

**SEVENTH FRAMEWORK PROGRAMME  
SUSTAINABLE SURFACE TRANSPORT (SST)-2008-RTD-1**



Integrated system for safe transportation  
of children to school

**SAFEWAY2SCHOOL**  
Collaborative project 233967

**Final report**

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Authors (per company, if more than one company provide it together)		<b>Anna Anund (VTI), Eleni Chalkia (CERHT/HIT), Leon Nilsson (Amparo Solutions), Frederik Diederichs (USTUTT), Chiara Ferrarini and Roberto Montanari (UNIMORE), Lennart Strand (Mdh), Eva Aigner-Breuss (KfV), Dagmara Jankowska, Justyna Wacowska-Slezak (ITS)</b>	
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## List of abbreviations

<b>Acronym</b>	<b>Description</b>
BS	Bus Sign
BSS	Bus Stop Sign
BiciBus	A constellation of a group of children going together with bicycle to school accompanied with an adult.
DOW	Description of Work
DSS	Driver Support System
IBS	Intelligent Bus Stop
ISA	Intelligent Speed Adaption
IPR	Intellectual Property Rights
OBU	On Board Unit
RFID	Radio Frequency Identification
SBS	School Bus Sign (the electronic sign on the bus)
SW2S	Safeway To School EU project
TBD	To Be Defined
TCC	Traffic Control Centre
VMS	Variable Message Sign
VRU	Vulnerable Road User



# PROJECT FINAL REPORT

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**Name, title and organisation of the scientific representative of the project's coordinator**

Dr. Anna Anund STATENS VAG- OCH TRANSPORTFORSKNINGSINSTITUT

**Tel:** +46 13 204327

**Fax:** +46 13 141436

**E-mail:** anna.anund@vti.se

**Project website address:** [www.safeway2school-eu.org](http://www.safeway2school-eu.org)



## EXECUTIVE SUMMARY

Going to and from school is a daily journey for millions of children around Europe. The crash statistics is lacking information about the exact number of child casualties during those trips, but available sources identify the most dangerous situation as the way to and from school buses, situations when the children are unprotected road users. In addition there are several proofs for the need of a door to door perspective in order to improve the safety for the children. SAFEWAY2SCHOOL aimed to design, develop, integrate and evaluate technologies for providing a holistic and safe transportation service for children, from their door to the school door and vice versa, encompassing tools, services and training for all key actors in the chain.

The project has a user oriented approach and the EU so called FRAME approach have been used for a stepwise process with a starting point in user wishes, moving on to identification of those in relation to the system being developed, formalization of them into user needs and combine them into use cases. This is the ground for the definition of the system requirements. The requirements were grouped into blocks of functions.

The functional blocks identified based on system requirements were:

- Safe route planning
- Information and warning
- Bus driver information
- Notification
- Training and Education

For each identified block data in and out were identified and finally the system architecture was put together. The main tool developed were HW and SW for localization, route planning, navigation, communication between vehicle and road, vehicle based system supporting bus drivers, bus stops, bus stop inventory tool, VRU unit, mobile applications and training schemes for all involved stakeholders. Tools, technology and software were developed, put together and evaluated from both a technical point of view, safety and security point of view and from an a user oriented point of view.

The results are positive, showing cost effective solutions with high acceptance for the holistic approach but also for most of the sub systems behind. However, no chain is stronger than the weakest link and this is true also when it comes to school transportation. Based on a very extensive work to identify future work with standardisations and policy the most essential improvements identified were related to School Travel Plans, Sign at all bus stops and improved driver education. Evaluation of the system (total system or parts of it) has been done at five different pilot sites (Sweden, Poland and Austria, but also a simulator experiment in Germany).

## 1. Project context and objectives

### 1.1. Aim and scope of the project

Between 1994 and 2001, 361 children were injured or killed during transportation to/from their schools in Sweden, whereas 455 were killed or injured in Austria only in 2007 and 97 were killed in Italy in 2005. In a single school bus accident in Greece in 2003, 20 children lost their lives. Different as the above numbers may be, they all tell us one thing: Crashes involving school buses and crashes involving children travelling to/from school, are far from negligible and require further efforts to be drastically reduced (Anund, Dukic, Falkmer, & Thornthwaite, 2010).

**SAFEWAY2SCHOOL aims to design, develop, integrate and evaluate technologies for providing a holistic and safe transportation service for children, from their door to the school door and vice versa, encompassing tools, services and training for all key actors in the chain.**

SAFEWAY2SCHOOL aims to design, develop, integrate and evaluate technologies for providing a holistic and safe transportation service for children, from their home door to the school door and vice versa, encompassing tools, services and training for all key actors in the relevant transportation chain. These include optimal route planning and rerouting for school buses to maximize safety, on-board safety applications (i.e. for speed control and seat belts), “intelligent” bus stops, effective warning and information systems for bus drivers, children, parents and the surrounding traffic; as well as training schemes for all actors. The project innovative systems, services and training schemes will be tested in 4 sites Europewide, including North (Sweden), Central (Austria), South (Italy) and Eastern (Poland) Europe; to evaluate their usability, efficiency, user acceptance and market viability; taking into account the very different children’s transportation to/from school systems across the different European regions as well as key cultural and socio-economic aspects.

More specifically, SAFEWAY2SCHOOL aims at:

- Developing optimal route planning for school buses, to guide them through areas of low traffic, avoiding black spots.
- Developing optimal real-time route guidance, taking into account dynamic traffic data, as well as the arrival and estimated arrival of children at the bus stops.
- Developing “intelligent” bus stops that understand the position of children and school buses and transmit relevant info and warnings to both actors.
- Developing a seamless, reliable and secure system of school bus position tracking and monitoring and a parents’ notification system, when children are on-board the school bus.
- Integrating safety enhancement applications regarding speed monitoring and safety belt usage for the school bus, while travelling.
- Developing warning systems for surrounding vehicles on the existence of stopped school buses or/and children waiting/ entering/ exiting.
- Developing appropriate training schemes for school bus drivers, children, parents and all drivers, for optimal use of the developed systems and children safety enhancement in general.
- Performing socio-economic analysis, to identify the optimal business plans, legal schemes and organizational incentives for rapid adoption and wide market penetration of SAFEWAY2SCHOOL system.

Target Groups of the project include:

- School bus drivers.
- Students/ children: 6-9, 10-12 and 13-16 years old, with and without disabilities, when they may travel alone from/to school bus, although some applications (e.g. safety belt use) are for all ages.
- Families of the children.
- Infrastructure (i.e. bus stops or bus fleet operators).
- Car manufacturers (OEM's).
- Authorities (legislators, municipal and school authorities).
- All drivers (i.e. of surrounding traffic vehicles).

The scope of the SAFEWAY2SCHOOL is based on a holistic approach, from door-to-door, see Figure 1.

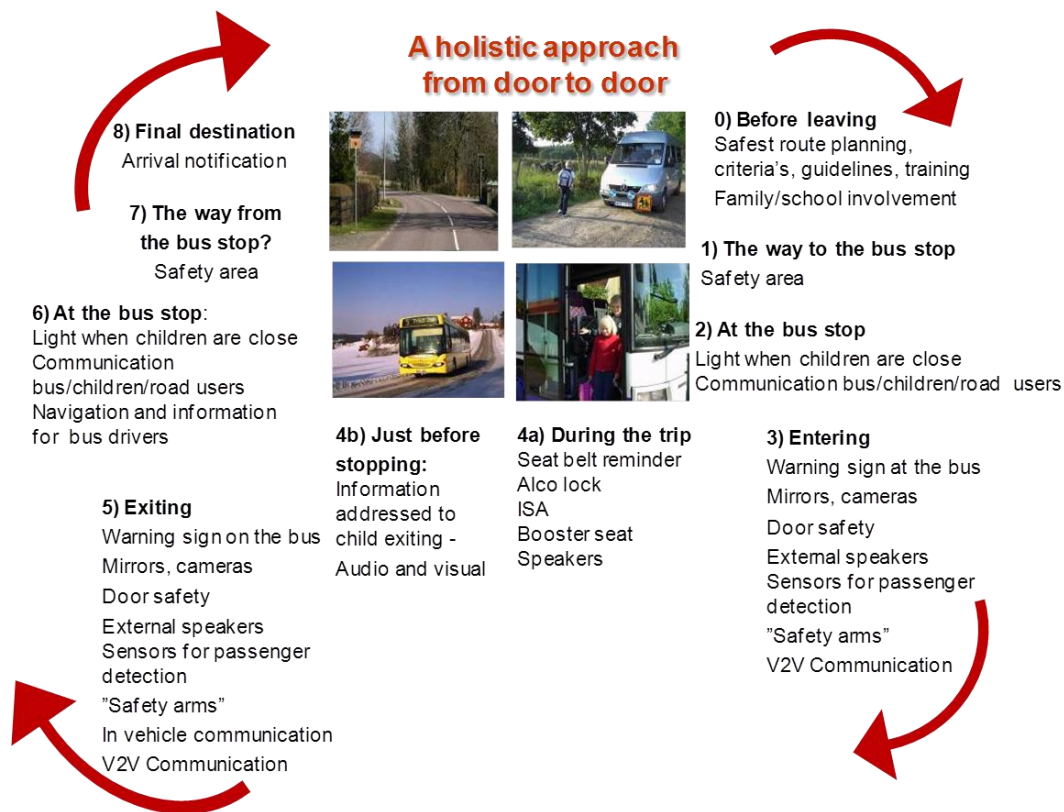


Figure 1 The holistic approach of SAFEWAY2SCHOOL.

## 1.2. Objectives of the project

The project has various objectives in order to achieve its scope and goal. This section illustrates the objectives of each WP and in the end provides an overview of the interrelations between WPs.

### 1.2.1. Use cases

- To investigate various accident databases, in order to prioritise the scenarios with maximum potential impact to traffic safety.
- To identify user and stakeholder needs in the field of school transportation safety.

- To perform a benchmarking and state-of-the-art analysis of existing systems and prototypes related to SAFEWAY2SCHOOL developments.
- To define the project priority use cases, in terms of type of bus, road type and scenarios of vehicle interactions, systems and other equipment used, number of occupants and other environmental factors (i.e. weather, time of day, etc.).

### **1.2.2. System specification**

- To specify the architecture of the school transportation systems that will be developed within the project, as well as its modules: the route inventory tool, the route planning and administrative tool, the driver support system, the VRU units, the “intelligent” bus stop and the on-bus warning sign.
- To analyse and minimize possible risks associated with the systems, for children, school bus drivers and other road users.
- To carefully investigate security and privacy issues of children and bus drivers when using the systems.

### **1.2.3. Safest route planning/monitoring**

- To implement and evaluate a safest route planning and optimal real time route guidance system with dynamically updated travel time information and children arrival times.
- To develop a school bus position tracking and monitoring and a parent’s notification systems when children are on board.
- To develop an intelligent bus stop that receives the position of children and school buses around it and transmits the important information and warnings to both buses and children.
- To develop a real time safe vehicle rerouting technique, in case of traffic problems or if a child is far away from the bus stop.
- To develop warning systems for surrounding vehicles on the existence of stopped school buses or/and children waiting/ entering/ exiting, applying V2I communication.
- To implement on-board safety enhancement applications regarding speed monitoring and safety belt usage for the school buses.

### **1.2.4. VRUs routing and monitoring**

- To develop a low cost, easy to wear, light-weighted, high reliability and standards abiding VRU identification and location unit.
- To develop an “Intelligent” bus stop as a key node between the bus and the children awaiting it.

### **1.2.5. User interface and design and development**

- To develop an information and warning concept for all user groups and beneficiaries of SAFEWAY2SCHOOL system.
- To develop and prototype a school bus driver notification and warning.
- To develop and prototype a VRU information and warning system.
- To develop and prototype a family and third party information system.
- To develop and prototype a surrounding traffic information system.

### **1.2.6. System integrations**

- To integrate the different school transportation subsystems developed within the project on a technical level; the route inventory tool, the route planning and administrative tool, the driver support system, the VRU units, the “intelligent” bus stop and the on-bus warning sign, and to technically demonstrate and validate the functionality on a system level.

### **1.2.7. Pilot evaluation**

- To constantly and throughout the project set up the evaluation framework, monitor and adjust the planning, progress and realization of the implementation of project results testing.
- To test the usability of the selected implementation scenarios and concepts.
- To provide the necessary evidence for adapting technology to school transportation from a holistic approach and to provide input for guidelines, training schemes and policies

### **1.2.8. Dissemination and exploitation plan**

- To widely disseminate project concept, developments and findings to all key actors in the field in an interactive way, integrating their feedback at key points of the specification, design, development and evaluation work.
- To perform Market Analysis, in order to place project developments into the Market and issue business scenarios for project results market penetration.
- To perform socio-economic studies on the developed applications, in order to define their Cost Benefit Analysis, Cost Effectiveness Analysis and finally their Market viability.
- To plan and realise key workshops and events and administer a User Forum, to support the wide diffusion of the project concept and results and guarantee proper input and feedback by key stakeholders.
- To issue exploitation plans for key project results.
- To merge existing guidelines/regulations with the results achieved in the course of the project, focusing on successful applications, considering the different situations in countries.
- To develop effective training schemes for all actors involved, supporting the effective use and uptake of developed systems and proposed guidelines.
- To safeguard that project developments are according to all existing and emerging standards and laws in Europe and to propose new legislation and standardisation actions to enhance the safety and security of children travelling from/to school.

