TELSCAN

TELematic Standards and Coordination of ATT systems in relatioN to elderly and disabled travellers

TRANSPORT TELEMATICS PROJECT N°.: TR 1108

Title	Updating of User Requirements of Elderly and Disabled Drivers and Travellers.
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Summary:	This deliverable is a summary of the user requirements reassessed in the light of the results from the collaborative evaluations with other Transport Telematics Projects, as well as data and expertise gathered from the literature and other experts in the field.
Status:	Final
Distribution:	All Partners
Document ID:	D 3.3
Date:	September 1999

Commission of the European Communities

Telematics Applications Programme - Transport Sector

Deliverable 3.3 Updating of user requirements of Elderly and Disabled drivers and travellers

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1 Executive summary

The user requirements have been reassessed in the light of the results from the collaborative evaluations with other Transport Telematics Projects, as well as data and expertise gathered from the literature and other experts in the field. The user requirements identified are also the fundamental base for the development of different parts of the TELSCAN project. User requirements cover, of course, a multitude of different aspects, and to demonstrate how they have been integrated into the project's output, they have been grouped into the following categories:

- System function requirements
- Interface requirements
- Information requirements
- Protocol requirements

To assist developers of multi modal travel information systems a travel task and a travel information checklist were developed. The travel task is related to public transport as well as private transport and consists of main tasks, sub tasks and prompts. A checklist of travel information items has been produced aimed at the developers and evaluators of travel information systems. To obtain information about the relative importance of the travel information items within the checklist a questionnaire was used.

Nearly all information in the travel checklist seems to be relevant to at least the user groups consulted. The conclusion can be drawn that the selection of travel information items related to one category of impairment should be used with care against a design for all perspective. To avoid overkill on information, part of the information should be used by the travel planner system to produce a usable trip solution, without informing the client directly of all choices. Depending on the kind of impairment category and use circumstances the travel advice should be more or less detailed.

When reviewing our work in the area of user requirements and existing telematic solutions, we find several examples of adaptation or enhancement of current solutions is needed and where new systems ideas may emerge. The following list gives an overview of developmental needs.

Improved Contact
Improved Methods of Comparison of Alternative Trips
Reliable information and information systems
Detailed information
Improved multi-modal trip information source
Simple Easy-to-Use Solutions
Intelligent smart card
Speech recognition

The user requirements have promoted the development of three valuable outputs of the TELSCAN project - the Design Guidelines Handbook, the Travel Information Checklist, and the Assessment Methodology. However, it is important to stress the interaction between these 3 outputs.

2 Introduction

The following report is the final product of the TELSCAN project's Workpackage 3: Identification and Updating of User Requirements of Elderly and Disabled Travellers. The main objectives of this workpackage were:

- To develop an assessment method to identify the needs of elderly and disabled (Elderly and Disabled) travellers, and
- To identify and update the user requirements of Elderly and Disabled drivers and travellers, particularly in relation to Advanced Transport Telematic (ATT) systems

The objective of this deliverable is to update the user requirements of elderly and disabled travellers, which were identified and analysed earlier in the project through the production of two deliverables summarised below: Deliverable 3.1 (Nicolle et al., 1998) , and Deliverable 3.2 (Börjesson et al., 1998).

2.1 Deliverable 3.1

Deliverable 3.1 (Inventory of ATT System Requirements of elderly and disabled drivers and travellers) resulted in a summary of the requirements of elderly and disabled travellers using different modes of transport, including private cars, vans/minibuses, buses/trams, metros/trains, ships and airplanes. It provides an overview of:

- The components of the travelling task causing difficulties for the main impairment groups
- What their main requirements are in general and to what degree ATT can fulfil these requirements, and
- Modifications to some existing systems or new system ideas

The requirements were identified using a methodology developed in TELSCAN, which includes the following tools:

Definition of the Travelling Task (see Table 1 below)

This was used to ensure that all relevant components of the travelling task, using the various modes of public and private transport, were considered. It was divided into separate "checklists" for each mode of travel to facilitate data collection.

Functional Classification of Elderly and Disabled Travellers (see Table 2 below)

The Elderly and Disabled Classification was used to ensure that every impairment group was considered. During data collection with elderly and disabled users, the Classification was used to help choose a range of impairments to invite to the focus group interviews and to define the boundaries for each interview group. The Classification also provides a structure for other Transport Telematics projects to

identify and capture requirements, evaluate their product/service with the relevant Elderly and Disabled groups, and ensure that Elderly and Disabled are not excluded from using it.

Table 1 Overview of the Travelling Task

DRIVER	**PASSENGER**						
I	**II**		**III**				
Private transport	Private transport	Special transport	Public transport				
car/van	car/van	car/van/ minibus	taxi	bus/tram	metro train	ship	airplane

Table 2 Overview of the TELSCAN Elderly and Disabled Functional Classification

Impairment	**Disability**	**Potential Problems**
SKELETAL - Motion of lower limbs	eg, Cannot walk	eg, Reaching departure points
SKELETAL - Motion of upper limbs	eg, Cannot use arms	eg, Use of ticket machines
SKELETAL - Motion of upper body	eg, Cannot turn head/neck	eg, Restricted scanning of environment
SKELETAL - Anthropometrics	eg, Short stature	eg, Reaching ticket machines
SKELETAL - Co-ordination/dexterity	eg, Difficulty using hand controls	eg, Using small buttons/ knobs
SKELETAL - Force	eg, Reduced force in arms/hands	eg, Opening doors
VISCERAL	eg, Sudden loss of consciousness	eg, Obtaining help
VISION	eg, Blind or reduced vision	eg, Obtaining written information
HEARING	eg, Total or partial deafness	eg, Hearing announcements
LANGUAGE AND SPEECH (Communication)	eg, Cannot read or speak	eg, Obtaining travel information
INTELLECTUAL/ PSYCHOLOGICAL Cognitive Functions	eg, Difficulty with new tasks or in decision making	eg, Operating new technology

Note: The shading in the boxes above indicates those user groups interviewed in the data collection for Deliverable 3.1, in order to cover a range of physical, sensory and cognitive types of impairments. Elderly people were also included as a separate category as their needs can be very different.

Deliverable 3.1 thus provides generic user requirements specification, which can guide the design of all transport telematics systems. However, it stresses that, using such methodology and tools, projects should also capture a more detailed definition of user requirements for their specific application area or system.

2.2 Deliverable 3.2

In Deliverable 3.2 (ATT Systems and their relevance to Elderly and Disabled travellers), the user requirements which are relevant to ATT have been extracted from Deliverable 3.1, condensed, clarified and grouped according to system functions. In doing so, it better illustrates problem areas and possible improvements, and how functions are relevant to each Elderly and Disabled group. All the categories from the Elderly and Disabled Functional Classification were considered based on the literature and Consortium expertise. These user requirements are, of course, important to all travellers, but certain impairment groups are noted as particularly relevant, in varying degrees of severity and for different reasons.

Deliverable 3.2 explains what is meant by relevance of ATT systems to Elderly and Disabled, and what it can encompass, i.e.,

- A system can be relevant when it **presents the information** in a way that is easier to receive and understand by Elderly and Disabled, for example providing a blind person with spoken information.
- A system is relevant when it **includes information** important to Elderly and Disabled; for example a system giving a person travelling in a wheelchair information about where to find attended petrol stations.
- An ATT system is relevant when it **gives assistance** in avoiding the problem and where to get help if needed. One example is reporting gaps in traffic to people for whom twisting the body is difficult.
- An additional example of relevance is when ATT systems **give integrated or alternative solutions** to replace a mode of transport experiencing a problem. The system can either suggest an alternative traditional transport with no, or fewer, problems for Elderly and Disabled, or offer a new integrated transport solution like demand responsive transport.
- Lastly we can regard ATT systems as relevant if they **give operators feedback** information. This feedback could be in real time when a person needs help or information about frequently asked questions when Elderly and Disabled travellers have trouble carrying out a trip without any obstacles. These kinds of applications are very important in order to encourage operators to improve their service.

Using ISO TC204/WG1, “Architecture, Taxonomy and Terminology” Deliverable 3.2 also identified the main system functions where user requirements need to be elicited or confirmed through TELSCAN’s collaboration with other projects:

Pre-trip planning

Trip Information

Access to vehicle/service

Vehicle Control

Parking

Dealing with weather and environment

Emergency warning and driver support

Ticketing/Payment

Toll Collection

Integrated user tasks (which includes Demand Responsive Public Transport. Integrated user tasks is not mentioned in the handbook as no specific guidelines were produced.)

Finally, deliverable 3.2 emphasised two main areas where new technology can cause new problems for Elderly and Disabled:

- With regard to **presentation of information** that is accessible to persons with impaired vision, hearing, communicative and cognitive functions
- With regard to **information content** about obstacles/delays/disturbances that is of particular relevance to people with disabilities

To illustrate, people with lower limb impairments would like to have more relevant information to help them plan their train journey, e.g. which stations are wheelchair accessible. Trip planning systems at accessible locations may be a solution to their problem. However, the kiosk must be designed so that a person in a wheelchair is able to get close enough to input a query, and so that the buttons are within easy reach. Hence, there is a real need to follow up the identification of user requirements with:

- Interface design guidelines so that designers are advised on just how to put those requirements into practice, developed by the TELSCAN Handbook of Design Guidelines (Nicolle and Burnett, Eds., 1999), and
- Recommendations of specific information required by travellers from different impairment groups so that users find those systems useful and relevant (developed by the Traveller Information Checklist, described below).

3 Updating user requirements

The user requirements have now been reassessed in the light of the results from the collaborative evaluations with other Transport Telematics Projects, as well as data and expertise gathered from the literature and other experts in the field. The user requirements have been compiled during the whole TELSCAN project and have been an important base for the recommendations given to the supported Transport Telematics Project. The user requirements identified are also the fundamental base for the development of different parts of the TELSCAN project. How the user requirements have been used can be illustrated by figure 1.

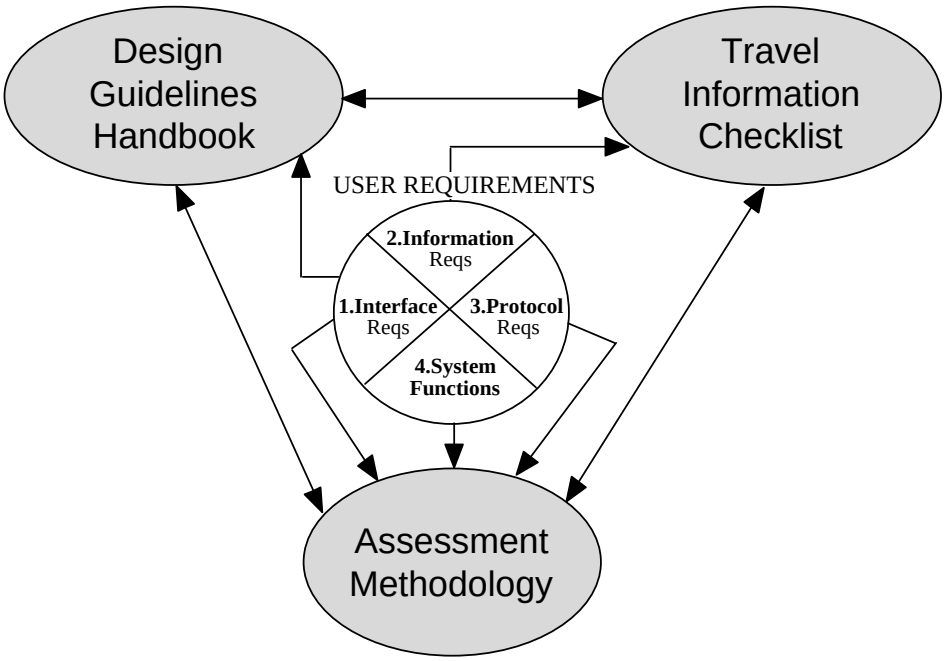

Figure 1. Importance and Integration of User Requirements in TELSCAN Output

User requirements cover, of course, a multitude of different aspects, and to demonstrate how they have been integrated into the project's output, they have been grouped into the following categories:

- **System function requirements**
- **Interface requirements**
- **Information requirements**
- **Protocol requirements**

1. System function requirements

TELSCAN has identified the numerous difficulties experienced by elderly and disabled people when travelling via different modes of transport (TELSCAN Deliverables 3.1 and 3.2). Such problems can be alleviated via the functionality offered by ATT

systems, for instance, a wheelchair user might benefit from increased knowledge to aid in trip planning, such as whether there are any lifts at the destination station.

