An application for the information of children according their school transportation

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Abstract

The school transportation is a very critical type of transportation since it involves the most vulnerable road users, the children. Even if the school transportation is considered nowadays as the “on the bus” route, in order to have a holistic view, we should bear in mind the whole school transportation chain from a door (home) to door (school) perspective. This is the objective of SAFEWAY2SCHOOL project, which is an EU funded STREP focused on the optimisation of school transportation. In the current paper we present a VRU application for children, that has been developed within the framework of SAFEWAY2SCHOOL project.

1. Introduction

The school transportation is a very critical type of transportation, hiding various dangerous situations which involve the most vulnerable users of all the transportation means, the children. Despite the fact that the school transportation is considered from most of the people as the "on the bus" trip only, this is not actually the case. In order to have a holistic view of the school transportation and gain optimal results according to its safety, security, efficiency and effectiveness, we should bear in mind the whole transportation chain from a door (home) to door (school) perspective. This is what we have done in...
SAFEWAY2SCHOOL project (http://safeway2school-eu.org), which is an EU funded STREP focused in
the optimisation of school transportation, following a holistic approach (door2door perspective).

In the current paper we focus on presenting the childrens’ application, which will be from now on
called VRU (Vulnerable Road Users) application, that has been developed within the framework of
SAFEWAY2SCHOOL project, in order to give to children personalized information about the school bus,
its routes, timetables and further useful for the school transportation data. The VRU application, is being
launched on a mobile phone and it uses push message services, which is a style of internet-based
communication where the request for a given message is initiated by the SAFEWAY2SCHOOL server
that can inform the child about updated information, like timetables and changed routes. The VRU
application is one of the greatest innovations of the project, since there is no other relevant product on the
market yet.

The VRU application, for the children, is the one of the two parts of the SAFEWAY2SCHOOL
application, which is a mobile phone application with system related user information. The
SAFEWAY2SCHOOL application will be available for older children (9-16 years old), through the “VRU
Application” and for parents through the “Parents’ Application”. The two applications have been
developed using the same technology, but with different look and feel concepts for the HMI (Human
Machine Interface), and different functionalities, so as each one of them corresponds to the needs and
expectations of the corresponding user group it is addressed to. Thus, this paper describes the VRU
application.

The VRU application is a mobile application that has been developed to assist children at their
transportation to and from school. The VRU application runs on a generic mobile phone and serves as a
communication node between the child and the SAFEWAY2SCHOOL system, in order to provide the
children and the system with the appropriate information. Through the VRU application, the child can get
information about the status of the buses, the routes, the timetables and also his/her own location. In the
sections bellow we will present the story behind the development of this application and the user
expectations from which the functions of this application have been emerged, also the design
requirements, as well as the design loop that was followed from the beginning until the finalisation of the
application will be discussed.

2. Background information and user needs

2.1. The story behind

Going to and from school is a daily transportation habit realised by millions of children within Europe.
Everyone is somehow participating in this transportation, either directly, as a user or a provider, or
indirectly as a typical road users that is affected by the impacts of school transportation in the road traffic
(Robertson & Tsai, 2005). The number of children going to and from school with different transportation
means vary between countries; for example in Sweden the number of children (age 6-16) is estimated to
be 250.000, in Poland they are approximately 700.000 and in Austria they are about 450.000 (A. Anund
et. al. 2010), when in the United States approximately 26 million elementary and secondary school
children ride school buses twice a day, every day (US Department of transportation). In addition to the
variety of the number of children going to school in EU counties with different means, the organisation of
school transportation varies also worldwide. In the EU it is common to have a mixed system of school

transport (National Association for Public Education Transport, 1998; Anund et al., 2002). In US, the Committee on School Transportation Safety of the Transportation Research Board, that has studied the various modes of travel and associated risks for schoolchildren, estimates that the trips per year by mode of transportation during school hours are: 45% as vehicle passengers’ with adult driver, 25% with school buses, 14% as vehicle passengers’ with teen driver, 12% on foot, 2% on bicycle and 2% with other buses (Americas Academy of Pediatrics, 2007). In Europe, the school transport is most of the times free, organised and provided by the public authorities. However, the criteria that need to be fulfilled in order to have the right for free transport differ between countries. Thus, the school transport is not only provided by bus, even if this is the dominant mean, it can also be by taxi or other transportation means.