## 2. Main S & T results and foregrounds

### 2.1. User oriented approach

The work with Use Cases was done in Work package 1 in the SAFEWAY2SCHOOL project.

The work to identify the user needs was based on a combination of a literature survey and benchmarking, accident analysis and focus groups and workshops.

The SAFEWAY2SCHOOL is based on a user oriented approach where different stakeholders needs are the starting point. The needs have been identified through focus groups, interviews and questionnaires combined with benchmarking, literature reviews and accident analysis. The input was used to identify the most useful Use cases to build the SAFEWAY2SCHOOL system, see Figure 2.

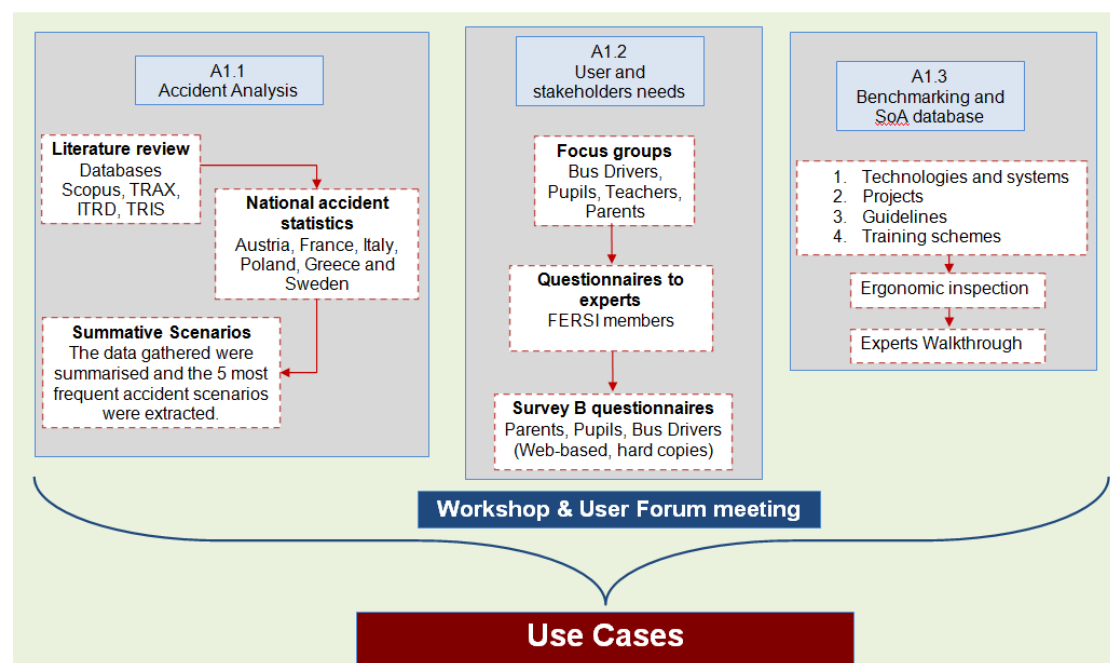


Figure 2 the model for identification of user wishes and user needs.

#### 2.1.1. Accident analysis

The accident analysis of the school transportation in EU has been one of the most challenging tasks in the beginning of the project. On the one hand it was not possible to find data that refer only to school transport accidents in the existing I accidents database in Europe, on the other hand the situation in the EU countries is so different that it is not possible to extract comparable results. Thus, the results of SW2S accident analysis show that the work related to national and international crash statistics have several limitations since it is not possible to find data that refer only to school transport crashes in classical crash database in Europe.

However, what we have learned is that between 1994 and 2001, 361 children were injured or killed during transportation to/from their schools in Sweden, whereas 455 were killed or injured in Austria only in 2007 and 97 were killed in Italy in 2005. In a single school bus accident in Greece in 2003, 20 children lost their lives. Different as the above numbers may be, they all tell us one thing: Crashes involving school buses

and crashes involving children travelling to/from school, are far from negligible and require further efforts to be drastically reduced (Anund, Dukic, Falkmer, & Thornthwaite, 2010).

To get more details specific data required there was a need to conduct dedicated analysis crossing key words such as “home to school transportation” and “6 to 16 years old children”. This in-depth analysis has been possible to do for two different databases; the French and the Swedish. For future European accident databases we recommend to report if a crash is school transport related or not, or at least to report the age of the child, year, day and time of the day when the crash occurred.

To summarize, the results from different available sources show that one of the most critical situations, in terms of safety, is dealing with pedestrians around bus stops, going to and from the bus. For SAFEWAY2SCHOOL it is clear that in order to identify a useful holistic approach, the need of well-defined use cases involved needs to take into account the interaction between the children and the school bus, but also the children and passing vehicles. In total, 4 promising scenarios were identified:

- A child is de-boarding in the afternoon, goes along the bus side and turns right and pass behind the bus to cross the road. An oncoming vehicle has no time for reaction and break. The oncoming car in high speed hits the child. Accident analysis and literature indicated the high risk related to bus stop for school children, especially when de-boarding in the afternoon.
- A scholar bus is manoeuvring (on the right or on the left) at a slow speed on a square or on a parking space. The driver attention is devoted to other pedestrians around the bus, to the surrounding traffic. The driver did not detect a pedestrian located on the side of the bus (blind spot). The pedestrian can get run over by the bus with high gravity of injury.
- Due to children crushes near the bus, a child can fall down between the bus and the sidewalk, or fall down from the sidewalk to the road at the arrival of the bus or when it is leaving the stop.
- A child is on the way to the bus stop. It is dark outside and the road has a speed limit of 70 km /h. A passing vehicle hits the child.

### **2.1.2. Focus groups and interviews**

For the identification of the users and stakeholders needs the following methods were applied (Aigner-Breuss et al., 2010):

- Focus groups with representatives of one user or stakeholder group
- Workshops with different stakeholders
- 2 questionnaire surveys

Problems and needs in the following areas were subject of discussions, interviews and questionnaires:

- Behaviour of road users interacting with school buses
- Behaviour of pupils on the school bus and while entering and exiting the same
- Design of bus stops
- Protection of pupils on the school bus
- Condition of school buses
- Education of school bus drivers
- Education of pupils concerning school transportation
- Information flow
- Route to/from school

The implementation of the aforementioned methodologies resulted in an identification of 6 main topics where problems occurred, see Figure 3.

- Communication
- Responsibility
- Behaviour of pupils
- Behaviour of other road users
- Infrastructure
- Safety systems in the bus

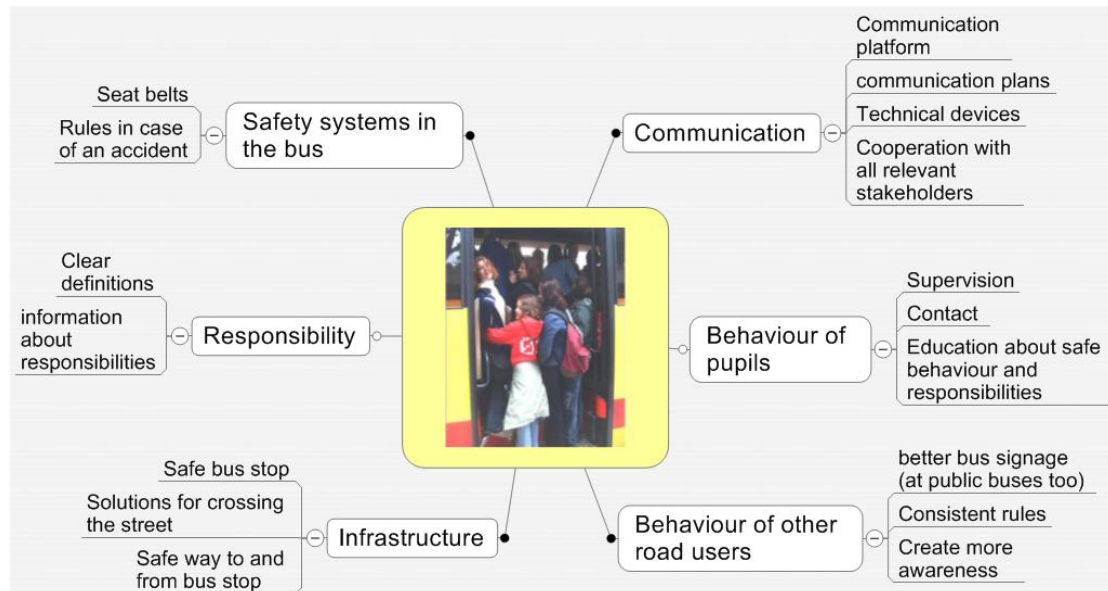


Figure 3 Overview of user and stakeholder needs.

### 2.1.3. Benchmarking and literature survey

In parallel to the user needs extraction and the accident analysis, a benchmarking database has been structured which includes data of the following fields (Montanari, Tesauri, Ferrarini, Chalkia, & Spanidis, 2011):

- technologies and systems [12 entries]
- projects [14 entries]
- guidelines/regulations [11 entries]
- training schemes [2 entries]

In total there are 39 entities in the benchmarking database.

- After the finalisation of the following activities, their results were gathered and consolidated in order to retrieve the final Use Cases of the SAFEWAY2SCHOOL project. The Use Cases follow the Domain Object Model (DOM) (Malan & Bredemeyer, 2001). However, the Use Cases are not explicitly object-oriented, but they are a broadly applicable requirements analysis tool. These tools can be applied to non-object-oriented projects, which increases their usefulness as a requirements method. For the description of the Use Cases, specialised templates have been developed according to “fully dressed” format template and distributed to the partners to be filled in. The template included the following fields:
  - *Brief description (user goal satisfied)*: This includes the description of the main use case, i.e. routing, re-routing, etc.
  - *Primary actor*: This is the actor who initiates the use case
  - *Secondary actor(s)*: This is the actor who might be effected by the use case



- *Type of vehicle:* The type of vehicle that can be realise the Use Case.
- *Road type and speed profile:* The type of road where the Use Case can be realised.
- *Lightning condition:* The lightning conditions of the road where the Use Case can be realised.
- *Weather condition:* The weather conditions of the road where the Use Case can be realised.
- *Other road participant:* Other road users that may participate at the Use Case but are not involved or effected.
- *Scenario(s).* This includes the upper level description of the Use Case, taken that the system will operate as expected.
- *System Input (trigger).* This is the first action/request that is provided by one actor.
- *System Output.* It is the feedback and the reaction of the system to the Input (trigger).
- *Quality of service indicator:* Indicators that show the succeed of the Use Cases/
- *Interaction steps:* A number of indicative steps (envisaged from the primary actor aspect) are outlined
- *Connected UCs or extensions.* This refers to any extension or connectivity of the current UC to other UCs.
- *Background info/reason on selection and on assigning the priority:* Reasons behind the selection of the current Use Case.
- *Main Risk:* Risk that may occur.
- *Alternative ways/fullback position:* contingency plans if the risks occur.

#### 2.1.4. Selection of Use cases

The result of all the activities was the identification of 15 priority SAFEWAY2SCHOOL Use Cases that was divided into seven different categorize with subgroups below.

A use case is a tool implemented in the system analysis to identify, clarify, and organize system requirements. A Use Case can be simply defined as what happens when actors interact with the system. The use case is made up of a set of possible sequences of interactions between systems and users in a particular environment and related to a particular goal. By recording all the ways the system is used (use cases) the requirements of the system are accumulated. Therefore, a Use Case is a collection of possible sequences of interactions (scenarios) between the system under discussion and its users (or actors), relating to a particular goal (Jacobson & Pan-Wei, 2005).

The results from the Accident Analysis, Focus groups and interviews and Benchmarking and literature surveys were the identification of 15 priority SAFEWAY2SCHOOL Use Cases. These Use Cases were divided into seven different categories, some with subgroups and some of these with more than one scenario. An overview of the SAFEWAY2SCHOOL use cases is as follows:

Category 1-Routing & rerouting

UC 1.1 Safest route planning

Scenario 1: School bus routing

Scenario 2: Pedestrian routing

Scenario 3: BiciBus routing

UC 1.2 Route monitoring

Scenario 1: School bus route monitoring

- Scenario 2: BiciBus route monitoring
- UC 1.3 Real time rerouting for traffic
  - Scenario 1: Rerouting due to traffic conditions
  - Scenario 2: Rerouting due to stop rescheduling
- Category 2-Surrounding traffic information
  - UC 2.1 Surrounding traffic information while en route
    - Scenario 1: Surrounding traffic information while school bus en route
    - Scenario 2: Surrounding traffic information while BiciBus<sup>1</sup> en route
  - UC 2.2 Surrounding traffic warning while for children ingress-egress
    - Scenario 1: School bus visible.
    - Scenario 2: School bus hidden, i.e. behind a curve
- Category 3-On board systems
  - UC 3.1 ISA
  - UC 3.2 Safety belt checker
- Category 4-Intelligent bus stop
  - UC 4.1 Child approach to bus stop notification
  - UC 4.2 Child at bus stop notification
- Category 5-Notification
  - UC 5.1 Family notification
    - Scenario 1: Ingress
    - Scenario 2: Ask about the child's situation
    - Scenario 3: Reach the school
  - UC 5.2 VRU notification
- Category 6-Training
  - UC 6.1 Bus driver training
  - UC6.2 Parent training
  - UC6.3 Children training
- Category 7 –Inventory tool
  - UC 7.1 Inventory tool classification of the bus stops

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<sup>1</sup> A constellation of a group of children going together with bicycle to school accompanied with an adult.