These requirements are reflected in the Mobility Indicator from TELSCAN's Assessment Methodology (Deliverable 4.2, Marin-Lamellet, 1999). Although clearly the provision of functionality within an ATT system can be considered important for all travellers, the methodology helps evaluators identify which different user groups are *most likely* to benefit from the provision of certain high-level functionality within an ATT system.

2. Interface requirements

People who are elderly or disabled may experience difficulties with various aspects of the interface to an ATT system. For instance, a system, which utilises a visual display containing text, may be a problem for those with poor sight and/or language skills. Consequently, travellers' interface requirements have contributed to two important products of the TELSCAN project:

- **Assessment Methodology** (Marin-Lamellet, et al., 1999). This provides a Problem Indicator listing questions that the evaluator should consider regarding the interface, and the corresponding user groups that are most likely to experience difficulties as a result of a 'yes' answer. It is evident that such questions will also point towards design guidelines for that system.

- **Design Guidelines Handbook** (Nicolle and Burnett, Eds., 1999). This provides guidelines on interface design to ensure that ATT systems are easy to use by elderly and disabled travellers. For example, it is recommended that simple symbols are used to assist people with cognitive impairments, and that alternative output is provided in both visual and audio modes to accommodate different user requirements.

3. Information requirements

Systems for travellers should include information, which an elderly or disabled person needs in order to make a journey safely and in comfort. For example, travellers may need to know:

- which buses have a low floor for easier access
- whether there are reduced fares for people who are retired or disabled
- how long it will take to walk from one platform to another
- if there are any stairs to climb

These information requirements have been developed within TELSCAN as the **Travel Information Checklist**, available in paper and a prototype electronic formats, to give designers this sort of advice (See Part 4).

Protocol requirements

The users requirements, as well as experience of the TELSCAN partners in conducting collaborative testing with other transport telematic projects, have identified certain protocols that should be followed when including elderly and disabled people in the

design and evaluation process (Marin-Lamellet et al., 1999). Various methods and tools either may not be appropriate for certain people or may require specialist knowledge in their use. For example, focus groups with people having hearing impairments need to consider whether a sign interpreter would be helpful, both for signing and to assist in understanding speech. Also, including elderly or disabled drivers in simulator testing must consider various issues such as accessibility of the simulator to people with lower limb impairments, the use of car adaptations, fatigue, and simulator sickness, all of which can either cut short the testing, or eliminate certain users entirely.

Examples of updated user requirements

All of the results from the updated user requirements are noted in the table in Appendix 3. Only some remarks are made here.

In co-operation with different telematic projects, we have primarily deepened our knowledge of travellers' requirements. Earlier, we noted the need for specific information for every handicap group. In our continued work we have been able to, more than previously note more concrete examples from travellers with different disabilities.

People with mobility impairments have given us the most detailed information regarding the information they need in order to comfortably plan and complete their journeys.

The Pre-trip Planning System must provide very detailed information regarding walking distance, ground level differences and stairs in terminals where travel begins, ends or transfers are required. The mobility handicapped are slightly stressed when transfer time is short, when they are uncertain as to walking distance while transferring and when they are ignorant of where a booked seat is located on a train.

Information about how to obtain special diet meals and hearing magnification aids for the hearing impaired are further examples of desired detailed information that have come forward.

Several groups have explained their specific problems more clearly. People with cognitive problems have commented on their need to know when low traffic periods with fewer travellers and less hectic traffic occur and their need to reserve special seats in vehicles. People who are blind have commented that the amount of spoken information has decreased with the introduction of information boards. Such information has, according to several accounts, resulted in poorer information for the sight impaired.

People with reduced arm strength desire pre-travel information regarding what baggage help is available and where baggage should be placed during the trip. Older travellers have pointed out that they want to be able to compare prices for alternative travel times and days.

During the study, we have also discovered that an important user group hasn't been given the consideration warranted by their need for information. This group, people with allergies, who are not specially mentioned in our grouping of relevant groups, has

proven to be in Swedish studies a large group with special information needs. These include, for example, information on non-smoking areas and which compartments allow travel with animals. For motorists with allergies information about pollen and pollution in an area can be as important as weather information and road conditions can be for other motorists.

Another dimension, although not new, is the users' need for information regarding the trip in its entirety, the significance being that information must be co-ordinated. Information regarding a journey in its entirety where several methods of transportation are utilised is vital, as the success of the journey is dependent on each leg of the journey being successful. To a certain extent this is included in "integrated user tasks". However, we want to emphasise this, since the user has so clearly voiced the need for "door-to-door information" even when the journey involves several different methods of transportation.

The TELSCAN co-operation with different projects has been very important in updating the user needs. The results are presented in the table in appendix 3 but some examples can be highlighted.

From the CALYPSO and ICARE projects we leaned that there are evidences that the contactless system can improve safety and accessibility. Regarding the safety issue, the validation time allows the passenger to get a seat right after entering the vehicle, particularly on bus and tramway. Moreover, the evolution to a multi-use smart card is a way of protecting vulnerable people from vandalism. In terms of accessibility, the main problem is the transportation network accessibility on its whole, but the contactless card can eliminate ticket and/or pass purchasing and the validation doesn't require more than one second. If the magnetic field could be extended, which is expected on the technological improvements' functioning, passengers could use any kind of public transportation having the badge in an appropriate bag. This is very important for people with reduced mobility, particularly for people using wheelchairs, as they can enter directly into the vehicle or station. Moreover, the same badge can be used for small payments, such as parking, newspapers, coffee, etc.

In the CONCERT project we noticed that VMS in the City of Thessaloniki mainly provide information for available parking sites which was found interesting but not sufficient. Many users questioned the reliability of the information presented and various aspects of the VMS design (i.e. inadequate lettering, wording, available time to read etc.) As a first step it is more than necessary to improve the level of understanding for the various ITS systems and the ways those are expected to influence or change some of our tasks as road users.

The DISTINCT project specially highlighted the unauthorised use of especially reserved parking bays, which is definitely a major barrier for most E&D drivers, directly influencing car usage. Users have found interesting the idea of pre-booking a parking space through the Internet, although the majority of them were not regular Internet users. They also favoured the use of mobile phones (GSM-SMS) as a better source of information on this aspect.

In the INFOPOLIS project we learned that persons with visual impairment underestimate the possibilities for them to get information from transport related web

site. Much information is available, provided the web site is designed so that it is accessible to screen readers. We also noticed that when interacting with the system, elderly persons expressed a need for guidance, a standard sequence of actions applicable for all applications, and one screen per type of information.

Waiting time information is interesting for travellers who are elderly.

In the PROMISE project a Personal Mobile Traveler was tested and persons over 60 found the information useful but they wanted to operate the system only when the car is stopped. Persons with hearing impairments are very interested in the possibility to access to information mainly given in an auditory format (radio or phone)

The Quartet plus project has been important to highlight user needs when developing real-time information at bus stops, the design of public transport information on the internet and the presentation of on-road hazard warnings and notification of other road traffic incidents in real time. In the project we also learned that disabled users need speech recognition systems.

Evaluations of the TRIPlanner terminal in the EUROSCOPE – ROMANSE II project have provided particularly valuable lessons on user needs, especially in relation to the use of touch screen technology for such a system. TELSCAN's research has highlighted the problems of parallax for people viewing a screen from different height perspectives; the problems caused for people with arthritic hands caused by the very sensitive nature of such screens and the fairly common mistake made by designers in assuming that all users will be computer literate to some degree, and so be familiar with terms such as "delete", "scroll", "menu" etc. In the context of the physical accessibility of TRIPlanner terminals, the collaborative evaluations underlined the number of people who might be excluded from taking advantage of a facility merely because the most basic principles of accessible design have not been considered. These include the provision of a recess below the user interface to allow enough room for a wheelchair user's feet and knees, and the positioning of the operational parts of the terminal (i.e. the screen) at a height that is reachable for a person in a wheelchair.

In the SAMPLUS project we learned that elderly are interested in the functions that new technology can provide, but not necessarily the applications provided. The latest version of the ROMANSE Project's pre-trip planning terminal – TRIPlanner Mk II – will contain an animated "talking head" feature. This provides the opportunity for help to be given to people with a visual impairment. It is not known whether the quality and clarity of this animation will be sufficient to enable deaf travellers who lip-read to take advantage of this new facility.

The information system proposed by SIAMS, strongly depends on the use of info-kiosks and the Internet. One of the main problems faced in Greece was that the majority of Elderly and Disabled users are having a hard time to deal with all kinds of new technologies and most of all with the Internet. Finally, although they do think new technology can be an interesting source of information they are questioning its reliability, especially when it comes to booking/ticketing procedures.

4 Travel information checklist

4.1 Introduction

Throughout the 4th Framework Transport Telematics programme many projects demonstrate multi-modal traveller information.

Elderly and disabled travellers rely on travel information, which has to be exact, even more than for younger or non-disabled travellers. While planning a journey travellers with a disability want to be sure that the trip is possible throughout the whole travel chain, which means the availability of correct travel information to the questions like: *'Which bus line has a low floor? Can I get assistance while boarding a train? Is accessible transport on demand available from the end station to the destination of the trip? Is there an economic way to travel from the airport to the city? Will I be able to get back in time (Is the assistance still available)? How about security, is it safe to travel late? Can I get help somewhere if I need it? ... '*

A travel task and a travel information checklist has been developed (see figure 2) to assist developers of multi modal travel information systems. The **travel task** is related to public transport as well as private transport and consists of main tasks, sub tasks and prompts. The use of the travel task is described in Nicolle, Veenbaas & Ross (1997) and Nicolle et al (1997).

The TELSCAN project investigated the travel information needs of elderly and disabled travellers. A **checklist of travel information** items has been produced aimed at the developers and evaluators of travel information systems. This checklist is aimed at the passenger who uses (public) transport in the wide sense, including transport for special user groups (transport on demand) and taxi. It does not include the information requirements for private (car) transport.

TNO-WT has been responsible for the development and validation of the travel information checklist program. This checklist gives an overview of travel information items. The program can be used by user needs evaluators, system designers and system evaluators to tailor travel information- and trip planning systems following a design for all principle. The travel information checklist is based upon user needs literature (Kort, 1997; Zeilstra, 1994), user interviews (OVR, 1997; TOER, 1998), and expert opinion and evaluated through the travel information checklist questionnaire with the user groups.

Users of the checklist program can scan through travel information items related to a specific travel subtask or the other way round to find travel subtasks related to a certain travel information item from the checklist.

Both, travel task and travel information checklist are related to the Guidelines which are developed in the TELSCAN project and to the user and impairment categories earlier defined in Nicolle C. (1998).

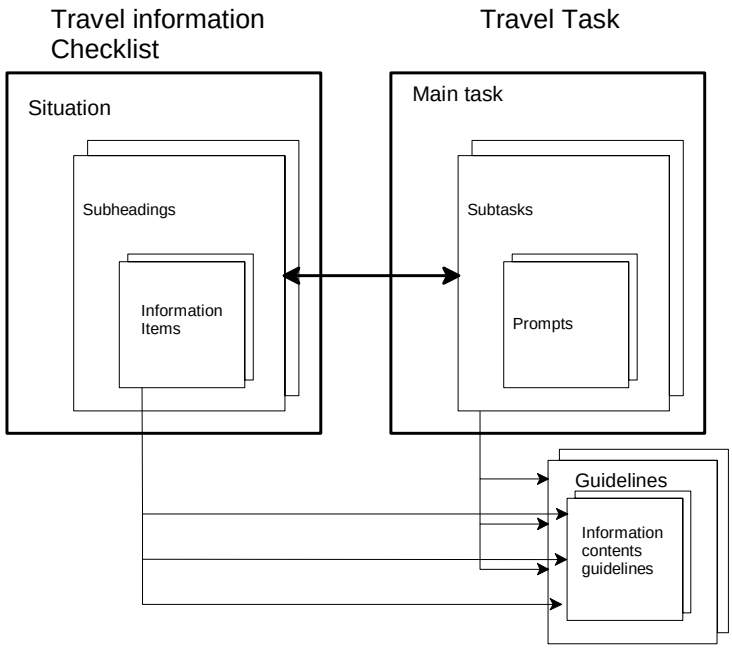

Figure 2 Structure of the information in the Travel Task and Travel Information Checklist

Hypothesis

The hypothesis was that a hierarchy in travel information items could be found relative to different impairment categories within the E&D user groups.

