggressive, leads to situations where motorcyclists need to act in order to avoid a dangerous situation. In addition, lack of visibility has been highlighted as a relevant issue, particularly when trucks or SUVs are involved.

On the other hand, from their group discussions, car drivers, aware of their comparatively protected position in traffic, mentioned the erratic behaviour of pedestrians, especially the unpredictable one of children, could be a trigger for unsafe situations.

Systems’ knowledge

With regards to the systems’ knowledge, systems that participants have actual experiences with are assessed more positively than those only known through media, as there seems to be a lack of trust towards unknown technologies.

While the number of systems mentioned in the group discussions covers a high variety of different systems and provides a good overview over technologies currently available on the market, it occurred that a high share is mainly addressing the needs of motorized traffic participants.

Generally, participants of all discussions suggest that:

• There is experience at all levels of ITS (mobile applications, in-vehicle, infrastructure based) and technologies (informing, intervening, warning);
• The highest level of experiences is among car drivers (BSD, ISA, GPS, Cruise Control, etc.);
• Considering ITS personally experienced, hardly any statements regarding their failings have been registered; on the contrary, usage of various systems resulted very positive.
**Benefits and advantages of ITS in view of traffic safety**

Systems focusing on the following aspects are considered having the highest potential of providing advantages and benefits to the users and traffic safety in general:

- Increased of visibility, thus systems aiming at providing information and warnings to both car drivers and VRUs to avoid critical situations caused by a lack of visibility;
- Increased overall traffic flow (automation), thus systems decreasing the complexity and density of urban traffic situations (e.g., intelligent traffic lights and road signs informing about speed limits, maintenance works and traffic jams);
- Increased economic (e.g., less fuel consumption) and ecological (e.g., less CO2 emissions) characteristics, aspects especially promoted by car drivers and PTWs;
- Increased comfort in traffic, thus systems usually producing pre- and on-trip information on aspects such:
  - Routing (best, fastest, scenic, safest, etc);
  - POIs: information on points of interest related to the chosen transport mode (e.g., bike stations, bike slots for safe parking, etc);
  - Road and weather conditions. Mainly cyclists consider these additional information as being influential on mode choice and general mobility comfort.

In addition, systems like intelligent traffic lights, which, for example, allow cyclists to maintain a more constant traffic flow, with shorter waiting periods, longer green phases and additional information about the duration of green phases, are perceived as being notably beneficial for augmenting comfort.

Overall, the various discussion rounds illustrated the need to consider regional characteristics, too.

**Identified hazards associated with ITS**

During group discussions, hazards originated by the use of ITS have been detected, too. For example:

- Loss of autonomy, expressly perceived among those who are using their mode of transportation as a leisure time activity [PTWs] and in view of systems that are intervening with the driving task;
- Distraction, mainly related to increased workload for car drivers due to warning signs (such as parking sensors, speed warnings, etc.), visual information (i.e., navigation systems, etc.) and interaction with the interfaces while driving and being active in traffic (this also includes the use of Smartphone-based navigation systems);
- Overreliance and overconfidence. By solely relying on drivers and riders supporting technologies, especially in critical situations that can only be solved by reacting rapidly and correctly, drivers and riders are losing skills and abilities. In addition, these effects can be observed in the context of decreasing spatial and orientation abilities due to the use of navigation or information systems in general;
- Responsibility. Traffic participants need to take responsibility for their actions in traffic;
- Reliability (technical limitations). The fear of relying on a system to work in a certain dangerous situation and actually function in an expected way, while, on the contrary, being let down is very immanent in most of the group discussions.
Acceptance and willingness to use ITS

When it comes to the actual willingness to use available ITS and/or accept the usage of these systems by other groups of road users these characteristics are classified as important:

- Price/affordability. For instance, high maintenance costs might discourage the implementation of infrastructure-based systems, while the fact that most modern ITS are associated with in-vehicle technologies peculiarly found and advertised for upper-price segment cars might fade their benefits;
- Usability and implementation. Generally, interface designs with simple layouts and a low level of complexity, regarding both understanding the functions and the actual usage, are more preferred by the older road users. Overall, proper instructions or education seems to be a prerequisite specifically for systems that are aimed at supporting road users in critical situations;
- Availability and accessibility mainly related to the already mentioned dimensions of costs;
- Standardization. Having experiences with different vehicles and technology brands brought up the aspect of standardization of both functions and design between different manufacturers;
- Reliability. In order to improve trust and reliability into the functioning of ITS and their positive effects on road safety some kind of universal certification is discussed;
- Privacy

WHAT THE EXPERTS SAY

Beside discussion rounds among representatives of different VRUs profiles, semi-structured interviews with experts from research, technology development, transport and traffic policies’ groups added insight on the current state of the art, gathering details also about traffic issues and future prospects.