## 2.2. FRAME approach for System architecture and specification

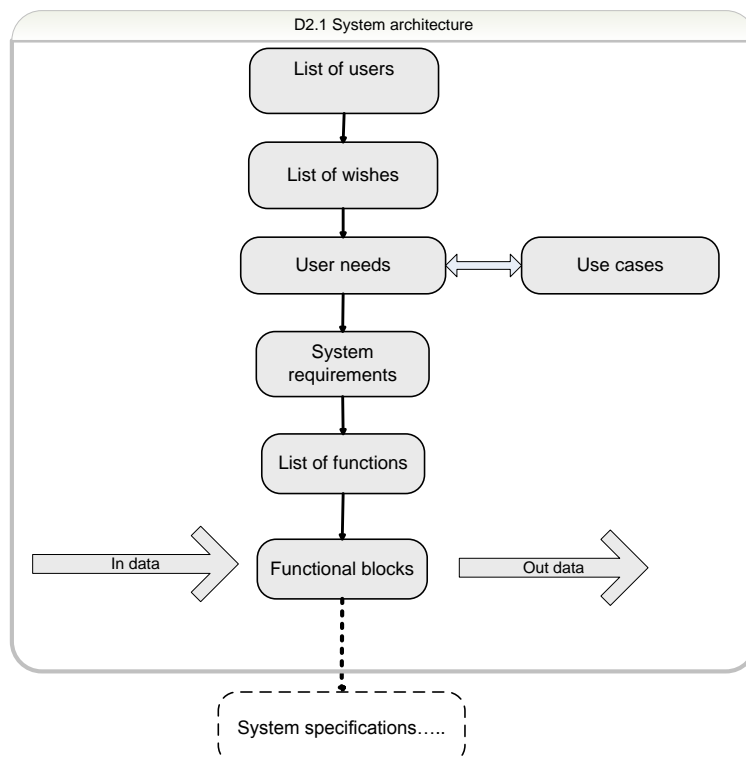
The work with system architecture and system specification for the SAFEWAY2SCHOOL concept was done in Work Package 2.

### 2.2.1. Frame approach

The system architecture construction is based on the European ITS Framework Architecture (FRAME) ([www.frame-online.net](http://www.frame-online.net)). FRAME provides a systematic approach and guidelines for the methodological framework for project developments. Although designed to support projects involving applications of ITS (Intelligent Transport Systems), the methodology is applicable to any type of project involving development work.

The process using the FRAME approach consists of the steps listed below and shown in Figure 4. These consist of:

- 1) Definition of the users of the system
- 2) Identification of their wishes in relation to the system being developed
- 3) Formalisation of these wishes in terms of User Needs
- 4) Description of a set of Use Cases
- 4) Definition of the System Requirements based on user needs (step 3) and Use Cases
- 5) Identification of the Main Functions
- 6) Description of the Functional Architecture into functional blocks
- 7) Definition of the Physical, Communications and Organisational Architectures



**Figure 4:** The process of developing the system architecture for SAFEWAY2SCHOOL, based on the FRAME approach.

The work following this line ending up with the system architecture has been done in close collaboration with the Use Case work and this link is highly valued and important. In the following sections a brief summary of the steps and results are presented.

#### 2.2.1.1. List of users

The list of users included all users that will be use or benefit from the system. For each user group there are also possible subgroups, see Table 1.

**Table 1 List of user groups**

<b>USER</b>	<b>DESCRIPTION OF USER AND POSSIBLE SUBGROUPS</b>
<b>School children</b>	Children attending school by using the school bus service. They may be divided into groups according to age and/or other characteristics, which affect their requirements. <ul style="list-style-type: none"> <li>- Age group 6-9 years old</li> <li>- Age group 10-12 years old</li> <li>- Age group 12-16 years old</li> <li>- Children with sight impairment</li> <li>- Children with hearing impairment</li> <li>- Children with primary visual impairments, such as blind children</li> <li>- Children with visual perceptual problems, such as Asperger Syndrome/autism</li> <li>- Children with cognitive problems (intellectual disabilities), such as Down's syndrome</li> </ul>
<b>Parents (or other persons responsible for schoolchildren)</b>	The persons who have responsibility for school children who intend to use the school bus service and in general the persons living at the same address
<b>School Transport Manager</b>	(Where such a position exists) the person or department responsible for organising or coordinating the bus transport for all schools.
<b>School</b>	Teacher or other responsible for regulating school bus services, the safety of children, information, education...
<b>Transport Company</b>	The organisation or company responsible for providing vehicles and services for transporting schoolchildren: These can be divided into: <ul style="list-style-type: none"> <li>- public transport agencies</li> <li>- private bus companies</li> </ul>
<b>Bus driver</b>	The person responsible for driving a school bus: <ul style="list-style-type: none"> <li>- driver of public transport vehicle</li> <li>- driver of private transport vehicle</li> </ul>
<b>Accompanying person</b>	(Where such a figure exists) the person who accompanies children travelling on a school bus.
<b>Road user</b>	Road users passing (on coming and overtaking) the school bus

### 2.2.1.2. User wishes to technical functions

Based on the output from the focus groups and workshops with all involved user a template with all user wishes were constructed and to each of them a functional requirement were identified. The user wishes was defined in line with the following principle: As a **[role/user]** I want **[something]** so that **[benefit]**. The functions developed for the SAFEWAY2SCHOOL concept is highly linked to the user wishes, since all wishes and needs were translated into a technical function, see Table 2.

**Table 2** An example of the step from user wish to technical function.

Level of implementation; S- Safe Route planning, I – Information /Warning, B=bus driver information, N-Notification, T- Training/Education , O-other	Number of function	User group	User wishes (from focus groups and workshops) (who-needs what-from whom-when-in order to...)	Description of system requirements	User affected by the function	Level of priority (Mandatory-Optional)
B	24	Bus driver	As a bus driver I want to be sure that every child is using the seat belt in order to assure their safety and fulfil law requirements.	The system shall inform if a seat belt is not used.	School children, bus drivers	M

### 2.2.1.3. SW2S system architecture

The functional requirements identified in the structure of Table 2 were grouped into functions that cover the areas of interest (Anund & Dukic, 2011). The functions were: Safe route planning, Information and warning, bus driver information, notification and training/education. The groups also supported that the physical architecture was easy to understand from a specific stakeholder's point view, in order to simplify a future implementation, see Figure 5.

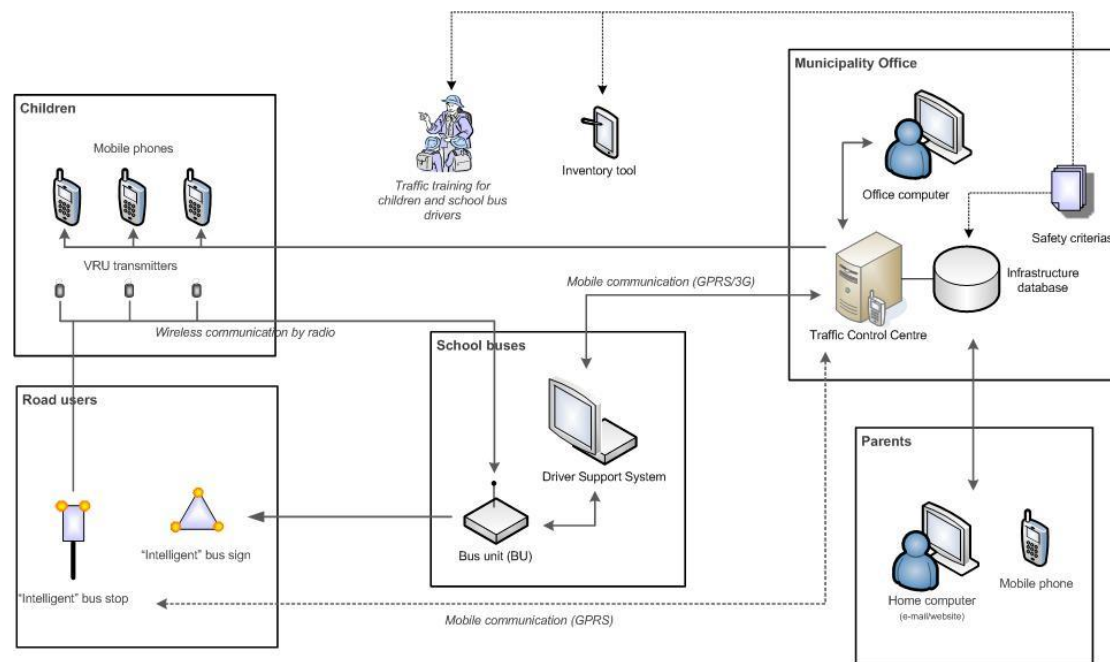


Figure 5 SW2S System Architecture

#### 2.2.1.4. System specification

The functional requirements for each module in the system architecture were specified with details enough to ensure interoperability, i.e. that the communication between the modules will work as planned. The System Specification was written from a bottom-up approach, as a difference to the System Architecture that has a top-down approach.

#### 2.2.1.5. Security and privacy issues

Before realization of a system as SAFEWAY2SCHOOL it was of major importance to have a deeper look at the security and privacy issues (Liedholm, 2011). A first review identified issues and proposes solutions that can be realized using off-the-shelf technology such as encryption, virtual private networks and firewalls. Important topics for security and privacy were raised such as user access, data security and system acceptance.

A security policy was proposed that covers safe data storage, auditability, availability and passwords. Confidentiality, integrity and authentication are pointed out as important aspects when transferring data. The impact of introducing security measures was also discussed. Based on the information about system requirements identified during the work with the system specification a methodology, based on a checklist approach, and was developed with the purpose to find issues regarding security and privacy. One of the results when using this checklist was to remove some system functions for the older children in order to gain heightened system acceptance.

While it is crucial to protect the system from third party access, this will not eliminate all security and privacy issues, since the system users and administrators pose threats within these subjects as well. It is therefore important to see to that the users

are properly restricted in their access to the system and that the administrator's actions are logged. Several technologies have been proposed to help secure the SAFEWAY2SCHOOL system. After implementing proposed measures it is however important to note that securing a system is a continuous function and maintained scrutiny is needed in order to be able to detect unknown flaws.

### 2.3. Route planning

The work with route planning was addressed in Work Package 3 of the SAFEWAY2SCHOOL project.

The work towards a realization of the route planning covers both: to include and to implement a set of core functions designed to increase the safety of school bus trips. Three major issues were dealt with: a tool to help plan the safest route for school buses; a system for monitoring school bus journeys and finally a system for warning surrounding traffic of the presence of children. To do so the work was divided into two phases: the planning and the monitoring phase, see Figure 6.



Figure 6 Route-planning consists of two phases: Planning and monitoring

#### 2.3.1. Planning

The achievements in relation to the route planning were the safe maps, monitoring and notification service, and on-board display for drivers. To achieve these safe criteria, data collection, safe stops, safe routes and finally safe maps were topics included.

##### 2.3.1.1. The Safe Map

The work with the safe maps involves a bus map, a bus stop map and a pedestrian map, see Figure 7.

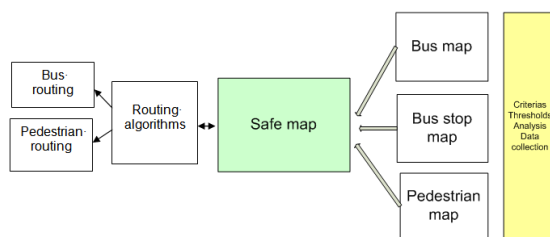


Figure 7 Main concept of the Safe Map approach.

The Safe Map is a geographical representation of the area in which school bus services are operated, see Figure 8, that is based on several layers so to say. Its construction requires an evaluation of the level of safety for each element of the journey: the walk to/from the bus stop, the wait at the stop, and the bus route.



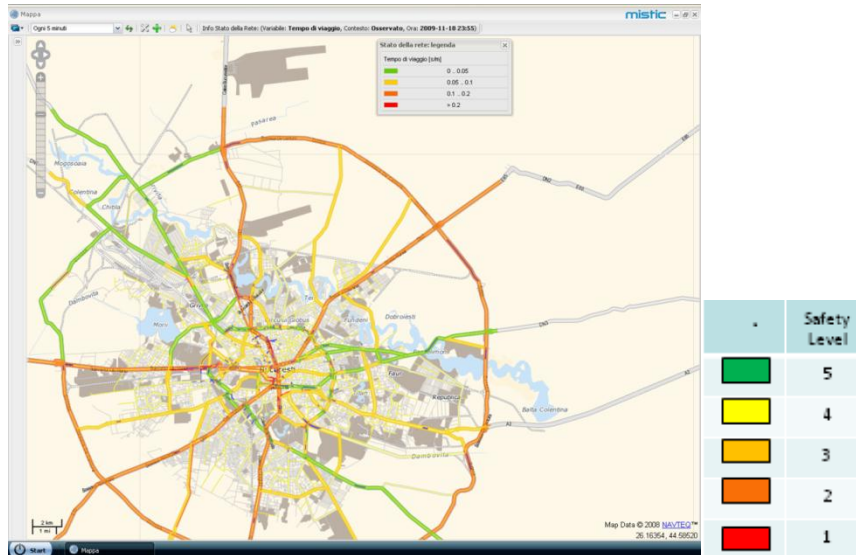


Figure 8 An example of a Safe Map for the school bus service.