4.2 Travel information checklist questionnaire

A user questionnaire was used to obtain information about the importance of the travel information items within the checklist (see Appendix 1). In the first part of the questionnaire the user gives information about the mobility aids he/she uses, the type of disability and the travel habits. Part 2 focuses on the travel information items.

A preliminary version of the questionnaire was held with a group of 4 elderly and 6 travellers with a mobility impairment in the Netherlands. The first part of the questionnaire was then adapted to include more detailed information concerning impairment categories.

The final questionnaire was used with a number of user groups in different European countries. Table 3 gives an overview of the different user groups. It also defines the European projects where the questionnaire was presented to users.

Table 3 Overview of the user group

Nr.	User group	part 1*	Telscan partner	Cooperating project
23	Elderly	x	TNO	INFOTEN
23	Mobility impaired (using manual and electric WC & walking aids)	x		
10	Visual impaired	.	INRETS	
10	Elderly	x	AUTH	
12	Mobility impaired (using manual and electric WC & walking aids)	o		
4	Elderly (preliminary questionaire)	o	TNO	
6	Mobility impaired (using manual and electric WC & walking aids) (preliminary questionaire)	o		
10	Elderly	x	TNO	PROMISE
8	Mobility impaired (using manual and electric WC & walking aids)	x		
16	Elderly	-	UTL	
5	Visual impaired	-		
8	Mobility impaired (using manual and electric WC & walking aids)	x	VTI	
2	Deaf	x		
	Visual impaired	.	HUSAT (expert walkthrough)	.

x	complete questionnaire	.
o	data missing in part 1	.
-	part 1 not filled in	.

From the 137 user group members who participated in filling the questionnaire 91 users filled in the whole questionnaire. The sample is not representative for the Elderly and Disabled user group as can be shown from the overview of handicap types (see Figure 3):

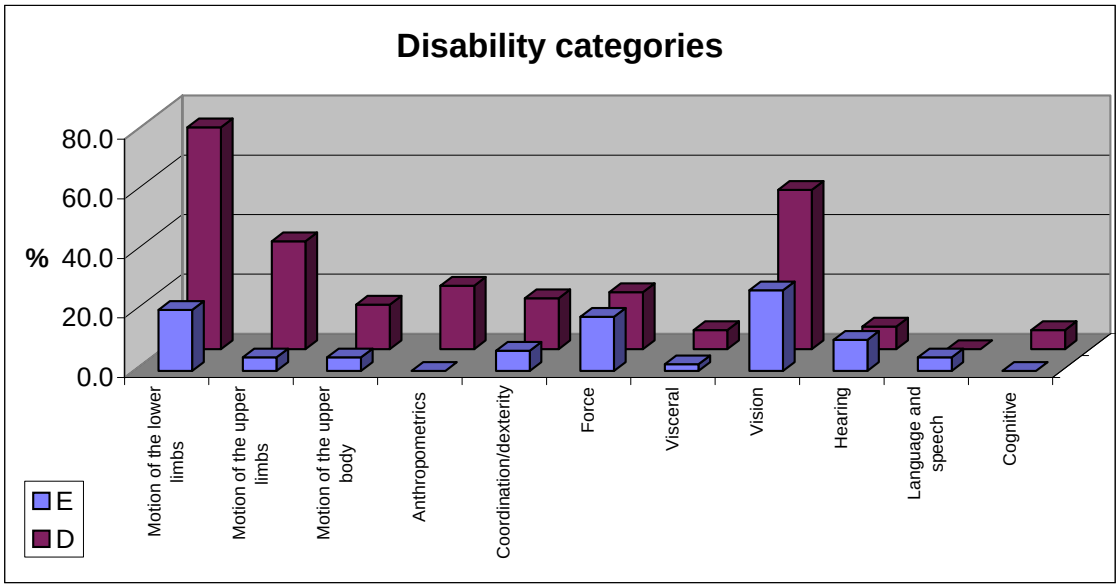

Figure 3 Overview of the user group disability categories

The sum of the disability categories given in figure 3 is higher than 100 % since some users indicated more than one disability category. Furthermore no distinction was made towards the severity of the impairment.

The emphasis during the current evaluation was on elderly, persons with a mobility- and with a visual impairment. The visceral, language and speech, hearing and cognitive categories were under-represented in the user group. Therefore, the results for elderly, mobility impaired and visual impaired users will be given below.

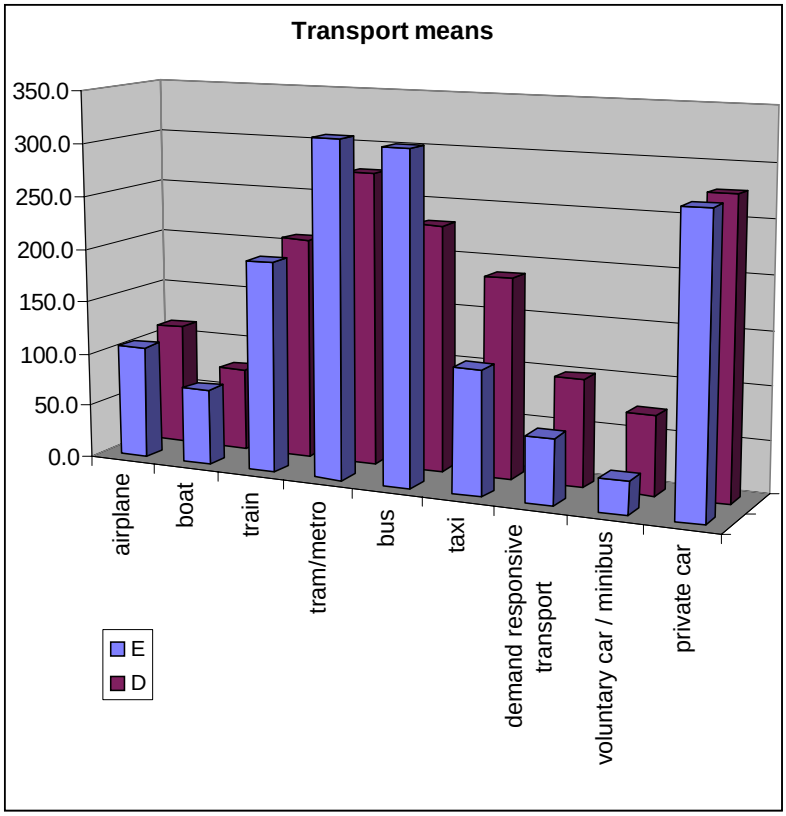

Figure 4 Transport means used by the user group. Average use (0 – never, 100 – very occasional, 200 – yearly, 300 – monthly, 400 – weekly, 500 – daily

In Figure 5 an overview is given of the mobility aids used during transport. Elderly with a wheelchair are under represented in this user group.

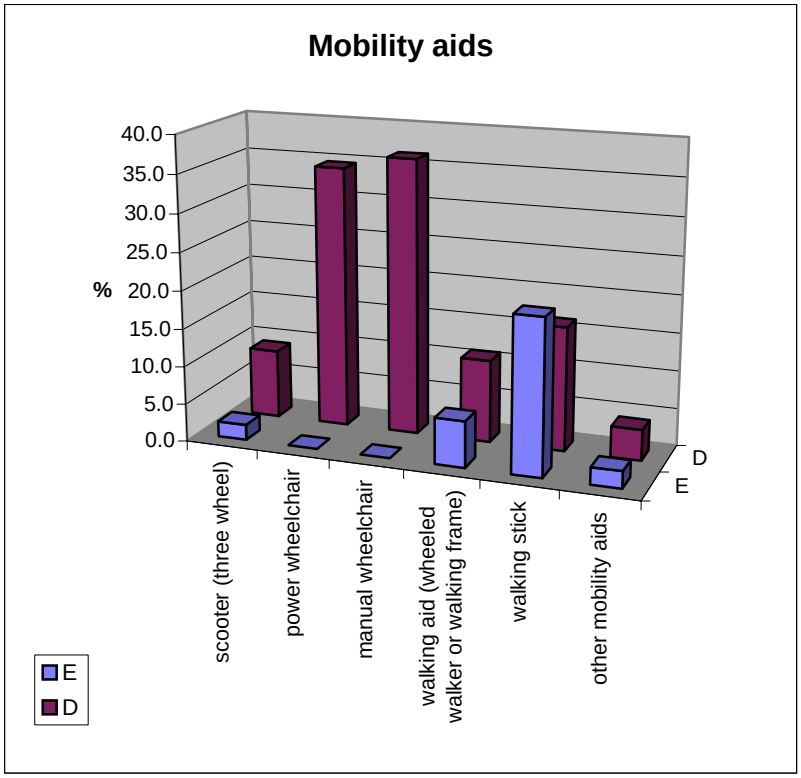

Figure 5 Overview of the mobility aids used by the Elderly and by the Disabled user group

User Group, relative importance of information:

Four categories of travel information relevance were made:

1. Information necessary for all (first page of the second part of the questionnaire) (information on departure and destination point, arrival- transfer- and travel times)
2. Information particular relevant to the specific user group
3. Information relevant to the user group
4. Useful but not essential

The first category is already available in most travel planners. It is therefore excluded from the current evaluation, which focuses on extra travel information.

The importance of each travel information item could be indicated by the users on a scale of 0 – 6, from irrelevant (0) through valuable but not necessary (2), valuable and necessary (4) to absolutely necessary (6) (see Appendix 1). All users were asked to fill in the questionnaire for their personal situation and not as a representative of the group.

For each user group and for each travel information item an average score was calculated (sum of the scores divided by the number of users). The average score can range from 0 to 600. The items with a score from 400 - 600 are given in the tables below to indicate the travel information items that each group indicated as most important. In the tables () representing the results from the user survey the items are presented in order of importance as indicated by the users (travellers).

Visual impaired User group

From the expert walkthrough (HUSAT) *Table 4* gives the information items that were marked as particularly relevant to travellers with visual impairment (not in order of importance). The knowledge for the expert walkthrough evolved through earlier focus groups and discussion with visually impaired people. In the rightmost two columns the correspondence to results from the user group questionnaire is given.

Table 4 Expert walk through (travel information items for visual impaired)

Travel information item	**user group**		
	Elderly	Disabled	Visual
availability of tactile/guidance systems			√
marking the location of the vehicle entrance			
auditory information to locate the entrance		√	
provisions for guidance dogs			√
available audible and visual announcements	√		
number of steps to take (up & down, to access vehicle or during transfer)			
location of lifts & escalators (up & down)		√	√
side of the vehicle to alight		√	
existence of a large gap to the platform		√	
audible announcement of the next stop (in vehicle)	√	√	√
announcement of interchange facilities are made during the trip	√	√	
unexpected changes of service are announced clearly audible and visual modes	√	√	
obstacles in the path during transfer (Reconstruction etc.)		√	√
indication on the next two departures from a stop, terminal or platform.	√		
audible and visual announcement of delays.	√		

From the questionnaire taken from elderly users who indicated a visual impairment, the following information was marked as particularly relevant:

(in each of the following Tables 5 – 10 the list of travel information items was split into columns. The items are arranged following the importance as indicated by the users, starting with the first column top to bottom and secondly the second column top to bottom)

Table 5 Travel information items important for elderly users (visual impairment) (N= 13)

Travel information item	
unexpected changes of service	departure, first and second
audible and visual announcements (delays)	connecting transport modes (location)
visual announcements (location)	waiting room opening time
available audible and visual announcements	situation map walking route
toilets, opening times & accessibility	ticket office (location & opening times)
weather protected waiting space	ticket machines (location)
toilets, accessibility, location key	vehicle identification
interchange facilities	next stop (audible)

In Table 6 the travel information items for disabled users (who also indicated a visual impairment) is given. This list is longer and due to users with more than one impairment items are also included which might not directly be related to the visual impairment.