Despite the mean with which the transportation is being realised, attention should be given to all the steps that are carried out from children, on their way to and from school. To this end, in SAFEWAY2SCHOOL we have developed a methodology that covers the whole school transportation chain, providing a seamless and secure way to and from school. The methodology developed includes 10 consecutively steps that cover all the school transportation chain and have in the centre the primer user who is the children. The methodology is presented in the figure that follows and it is called SAFEWAY2SCHOOL holistic approach.

![Fig. 1. The holistic approach of the school transportation](image)

### 2.2. User needs and expectations

The VRU Application for children has been designed to inform children about their transportation to and from school, in full compliance to their needs and expectations, bearing in mind the safety and security issues that may occur. In 2009 and within the framework of SAFEWAY2SCHOOL project, a research has been realised, in order to identify the needs and expectations of the different user groups of the school bus transportation, from a system like SAFEWAY2SCHOOL. All stakeholders relevant to school transportation; children, parents, bus drivers, school representatives and administrators, traffic
safety authorities, research institutes and bus operators have been participated in this extended survey that took place in seven countries, namely Sweden, Poland, Italy, Germany, France, Greece and Austria. The needs of more than 200 children have been reflected through workshops and focus groups, as well as by filling in different questionnaires (E. Aigner-Breuss et. al, 2010). From this survey it was proved that children really wanted to be notified from an automatic system about specific issues of their transportation to and from school. It was shown that children really want to know when the bus will arrive, in order to be on the bus stop on time and not wait the bus nor run behind it or lose it. Additionally, the need of a mobile phone for the implementation of the aforementioned needs was shown from the fact that the children also want to have the possibility to view the aforementioned information, as well as, contact their parents at any time. From these needs, the Use Cases of the system have been emerged. The Use Cases have been used as the basis to develop the functional specifications of the system, which lead to the final functionalities that have been realised at the VRU application. The figure below presents the methodological framework, which was used for the extraction of the final VRU application functionalities.

Fig. 2. The methodological framework to the functionalities of the VRU application.

The transition of the User wishes to the Use Cases and then to the system functional requirements is being presented in the table that follows.
Table 1. User Needs of children, Use Cases developed and system requirements.

<table>
<thead>
<tr>
<th>User group</th>
<th>User wishes (from focus groups and workshops)</th>
<th>Use Cases</th>
<th>Description of system requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children</td>
<td>As I child I want to know when my bus will arrive in order to be there in time.</td>
<td>The child is in his/her house and is getting prepared for the school day. He/she opens the VRU application and sees when the next bus is going to be at the closer to his/her home bus stop. He/she sees that the school bus is going to be 5 minutes later than usual and he/she does not want to go to the bus stop earlier because it is pouring rain. He/she leaves the home just in time and catches the bus. During the ride he/she calls his/her mother, through the VRU application speed dialing and ask her about the lunch. As the trip to school continues, he/she checks a place that he/she is interested on visiting and while the bus has stopped at the traffic light, enables the GPS and gets the address of the spot he/she is interested in.</td>
<td>The system shall inform child when bus will arrive (late) at a bus stop Cell phone, SMS or push-based contact possibility.</td>
</tr>
<tr>
<td>Children</td>
<td>As a child I want to have a possibility to contact my parents at any time.</td>
<td>Cell phone, SMS or push-based contact possibility.</td>
<td></td>
</tr>
<tr>
<td>Children</td>
<td>As a child I want to know when the bus has left my bus stop so when I do not arrive in time I do not need to run anymore.</td>
<td>Cell phone, SMS or push-based contact possibility.</td>
<td></td>
</tr>
<tr>
<td>Children</td>
<td>As a child I want to get a reminder when I need to leave the house in order to arrive in time at the bus stop.</td>
<td>Cell phone, SMS or push-based contact possibility.</td>
<td></td>
</tr>
</tbody>
</table>