### Bus stops

Within SAFEGWAY2SCHOOL a set of criteria’s were defined so that a safety-related ‘score’ could be assigned to the network and to bus stops. To simplify the inventory work the safe pedestrian algorithms finally decided about was implemented in a software that made it possible to do the inventory on site and then use the database for both analysing the status of the bus stop and to do the routing, see Figure 9.

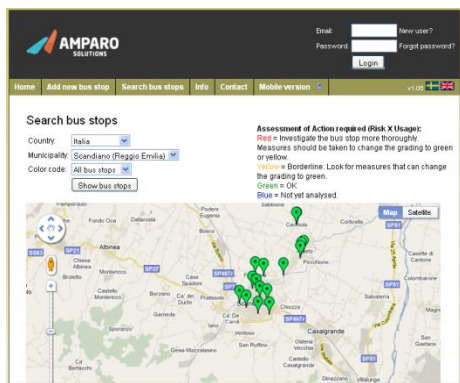


Figure 9 The Bus Stop Inventory tool, runs also on both iPhone and Androids.

### Pedestrian map

The SW2S pedestrian routing for the children to the bus stop was based upon the distance criterion like Schittekat, Sevaux and Sorensen did, but the final allocation of the students to the bus stops is going to be based only upon the safety criterion that is using a variation of the Dijkstra’s algorithm in order to instead solve the safest path problem , see Figure 10.

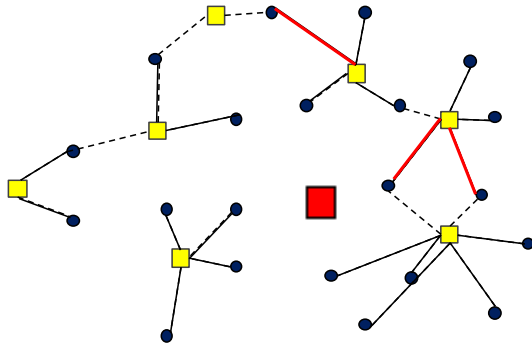


Figure 10 Safest pedestrian routes to bus stops, black dots = children, yellow = bus stops and red = school.

All inventory information made it possible to produce a digital map, which then could be used to calculate the best bus and/or pedestrian routes by means of special routing algorithms and to improve and select the safest location of bus stops.

### 2.3.2. Monitoring and notification service

In order to monitor the safety of children when traveling to school, SW2S adapted conventional fleet management systems by integrating technologies (VRU-unit or RFID) able to 'recognize' the children when they approached a stop and/or when they boarded a school bus. When this information is transmitted to the Central System, it was possible to know if any of the children who had booked to use the service failed to take the bus. In such cases, an SMS alert was possible to automatically be sent to the parent or carer responsible for the child, see Figure 11. Parents who wanted this information needed to apply for it.

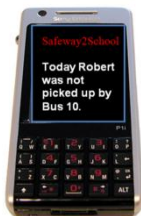


Figure 11 Notification to parents that applied for this support.

### 2.3.3. Systems to support bus drivers and passing drivers

The routing needs to be communicated to the bus drivers so they know the safe route to go are. SW2S has sought to facilitate the task of school bus drivers by providing specially designed on-board displays offering not only the route but also, for example, information on the distance to the next stop, any delay in the service, and the bus speed (when exceeding the limit), see an example of the design of one of the screens in Figure 12. Here the bus drivers can follow the safe route to go, but they can also see information about the eco-driving (top in right column), the next bust stop and the distance to there in time and meter (bottom right column). There are also some status symbols at the bottom. It is not possible for the drivers to check the status of children on board (barn ombord), boarding/deboarding (På/avstigning) when driving. This information is only possible to use at stand still.



Figure 12 On-Board bus drivers support

SW2S also studied ways of warning surrounding traffic of the presence of school children at bus stops or boarding/alighting from buses. As a result the project produced a recommended sign bot in a low and high tech (LED) version.



Figure 13 Out-side bus stop sign

All of the systems and tools described above have been tested during the project in Pilot Sites.

### 2.3.4. VRUs routing and monitoring

The work about VRUs routing and monitoring was done in WP4.

One issue to be solved was the routing and monitoring of the VRUs. The aims were to develop both a low-cost, easy to wear, light-weighted, high reliability and standards abiding VRU identification and location unit and to develop an Intelligent Bus Stop (IBS) as a key node between the bus and the children awaiting it. The key functionality for the two solutions ended up with a VRU unit that sends information, using radio signals, about the presence of a specific VRU and an IBS that receives information, using radio signals, about the presence of a specific child and act upon it, e.g. by flashing its warning lights. The VRU unit and the IBS are based on the traffic safety concept SeeMe® by Amparo Solutions. The SeeMe system has been evaluated numerous times and the Swedish National Road and Transport Research Institute, VTI, states that the speed reducing effects of these warning lights have been found to be 7%. For the SeeMe concept the only purpose of the IBS is to start flashing when the VRU unit is in the vicinity. However, in SW2S, the IBS was also used to inform other SW2S systems about the presence and identity of the VRU. The IBS communicated with the Bus Unit located on the bus and with the VRU & IBS server. The VRU unit ID, an impersonal number, was used by the Driver Support System to identify the VRU. Finally, on the bus there was a Bus Unit installed that routes the wireless information to a wire connected to the On Board Unit (OBU). The OBU runs the Driver Support System (DSS) software that will keep track on which children that is on board and which children to expect on the next bus stop.

This means that if a VRU unit is measured to be close to the bus stop, i.e. within a predefined active area, the IBS will start to flash its warning lights. The flashing lights inform passing traffic about the presence of children and that they should increase their attention and decrease their speed. To enable the new functionality the SeeMe system was updated accordingly: bigger solar panel, heavy-duty batteries, more advanced microcontroller, adding a GPRS modem, serial communication, new real-time operating system, enhanced radio protocol and more adjustable light intensity. In this work package the construction of the Bus Unit, which was based on the same hardware as the IBS, was also conducted, see Figure 14.



Figure 14 The IBS installed along a road in Sweden.

#### 2.3.4.1. The VRU unit

The VRU unit consists of a small standalone radio transmitter that sends information on the ISM radio bands about the presence of a specific child, see Figure 15. It has a reflective surface and a waterproof sealing so that it can be attached to the VRU, either on the jacket or on the backpack. The VRU unit communicates with the IBS and with the Driver Support System, DSS. The VRU unit is only active when the VRU is in motion, including riding on the bus. The VRU unit is based on a Printed Circuit Board, PCB, containing the critical components needed. The PCB has a microcontroller that runs software to handle the tasks for the needed functions of the unit. The PCB and battery are mounted in a mechanical casing that withstands water and dust and protects against mechanical stress. It is built to function in an outdoor climate and works in temperature from  $-30^{\circ}$  to  $+70^{\circ}\text{C}$ .

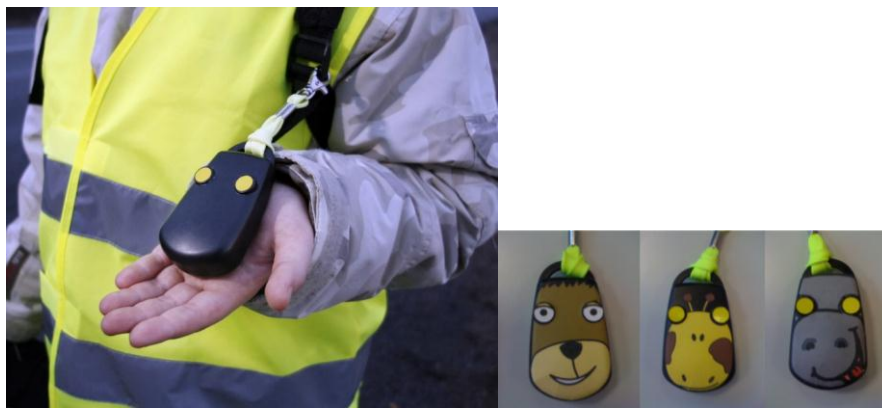


Figure 15 The VRU unit attached to a backpack, possible to personalize by the children.

#### 2.3.5. The Intelligent Bus Unit

The IBS consist of a warning unit located at the bus stop and mounted on top the bus stop sign. The IBS is activated wirelessly from either a VRU unit or another close by IBS. The unit has yellow LED lights on each side that flashes by turns when a VRU is present. The flashing light informs passing drivers that a VRU is close by and that extra care should be taken. The IBS has an active area that can be configured so that the IBS is only active when a VRU is within this area. The IBS adapts the intensity of the flashing lights to ambient light conditions. It measures the incoming light energy from the solar panels and adapts the light so it is dimmed when it is dark. It runs on the energy from a solar panel and on battery. The IBS can be configured to broadcast activation messages to other IBS and to Bus Units. ID numbers from VRU units are logged and transmitted to the VRU & IBS server by a GPRS modem. The system status is also logged and reported to the server. The electronics, the solar panel and the batteries are mounted in a mechanical casing that withstands water and dust and is built to last in a traffic environment. It works in temperatures from  $-30^{\circ}$  to  $+70^{\circ}\text{C}$ .

The biggest challenge for the IBS was to ensure that the radio communication works for up to 30 VRU units simultaneously. For this reason the radio protocol has been enhanced and simulations have been conducted to verify that it will work.

#### 2.3.6. The VRU application

A VRU application that runs on a generic mobile phone has also been developed. The application serves as a communication node between the VRU and the SW2S

system. Through the VRU application the VRU can get information about the status of the bus and also provide information to the SW2S system. Since the age group of 9 years and above should be able and willing to use mobile phone applications individual differences and preferences of children needed to be considered when offering the application, see Figure 16.



Figure 16 VRU applications for younger (left) and older (right) children were developed

## 2.4. User interface design and development

The work with user interface design and development was done in WP5.

The developing and adapting of devices that send information to the users of the system involved different stakeholders. The focus was on the interface design of information and warning. This was involved in the system for school bus driver notification and warning, for the VRU notification and warning, for the family and third party notification and for the surrounding traffic information and warning (Diederichs et al., 2011).

The devices developed were embedded into a complex communication network. The graphic in Figure 17 displays the devices schematically and their communication paths.

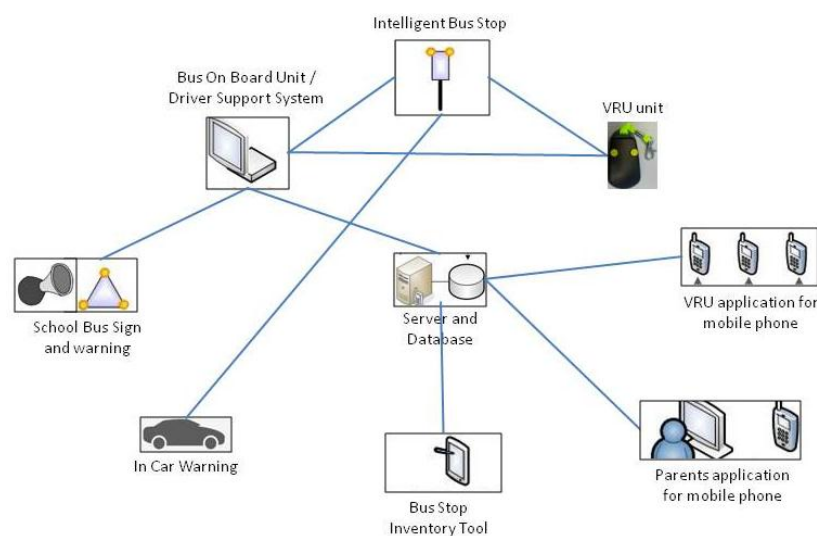


Figure 17 Graphic displays of the devices and their connections

### 2.4.1. V-ISO model

For the development and adaptation process of the user interface devices a common methodology has been provided, the so called V-ISO model (Diederichs, Weber, & Ganzhorn, 2011). A wide range of elaborated development process models has been provided by system engineering (i.e. waterfall, spiral, v-model) as well as by human factors engineering (e.g. ISO 13407). The V-ISO model is a fusion of the v-model and the ISO 13407. An important advantage of this approach is the familiarity of different professions with either one of the development approaches, so to say speaking the language of both. The proposed new model promotes a clearly structured, hierarchical, sequential, and still user centred development process, see Figure 18.