Table 6 Travel information items important for disabled users who also indicated a visual impairment (N= 31).

Travel information items	
vehicle type (accessible with help)	phone number train assistance
toilets, opening times & accessibility	ticket office (accessibility)
assistance available (time)	local phone number for reservations
audible and visual announcements (delay's)	wheelchair types accepted
help points (location)	vehicle identification
unexpected changes of service	large gap to platform
vehicle type (accessible with help)	rebooking telephone numbers
toilets, accessibility in vehicle	ticket office (location & opening times)
wheelchair (location on vehicle)	accompanying persons
routing for wheelchair users	side of the vehicle to alight
toilets, accessibility, location key	vehicle type (stand alone accessibility)
trip planning services (for Elderly and Disabled)	national phone number for reservation
wheelchair types accepted	available aids
cost (incl. reduced fare information)	situation map walking route
obstacles in the path during transfer (Reconstruction etc.)	vehicle identification
restraint system (needed, type, available)	minimum time to book in advance
connecting transport modes (location)	lifts & escalators up or down (location)
information telephone number	terminal procedures
next stop (audible)	dimensions of entrance gap (hor. & vert.)
demand responsive transport available Elderly and Disabled (member card)	interchange facilities
available all Elderly and disabled	area of reach (transport on demand, traintaxi)

A user group of 5 persons was selected specifically on visual impairment in Portugal. The results from these users (scored 500-600) are given below in Table 7.

*Table 7 Travel information important for **visual impaired** user group (N=5). Mobility impaired user group*

Travel information items	
available all Elderly and Disabled	vehicle type (stand alone accessibility)
help points (location)	wheelchair types accepted
auditory information to locate entrance	restraint system (needed, type, available)
toilets, opening times & accessibility	availability tactile/guidance systems (type)
information telephone number	ticket office (accessibility)
openingstime/ availability kiosks	ticket machines (wheelchair accessible)
toilets, accessibility, location key	vehicle type (accessible with help)
accompanying persons	dimensions of entrance gap (hor. & vert.)
assistance available (time)	provisions for guidance dog's
cost (incl. reduced fare information)	parking spaces (disabled)
trip planning services (for Elderly and Disabled)	phone number train assistance
weather protected waiting space	waiting room opening time
waiting room smoking / non smoking	lifts & escalators up or down (location)
accessible telephones (location)	routing for wheelchair users
next stop (audible)	induction loops available
obstacles in the path during transfer (Reconstruction etc.)	day and hour availability
ticket office (location & opening times)	max. waiting time
ticket machines (location)	

In the following three tables the results from the mobility impaired user group are given.

Table 8 represents the travel information items indicated by users with lower limb impairment. Table 9 gives the cross section for power wheelchair users and Table 10 for manual wheelchair users.

Table 8 Travel information important for mobility impaired user group (lower limbs, N= 35).

Travel information item	
vehicle type (accessible with help)	parking spaces (disabled)
vehicle type (stand alone accessibility)	information telephone number
toilets, accessibility, location key	large gap to platform
lifts & escalators up or down (location)	distance
assistance available (time)	day and hour availability
routing for wheelchair users	max. extra journey time
wheelchair (location on vehicle)	max. waiting time
toilets, opening times & accessibility	ticket machines (wheelchair accessible)
toilets, accessibility in vehicle	number of steps to take (up & down)
obstacles in the path during transfer (Reconstruction etc.)	subscription needed
wheelchair types accepted	national phone number for reservation
vehicle type (accessible with help)	position railway carriage (class & nr)
departure time	local phone number for reservations
dimensions of entrance gap (hor. & vert.)	situation map walking route
available all Elderly and Disabled	vehicle identification
available Elderly and Disabled (member card)	vehicle identification
ticket office (accessibility)	ticket office (location & opening times)
transfertime	minimum time to book in advance
help points (location)	accessible telephones (location)
terminal procedures	accompanying persons
audible and visual announcements (delay's)	cost (incl. reduced fare information)
trip planning services (for Elderly and Disabled)	number of steps to take (up & down)
wheelchair types accepted	restraint system (needed, type, available)
unexpected changes of service	available aids
audible and visual announcements (delay's)	available audible and visual announcements
phone number train assistance	interchange facilities
connecting transport modes (location)	available for elderly
rebooking telephone numbers	next stop (visual)
area of reach (transport on demand, traintaxi)	

Table 9 Travel information important for mobility impaired user group (power wheelchairs, N= 19).

Travel information item	
vehicle type (stand alone accessibility)	position railway carriage (class & nr)
dimensions of entrance gap (hor. & vert.)	rebooking telephone numbers
assistance available (time)	phone number train assistance
vehicle type (accessible with help)	area of reach (transport on demand, traintaxi)
available all Elderly and Disabled	subscription needed
lifts & escalators up or down (location)	minimum time to book in advance
obstacles in the path during transfer (Reconstruction etc.)	local phone number for reservations
toilets, opening times & accessibility	weather protected waiting space
toilets, accessibility, location key	cost (incl. reduced fare information)
routing for wheelchair users	available audible and visual announcements
toilets, accessibility in vehicle	number of steps to take (up & down)
wheelchair types accepted	audible and visual announcements (delay's)
available Elderly and Disabled (member card)	max. waiting time
wheelchair (location on vehicle)	distance
Transfer time	ticket machines (wheelchair accessible)
help points (location)	audible and visual announcements (delay's)
connecting transport modes (location)	day and hour availability
situation map walking route	vehicle identification
large gap to platform	ticket office (location & opening times)
ticket office (accessibility)	intermediate stops
trip planning services (for Elderly and Disabled)	waiting room opening time
restraint system (needed, type, available)	accompanying persons
information telephone number	indication of end station
national phone number for reservation	visual announcements (location)
max. extra journey time	accessible telephones (location)
unexpected changes of service	available for elderly
parking spaces (disabled)	number of steps to take (up & down)
terminal procedures	

Table 10 Travel information important for mobility impaired user group (manual wheelchairs, N= 20).

Travel information item	
toilets, accessibility, location key	distance
lifts & escalators up or down (location)	day and hour availability
vehicle type (accessible with help)	max. waiting time
wheelchair (location on vehicle)	connecting transport modes (location)
toilets, accessibility in vehicle	vehicle identification
vehicle type (stand alone accessibility)	ticket office (location & opening times)
toilets, opening times & accessibility	subscription needed
obstacles in the path during transfer (Reconstruction etc.)	information telephone number
routing for wheelchair users	accessible telephones (location)
audible and visual announcements (delay's)	accompanying persons
vehicle type (accessible with help)	number of steps to take (up & down)
assistance available (time)	local phone number for reservations
phone number train assistance	wheelchair types accepted
ticket office (accessibility)	max. extra journey time
terminal procedures	available aids
help points (location)	available aids
trip planning services (for Elderly and Disabled)	vehicle identification
wheelchair types accepted	parking spaces (disabled)
available Elderly and Disabled (member card)	minimum time to book in advance
dimensions of entrance gap (hor. & vert.)	cost (incl. reduced fare information)
available all Elderly and Disabled	position railway carriage (class & nr)
unexpected changes of service	large gap to platform
transfertime	ticket machines (wheelchair accessible)
area of reach (transport on demand, traintaxi)	ticket machines (location)
rebooking telephone numbers	interchange facilities

From the comparison of the last two user groups (users of power wheelchairs and users of manual wheelchairs) it is clear that power wheelchair users need more information about the entrance circumstances (gap) and assistance than manual wheelchair users. Although more help might be needed entering vehicles for power wheelchair users, the stand-alone accessibility of vehicles is highly desired. As expected the location of lifts and escalators as well as the location of the wheelchair on the vehicle is of more importance to manual wheelchair users than power wheelchair users (endurance).

Travel information items with low priority

The only item from the travel information checklist not mentioned as primarily important to the different user groups, from the previous tables, was the opening time and availability of a restaurant (during transfer).

4.3 Discussion

1. Hierarchy of travel information items

From the results of the questionnaire it became clear that there is a large overlap between the different user groups. It seems that different categories of users share a large part of interest in travel information items from the checklist beit that the order of importance is somewhat different for the different user groups. The hypothesis at the beginning was that a clear hierarchy could be found once different user groups would give their main interests in travel information. >From the results it becomes clear that this hypothesis cannot hold. One of the explanations is that a number of users in the user group have more than one impairment and that all the user groups were not fully represented.

2. Accessibility versus travel information

It should be noted that the results reflect the current situation with different accessibility conditions of transport between different countries. From the questionnaire it becomes apparent that there is a great need for accurate travel information in order to be able to plan one's journey. Furthermore the results do not take the travel wish amongst Elderly and Disabled users into account.

Once accessibility becomes more obvious, the need for specific travel information will be less, just concerning the possibilities to use different transport means.

comparing for example the general situation in Europe to transport in the USA, in Europe the accessibility of public transport is still a goal in many countries while in the USA the need for information on accessibility of specific locations and transport vehicles will be less, due to the the ADA which prescribes accessible locations and transport,. Figure 6 illustrates the dependence between accessible infrastructure cost and the cost of the user information.

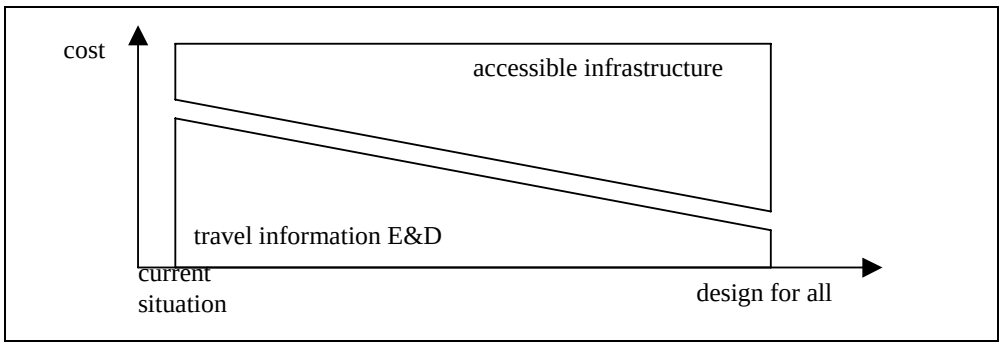

Figure 6 Relation between the availability of accessible infrastructure and the need for specific Elderly and Disabled travel information.

3. Cost Benefit ratio

Some of the information in the checklist requires a large investment to obtain and maintain. Especially if it concerns time variant information (like obstacles due to

reconstruction) or very specific information like the exact distance, and detours, between platforms during transfer. In order to be able to predict transfer times for wheelchair users this information should be available. But what if the train stops at another platform? Then the information is dynamic as well, which would require a link between the train traffic controller data and the trip planner software. Apart from the ownership aspects of the information, this might become a costly exercise to implement.

Consequences to the travel information database program

The scheme presented in figure 2, where the relations were given between travel task and travel information checklist, can be redrawn including the links with the guidelines and user (impairment) groups (see Figure 7 Design of the travel information database program).

Different links between user groups, design guidelines, travel task and travel information questionnaire can be distinguished. Not all links share the same relevance as will be explained in the next section.