One of the major aspects brought up in these interviews is the need for a better organization of traffic, possible through a separation among the different road user groups by providing them with the space and the infrastructure needed to be safely and efficiently mobile, especially in urban environments.

Moreover, experts emphasize the visibility issue and point out the potential both of technologies aiding car drivers in the detection process of other road users in different situations and of technologies informing/warning VRUs on dangerous situations, in order to be able to actively avoid them.

In view of future prospects, a broader scale deployment of already existing technologies is expected on an international level and in different national markets (i.e.: dynamic speed adaptation, emergency brake assistant, lane departure warning, automatic cruise control, crossing assistance, etc.).

In addition, technologies based on road infrastructure, which help to improve traffic flow and inform/warn VRUs in certain situations, are considered to have benefits for all road user groups, regardless of transport mode (i.e.: at traffic lights).

Demographic changes (e.g., population ageing) and variations in transportation modes (e.g., electric vehicles) need to be taken into account, by providing technologies and solutions specifically adapted to the needs of different road user groups. These issues again underline the need for sound data basis on traffic safety related data, including traffic conflicts, task demands and accident data to adapt existing and future ITS to the actual situation in traffic; lack of data is an especially pressing topic.
One of the activities performed by the VRUITS consortium aimed at providing an overview of existing and upcoming ITS systems for VRUs, as well as selecting and prioritizing the most promising solutions for further evaluation. An exhaustive process of identifying and documenting systems for consideration took place, starting from a comprehensive literature review and then focusing not only on market applications, but also on prototypes or ideas.

Through a properly developed template for systems’ description (SDP) a total of 14 systems addressing pedestrians, 34 addressing cyclists, 28 for PTWs, and a number of 10 in-vehicle systems which benefit all kind of VRUs have been picked. In order to identify the most promising solutions, a workshop with 40 relevant stakeholders was held in Brussels on September 18th, 2013. In this workshop, representatives of VRU groups, national and European authorities, infrastructure service providers and ITS-related organizations contributed to the prioritization process. Participants selected the applications having the highest potential for VRUs safety and rated these ITS solutions according to a set of criteria previously decided by VRUITS partners.

This second screening formed the basis for the VRUITS project to decide the final set of systems for further assessment.

### FIRST INTEREST GROUP WORKSHOP - RESULTS

<table>
<thead>
<tr>
<th>ITS applications</th>
<th>Type of VRU</th>
<th>Impact</th>
<th>Type of ITS</th>
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<tbody>
<tr>
<td></td>
<td>Pedestrians</td>
<td>Cyclists</td>
<td>PTWs</td>
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<tr>
<td>Blinding Spot Detection</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Intelligent Pedestrians Traffic Signal</td>
<td>X</td>
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<tr>
<td>ISA (Intelligent Speed Adaptation)</td>
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<td>Red Light Camera /Average Speed Camera</td>
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<td>Intersection Safety</td>
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<td>Pedestrian Detection System + Emergency Braking</td>
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<td>Navigation systems for VRUs</td>
<td>X</td>
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<tr>
<td>PTW Oncoming vehicle info system</td>
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<td>VRU Beacon System</td>
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<td>Cyclist digital bicycle rear-view mirror</td>
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<td>Roadside Pedestrian Presence</td>
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<td>Urban sensing system</td>
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<td>Automatic Bicycle Identification</td>
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<td>Night Vision and Warning</td>
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<td>Information on vacancy on bicycle racks</td>
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<td>Bicycle to car communication</td>
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<td>Rider Monitoring System</td>
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<td>Crossing Adaptive Lighting</td>
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<td>Infotainment</td>
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<td>Real-time information systems for public transport</td>
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<td>Road weather warning for pedestrians</td>
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<td>Advice system for elderly cyclists</td>
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Figure 5: Prioritization of ITS for VRUs at the First Interest Group Workshop.
THE SYSTEM EVALUATION CONTINUES

In Work Package 4, the VRUITS Consortium created a usability questionnaire on the interfaces of various systems aimed at improving the safety of Vulnerable Road Users. It will be distributed to a list of about 100 experts, attached to few pages and links describing the systems under assessment, one per each type of VRU, generally closed to the market or in prototyping and development stage. Results will strongly contribute to the next project’s steps. For instance, data collected from these test fields will be analysed focusing primarily on the concepts of risk perception and risk communication. Moreover, these processes will be used to develop a reference table to be overall implemented for usability testing and assessment.