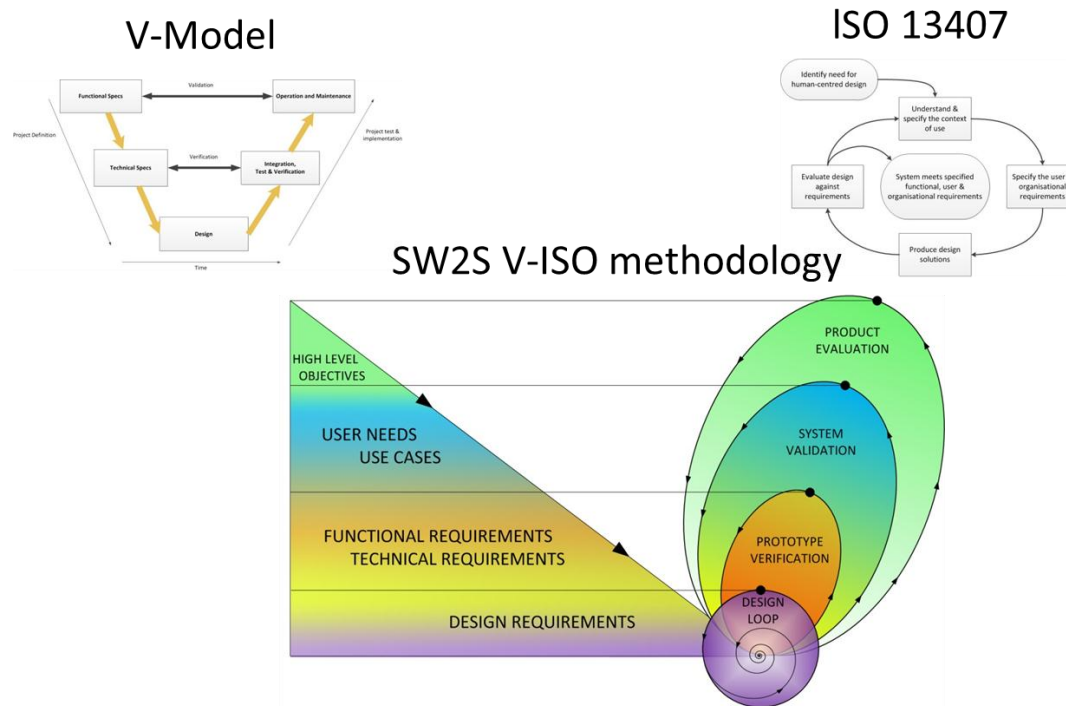


Figure 18 V-Model – A user centred process for development.

The V-ISO model contains on the left side a user oriented requirements engineering with a hierarchical and chronological sequence according to the v-model and on the right side an iterative and user centred development and testing procedure according to ISO 13407. Requirements engineering and iterative and user centred development both take place on four hierarchically ordered levels. The requirements engineering starts after a general description of the product idea with high level objectives for the product that is to be developed. The high level objectives can be defined in the very beginning of the project, without having yet specified the precise use context and users. They rather refer to the problems and how the product shall enhance the situation. The next step is to find and define the stakeholders in this situation and to define the users that shall use the system in order to enhance the situation. Now a precise description of the user needs, user motivation and the use cases is carried out. The use cases are defined as situations where the users will use the product. After describing the high level objectives, user needs and use cases the next step is to derive the functional and technical requirements for the product that are needed in order to meet the high level objectives and user needs, e.g. a list of functions is needed and a technical description with the requirements for such a product. In a 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. The iterative and user centred development on the right side is the actual development of the product. Special about the iterative and user centred development is that it includes users several times during the development, at least once per level. A higher level of the development is only undertaken when the requirements from the respective level on the left side are met. In the design loop several designs are proposed to experts and users in order to find a design solution that meets the design requirements and reaches high acceptance among the users. The design loop is left when the design requirements are met. When a design is approved a prototype of the system can be developed. The prototype shall meet the



technical requirements and the functional requirements defined in the left side of the V-ISO model. The prototype verification thus focuses on the fulfilment of the functional and technical requirements. The prototype is optimized until all requirements are met. On the next level of the development process the prototype can be integrated. It shall now not only work as a standalone device but also in the intended system, infrastructure and context of use. The system validation is carried out with users and with focus on the user needs. When the product fulfils the user needs in the respective use cases the next level of assessment is the product evaluation. Now a general evaluation and appraisal of the system can be performed, following the question to what extent the system contributes to the high level objectives. By using the V-ISO model the reports of the development and evaluation processes of different products within one project get standardized. The chronological development makes it also easy to pass the development to other work groups, which is often the case in larger projects.

### 2.4.2. The devices

The user interfaces have either been developed within the project or discovered somewhere in Europe to be integrated into the holistic approach. Together they provide a toolkit to enhance the safety and comfort of children using school busses for their daily commuting.

#### 2.4.2.1. Intelligent bus stops

The bus stop is equipped with a light indicator placed in the upper part of the sign that illuminates itself when children are approaching. The goal is to put into evidence the presence of children to passing drivers so that they reduce vehicle speed, such device reveals to be very useful especially in case of fog, rain or poor visibility, see Figure 19.



Figure 19 The intelligent bus stop (IBS) activated by the children's VRU-unit.

#### 2.4.2.2. VRU-unit for children who use the intelligent bus stops.

The VRU-unit communicates wirelessly with the intelligent bus stop, which will indicate the presence of the child to passing drivers. The VRU-units are distributed to children and can be easily pinned to their school bags. In the Swedish pilot site the VRU-unit communicates also with a Driver Support System placed on the bus, see Figure 15.

#### 2.4.2.3. A New bus sign and bus stop sign

A new bus sign and bus stop sign, indicating the presence of children, are placed onto the school busses and at intelligent bus stops. The signs have been elaborated in the project to function as signals, which are clearly visible and recognizable over long

viewing distances and at high speeds, in order to warn drivers (Egger, Ganzhorn, Diederichs, Porathe, & Strand, 2010), see Figure 20.



Figure 20 Sign to use on signs at bus stops and on buses.

#### 2.4.2.4. Driver Support Systems

The Drivers support system (DSS) was aimed to be placed onto the school buses to support the bus drivers in their daily work. The aim of the DSS is to make the drivers' task easier, safer and allowing them a more personal communication with the travelling pupils. The DSS provides useful information about children on board, where they enter and when they have to leave, bus stops, timetable, planned or changed route, fuel consumption, speed limit and support in accidents or unusual situations like road blockings or bus break downs. Before the final development a mock-up was developed and comments from the bus drivers were merged with the knowledge from already existing systems.



Figure 21 Example of the Mock-up tested at first.

#### 2.4.2.5. Notification to parents and children

Parents, students, on-board assistants and service organizers can use smartphones equipped with a SAFEWAY2SCHOOL application specifically created for the project aimed at improving the communication among users. A special user-friendly version has been developed for young children and for older children and parents, see Figure 16. The Symbian and Android platforms are supported.

#### 2.4.2.6. The Bus Stop Inventory Tool

The inventory tool is used to find and classify bus stops from a safety perspective. The bus stops safety degree is assessed on the basis of the risk of accidents and degree of insecurity for all types of passengers while waiting at a bus stop, see Figure 9.

#### 2.4.2.7. The In-Vehicle Driver information and warning

This system runs on a display inside the car and appears when the driver is approaching an intelligent bus stop with children waiting. It is based on an icon in the dashboard and a representation of the bus stops in the navigation map. Special is that the icon is only activated and accompanied by an information sound when children are close to the bus stop. Only in this case the bus stop is also highlighted in the map.



Figure 22 The mock-up of the in-car system that supports passing vehicles.

Due to the use of the V-model, all of the systems systematically developed and improved and good HMI principles were met.

### 2.4.3. System integration and technical verification

When all systems were developed the work started to integrate and verify the technical functions. This work was done in work package 6.

The objective of the System integration and technical verification were to integrate the different school transportation subsystems developed within the project on a technical level; the route inventory tool, the route planning and administrative tool, the Driver Support System, the VRU units, the Intelligent Bus Stop and the On-bus Warning Sign, and to technically demonstrate and validate the functionality on a system level. In this work the integration of the different modules developed were done strictly abiding to the System Architecture and the User Interfaces. The integration was done based on what was required on each pilot site that has its unique combination of modules and configuration. The pilots were ready to run only after the installation and the technical verification at each pilot site.

The work included six activities:

1. Decision Support System – DSS: the integration of the control intelligence module
2. On-Board Unit – OBU: the integration and interface of all systems on-board
3. Intelligent Bus Sign / Marking: the intelligent bus sign developed and prepared for integration
4. Intelligent Bus Stop integration: the integration and verification of the IBS
5. VRU unit: the integration of the wearable units
6. Technical verification: testing of single modules, subsystems and their interfaces

The overall goal was to provide all the relevant information about what has been installed and how it has been installed. This was the first time when the complete system was running at the same time and where all the different modules were interconnected. The different modules were delivered by different partners, which made the integration even more challenging. The pilot sites were distributed around Europe, from Italy in the south to Sweden in the north. In the west the pilot site was located in Austria and in the east the pilot site was located in Poland. A fifth pilot site was located in a simulated environment in a traffic simulator in Stuttgart, Germany. The four pilot sites also have different setups and all modules were not installed on all the sites. Having different solutions on the pilot sites made it possible to test and evaluate the differences in performance of the various solutions.

### 2.4.4. DSS prototype

The objective of the DSS was to assist school bus drivers in making suitable decisions and adopting a driving behaviour, which can enhance the safety of their passengers. Two different DSS were developed for SW2S, one implemented on the Swedish Pilot Site, the other on the Italian Site.

The support offered by the DSS takes various forms, including information offered on a display visible to the driver:

- The route to the next stop (shown on a cartographical base).
- The distance to the next stop.
- The recommended (safe) speed.
- A list of passengers (children) who are expected to board at each stop.
- Details about the passengers (children) like contact information to parents and information regarding special needs for example cognitive disabilities.
- Indications if any passenger is not wearing the seat belt.

There are also automated functions including:

Generation of warning message if the bus is expected to arrive late.

Recording of the ID of children boarding the bus, comparison with registered passengers, and generation of message if a child is missing.

Generation of reports regarding each trip (e.g. stops made, vehicle speed, etc.) and statistical analyses.

#### **2.4.5. OBU prototype**

The scope has not been to develop new hardware for telematics systems but to define requirements for On-Board Units suitable for School Bus operations. The OBUs also enables the integration of all functionalities specified in the Driver Support System (DSS) and delivers the required data, such as positions and notifications etc., to the Bus Operator System (BOS). Two different OBUs have been chosen due to different subsets of requirements for the two pilot sites running OBUs. For the system in Sweden the OBU identifies the VRUs using communication with the automatic tags called VRU units. On the Italian site the VRUs are identified using RFID cards that the children must manually present. Both OBUs fulfil the requirements, from a specification point of view, enabling all functionality specified in the DSS that will be tested on the pilot sites in Sweden and Italy. Other aspects were also evaluated such as ergonomics, safety, driver distraction etc.

#### **2.4.6. VRU unit**

The VRU unit consists of a small standalone radio transmitter that sends information, on the ISM radio bands, about the presence of a specific child. VRU units have been produced, individually tested and shipped to the pilot sites. The biggest challenge for the VRU unit was to ensure that the radio communication works for up to 30 VRU units simultaneously. For this reason the radio protocol was enhanced and the timing for the VRU units altered. The purpose with the tests conducted in this activity was to validate the fulfilment of this functionality.

#### **2.4.7. Technical verification report**

The technical verification focused on the SW2S systems to verify a fully functional and compliant system in relation to the initial requirements. To check this, a technical verification protocol was defined in order to test each system developed within the project and to use common verification procedure between different plots sites. The methodology that was developed is compliant to the ISO 9001:2008 (Quality Management Systems) and requires the compilation of Design Verification Plans (DVP) for each of the system developed within the project. The Technical verification protocol of SW2S foresees that for each module a copy of the DVP should be completed, signed and stored as a record of technical verification. A set of DVPs were presented to ensure that each requirement was verified. Each partner responsible for technical verification of a system was required to complete the relevant DVP forms, keeping a record of the completed forms. All the systems developed within the project were technically verified and with only a few minor changes, the technical requirements for the SW2S prototype have been achieved.

The following modules have been technically verified within the project:

- Driver Support System, DSS
- On board Unit, OBU
- Bus Unit, BU
- Intelligent Bus Stop, IBS
- VRU Unit

- Bus Stop Inventory Tool, BSIT
- Mobile application

It is important to note that the verification conducted here does not replace the legal (or other) requirements associated with the use of each test site (or public road network). Each partner is individually responsible for ensuring compliance with any regional, or site-specific, requirements for testing of prototype equipment and vehicles.

## 2.5. Pilot evaluation

The planning, realisation and consolidation of the results was done in WP7.

Pilots are experiments with users, which aim to contribute to the overall evaluation of the SAFEWAY2SCHOOL system. The different Pilot sites evaluated selected evaluation scenarios and tested a selected number of equipment using the appropriate evaluation tools. In this way all needs across SAFEWAY2SCHOOL subsystems or units, stakeholders, different environments, etc. were covered. A guarantee for successful pilots and for a possibility to evaluate and especially to consolidate the results is the planning that needs to be integrated as a natural part throughout the project. To do so, lots of efforts have been spent on the planning phase (Börsbo et al., 2010). The success criteria listed beforehand were: at least 3 out of 4 pilots successfully realised, at least half of the project system to be proven to have the potential to enhance traffic safety. Both these were fulfilled as all pilots (the 4 and the simulator test) were realised successfully and all project systems have been proven to enhance traffic safety from 98.3 % of the pilot test participants.