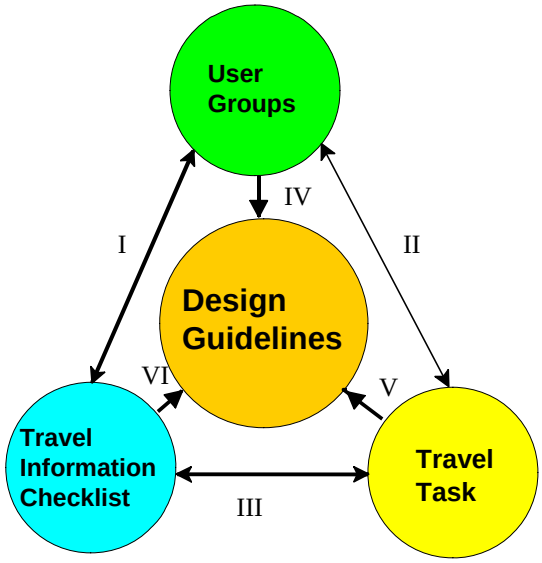

Figure 7 Design of the travel information database program

Link I:

There is not a very clear distinction between user groups and the travel information checklist as was expected. Although the user group was asked to fill in the questionnaire for their own situation, it became apparent that partly due to travellers which have more than one disability there is no clear distinction between items which were preferred by a certain user group. The results from table 2 – 8 were used to create

link I between user groups and travel information checklist. As can be seen from Figure 2 above, not all disability categories were represented in the user group.

Table 11, gives an overview of the disability categories from which links to prioritised items in the checklist are given for elderly as well as disabled travellers.

Table 11 Impairment categories for which prioritised travel information checklist items are presented by the travel information checklist program (CD-ROM).

Disability category	Elderly	Disabled
SKELETAL motion of lower limbs	√	√
SKELETAL Motion of upper limbs		√
SKELETAL Motion of upper body		
SKELETAL Anthropometrics		√
SKELETAL Co-ordination/dexterity		√
SKELETAL Force	√	√
VISCERAL		
VISION	√	√
HEARING		
LANGUAGE AND SPEECH (communication)		
INTELLECTUAL/ PSYCHOLOGICAL Cognitive Functions		

Table 12 Impairment categories for which prioritised travel information checklist items are presented by the travel information checklist program (CD-ROM).

Link II:

The major part of the travel task is valid for all users since it contains tasks which should be executed in a row to be able to reach a destination through a number of travel modes. Specific Elderly and Disabled travel tasks would be tasks that are related to the impairment (e.g. handling and making provisions for a guidance dog). This link between the user groups and the travel task will not be created in the database.

Link III:

This link relates subtasks in the travel task to travel information items and vice versa and is already implemented in the preliminary version of the travel information checklist database program.

Link IV:

The link between user groups and guidelines is already available within the final version of the guidelines concerning Elderly and Disabled issues (see Nicolle, Burnett, 1999)

Link V&VI:

Both links will be incorporated into the database structure.

Concluding:

On the CD-ROM with the user profile, travel task, travel information checklist and guidelines, the main connections which exist between the different categories will be:

I User Group -> travel checklist

III Travel task <-> travel checklist

IV User group -> design guidelines

V Travel task -> design guidelines

VI Travel checklist -> design guidelines

Use of the travel information database program by system designers.

Travel information system designers can use the travel information database program in several ways:

1. When designing for a specific user group, by selection of the impairment category, related guidelines become available. Furthermore a selection of travel information items which should be considered during the design process is available related to the specific impairment category.
2. When seeking a travel information solution for a specific travel task, travel information items are available when selecting that travel task.
3. The travel information checklist is available as a questionnaire to assess the travel information needs for a specific user category.

Further development work on the checklist is still needed in order to allow searching for travel information according to:

- the constraints of the information transfer (internet, short message systems, portable digital assistant, call centre etc.),
- the impairment category of the end user (lower limb impairment, cognitive impairment)
- the circumstances of use (time constraints: at home pre trip planning or while travelling finding an alternative),

is wether:

- the information item is used to calculate and present an optimal advice to the end user
- to present the information to the end user to let them select their own advice from a number of possible alternatives
- to tailor the advice in a person to person conversation (call centre).

4.4 Conclusions

1. The distinction between travel information items for the different user groups was less clear than was expected partly due to persons with more than one impairment. From this the conclusion can be drawn that the selection of travel information items related to one impairment category should be used with care against a design for all perspective.

2. Nearly all information in the travel checklist seems to be relevant to at least the user groups consulted in the previous period. To avoid overkill on information, part of the information should be used by the travel planner system to produce a usable trip solution, without informing the client directly of all choices. Depending on the kind of impairment category and use circumstances (time pressure) the travel advice should be more or less detailed.

3. Creating a trip planning system, which includes all travel information, could be costly. An optimum trip planner still does not change the environment and the accessibility of travel solutions. Therefore investments in making all public transport accessible have to be weighted against the cost of a travel information system. And an optimum solution should be striven for (see Figure 6). Investigating the need for infrastructural changes towards transport accessibility falls outside the scope of a Telematics project like TELSCAN.

Although many of the travel information items in the checklist do have great benefits for the “average” traveller as well, the link between an increase of travel and associated benefits for the transport companies is not very clear. Further more, to fully take the advantage of increased travel by a growing elderly part of society, public transport should be highly accessible and a accompanying travel advice system should be concise, clear and accurate to enhance the trust into the system.

5 Important Development Areas

The expected final outcome of the identification and updating of user requirements is:

- A definition of areas where no solutions exist
- An illustration of where adaptation or enhancement of current solutions is needed and where new systems ideas may emerge

When reviewing our work in the area of user requirements and existing telematic solutions, we find several examples of all of these three areas. Furthermore, the earlier data collection and literature reviews have been ongoing throughout TELSCAN to ensure that the project kept abreast of new developments that will meet the requirements of elderly and disabled people.

The following table provides an overview of developmental needs.

Table 13 Overview of Existing Areas in Need of Development or New Solutions

System function requirements	**Interface requirements**	**Information requirements**
Facilitation of initial contact between assisting-staff and travellers including waiting location of staff and arrival location of travellers. Improved contact and communication in emergencies. Contactless smart card with information regarding user requirements. Improved methods for comparison of trip alternatives with reference to user requirements and price. Reliable information and information systems.	Speech recognition, widespread use of speech input Improved contactless means of payment automated payment Simple easy-to-use solutions	Improved multi-modal trip information dissemination Detailed information with reference to specific user requirements e.g. calm traffic conditions, non-smoking areas, access to special diet foods, luggage assistance, access to inductive loopset for hearing aids etc. Improved information to traffic operators regarding their passengers' requirements.

5.1 Improved Contact

Early in this study we noted that passengers and staff have difficulty finding one another during journeys. This knowledge was augmented during discussions with the sight and hearing impaired in Sweden (Sekara & Karlsson 1997). Both the staff

assigned to help travellers and the travellers themselves are unsure where to find each other. This leads to unnecessary waiting and anxiety. During a journey a blind person might need to get in touch with staff but he/she is unable to distinguish if passerbys are staff or fellow passengers.

In several studies done in Sweden the elderly and disabled have expressed a desire to be able to manage on their own without having to ask for help (Ståhl 1993). At the same time help when needed is desired. This could be accommodated for example, if better information to travellers was provided about where and how one can find assistance and at the same time staff is provided with information as to the special needs requested or specified by different travellers. If both staff and travellers have access to better information, unexpected occurrences and problems are solved more quickly and effectively.

Many disabilities are not obviously apparent, making it difficult for staff to ascertain without a help request whether or not a person is disabled and in need of help (Waara 1999). In cases of emergencies or accidents it is imperative that staff know the location of disabled people who might not otherwise be warned or who need assistance.

5.2 Improved Methods of Comparison of Alternative Trips

Trip planning systems place trip alternatives in preference to shortest travel time. Other factors can be decisive for the disabled. Transfer at a terminal without stairs can be a better alternative for someone who finds stairs difficult, than a quicker trip using a terminal with difficult staircases. This exemplifies users' desire for aid in comparing trip alternatives with reference to individual requirements. Users clearly stated in studies in conjunction with the development of the information system TågplusGuiden in Sweden that the need for planning information before travel is significant (Waara 1999). The elderly and disabled are often anxious and fretful before planned travel. The level of anxiety and worry had such significance for them that the availability of pre-travel information could be the deciding factor in whether or not a trip is realised. However, otherwise the majority of requests for better pre-trip information were not considered deciding factors in whether or not a trip was realised but rather were important factors as to how the traveller experienced the trip. Even several other minor factors otherwise not normally considered obstacles or problems can be sources of anxiety for different impairment groups (Warsén & Björnehult 1995). This anxiety can to a certain extent be reduced with better and more exact pre-trip information.

All information should apply to the trip in question. The elderly and disabled are not interested in general information as to compartment standards or general opening and closing times. They are interested in conditions when they plan to travel (Waara 1999). It is not satisfactory to provide information on general opening and closing times weekdays and week-ends. Information must be applicable to the planned trip i.e. the elderly and disabled want to know when the transit hall is open when they arrive.

It became clear in studies done with the elderly that when choosing, price knowledge is also of importance to them. Price comparisons for different modes of transportation was a desired function in the system as was pre-trip information as to method of payment

(Waara 1999). Method of payment for bus transportation is of particular importance since different types of payment automation is usually involved and these can be difficult for the disabled to use (Karlsson 1995).

5.3 Reliable information and information systems

In several studies users have pointed out lack of reliability in new information systems (Warsén & Björnehult 1995, Waara 1999, Karlsson 1995). Deficiencies concern both the information's content and the technical reliability of the system. Setting up real time information boards that give actual departure times increases travelers' demands on the information system Gotic in Gothenburg (Sekara & Karlsson 1997).

5.4 Detailed information

The need for information regarding access to different service functions during a journey varies with different groups. The possibility of realizing a journey in peace and quiet is a deciding factor for some groups. In that case, availability of seating is essential pre-trip information.

Other groups must plan mealtimes and visits to the toilet carefully. Pre-trip information about services like these are a deciding factor for whether or not the trip will be satisfactory (NNH 96, Karlsson 1997).

5.5 Improved multi-modal trip information source

A large proportion of journeys consist of a combination of different forms of transportation. Travellers view the journey as a whole, not as several small trips. It is above all transfers that are the source of anxiety and worry before a journey. The elderly and disabled often experience transfers as a large and particularly stressful problem. Their anxiety concerns the number of transfers and the transfer situation e.g. accessibility and lack of time. Since travellers view the journey as a door-to-door experience, getting on or off at bus stops are considered transfers (Waara 1999).

All information a traveller needs for a single journey should also be available for combination journeys that use several forms of transportation. This information can be quite complicated. For example a journey might involve an automobile trip using the travellers own car that needs to be parked at a terminal, continuing by train with a transfer to a bus and finally reaching the destination on foot. For each and every leg of the journey, the traveler needs the particular information relevant to his special needs.

5.6 Simple Easy-to-Use Solutions

Easy to use systems i.e. easy to use for those unfamiliar and not used to using new technologies were clearly desirable. In all group discussions the desirability of easily accessible systems was expressed. Information systems should be accessible by different means e.g. by telephone, internet, or changeable information boards etc.

Nothing has shown that the elderly or disabled have negative attitudes to new technologies (Warsén & Björnehult 1995). One study for example showed that people over 65 were more positive to the possibilities opened up by new technologies than people under 65 (Viborg 1999). The older generation however, has more difficulty in using the new technical applications. For example, in tests of the new automobile navigation systems older drivers have said that they can not use the system while driving, but must stop the car when receiving new data (Ståhl 1997). This can mean that the older generation will not have access to telematic solutions that they think would alleviate their travels because the system is too complicated.

The lack of experience of new technology gives many persons a psychological barrier to use new aids. In the project Personal Communication Devices with Digitized Speech has focused on more structured methods for introducing personal communication devices and for the training in their use. The project chose to create natural situations for the communication training (Nordström & Åström 1996). This has proved an advantageous method to apply for communication training among persons with mental handicap. The communication training is more functional if persons who know the user participate in the training. This increases the motivation. For users with a need for communication support in many situations it is important to initially make plans for increasing the number of situations in which the communication device can be used (Granlund et al.1995 Lundman et al 1995).

A major result of the study together with SAMPLUS was that the dialogue must be very simple and consistent. This study also revealed the importance of sensitive push buttons that are easy for people with arthritis to press. The study once again focus on the importance of sustems that are easy to understand and easy to use(Westerluns &Ståhl 1999).