3. Objectives and Requirements

Since the VRU application is totally devoted for usage from children, it must be easy to use, having a plain by appealing look and feel. The children should be eager to download and use the application, so both the screen appearance and the application usability have been considered. The application has to provide features that can be easily handled and understood by a child, who should be able to operate this device as simply as possible and with complexity adapted to the child’s ability. The application shall provide information relevant to the child (from children’s point of view). The information shall arrive in the right time from the children’s point of view and perception, when the messages shall be noticed at the right moment providing notification that is effective but not disturbing or annoying and the information provided shall be fully understandable by all users. Finally all the aforementioned must be taken into account, considering also that the application shall not reduce the functionality of the phone where it is installed.

3.1. Functional Requirements

In order to cover the needs of the children and provide also additional functionalities to the system, that will make the application appealing for them, the actual functionalities of the application have been identified, based upon the functional requirements presented in Table 1. To this end, the application will have the ability to send automatic text messages to the children when there is a delay in the school bus service, this information will be realized technically with a push message, which is a style of internet-based communication where the request for a given message is initiated by the SAFEWAY2SCHOOL server and in this way the child can be informed about updated information, like timetables and changed routes. Also, the application will show the calculated expected time of arrival of the school bus at the predefined bus stop which is closer to the child’s home, this will be technically realized with pull information, which is a style of internet-based communication where the SAFEWAY2SCHOOL server pulls information from the specific component of the system. Additionally, the system will be able to inform the child when the bus will arrive at the destination bus stop, with visual message, as well as push
Finally the child will be able to use the GPS of the mobile device and find out his/her exact address on the map. In order to use the application, the user will have to login, and also create a user profile that will contain the following information:

- Party (child, parent)
- Age
- Home bus stop
- School
- City
- Country
- Home phone number
- Emergency phone number

3.2. Design Requirements

Many design principles exist for the development of adult interfaces, but most of them cannot be applied to children’s products because the needs, skills, and expectations of this user group are different than those of adults. Additionally, there are many design guidelines for the desktop environment which are totally different for the ones that must be taken into account for designing mobile interface. The design requirements for the VRU application apply first for the application look and feel itself, devoted to children, but also for the operating system (Android OS and Symbian OS) of the mobile phone and the possibilities each one offers and the limitations it incorporates for the application development. Most of the design appearance, the dialogues and the interaction are set by the operating system. Still, since the application is addressing children, through its development the following relevant HMI guidelines and principles have been studied and considered:

- The Golden Rules of User Interface Design (Mandel T., 1997). These are principal rules of user interface design which are to be considered for all devices.
- Guidelines for Handheld Mobile Device Interface Design (Gong et al. 2004). These are guidelines that highlight the special interface aspects for handing mobile devices.
- Children vs. Adult Users (Nielsen, 2010). These are guidelines for the child appropriate application design.
- Design Principles for Children’s Technology (Chiasson et al., 2005). This study takes a first collects and organizes design principles and insights, gathered from several sources, into an initial catalogue of design principles for children’s technology.

To this end, in order to develop a concrete and adequate HMI for the needs of the children and in compliance to the operating system used for the VRU application, all the aforementioned guidelines have been taken into account as design requirements.