### 2.5.1. Pilot framework

The evaluation framework was built upon Haddon's matrix (Haddon, 1972), a relevant framework that has been frequently used for structured analyses of traffic injury events. In the matrix, the contributions of human, vehicle/equipment and environmental factors to the events are taken into account. The matrix was combined with the holistic approach to school transportation, which covers all the aspect of relevance from home to school setting the child in focus and not the means of transportation. This correlated all of the Holistic stages to the factors of interest for SAFEWAY2SCHOOL. In order to evaluate the SW2S system, detailed evaluation scenarios were developed. These scenarios were based upon the project Use Cases, developed earlier in the project: 1) School bus route planning, 2) Pedestrian route planning, 3) School bus route monitoring, 4) Surrounding traffic warning while for children board or disembark, 5) Intelligent Speed Adaptation, 6) Safety belt checker, 7) Child approach to bus stop notification, 8) Child at bus stop notification, 9) Family notification, 10) VRU notification and warning, 11) Inventory tool classification of the bus stops, 12) Training. A common set of tools were developed in order to evaluate and to consolidate the results from the pilots that was done in Sweden, Italy, Poland, Austria and Germany. The tools used were:

- *Direct observations* (Speed measurements, Eye-tracking measures of bus drivers or drivers of passing vehicles)
- *Event diaries* (Waiting at the bus stop)
- *Observation* (Children's safety behaviour and bus drivers behaviour in relation to DSS functionalities)
- *User surveys* (Acceptance and Usability for children, parents, bus drivers and transport operators, Quality of Service for bus drivers, Use interface for children and adults, Usability of training kit)

### 2.5.2. Pilot realisation

Pilots are experiments with users, which aim to contribute to the overall evaluation of the SAFEWAY2SCHOOL system. The different Pilot sites evaluated selected evaluation scenarios and tested a selected number of equipment using the appropriate evaluation tools. In this way all needs across SAFEWAY2SCHOOL subsystems or units, stakeholders, different environments, etc. were covered. The success criteria listed beforehand were: At least 3 out of 4 planned Pilots successfully realised, at least half of the project systems to be proven to have the

potential to enhance traffic safety were both fulfilled, all pilots were realised successfully: the 4 real pilots and the simulator, finally that all project systems have been proven to enhance traffic safety from 98.3% of the pilot tests participants. All success criteria's were full filled.

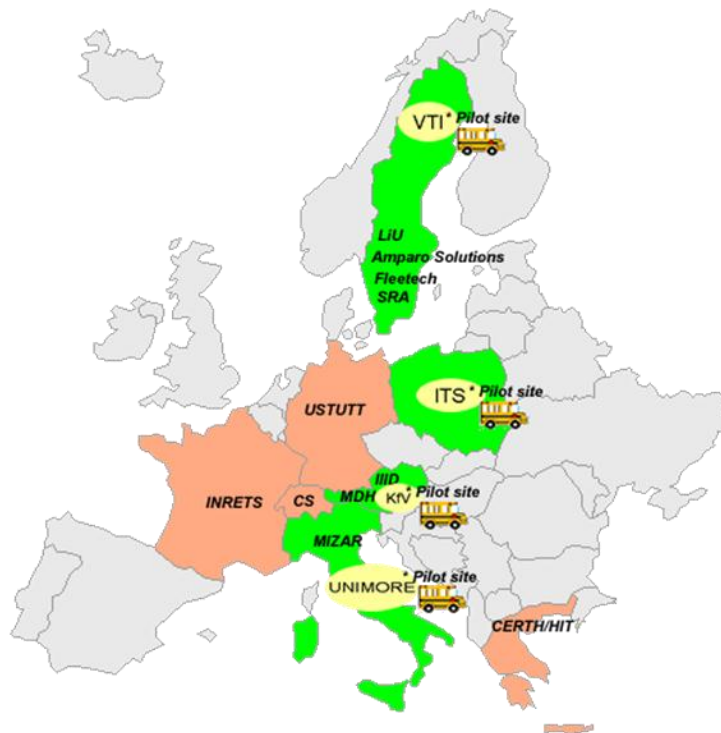


Table 3 Countries involved in the pilots.

### 2.5.3. Pilot results

In total 295 persons representing different stakeholders participated in the pilots throughout Europe. The consolidation of the results showed that in general the users accepted the system. It was considered as a victory that the greatest acceptance was received from the children who really liked and wanted to use the system. The bus drivers on the other were rather critical and this can be explained by the fact that there were several technical problems in the beginning of the pilots and the bus drivers only had a short time when they could enjoy the full functionalities of the system. Finally, also the parents liked the system, feeling though that it would increase the feeling of safety and security of their children during their school transportation.

The result shows that a weak point on the pilot results is the Willingness to Pay among the users. As far as the Willingness to Have (WTH) is concerned, this reached the level of 76%, which is quite encouraging. Unfortunately, only a few users were willing to pay for it. Of course this should have been anticipated, since the SW2S system is not destined to be paid by the users that participated in our pilots. In case such a system goes to the market most of the costs will be covered by the municipality or the bus fleet operator, which did not answer the WTH and WHP questions.

About the SW2S bus sign, generally the speed measurements showed that the new bus sign had no significant influence on speed of passing road users. This could also be confirmed by the observations and bus driver's opinions. The fact that people seem to notice the sign argues for the use of the sign anyway, but the installation of a



school bus sign has to be accompanied by other measurements, especially awareness-raising in order to obtain the expected results. The application of the SW2S school bus sign alone does not lead automatically to a change in driver's behaviour i.e. of reduction of speed even if this sign is well recognizable as prior studies had found out (Egger, et al., 2010). Nevertheless, the bus drivers stated that the SW2S bus sign is meaningful in principle. But they also think that sign have no impact on driver's behaviour. Bus drivers desire a connection of the sign with a legal code of conduct. Furthermore, more awareness-raising would be needed to show drivers the consequences of inappropriate speed when passing a bus. A bundle of measures consisting of communicating the rules, awareness campaigns and fines would be good.

About the SW2S Intelligent bus stop sign, in two of the three pilot sites the speed of the surrounding traffic vehicles was reduced when the IBS was active. In one pilot site (Italy) the results suggest that IBS usage does not support a statistically significant difference between baseline and pilot conditions. The following issues could affect this statement:

- The speed measurement has been collected during springtime when children wait for the bus in the morning in full sunlight. The IBS is poorly visible during light hours.
- Italian bus stops are mainly located in urban areas nearby other road sign or houses; such a crowding of information could affect driver perception of the bus sign.

Despite this the use of the IBS was appreciated a lot by children and parents. At the majority of the bus stop only the new sign was used. The results were very positive among all stakeholders. This made it clear for the children were to wait or be dropped of, for the bus drivers were to expect children, for the car drivers where to be extra focused.

In general the results of the SW2S pilots can be summarised in the following bullet points:

- The IBS attracted the passing drivers' visual attention more than a SW2S bus stop (supported by the results from Poland)
- The passing drivers reduced their speed when the bus stop sign was installed and even more when the IBS was activated (supported by the results from Poland, Sweden and Germany)
- The IBS and the in-car warning indicating the presence of children have a significant impact on the speed reduction (supported by the results from Germany)
- The Bus sign had no significant impact on the speed of the passing drivers (supported by the results from Austria)
- Training is important for the stakeholders and highly rated (Supported by the results from all sites)
- The VRU-unit are more appreciated compared to the RFID cards (Supported by the results from Italy)
- The Bus stop inventory tool is useful and supports the selection of safe bus stops (Supported by the results from all sites)
- The VRU application is highly appreciated by the children (Supported by the results from Italy)
- The DSS is appreciated for inexperienced drivers (Supported by the results from Italy)

- The DSS could be helpful for inexperienced drivers to make them more aware of the route and bus stops (Supported by the results from Italy and Sweden)

#### **2.5.4. Ethical considerations**

To run the SW2S project risk assessments and ethical considerations were important issues to consider especially in relation to the pilots, this was part of WP10. A methodology for the risks identification, their analysis and the methodology for the risk management was developed, in addition privacy and security issues based on a questionnaire that was constructed and distributed among partners were used. A checklist to check security and privacy was used to capture the most important parts and to avoid problems. Further, all pilots were proven by the national ethical board or similar.

## 2.6. Training, application guidelines and proposals for standards and policies

The work with training and future standards and policies was done in WP9 and was divided into three parts:

- (1) Training
- (2) Application Guidelines
- (3) Standardisation, policy and recommendations

### 2.6.1. Training schemes

The training schemes were focused on the development of tools relevant for the SW2S system users and also on the creation of a multimedia tool which should help stakeholders to become familiar with the SAFEWAY2SCHOOL system and specifically with its elements.

The target groups for which the training schemes were elaborated are: children aged 6-9, 10-12, and 13-16, parents, school bus drivers and bus assistants. The trainings cover a varied scope of topics. Due to the structure of the programme, the training can be implemented in full or in elements.

- Module 1: Training guidelines for children 6–9 years old (and their parents; the training can be conducted by parents themselves at home with their children) + disabled children;
- Module 2: Training guideline for children 10–12 years old;
- Module 3: Training guideline for children 13–16 years old;
- Module 4: training guideline for school bus drivers;
- Module 5: Training guideline for parents training schemes were tested and evaluated within the pilots of SW2S.

All of the training schemes modules were tested and evaluated within the pilots of SW2S. Each of the scenario-modules contains the following material:

Each scenario-module contains the following material:

- detailed educational objectives
- training material
- information about module units' duration
- exercises
- teaching resources
- teaching material realisation methods
- methods to check and evaluate students' learning achievements and/or assess activities
- implementation conditions

The flexible structure of the training and its scenario-modules can be updated easily, modified, supplemented or replaced, depending on the individual educational requirements. Additionally, each scenario-module gives information on duration and realisation conditions with respect to equipment and qualifications of the training facilitator.

A multimedia tool was designed in order to assist all stakeholders of the school transportation to understand and to use the tools and systems created by SAFEWAY2SCHOOL. The multimedia tool is complementary to the main training schemes tool and can be used broadly, for training and for dissemination reasons (Jankowska, Leśnikowska-Matusiak, Wacowska – Ślęzak, Wnuk, & Chalkia, 2012).

### 2.6.2. Best Practices and guidelines

An inventory was developed to be able to explore the current situation of school transport in the different countries (Aigner-Breuss, Braun, Pilgerstorfer, & Müller, 2012). Included were design rules and required safety features of school buses and of school bus stops, but also regulations and guidelines targeting safe use of school buses. Country experts at the national level helped collecting the information. Data collection on regulations and Best Practices was carried out in Austria, Germany, France, Greece, Italy, Poland and Sweden. This was a challenging task as school transport is covered by several different legislative texts in a country. Regarding a legal definition of school transport, it is defined explicitly by a national law only in some SW2S countries, e.g. Austria. In other countries it might be the municipality, which defines school transport, as is the case in Italy. The access to school transport – meaning who has the right to use it – is mostly defined by age of the pupils and distance from school to home. In all the participating countries of this EU project, school transport is funded. In some countries costs are completely taken over (e.g. by municipalities in Sweden), in some countries pupils have to pay a contribution (e.g. Austria). The equipment of school buses is already partly regulated by EU Directives. At present it is necessary to be aware that there are different kinds of school transport by bus. In principle there are two modes of school transport in force in most countries: school transport within line operation as public buses and school transport by purchased buses. These two modes imply some important differences in service and realisation of legal regulations. As different vehicles are used as school buses, different regulations are in force (e.g. targeting access for drivers, equipment of vehicle). Bus stops used within line operation are already covered by some legal regulations; nevertheless, improvements and a definition of basic requirements would be useful as accidents often happen at bus stops. Regulations and guidelines comprising the safety of the school bus stops are rare. Only a few countries have either a legal regulation or a recommendation to educate and train pupils on the safe use of school buses. Nevertheless, evaluated programmes are available to make children aware, and develop and train necessary skills. Regarding professional school bus drivers, the EU Directive on driving licences (2006/126/EG) defines rules on driving licences including minimum age, exam and fitness to drive. The EU Professional Driver Directive (2003/59/EG) defines frame conditions for education of all bus drivers including school bus drivers all over the European Union. The Directive also asks for further training every five years.

Good and Best Practices from the participating countries can be recommended for all fields for some examples captured from the different countries see Table 4.