It is important to include the user in the process of selecting messages for the communication device. This can be done by presenting a selection of messages to the user, orally or in the form of pictures or symbols. The results showed that speaking partners were chosen among personnel, relatives and sometimes among other disabled employees at the day centre. This means that the communication devices were seldom used to communicate with persons outside this rather limited circle of people. In several cases personnel ordered the user to use the communication device. In general it is more favourable if the user takes the initiative to a conversation as orders impose a passive role on the user. Initially this can be necessary as many users have difficulty in initiating a conversation. It is also important to have a plan to gradually give less orders and provide less encouragement to the user to use the communication device. A communication device can seldom or never be used as a sole means of communication but should rather be regarded as a complement to other forms of communication.

5.7 Intelligent smart card

When updating the user requirements we found that detailed information according to personal needs was of great importance. It is easy to figure out that detailed information of that kind is impossible to give in a general distributed form but need to be given personally in one or the other way. When using a pre trip planning system it is possible

to ask for not only a individual trip but also of a trip that shall fulfil individual user requirements. Instead of giving all personal requirements each time planning a trip it could be possible to store the requirements on a card or in a file in the system. If the requirements are stored on a card the information could be used for improved service during the trip. For example the user requirement of a spoken announcement at a bus stop could be recorded at the same time as payment of ticket, and the service automatically given.

The use of intelligent smart card is studied in several projects. Some examples can show the development and the possibility to improve the card for elderly and disabled persons.

ADEPT II created a prototype of automatic debiting systems and electronic payment for transport. Demonstrations took place in Finland, Göteborg and Thessaloniki. A "citizen card" to pay for public transport, car parking, toll roads and other public facilities such as libraries, canteens and swimming pools has been developed and demonstrated (Automatic Debiting And Electronic Payment For Transport; ADEPT II, CORDIS RTD-RESULTS Record Control Number: 22667, 1999). It is based on smart card technology and will allow more efficient use of public systems. This concept could be used by the citizens in every large urban area world-wide.

Next step was to develop an interoperable bi-compatible contact/contactless Smart Card System. The worlds of transport ticketing and other contactless card applications are isolated from the world of banking cards. The needs for interoperability between card applications have created market demand for a secure bi-compatible, contact/contactless card. The project (Contactless interoperable microcontroller based Smart Card System. CORDIS RTD-RESULTS Record Control Number: 21026) is developing a Smart Card System that combines ISO7816 contact with 'remote coupling' (10 cm distance) contactless operation. The Smart Card itself will be based on a single secure microcontroller chip, the only viable solution for meeting high security standards and optimized user-friendliness under fully automated and highly reliable manufacturing process. The outcome is an industrially and economically viable solution based on sound research and development involving:

- Specification and performance that meet world-wide market needs and standards
- Research and design of a contactless/contact secure microcontroller chip
- Research, development and design of a companion terminal interface chip
- Development of a cost effective Smart Card assembly process
- A break-through in low-cost terminal architecture
- Stable and secure microcode for the contactless functions of the Smart Card and terminal subsystem.

The interoperable bi-compatible Smart Card will enable card issuers to provide co-branded solutions for some of the most important card applications to come (transport ticketing, electronic purse and combined schemes).

CARDLINK (CARDLINK: health care cards and telematics CORDIS RTD-RESULTS Record Control Number: 20936): health care cards and telematics has implemented and

demonstrated a patient held smart card medical record for particular applications in case of medical emergency. The record is electronically stored in a secure form on the smart card and may be accessed and updated by the general practitioner, hospital specialist, pharmacist or authorised administrative staff. The core dataset conforms with the decision of the European Council of Ministers for the development of an emergency health passport for use throughout Europe.

CARDLINK provides the citizen with a portable medical record which makes it easier to take up residence, travel and work in any participating member state, because diagnoses, allergies, medications, therapies and vaccination records. Next of kin and insurance information will be made readily available to doctors wherever the patients seek healthcare.

One problem has been the security when storing money and private information on a card. A powerful new cryptographic reduced instruction set processor (CRISP) has been developed which includes a unique security kernel (CRISP: smart card integrated circuit meets mass market needs, CORDIS RTD-RESULTS Record Control Number: 19746). This guarantees the integrity and data independence of individual applications on a card, delivering a truly secure multisession environment. The project is developing a complete low cost smart card integrated circuit (IC) combining high speed and PKC security, with the high performance and silicon area efficiency of a reduced instruction set computing (RISC) architecture.

The kernel itself can be configured to the target operating system at the time of issue and applications can be loaded remotely later, without compromising security. An instruction set optimized for smart cards includes comprehensive bit-manipulation instructions and a high level function library.

It has also been a development to make it possible to communicate information on a smart card with different systems. The proposed solutions are based on a multilingual platform access control and electronic purses using PC software and firmware and electronics networking (gateways, routers, local units).

This new technology offers a quick application development platform for multi-applications centred on smart cards. The solutions are based on the platform access control and electronic purses.

The multilingual platform is based on PC software and firmware, and on electronics networking (gateways, routers, local units). It integrates the common functions of all applications and our expertise obtained through many successful achievments. Solutions are built around the platform integrating electronics and card readers. With only one card, the user (for example a student) can get into places such as a laboratory, a conference room, a library, ~~a~~ buy-food and drinks, use the copier, park his bike, use an electronic locker, etc. All types of applications are possible.

Main targeted business categories are: educational, cities, companies. The system can also include applications for smart building and hopefully user needs of elderly and disabled persons.

5.8 Speech recognition

A clear requirement is the need for more widespread use of speech input to alleviate the problems of many people with disabilities. TELSCAN has identified the following user requirements with regard to vehicle control, and has suggested that a more widespread use of speech recognition would be a solution for people with various types of disabilities:

- Improved/alternative means of accessing secondary controls - due to problems of reach
- Improved/alternative means of accessing secondary controls - due to problems of vision (particularly at night)
- Improved/alternative means of accessing secondary controls - due to overload on residual capabilities
- Improved/alternative means of accessing secondary controls - due to physical overload on limbs (as a result of using adapted primary controls)
- Improved/alternative means of accessing secondary controls - due to problems in touch/grip etc.

The human factors of automatic speech recognition (ASR) were investigated as part of a literature review for the SPEECH IDEAS project, a UK project funded by the ESRC and DETR under the LINK Inland Surface Transport programme (Graham and Carter, 1998). Although the review concentrated on aspects particularly relevant to in-car use, many of the issues are important for TELSCAN to consider for all systems for travellers, for example in pre-trip planning systems via kiosks, the internet and other technologies. The review is divided according to 4 main variables (Graham and Carter, 1998):

- User variables (i.e. who the users are)
- System variables (i.e. what the device is like)
- Task variables (i.e. how the user is interacting with the device)
- Environmental variables (i.e. where the user and device are located)

The literature review highlighted the fact that there are few successful applications of ASR for use by the general public, probably due, at least in part, to the wide variation in the speech of users. It also pointed out that applications of ASR which are both public and in demanding environments (e.g. an information kiosk in a busy station) are very rare. This can be expected to question the potential success of such systems for in-car use in the future.

Nevertheless, for the disabled and elderly traveller, speech recognition poses a valuable alternative to system input, and the TELSCAN user requirements found that certain impairment groups could particularly benefit. The following issues are particularly relevant to TELSCAN and to people who are elderly and disabled.

User Variables

Age

Older users tend to experience greater problems when using speech recognition than younger people.

Older people experience a general slowing in cognitive functioning which can influence the rate and accuracy of their speech, hence the recognition of their speech by the system.

Computer anxiety is highly correlated with age and hence may make speech recognition problematic.

Experience

Performance of inexperienced users (which is likely to include people who are elderly) can be improved if they are given a demonstration of system use by an experienced user, a larger improvement than if they are just given verbal instructions.

Users inexperienced with computers (likely to include people who are elderly) have low expectations of ASR technology, and therefore may be more accepting of a speech-driven system.

Attitude, motivation and expectation

The strongest predictor of usage is the user's attitude to the system. In particular, people who hold positive beliefs about technology are likely to be the most willing to experiment with new communication channels. This is likely to include people with disabilities who find operating the controls difficult or impossible, or who already have excessive workload on their upper limbs. If speech recognition will enable them to perform an otherwise impossible task or to enable them to perform it more easily, comfortably, and safely, then motivation is likely to be very high.

System Variables.

Since most in-car ASR devices are likely to be used by not more than one or two drivers, speaker-dependent recognition in cars may be more suitable than speaker-independent recognition. However, if systems for travellers in general (e.g. in a train or bus station) wish to employ ASR, then it is likely that systems will need to use speaker-independent recognition. Speaker-dependent recognition tends to be more accurate than speaker-independent recognition, and would require more time to train the system. However, even though speaker-independent recognition would require less training time, a poorer recognition rate will affect user acceptance and motivation to use the system. This trade-off between training time and system accuracy should be investigated, especially with regard to elderly and disabled people, although it is likely that motivation, especially with respect to some people with disabilities, will determine acceptability and success of the system.

Recognition performance may be affected by a number of factors: frustration or anger if the error rate is high, relaxed if this is particularly low, stressed by pacing, or fatigued if the task takes too long. Elderly people or people with disabilities may have changing

abilities over time, or they may experience more and earlier fatigue while travelling. Hence these factors may exacerbate an already poor recognition performance.

The user's motivation to use ASR, and success in doing so, will depend on the availability and performance of any alternative means of input. TELSCAN always recommends alternative back-up devices, and in the case of ASR, they are even more crucial. Back-up systems will act as a safety measure in case the ASR fails, or can be used when the user becomes too busy or fatigued to use the ASR effectively.

Task Variables. Task duration

When speech recognition is used over a long period of time, its performance tends to decline. Since many elderly and disabled travellers tend to become more fatigued or their impairment may change over time, this decline in system performance is likely to be more noticeable or more frequent.

Environmental Variables. Psycho-social environment

One of the main barriers to acceptance of speech-driven systems like cash machines is the embarrassment of using such a system in a public location. However, as discussed above because of their attitude and motivation towards using the system, disabled users are often more receptive to speech than other user groups, as it can enable their performance on tasks otherwise too difficult or impossible to carry out.

Implications for the design of ASR

The speaker database used to train the ASR device should include females, older people, non-local accents, inexperienced users, etc.

An effective performance evaluation must include a range of users, including elderly and disabled people, and should be performed in actual use in the travelling environment, where the user will be subjected to concurrent tasks, time pressure, emotional stress, and fatigue effects.

Since older travellers will have particular problems when carrying out concurrent tasks and machine-pacing, speech system dialogues should be user-paced where possible.

Since speech recognition may never be a successful option for some users, an alternative means of input should always be provided to cater for the needs of every user group. Speech interfaces should therefore be an addition to, rather than a replacement for, existing visual and manual interfaces.

Speech systems should be designed to be as undemanding as possible to use, so that all users, especially people who are elderly or disabled, will be able to use them effectively.

General training on the use of speech recognisers and specific training to cope with high levels of stress, workload or fatigue are important for all users, but especially for people who are elderly or disabled. Graham, R., and Carter, C. (1998).

6 Conclusions

TELSCAN's collaborative testing, involvement of elderly and disabled people and ongoing reviews of the literature and other projects have resulted in an update of user requirements for elderly and disabled travellers, particularly in relation to ATT system interface design and information provision. The user requirements have promoted the development of three valuable outputs of the TELSCAN project - the Design Guidelines Handbook, the Travel Information Checklist, and the Assessment Methodology. However, it is important to stress the interaction between these 3 outputs (See Figure 1)

It is not enough that the system interface is designed with the user's needs in mind - it must also contain relevant information for different user groups, information that can be found in the Travel Information Checklist.

Furthermore, as suggested above, the Problem Indicator in the Assessment Methodology will point towards design guidelines for that system, and the Design Guidelines Handbook will help to eliminate some of the problems people with different types of impairments have when using the system. Likewise, the Mobility Indicator of the Assessment Methodology will suggest which different user groups are most likely to benefit from the provision of certain ATT systems, and of course from the provision of relevant travel information to meet specific needs.