Figure 6: Examples of ITS to be evaluated in the VRUITS WP4 usability questionnaire.

USABILITY QUESTIONNAIRE RESULTS

We will keep you updated on the VRUITS WP4 usability questionnaire’s results in the next editions of the project’s Newsletter.
CONCLUSIONS

From all so far conducted interviews, surveys, and group discussions these are the predominant outcomes:

• For the success of ITS systems, it is essential that they are tailored to the specific needs of road users.
  • Junctions are one of the most relevant unsafe situations for VRUs, where VRUs are endangered due to being hardly visible or easily over-looked. Moreover, situations where cars overtake cyclists or PTWs are assessed as being critical due to high traffic speeds and, in some cases, to the perceived reckless behaviour of car drivers.
  • Correspondingly, technologies and systems enhancing the detectability and visibility of VRUs are considered to have high potential to increase the traffic safety of VRUs (e.g., cooperative systems, based on simple beacons carried by VRUs, or two-directional devices allowing communication between PTWs and vehicles)
  • All involved road user groups regularly use Smartphone-based applications for routing and navigation.
  • Overall willingness to use VRUs dedicated ITS and the evaluation of their benefits for traffic safety and general mobility was assessed on a very high level by both experts and focus group participants.
  • ITS could help not only to avoid road accidents, but also to be a source for new data gathering on PTW’s incidents.
  • ITS can also be used for education and training; these systems can help to train novice riders to tackle critical situations.
  • Promoting a change in attitudes and behaviour is suggested in addition to the installation of systems like Red Light Cameras, Intelligent Speed Adaptation or automated speed enforcement, particularly for scenarios with high vehicle’s speeds. In this regard, enforcement should be accompanied by educational measures, in order to modify intentions to break the law.
• Intelligent Pedestrian Traffic Signals are seen as promising ITS for pedestrians and cyclists. In fact, by providing pedestrians with the amount of time they need to cross at the speed they are capable of, VRUs are less likely to cross during the red light phase.
  • ITS technologies capable of distinguishing between different types of VRUs and of rapidly deploying tailored countermeasures are encouraged (e.g., Blind Spot Detection systems).
  • Regarding PTW’s, while on the one hand systems supporting visibility or communication between PTW’s and cars are considered very positive, on the other hand ITS interfering with the riding task or those perceived to take away the autonomy from the rider are seen as very skeptical. Training and education are considered to be of major importance in this group, with ITS having mainly adverse effects on riding behaviour.
  • Systems can only enhance users’ safety and mobility if they are fully used. For this reason, acceptance is a decisive aspect to be considered in their development process.
  • The general usage of systems while being part of the traffic system and the mere interaction with different HMIs could increase the cognitive load of the user and negatively affect his behaviour. Therefore, both usability and potential effects on different user groups need to comprehensively be assessed.
  • Single VRU accidents, especially pedestrians and cyclists, are underreported in traffic accident databases. There is only little research performed on the scenarios of these accidents, and there are only little ITS applications attempting to avoid them.

IMPROVING THE SAFETY AND MOBILITY OF VULNERABLE ROAD USERS THROUGH ITS APPLICATIONS
VRUITS FUTURE EVENTS

The VRUITS project will meet in the following upcoming events:
• VRUITS Symposium and Consortium Meeting in January 2014;
• 10th ITS European Congress in June 2014.
• 2nd Interest Group Workshop on Monday 16th June 2014.

HOW TO PARTICIPATE IN VRUITS

The VRUITS project is looking for feedback of experts in the VRU and ITS fields to provide feedback on key issues such as impact of ITS applications and ITS implementation issues.

Are you interested in giving your contribution to the VRUITS project? Would you like to answer to further questionnaire prepared by the Consortium? What about participating to upcoming VRUITS Workshops?

If you desire to be included in our list of experts, please send us your credentials to the following e-mail addresses:

Project Coordinator: johan.scholliers@vtt.fi
Dissemination Manager: vruits@kitesolutions.it

You will receive invitations to future meetings and we will consider your name for late surveys.

Figure 7: the VRUITS Consortium
Visit www.vruits.eu

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