**Table 4 Examples of good practice received from participating countries**

Field of Best Practice	Number of measures	Examples
School buses	6	<ul style="list-style-type: none"> <li>• Intelligent Speed Adaption</li> <li>• Alcohol interlock</li> <li>• Regulations “30 km/h” for passing traffic when a school bus in in a stop</li> </ul>
School bus driver	2	<ul style="list-style-type: none"> <li>• Special driver training</li> </ul>

Field of Best Practice	Number of measures	Examples
School bus stops	13	<ul style="list-style-type: none"> <li>• Moveable bus platform</li> <li>• Checklist for school bus stops</li> </ul>
Safe use	5	<ul style="list-style-type: none"> <li>• Bus school</li> <li>• Bus guards</li> </ul>

### 2.6.3. Standardisation, policy and recommendations

Standardisation, policy and recommendations were seen as important to safeguard the aim that the project developments should be done according to all existing and emerging standards and laws in Europe and to propose new legislation and standardisation actions in order to enhance the safety and security of children travelling from/to school (Appeltoft, Viklund, & Anund, 2012).

The work was carried out in three phases: First of all to identify problems and obstacles of regulations that are already in force; secondly, to generate proposals with the support of experts; and, finally, to proof the acceptance within National Workshops in five countries. In these National Workshops, the proposals were discussed and ranked by experts of the single countries. In a final Workshop, it was aimed to gain acceptance on presented suggestions of new or updated recommendations and regulations and to stimulate future decisions in order to gain safer school transportation.

The result showed that the legal aspects surrounding the area of school transport are quite vague. There are many different regulations in the European countries covering the topic in different aspects. Another important matter to consider is that different regulations are valid for different modes of school transport such as special purchased school buses and school transport conducted of inline operators, which makes the school transportation area even more complex. SAFWAY2SCHOOL project developments were not found to be in conflict with existing regulation even though there have been some legal aspects in need of extra attention in order to gain a smooth future implementation.

The final result point at three important areas for the future work in order to improve the safety and security for the children;

- School Travel Plans
- Sign at all bus stops
- Improved driver education

These proposals have a high acceptance in the SAFWAY2SCHOOL consortium and are seen as useful contribution to safe and secure transportation of children to and from school. SAFWAY2SCHOOL recommended these three proposals for further development at a European, national or local level.

## 3. The potential impact

### 3.1. Market analysis

One important part in relation to the dissemination is the market analyses that were aimed to provide an in-depth analysis that can act as a foundation of the market feasibility of the systems and technologies produced within the SAFEWAY2SCHOOL project (Nilsson, Linell, Werner, Bekiaris, & Chalkia, 2010). The main results emerged during the market analysis are the following:

- Market for school transportation technology is still rather immature.
- Market penetration process of technological products plays a major role.
- Saving cost is an important driving force in the niche and wide market scenarios.

The largest entry barrier for the SAFEWAY2SCHOOL system is to change the widespread attitude to look at school transport mainly as a logistic issue rather than a safety issue.

One part of this work was to identify a business plan in order to study and analyse the elements and stakeholders interacting in a market environment where the project results could be applied. The Business plan introduces the business strategy that must be applied in order to achieve the best penetration of the exploitable project results in the market and ensure the delivery of the benefits to the users. Three different scenarios were developed to show target groups and exploitable products and their possibility to penetrate three different markets:

- Niche market scenario: This scenario will be applied in the 1-2 years after the finalisation of the project and it supports only private implementation of the basic exploitable products.
- Wide Market scenario: This scenario will be applied in the 3-5 years after the finalisation of the project and it will support both public and private implementation of all exploitable products.
- Mandatory Market scenario: This scenario will be applied in the 5-10 years after the finalisation of the project and supports only public implementation of the majority of the exploitable products.

### 3.2. CBA

The Cost Benefit Analysis and Cost Effectiveness Analysis give an estimation of the relationship between the potential benefits of the SW2S system and the necessary costs for its implementation. In more detail, the Cost Benefit Analysis of the SW2S system has been used in order to identify the impact of the implementation of the system to the society. By the term society here, we have to clarify that we mean the increase of the safety and the reduction of accidents with children. Other societal benefits, such as environment, or time of delays, etc. have not been taken into account. This is a very difficult task to realise and for this reason many hypothesis were made. For the calculation of the CBA indexes three scenarios were taken into account.

#### 3.2.1. Niche market scenarios - simplistic scenario

The first scenario was an over simplistic scenario that has been taken as the basis for the system. This was the Niche market scenarios and where the SAFEWAY2SCHOOL system is implemented by a (group of) school district(s) to facilitate planning and monitoring of the school transportation, or a transport company to facilitate planning and monitoring of their fleet and increasing the service level for their clients. In this case the SAFEWAY2SCHOOL

system is adopted on a voluntary basis as an enhanced safety measure, to improve the efficiency and increase the safety and the security, as well as to reduce the cost of the operation. The SAFEWAY2SCHOOL system can be conceived as a specialised client server system for integrated transportation planning. This scenario can easily be implemented with the advantage that there is no need for promotion by anyone and no specific agreements are required. The main stakeholders that can use the SAFEWAY2SCHOOL system in the current scenario are the transportation companies (transport operators), the parents (private organisations) and the schools (school districts). The municipality has no or only a limited role in this scenario, not being the prime initiator of the system. However, they might collaborate by supplying up to date information on travel/passage times and events, as well as other details as far as is in their interest and benefit from some knowledge on the specific trips of the school buses monitored by the system. Market penetration is expected to remain low (only large hauliers to be involved in otherwise private operation). In this rather low penetration scenario is difficult to implement all the SAFEWAY2SCHOOL system components. Thus for each market scenario we initiate the exploitable outcomes and features of them that are possible and feasible to be implemented. In this scenario only some of the SW2S systems will be implemented to a small scale. The systems that were seen more simple to use and also more acceptable for the users, according the SW2S pilot trials are the VRU unit and the IBS. It was also expected that these two systems will have a great impact on the safety and the security of the transportation and for the calculation of the CBA ratio the environmental and operational cost, do not need to be taken into account. This scenario is very important since it provides a way of supporting the uptake of the wider system on the basis of cost/initial financial outlay. If a simple version can be bought and tried with the possibility to buy more of the system at a later date (when the simple system has proved to be beneficial) the customer may well upgrade to the more expensive system. This is an approach for customers who can't purchase a very expensive system at first but could spend more if it was proved to be beneficial for them. This scenario has very low costs and uses components of the SW2S that are very critical to increase the safety and security of the transportation, and thus may result in a reduction in crashes. To this end and even if the market acceptance index of this scenario is quite low (D1=41,2%) and so the effectiveness (E1=33%) its low cost and easiness of implementation brings it the most beneficial scenario of all with a CBA index equal to 5.24 which means that: taking into account the costs of the various components and the running of the system, the number of people using them and a predicted reduction in accident figures attributable to the system:

***'For each euro dedicated to the voluntarily implementation of the SW2S system, the society will save 5.24 € through the avoidance of a series of fatal and serious injured accidents'.***

### 3.2.2. Wide Market scenario – voluntary use

Following, the second scenario implies that municipalities will introduce the SAFEWAY2SCHOOL system as an additional system to their core transportation system. In this way the infrastructure components that are needed to be installed for the full functionality of the integrated systems will be supported by the municipality. In this scenario, the system implementation is mainly private, with the same involved stakeholders with the previous scenario, but is supported by public authorities. The Intelligent bus stop and the intelligent bus sign will be promoted by the municipality, which will install them and allow the school districts to use them. The adoption of the system is voluntary and will be undertaken by selected transportation companies and schools, of high volumes. The more infrastructure operators adopt such a (harmonised) system the more attractive it will become for transporters and schools to adopt such a system. This scenario also includes the support of the SMEs and the car manufacturers. The Car Driver device is another component that should be used in order to have full functionality of the system. The Inventory tool could be separately launched, even as a service for parents to identify and highlight specific safety issues at the children's bus stops. A gradual market penetration is foreseen in this scenario focused on the school bus transportation vehicles, the road infrastructure and the schools and the transportation companies which may choose to equip their vehicles and use SAFEWAY2SCHOOL procedures (or continue without). The volume and growth is directly related with the number and the importance of the infrastructure operators involved.

In this gradual penetration scenario some of the features and exploitable products of the SAFEWAY2SCHOOL system will be implemented by the public sector and the rest from private transportation companies and schools. In this wide market scenario that supports public and private implementation the following exploitable products and features of them can be implemented:

- Decision Support System (DSS)
- On-Board Unit (OBU)
- Intelligent Bus Sign (IBSign)
- Intelligent Bus Stop (IBS)
- VRU units
- Surrounding traffic information system
- Family and third party notification system
- Training kit
- Inventory tool
- Car Driver Device

This scenario has not such a low costs as the first one. It is a wider scenario that also implies greater market acceptance index ( $D2=82.4\%$ ) and so is the effectiveness ( $E1=65\%$ ). Despite these characteristics though this scenario has the lowest CBA index of all, since this market acceptance and effectiveness rate cannot make up to the great implementation costs of the system. The CBA index of this scenario is equal to 2.16 which means that, taking into account the costs of the various components and the running of the system, the number of people using them and a predicted reduction in accident figures attributable to the system:

***'For each euro dedicated to the wide implementation of the SW2S system, the society will saved 2.16 € through the avoidance of a series of fatal and serious injured accidents'.***

### 3.2.3. Mandatory use – across all national school travel

Finally, there is the mandatory scenario where the SAFEWAY2SCHOOL system is introduced by specific infrastructure or for whole areas/countries as mandatory for all school bus vehicles. This is the most optimal scenario, but also the one with the greatest time horizon.

In this scenario there is no private participation. All the components of the system are mandatory to be implemented from the government. The school bus manufacturers must incorporate the proper changes in the school bus interior and also include the intelligent school bus sign. The SMEs should provide the transportation companies with the OBU that supports the school bus driver in all its decisions. The municipality is obliged to make an inventory of, and safety classify the School bus stops with the Inventory Tool. The municipality should install the intelligent bus stops at the specific spots where increased safety is needed to reach set legal standards. Finally the transport operator has to operate this whole system monitor, maintain and updated it regularly. The only feature that cannot be embedded in this scenario is the car driver device, because its use and implementation requires the involvement of many private companies, which makes its mandatory implementation difficult. Fast market penetration is expected in this case (from 50% to 100%, depending upon the type of law restrictions; i.e. local vs. national). In this mandatory use market scenario that supports public implementation the following exploitable products and features of them can be implemented:

- Decision Support System (DSS)
- On-Board Unit (OBU)
- Intelligent Bus Sign (IBSign)



- Intelligent Bus Stop (IBS)
- VRU units
- Surrounding traffic information system
- Family and third party notification system
- Training kit
- Inventory tool

This scenario has very high costs, since it includes all the SW2S system components. It is the widest scenario that also implies greater market acceptance index (D2=100%) and so is the effectiveness (E1=79%). Despite its high cost, this scenario comes second in the CBA index, though very close to the second one. The CBA index of this scenario is equal to 2.62 which means that, taking into account the costs of the various components and the running of the system, the number of people using them and a predicted reduction in accident figures attributable to the system:

***'For each euro dedicated to the mandatory implementation of the SW2S system, the society will saved 2.62 € through the avoidance of a series of fatal and serious injured accidents'***

All the aforementioned drive us to conclude that when someone wants to purchase and implement the SW2S system it is better to start with simpler and low cost solutions, that will provide changes in the level of safety and security. This step will prepare the market to accept in a latter step the whole SW2S system more smoothly.

### 3.3. CEA

To complement the Cost Benefit Analysis a Cost Effectiveness Analysis (CEA) was also realised. CEA is a tool that cannot be used on its own, but only as a part of a holistic study that includes also a CBA. So, CEA comes to complement the CBA providing also to the Consortium a view of the potential impacts of the SW2S system taking in mind the subjective opinions of experts. The CEA of SW2S was also seen as an opportunity to include possible impacts of the systems to the society, which were not included in the CBA. For example one major issue that could not been taken into account is the environmental issues, which is taking part in the CEA. . Some of the highlights of this procedure are that the major innovation and strength of SAFEWAY2SCHOOL system is its impact in the road safety of the school transportation. Taking into account that SAFEWAY2SCHOOL constitutes a win-win business proposition to all involved stakeholders, everyone involved benefits in terms of safety, comfort and even operational costs. There is also a noticeable potential for added value services to which SAFEWAY2SCHOOL can be extended with, e.g. (security, overall environmental safety indices). This opens the opportunity to have a further improvement for the system and to keep it as state of the art for the next years.

### 3.4. Exploitation of the results

The exploitation plan identifies and describes the main exploitable results developed within the project. For each result, it identifies the target markets; it provides price estimates, penetration rates, the time-to-market and the planned distribution channels. The plan takes into account the overall business plan of the Consortium as a whole, as well as the plan of individual partners.

A brief list of Project exploitable results is reported in Table 5.