Thus, the TELSCAN user requirements underpin three important products of the project - the Design Guidelines Handbook, the Travel Information Checklist, and the Assessment Methodology. Together they can provide a design and evaluation package that will lead to more usable systems for all.

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8 Appendix 1 Travel Information Checklist Questionnaire

In this Appendix, example of parts of the travel information checklist questionnaire is given. The questionnaire was used with an Elderly and Disabled user group to obtain information about the relative importance of the checklist items to different categories of users.

User ID
Age: Date
Gender: m / v

1 Are you using a mobility aid? Yes / No
If Yes which mobility aid:
scooter (three wheel)
power wheelchair
manual wheelchair
walking aid (wheeled walker or walking frame)
walking stick
other mobility aids:

2 Which of the following applies to you and has a strong effect on your travelling:
(more than one answer possible!)
elderly age over 65
Impairments
Motion of the lower limbs (e.g. cannot walk)
Motion of the upper limbs (e.g. cannot use arms)
Motion of the upper body (e.g. cannot turn head)
Anthropometrics (e.g. short stature)
Coordination/dexterity
Force (e.g. reduced force in arms/hands)
Visceral (e.g. fainting)
Vision (e.g. blind or reduced vision)
Hearing (e.g. Total or partial deafness)
Language and speech (e.g difficulty with reading or speaking)
Cognitive (e.g. memory problems)

3 Which of the following travel modes do you use?
(Cross one possibility per line, indicating the frequency of use)
frequency dayly weekly monthly yearly very never
Transport mode occasional
airplane
boat
train
tram/metro
bus
taxi
demand responsive transport
voluntary car / minibus
private car

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	absolutely necessary		valuable and necessary		valuable but not necessary		irrelevant
	6	**5**	**4**	**3**	**2**	**1**	**0**
Trip planning							
1. Common Travel information							
2. Accessibillity							
3. Wheelchair accessibillity							
4. Accessibillity visual impaired							
5. Extra route information							
6. Information and reservation							
7. Local information (travel route)							
8. Local information (waiting)							
9. Complementary transport on demand							
On vehicle							
1. Accessibillity							
2. Wheelchair accessibillity							
3. Accessibillity visual impaired							
4. Extra route information							
Interchange							
Waiting for trip continuation							
Charging method							
Unexpected situations and rush hour							

Example of questions in Travel Information Checklist Questionnaire

9 Appendix 2 Table of User requirements

User requirements for different impairment groups

User Requirements	Relevant User Groups												Existing or R&D solution?	Example / Modifications / New solutions
	LL	UL	UB	A	C/D	F	SL	V	H	L/S	C	E		
1. Pre-trip Planning														
Accurate and up-to-date planning information (e.g. current bus timetables, disruptions on route)	4	4	4	4	4	4	4	4	4	4	4	4	YES	e.g. Pre-trip planning systems via kiosks, the internet and other technologies, but more widespread use is needed. The **ROMANSE** project's TRIPlanner is a good example. In collaborative testing with TELSCAN, most E&D users said that it would be extremely useful for planning their journeys. However, TELSCAN's evaluation has shown the importance of the interface design taking E&D needs into account. Collaboration with **QUARTET PLUS** found that better real-time information on waiting times at bus/tram stop makes travellers feel more in control and able to plan their trips better. Information on delays and disturbances was rated even more highly, though, than information on departure times. Elderly users in Gothenburg said that it was difficult to find out the departure of next bus/tram, and also that there is no information on prices at bus/tram stops or on-board buses/trams. Also a study with 2 internet services showed that the service content is not complete and does not answer all passengers' questions, especially those of E&D. Both services are limited to today's trips, which limits its usefulness, as most travellers with disabilities like to plan their journeys ahead.
Information in a form that Elderly and Disabled users can access (e.g. different modalities, large fonts, adjustable volumes, icons)								4	4	4	4	4	YES	e.g. Text to speech Web Browsers. Designers need to be made aware that speech recognition systems can only be used with textual interfaces. A person with visual impairment may lose important graphical information. A TELSCAN study with elderly users, in collaboration with **QUARTET PLUS,** found that loudspeakers in stations have poor output quality and it is easy to miss an announcement. Alternative modalities also need to consider E&D requirements.
Specific car/van planning information relevant to Elderly and Disabled, e.g. attended petrol stations, hotels, toilets, parking places, traffic conditions	4	4	4	4	4	4							YES	e.g. In-vehicle navigation/travel and traffic information systems. Need to provide information more relevant to Elderly and Disabled.
Specific public transport planning information relevant to Elderly and Disabled, e.g. layout of station, location of doors, length of carriages	4							4			4	4	YES	e.g. The TIDE MOBIC pre-journey system for blind travellers includes basic maps and routes (Strothotte et al, 1995). Such a system could be extended to meet the specific needs of further Elderly and Disabled groups. In addition, a video or computer simulation of the layout of the station/airport could be helpful.

User Requirements	Relevant User Groups												Existing or R&D solution?	Example / Modifications / New solutions
	LL	UL	UB	A	C/D	F	SL	V	H	L/S	C	E		
Specific public transport planning information relevant to Elderly and Disabled, e.g. layout of station, location of doors, length of carriages	4							4			4	4	YES	In an expert evaluation of the **INFOPOLIS** public transport information system, TELSCAN found that people with disabilities were not in the sample of those approaching the kiosk, since the metro stations were not accessible (at least not for people with mobility impairments). Effectiveness of a system will depend on the accessibility of public transport as a whole. It is also recommended that walking distances within stations need to accurately reflect the actual walking distance so that a person with mobility problems could easily decide if the trip is feasible.
Simpler means of making overall travel-related decisions (e.g. choice of transport mode, departure time, changes required)	4	4	4	4	4	4	4	4	4	4	4	4	YES	e.g. Multi-modal trip planning systems. These need to be designed so that they are accessible to all Elderly and Disabled user groups, and include information relevant to their needs. In a TELSCAN expert evaluation of the **INFOPOLIS** system, it was found that the system provides the ability to choose means of transport (metro/bus or combination of both), choices for point of departure and arrival, and places of special interest. However, there is a need to ensure that places of special interest for Elderly and Disabled are included. Elderly users, in **QUARTET PLUS**, said that an Information Centre has poor accessibility, even though providing an important service.
Improved means of knowing what assistance for Elderly and Disabled travellers is available (i.e. visibility of information) and where to get it	4	4	4	4	4	4	4	4	4	4	4	4	NO	Telematics may provide the information, but the actual availability of the systems needs to be publicised.
Detailed and clear information on procedures for Elderly and Disabled (particularly at airports)	4	4	4	4	4	4	4	4	4	4	4	4	NO	Information system at home/ travel agent to explain procedures.
Improved means of informing public transport authorities of specific Elderly and Disabled requirements (e.g. particular seats on plane)	4	4	4	4	4	4	4	4	4	4	4	4	NO	Smart cards could contain all of Elderly and Disabled users requirements (e.g. seating preferences, inabilities to work emergency exit) and could be used as boarding cards/tickets.
The ability to book reliable return transport (particularly from an airport to home)	4										4	4	NO	A longer-term booking system (accessible from home), or an easy to use, short-term booking system, accessible from abroad.
Alternative means of planning routes, due to difficulties with maps - Turning pages		4			4	4						4	YES	e.g. Trip planning systems and vehicle navigation systems to support Elderly and Disabled people, but more widespread use is needed.
Alternative means of planning routes, due to difficulties with maps - Colour coding								4			4		YES	e.g. Trip planning systems and vehicle navigation systems will support Elderly and Disabled people. But they must not place a reliance on colour coding.
Alternative means of planning routes, due to difficulties with maps - Reading/understanding text								4		4	4	4	YES	e.g. Trip planning systems and vehicle navigation systems will support Elderly and Disabled people. Well designed and tested icons/ visual representations should be given.
Alternative means of planning routes, due to difficulties with maps - Spatial complexity								4			4	4	YES	e.g. Trip planning systems and vehicle navigation systems will support Elderly and Disabled people. But they must not place a reliance on spatial information.

User Requirements	Relevant User Groups												Existing or R&D solution?	Example / Modifications / New solutions
	LL	UL	UB	A	C/D	F	SL	V	H	L/S	C	E		
Alternative means of planning routes, due to difficulties with timetables – Reading /understanding text								4		4	4	4	YES	e.g. Speech input/output interfaces at bus stops. These need to be more widely available.
Alternative means of planning routes, due to difficulties with timetables - Viewing information	4							4					YES	e.g. Speech input/output interfaces at bus stops. These need to be more widely available.
Non-verbal methods of obtaining and giving planning information									4	4	4		YES	e.g. Use of portable, visual devices, Internet use, e-mail, video text, video phones and multimedia computers. But these need to contain more information relevant to Elderly and Disabled travellers' needs.
Most convenient trip alternatives according to personal needs	4	4	4	4	4	4	4	4	4	4	4	4	No	An integrated Transport System with programmable smart card to indicate personal needs
Calm traffic time periods											4	4	No	Programmable Travel and Traffic / navigation systems
Comparison of alternative trip prices	4	4	4	4	4	4	4	4	4	4	4	4	No	Integrated travel and traffic information system with pricing info
Availability of hearing magnification for the hearing impaired in terminals and train compartments									4				Yes	Not always available or easy to find
Allergy-free areas, areas for pets Food suited to the needs of people with allergies	4	4	4	4	4	4	4	4	4	4	4	4	No	Information if and where its available.
Seat booking according to special needs (not only wheelchair)	4	4	4	4	4	4	4	4	4	4	4	4	Yes	Travel agents have such systems for parts of the public transport system, but it is not integrated across various modes of transport.
2. Trip Information														
Improved means of obtaining car/van navigation information - due to overload on residual mental capacities	4	4									4	4	YES	e.g. In-vehicle navigation systems. These should provide simple well designed step-by-step instructions. Roadside information transmitted to in-vehicle display/HUD would be an added feature.
Improved means of obtaining car/van navigation information - due to difficulties in searching/ looking for road side information			4	4				4			4	4	YES	e.g. In-vehicle navigation systems. These should not place a reliance on information to the side of the road (e.g. street names). Roadside information transmitted to in-vehicle display/HUD would be an added feature.
Improved means of obtaining car/van navigation information - due to difficulties in reading road signs								4		4	4	4	YES	e.g. In-vehicle navigation systems. These should not place a reliance on reading road signs.
Improved means of obtaining car/van navigation information - due to problems in using directions from passenger									4	4	4	4	YES	e.g. In-vehicle navigation systems. These should provide a redundant visual interface to the driver.
Aids to learning/remembering whole routes											4	4	YES	e.g. In-vehicle navigation systems. These should provide a level of information which will support route learning.