4. Design, Iterative and User Centred Development

The design of the VRU application has been realised following the framework of SAFEWAY2SCHOOL project V-ISO model (Diederichs et. al., 2010), presented in the following figure. The V-ISO model contains on the left side the user oriented requirements engineering and on the right side the iterative and user centred development and testing procedure (see, fig.3). Requirements engineering and iterative and user centred development both take place on four hierarchically ordered
levels (green, blue, orange and purple). The requirements engineering starts with a general product idea (not explicitly mentioned in the model) and high level objectives for the product that is to be developed. The next step is to find and define the user needs and the use cases where the product will be developed. Methods to do this are for example focus groups (as performed in SAFEWAY2SCHOOL) or a description of a typical persona that may use this product. The use cases are defined as situations where the product will be used by the users. Derived from those high level objectives and the user needs and use cases are in the next step the functional and technical requirements that the product shall meet, e.g. a list of functions is needed and a technical description with the requirements for such a product. In the last step design requirements are to be defined. The design requirements include visual, acoustic, tactile and haptic design. A special focus for the user centred development is to include also ergonomic aspects and the relevant HMI guidelines in the design requirements.

According to the V-ISO methodology the design loop of the VRU application started with an analysis of the design requirements and proposals on how to implement them into the design. Since many design aspects are dependent on the operating system of the mobile phone, initially a short overview was given on the two operating systems used for the VRU application, the Android and the Symbian, that was followed by specific screen designs that were proposed for each operating system, covering all functionalities.

These screen designs have been validated by German, Swedish and Greek children, by providing them screenshots of the application, see following figures. In total, 13 children participated in the validation 9 children, ages 10-14 were surveyed in public areas and 4 children with disabilities - with mild cognitive impairment, in a controlled environment. Nielsen (1994), reports that 5-7 users normally detect most of the problematic issues within a development stage. This prototype verification aimed at including users.
into the development process in an early stage when an initial design was available so as if problems are reported a redesign should be performed and a second small group of users should be involved (iteration).

Fig.4 Application validation with children with screenshots.

The iterative testing proved that the idea of implementing the presented functions in a mobile phone is highly accepted by the children. All children comments about the proposed functions of the application and the layout design were positive and the functionalities useful. A conclusion from those tests is that one major criterion for the use of the VRU application is the ability of children to use mobile phones and their readiness to exploit new functions that are available on modern Smartphones.

5. VRU application final design

The final version of VRU application both for Nokia and Android devices was released taking into account the feedback provided by the evaluation process, section 4. Some of the functions that have been described in section 3.1 are depicted as screen dumps of the final VRU application below, both for the Nokia and the Android version of the application.

Fig.5a Starting application  Fig.5b Main menu of child application  Fig.5c Family contacts

Fig.5 Screenshots of the final VRU application’s functionalities in the Nokia phone.
6. Conclusions

In the context of the SAFEWAY2SCHOOL project and its aim of raising the safety and security, as well as the efficiency of the holistic school transportation from a door to door perspective, the VRU application, that is focusing on assisting the children at their transportation to and from school, has been developed. The application’s functionalities have been based upon extensive research that has been made in the framework of SAFEWAY2SCHOOL, to capture the needs and expectations of all the school transportation stakeholders, including children. On the same time, the application design has been based upon many different design principles that combined the mobile device specificities and the children
characteristics, as target group. To this end, a VRU application has been developed and evaluated using the V-ISO model (Diederichs et al., 2010). The evaluation phases with children took place in 3 different countries, of North, Central and South Europe and the results drove to the development of a VRU application that can be launched in mobile phone that use Symbian and Android operating systems. The application can be used from children and notify them about various issues of their school transportation, like the timetables of the school buses, the time that the bus will stop at the bus stop closer to their house, the location of the bus, the location in terms of address of the child and to their fast dial contact, to cover also possible emergency issues. The application has been very well accepted from children, who were keen on the applications functionalities and its design also. The VRU application is one of the greatest innovations of SAFEWAY2SCHOOL project, since there is no similar product in the market yet.

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References

H. Robertson, J. C. Tsai, “Improving the Safety, Security and Quality of student travel”, TRB, TR news 237 March–April 2005
Anna Anund, Jörgen Larsson, Tania Dukic, Annie Pauzié, Blandine Gadegbeku & Hélène Tardy, D1.4 “Accident analysis report”, SAFEWAY2SCHOOL project 233967, 2010.
National Association for Public Education Transport School Transportation Safety in Europe; Summary of the study report. In, 1998.