Table 5 List of Exploitable results

ID	Project result	Partner responsible	Time to Market	Target Market	Price
1	Driver Support System (DSS)	Fleetech	Immediately	Bus operators, Municipalities	2.500 €
1bis	Driver Support System (DSS)	SWARCO MIZAR	End of 2012	Transport Company	2.500 €
2	On-Board Unit (OBU)	Fleetech	Strictly connected with DSS commercialization		
3	Intelligent Bus Sign (VMS)	AMPARO	1-2 years	Authorities, Transport Company	100 €
3bis	Bus Sign (BS)	AMPARO	Immediately	Authorities, Transport Company	70 €
4	Intelligent Bus Stop (IBS)	AMPARO	Immediate or within 12 months	Authorities, Transport Company	2500 €
4bis	Bus Stop Sign (BSS)	AMPARO	Immediately	Authorities, Transport Company	100€
5	VRU units	AMPARO	Strictly connected with IBS commercialization		10 € each
6	Surrounding traffic information system	AMPARO	To be defined	Authorities, Transport Company	150 €
7	Family and third party notification application	CERTH/HIT	6 months	Parents, Municipality	10 €
7bis	Family/Child Carer Notification Application	SWARCO MIZAR	End of 2012	School authority	300 € + 1 € for each RFID card
8	Training kit	ITS	Immediately	Authorities, transport companies, educational institution	350 € for a training session
9	Bus stop Inventory tool	AMPARO	Immediately	Authorities, transport companies	1.700 €
10	VRU application	CERTH/HIT	9 months	Parents, Municipality	2 €
11	School bus routing algorithm	CERTH/HIT	Strictly connected with DSS commercialization		

## 4. Dissemination

The dissemination was done in work package 8 together with the exploitation.

The aims of the Dissemination and Exploitation work were:

- To widely disseminate project concept, developments and findings in an interactive way to all key actors in the field, integrating their feedbacks at key points of the specification, design, development and evaluation work.
- To perform Market Analysis in order to place project developments into the Market and to issue business scenarios for project results market penetration.
- To perform socio-economic studies on the developed applications, in order to define their Cost Benefit Analysis, Cost Effectiveness Analysis and finally their Market viability.
- To plan and realize key workshops and events and administer a User Forum, to support the wide diffusion of the project concept and results and guarantee proper input and feedback by key stakeholders.
- To issue exploitation plans for key project results.

The dissemination activities were crucial to promote the deployment of the SAFEWAY2SCHOOL results and to endorse a common understanding between different stakeholders on the issues interfering to children transportation. Since the beginning of the project a holistic dissemination strategy has been defined in order to lay out the framework for a consistent and homogeneous dissemination strategy throughout the entire project duration, identifying the various tools that will be used, and by pinpointing the responsibilities of all partners.

### 4.1. The project logo

The project logo was conceived at the very beginning of the project and depicts in an attractive manner the concept of SAFEWAY2SCHOOL project that deals with “Service” and “Safety”, which are the core words of the project. The “Service” is represented by the school bus and the “Safety” by the road sign, see Figure 23.



Figure 23 The SAFEWAY2SCHOOL logo

### 4.2. Project website

The project website (<http://safeway2school-eu.org/>) represents a mean of dissemination due to its accessibility, anywhere and at any time, addressing a large audience.

The aims of the SAFEWAY2SCHOOL web site were the following:

- To provide information about the current status of the project to various stakeholders as well as to community planners, traffic and school authorities, and the general public.
- To receive feedback from stakeholders upon the project's aims, progress, and methods.
- To provide the public results of the project to everyone who is interested in accessing them.
- To generate interaction with various stakeholders.
- To propagate dissemination material to all interested parties.

### 4.3. Leaflets

The project leaflets were designed according to the look-and-feel of the project logo and it is folded into three parts for a total of six pages. Apart from providing an overview of the project consortium and some details on the project aims, the leaflet mainly focuses on the project concept, the objectives, the holistic approach and the expected results (Bullinger et al., 2010).

### 4.4. Posters and banners

The project posters (2) and banner, see recalls the layout, the graphical structure and the contents of the leaflet with the aim to make the project easily recognizable to the public, see Figure 24.



Figure 24 Banner of SW2S

### 4.5. Newsletters and workshops

On a six month basis a newsletter presenting the main results and activities of the project has been sent out. In total 6 newsletters were distributed and two Pan-European Workshops were organized by the Consortium (Strand, Porathe, Anund, & Chalkia, 2010)

- The first Workshop and User Forum was organized on the 10th of March 2010 in Munich, Germany. The aim of the workshop was to bring together various

stakeholders in the area of school transportation, to communicate the project objectives, to disseminate the project preliminary findings and, finally, to introduce and prioritize the projects' Use Cases.

- The final Workshop was organized on the 13th of June 2012 in Örnköldsvik, in Sweden, in order to disseminate the final SAFEWAY2SCHOOL results of the development phase and to visit the Swedish pilot site.

#### 4.6. Scientific papers, conference papers and video

During the project lifecycle several scientific papers were presented in peer reviewed journals or at peer reviewed international conferences in order to widely disseminate project results and activities (Strand, 2012) see also Annex. Finally, a Video and a Cartoon have been produced to explain and show project concept and on-site realization that is available on the web page.

#### 4.7. Contact information

Beneficiary	Name	E-mail
VTI	Anund Anna	anna.anund@vti.se
VTI	Therese Jomander	therese.jomander@vti.se
CERTH/HIT	Angelos Bekiaris	abek@certh.gr
CERTH/HIT	Eleni Chalkia	hchalkia@certh.gr
IFSTTAR	Annie Pauzie	annie.pauzie@ifsttar.fr
AMPARO Solutions	Samuel Vestlin	samuel.vestlin@amparosolutions.se
AMPARO Solutions	Leon Nilsson	leon.nilsson@amparosolutions.se
Fleetech	Jens Werner	jens.werner@fleetech.se
TRA	Katarina Appeltoft	katarina.appeltoft@trafikverket.se
TRA	Åsa Viklund	asa.viklund@trafikverket.se
KfV	Eva Eigner-Breuss	Eva.Aigner-Breuss@kfV.at
KfV	Monica Pilgerstorfer	monika.pilgerstorfer@kfV.at
UNIMORE	Roberto Montanari	montanari.roberto@unimore.it
UNIMORE	Chiara Ferrarini	chiara.ferrarini@unimore.it
USTUTT	Frederic Diederichs	Frederik.Diederichs@iao.fraunhofer.de
MIZAR	Guido Foglietta	guido.foglietta@torino.miz.it
ITS	Justyna Wacowska	justyna.wacowska-slezak@its.waw.pl
ITS	Dagmara Jankowska	dagmara.jankowska@its.waw.pl
IIID	Stefan Egger	stefan.egger@iiid.net
Linköping University	Björn Børsbo	Bjorn.borsbo@liu.se
MdH	Lennart Strand	lennart.strand@mdh.se

## 5. Conclusions

Going to and from school is a daily journey for millions of children around Europe. The crash statistics is lacking information about the exact number of child casualties during those trips, but available sources identify the most dangerous situation as the way to and from school buses, situations when the children are unprotected road users and a need of a door to door perspective in order to improve the safety for the children. SAFEWAY2SCHOOL aims to design, develop, integrate and evaluate technologies for providing a holistic and safe transportation service for children, from their door to the school door and vice versa, encompassing tools, services and training for all key actors in the chain.

The project has a user oriented approach and on-site test has been done in Italy, Sweden, Poland and Austria, but also a simulator experiment in Germany. All developed tools and technologies have been evaluated. The results are positive, showing cost effective solutions with high acceptance for the holistic approach but also for most of the sub systems behind. However, no chain is stronger than the weakest link and this is true also when it comes to school transportation. Based on a very extensive work to identify future work with standardisations and policy the most essential improvements identified were related to School Travel Plans, Sign at all bus stops and improved driver education.

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**Annexe/s**



Table 6 Dissemination activities; conferences, peer reviewed articles etc.

Author(s)	Title of paper	Journal, conference, etc.	Date
Anna Anund and Linda Renner	SAFE SMART SCHOOL BUS – A PILOT STUDY	The 16th ITS World Congress and Exhibition on Intelligent Transport Systems and Services.	Stockholm, Sweden September 25, 2009
Anna Anund, Linda Renner, Tania Dukic, Stella Nikolaou, Eleni Chalkia and Evangelos Bekiaris	Integrated system for safe transportation of children to school "SAFEWAY2SCHOOL"	RS4C 2010 Road Safety on Four Continents	Abu Dhabi, March 22–24, 2010
Leon Nilsson	The See Me-System	The 2 <sup>nd</sup> Annual Traffic Management Conference	London, Britain, May 19, 2010
Thomas Porathe, Lennart Strand	"Conspicuity Index: A Method of Measuring the Visibility of Traffic Signs."	5th International IIID Expert Forum Traffic & Transport Information Systems	Vienna, Austria, September 9-10, 2010
Anna Anund	SAFEWAY TO SCHOOL AND SAFETY AROUND BUS STOPS	The National School Transport Conference 2010, Safety and Security	London, Britain, October 13, 2010
Anna Anund	Presentation of the SAFEWAY2SCHOOL project	Cypriot police officers visiting Sweden	Stockholm-Linköping, Sweden, October 25, 2010
Anna Anund – Chiara Ferrarini, Roberto Montanari, Francesco Tesauri	SAFEWAY2SCHOOL: a scuola in sicurezza (safe to school).	Società Italiana di Ergonomia (Italian Ergonomic Society).	Rome, Italy, October 28, 2010
Anna Anund	Presentation of the SAFEWAY2SCHOOL project	Stockholm Fair, Persontrafik 2010	Stockholm, Sweden, October 26-28, 2010

Author(s)	Title of paper	Journal, conference, etc.	Date
Jens Werner, Fleetech, Leon Nilsson & Samuel Vestlin, Amparo Solutions	Presentations of the SAFEWAY2SCHOOL project	Stockholm Fair, Persontrafik 2010	Stockholm, Sweden, October 26-28, 2010
Anna Anund, VTI, Katarina Appeltofft, Trafikverket, Samuel Vestlin, Amparo Solutions	Presentation of the SAFEWAY2SCHOOL project Opportunities, safety and technology	Transportforum 2011	Linköping, Sweden, 12-13 January
Torbjörn Falkmer & Linda Renner & Anna Anund	Estimated societal costs of a hierarchical measures approach to enhanced school transportation safety at bus stops on roads with high speed limits.	European Transport Research Review: (2010) 2:201–207	This article is published with open access at Springerlink.com
Anna Anund & Tania Dukic & Björn Börsbo & Torbjörn Falkmer	Piloting smart safe school bus: exploration of security gains from implementation of a driver support system, additional technical equipment and intelligent bus stops	European Transport Research Review: Volume 2, Issue 4, 2010.	This article is published with open access at Springerlink.com
Thomas Porathe & Lennart Strand	“Which sign is more visible? Measuring the visibility of traffic signs through the conspicuity index method.”	European Transport Research Review: Volume 3, Issue 1 (2011), Pages 35-45.	This article is published with open access at Springerlink.com
Anna Anund & Tania Dukic & Sian Thornthwaite & Torbjörn Falkmer	”Is European school transport safe? – The need for a “door-to-door” perspective.”	European Transport Research Review: Volume 3, Number 2, Pages 75-83.	This article is published with open access at Springerlink.com
Anna Anund	Presentation of the SAFEWAY2SCHOOL project	Curtin University	Perth, Australia, 2011

Author(s)	Title of paper	Journal, conference, etc.	Date
Tania Dukic & Samuel Vestlin	Presentation of the SAFEWAY2SCHOOL project & Amparo See Me project	Chalmers: SAFER – Vehicle and Traffic Safety Center	Göteborg, Sweden, April 7, 2011
Åsa Viklund & Katarina Appeltoft	Experiences from an application for safe transport to and from school A step toward SAFEWAY2SCHOOL	11th International Conference on ITS Telecommunication, ITST 2011	St. Petersburg, Russia, August 23-25, 2011
Anna Anund & Tania Dukic	From user wishes to system architecture Safety for children going to and from school by bus	11th International Conference on ITS Telecommunications, ITST 2011	St. Petersburg, Russia, August 23-25, 2011
Melanie Ganzhorn & J. P. Frederik Diederichs & Harald Widroither	Enhancing the reproduction of road signs in automotive HMIs to protect children	11th International Conference on ITS Telecommunications, ITST 2011	St. Petersburg, Russia, August 23-25, 2011
J. P. Frederik Diederichs & Betina Weber & Melanie Ganzhorn	Experimental Evaluation of ITST based School Bus Stop Notifications for Car Drivers	11th International Conference on ITS Telecommunications, ITST 2011	St. Petersburg, Russia, August 23-25, 2011
Anna Anund	ITS utmaningar för oskyddade trafikanter (ITS challenges for protection of vulnerable road users)	The 7th Swedish National ITS Conference 2011	Stockholm, Sweden, 20-21 September, 2011
Evangelos Bekiaris, Eleni Chalkia, Anna Anund	Enhancement of school transportation safety by using innovative integrated technologies, the SAFEWAY2SCHOOL project.	The World Road Association (PIARC) XXIV World Congress	Mexico City, Mexico, September 26-30, 2011
International Institute for Information Design	SAFEWAY2SCHOOL	Taiwan International Design Expo	Taipei, Taiwan, 30 September-30 October, 2011.
International Institute for Information Design	SAFEWAY2SCHOOL	Forschungsgesellschaft Straße, Schiene, Verkehr: Graphic design of traffic signs and symbols.	Salzburg, Austria, October 4, 2011.

Author(s)	Title of paper	Journal, conference, etc.	Date
Chiara Ferrarini, Roberto Montanari, Francesco Tesauri	SAFEWAY2SCHOOL: "From door to door: An example of how it can work." Poster and paper presentation.	TRA: Transport Research Arena	Athens, Greece, April 23-26, 2012.