User Requirements	Relevant User Groups												Existing or R&D solution?	Example / Modifications / New solutions
	LL	UL	UB	A	C/D	F	SL	V	H	L/S	C	E		
Up-to-date traffic/weather information - needed, due to problems experienced in planning/ following new routes											4	4	YES	e.g. Travel and traffic systems. Also VMS (e.g. as those provided in **CONCERT**). TELSCAN collaboration has supported the provision of simple, easy to understand information to the traveller. Collaboration with **QUARTET PLUS** found that there was an increase in the use of real-time information in poor weather, possibly because passengers use the shelters more (where the displays were located), but also because real-time information becomes more important to passengers in these situations.
Non-verbal means of obtaining up-to-date traffic information									4	4			YES	e.g. Travel and traffic systems. These should provide a redundant visual interface to the driver.
Alternative/improved means of identifying correct stop/station (when on the bus/train)								4		4		4	YES	e.g. On-board information systems, but information should be provided in visual and auditory form.
Alternative/improved means of maintaining sense of location during public transport journey								4		4	4	4	YES	e.g. On-board information systems will provide a sense of orientation and reassurance. But there should be a means of obtaining information in a non-visual format.
Use of visual modality for trip-related announcements/improved quality of spoken announcements									4	4	4	4	YES	e.g. Information panels within stations/airports. But these should not be a substitute for well spoken and frequent auditory announcements.
Easy and explicit controls to ask the bus/tram driver to stop		4			4	4		4		4	4	4	NO	Effective communication system is needed between the traveller and driver.
Specific information relevant to Elderly and Disabled, e.g. facilities for waiting, following a change in the regular travel schedule	4						4				4	4	YES	e.g. Multi-modal, portable trip planning systems. These need to be designed so that they are accessible to all Elderly and Disabled user groups, and include information relevant to their needs.
Information to support re-planning of journey following a change in the regular travel schedule	4							4		4	4	4	YES	e.g. Multi-modal, portable trip planning systems. These need to be designed so that they are accessible to all Elderly and Disabled user groups.
Means of wayfinding on ships to avoid fear of falling overboard								4					NO	Portable, personal orientation and navigation devices should be available for use on ships.
Reliable information	4	4	4	4	4	4	4	4	4	4	4	4	No	Systems and their information must be reliable to be used and useful
Information updates specified	4	4	4	4	4	4	4	4	4	4	4	4	Yes	Not always implemented
Reliable information systems	4	4	4	4	4	4	4	4	4	4	4	4	No	Systems and their information must be reliable to be used and useful
Information regarding alternative information sources during information system breakdowns or disturbances	4	4	4	4	4	4	4	4	4	4	4	4	No	Systems and their information must be reliable to be used and useful
Written information about the entire journey e.g. distance to booked assistance etc., not just departure times	4								4		4	4	No	Systems and their information must be reliable to be used and useful
Pre-trip information about consequences if a promised service fails	4	4	4	4	4	4	4	4	4	4	4	4	No	Information needed on integrated an attractive services

User Requirements	Relevant User Groups												Existing or R&D solution?	Example / Modifications / New solutions
	LL	UL	UB	A	C/D	F	SL	V	H	L/S	C	E		
Pre-trip information of changes or adjustments in connecting transportation due to traffic disturbances	4										4	4	No	Integrated travel and traffic information / navigation systems wich consider individual's special needs
The oral system shall use simple language								4	4	4	4	4	Yes	Not always available
The information system shall give instructions on its use	4	4	4	4	4	4	4	4	4	4	4	4	Yes	Not always available
3. Access to vehicle/service														
Better information regarding waiting time at bus/tram stops and train/metro stations - to plan better and to avoid long waiting times	4	4	4				4				4	4	YES	e.g. Information systems exist which show waiting times. These should be more widely available.
Non-visual information indicating the arrival of a bus/ tram, its number and destination								4				4	YES	e.g. Systems exist which give an auditory announcement triggered by a transmitter on the bus/tram. Such systems should be more widely implemented. In collaboration with **ADEPT II**, TELSCAN has suggested that the smart card could help a blind passenger locate the door of the bus through a beeper, or start the procedure of lowering the bus floor for people with mobility impairments.
Improved means of identifying the correct bus/tram - due to limited perceptual and/or cognitive functions								4			4	4	YES	e.g. Off-board information systems present at the bus/tram stop. Information should be available in both visual and auditory forms.
Visual means of informing travellers that automatic doors about to close									4			4	NO	An integrated visual and audio warning system within public transport vehicles.
Clear and easy identification of bus/tram stop								4		4	4	4	YES	e.g. The ISAAC personal digital assistant will provide navigation support (Jönsson & Svensk, 1995). The system has the potential for much wider use by other Elderly and Disabled groups.
Improved means of finding station and/or correct platforms - due to difficulties with maps		4			4			4		4	4	4	YES	e.g. The TIDE OPEN system will provide navigation support for visually impaired travellers (Stephens & Longley, 1995). With modifications, the system may be of relevance to other Elderly and Disabled groups.
Means of quickly informing staff of need for assistance when opening doors of train	4	4	4		4	4		4				4	NO	Effective communication system between the traveller and staff.
Means of identifying unoccupied seat and avoiding luggage left on seats or in the aisles								4					YES	e.g. Sonar headsets could give the visually impaired traveller an impression of their surroundings (BBC, 1997). However, availability of human assistance is preferred.
Means of ensuring proper and effective use of 'disabled' parking spaces	4	4	4	4	4	4	4	4	4	4	4	4	NO	Smart cards for providing legitimate access to parking places.
Direction assistance at airports through non-visual means								4				4	NO	Portable auditory navigation systems available in different languages that can guide an individual around the airport.

User Requirements	Relevant User Groups												Existing or R&D solution?	Example / Modifications / New solutions
	LL	UL	UB	A	C/D	F	SL	V	H	L/S	C	E		
Improved/alternative means of communication with authorities and passengers during journey, particularly during rush hours								4	4	4	4	4	NO	Effective communication system between the traveller and authorities/other passengers.
Walking directions at transfers	4	4	4	4			4	4				4	No	Trip info systems with virtual reality walk through
Ground level differences in walking paths, thresholds, elevators and escalators	4	4	4	4			4	4				4	No	Trip info system providing protable advice on route landmarks and hazards
Location and track for departure and arrival.	4	4	4	4			4	4				4	No	Trip info systems with virtual reality walk through
Location of compartments with seating for disabled.	4	4	4	4			4	4				4	Yes	Info on seating for disabled could be stored on a smart card and always used when booking
4. Vehicle Control														
Improved means of spotting gaps in traffic - due to problems in turning body	4		4									4	YES	e.g. Gap acceptance collision avoidance systems. 'Acceptable' gaps may be larger for Elderly and Disabled groups, and should be tested.
Improved means of spotting gaps in traffic - due to problems of vision (particularly at night)								4				4	YES	e.g. Gap acceptance collision avoidance systems. Systems need to be tested with people with visual impairments. Vision enhancements systems for side windows may provide a novel solution to this problem.
Improved/alternative means of accessing secondary controls - due to problems of reach		4	4	4									YES	e.g. Speech recognition technology within vehicles, but more widespread use is needed.
Improved/alternative means of accessing secondary controls - due to problems of vision (particularly at night)								4				4	YES	e.g. Speech recognition technology within vehicles, but more widespread use is needed.
Improved/alternative means of accessing secondary controls - due to overload on residual capabilities	4	4									4		YES	e.g. Use of speech recognition technology within vehicles. Systems will have to consider the effects of high mental workload on speech.
Improved/alternative means of accessing secondary controls - due to physical overload on limbs (as a result of using adapted primary controls)	4	4											YES	e.g. Speech recognition technology within vehicles, but more widespread use is needed.
Improved/alternative means of accessing secondary controls - due to problems in touch/grip etc.		4			4	4						4	YES	e.g.-Speech recognition technology within vehicles, but more widespread use is needed.
Improved/alternative means of perceiving surroundings (behind and to side) - due to problems in turning body	4		4									4	YES	e.g. Parking aids/blind spot detectors. Such systems should not require the driver to turn head/trunk to accurately focus on details.
Improved means of establishing which lane to take								4		4	4	4	YES	e.g. Vehicle Navigation systems that recommend a lane choice.
Improved/alternative means to using road signs (particularly at night)								4				4	YES	e.g. Vehicle Navigation systems that do not place a reliance on road sign related information.

User Requirements	Relevant User Groups												Existing or R&D solution?	Example / Modifications / New solutions
	LL	UL	UB	A	C/D	F	SL	V	H	L/S	C	E		
Driver support to perceive and estimate driving distances and vehicle speeds								4			4	4	YES	e.g. Intelligent cruise control systems will support drivers. More testing is required to confirm TELAID's recommendation on headway (Veenbaas et al., 1995),.
Non-visual means of providing traffic light status information								4				4	NO	In-vehicle communications may be used to provide traffic light status in an auditory form.
Non-auditory means of providing vehicle feedback/status information									4			4	NO	Information may be presented via the visual, auditory, and/or tactile senses.
Improved/alternative means of obtaining advanced warning regarding potentially dangerous manoeuvres (e.g. sharp bends)	4	4						4			4	4	YES	e.g. Vehicle Navigation systems that provide advance warnings.
Pre-trip knowledge regarding bridges/flyovers/tunnels and ability to avoid these (phobias)											4		YES	e.g. Vehicle Navigation systems. These should explicitly allow the avoidance of roads/ junctions in which phobias may be activated.
Improved/alternative means of perceiving movements of surrounding traffic	4		4					4			4	4	YES	e.g. Longitudinal and lateral collision avoidance systems. Such systems should consider the requirements of Elderly and Disabled people in the design of interfaces.
Means of alerting staff at filling stations of need for assistance/ alternative means of re-fueling vehicle	4	4	4		4	4						4	YES	e.g. Automatic fuelling systems are being developed and assistance calls are available. It will be important that such systems account for the needs of Elderly and Disabled people groups.
Means of paying for fuel without leaving vehicle	4											4	YES	e.g. Automatic fuelling systems, plus contactless/smart cards and 'Fastcard' (Nicolle, ed., 1998) Such systems will need to consider the needs of Elderly and Disabled people, e.g. reach envelopes.
5. Parking														
Alternative means of paying for car parks - due to problems with using existing ticketing machines	4	4	4	4	4	4		4	4		4	4	NO	The use of smart or contactless cards will enable Elderly and Disabled people to pay for parking (preferably without leaving vehicle).
Alternative means of reserving/ securing a car parking place	4	4	4	4	4	4	4	4	4	4	4	4	NO	Prototype systems exist which enable a driver to obtain pre/on-trip information regarding the availability of parking places, but not to reserve such places. In collaboration with **ADEPT II**, TELSCAN has recommended that a smart card ~~could~~ provide the user with voice information on whether there is a parking place for a person with disabilities, where it is and the ability to gain access to it The follow-on DISTINCT project developed a smart card access control system for parking spaces reserved for disabled drivers. This application will provide real-time information for parking usage through both existing VMS and the TELSCAN website.
Improved/alternative means of perceiving surroundings (behind and to side) - due to problems in turning body and maintaining balance	4		4									4	YES	e.g. Parking aids. Such systems should not require the driver to turn head/trunk to accurately focus on details.
Improved/alternative means of estimating gaps between vehicles								4				4	YES	e.g. Parking aids. Such systems should provide information in both visual and auditory modalities.

User Requirements	Relevant User Groups												Existing or R&D solution?	Example / Modifications / New solutions
	LL	UL	UB	A	C/D	F	SL	V	H	L/S	C	E		
Improved/alternative means of lining up vehicle with kerb								4			4	4	YES	Parking aids could provide this facility, and should provide the information in both visual and auditory modalities.
6. Dealing with weather and environment														
Improved view of roads and markings (particularly those that are un-lit) at night								4				4	YES	e.g. Vision enhancement systems are under development. It will be important that the design of such systems accounts for the needs of Elderly and Disabled drivers.
Improved/alternative means of accessing secondary vehicle controls/displays at night								4				4	YES	e.g. Speech recognition technology within vehicles, but more widespread use is needed.
Pre-trip information/support to enable driver to avoid adverse weather conditions, e.g. fog , heavy rain	4	4						4				4	YES	e.g. In-vehicle navigation systems that are linked to travel/traffic information.
Improved views of road when driving in fog/heavy rain, and with windscreen wipers on								4				4	YES	e.g. Vision enhancement systems are under development. It will be important that the design of such systems accounts for the needs of Elderly and Disabled drivers.
Use of visual modality when making trip-related announcements/improved quality of spoken announcements (in noisy conditions, e.g. heavy rain, high winds)									4	4	4	4	YES	e.g. The TIDE SPACE system is a noise reduction aid which compensates for hearing impairments.
7. Emergency warning and driver support														
Support in event of emergency/ breakdown - due to fear, lack of confidence, and/or physical ability to cope with the situation	4	4	4	4	4	4	4	4	4	4	4	4	YES	e.g. Emergency vehicle location and call. Such systems should be designed to be usable by all Elderly and Disabled people.
A mechanism for alerting other road users (for support) in the event of a car/van accident/ breakdown	4	4	4		4	4	4		4	4	4	4	YES	e.g. Co-operative driving systems. The acceptability of such systems for Elderly and Disabled drivers requires testing.
Improved/alternative means of contacting emergency services in the event of an accident/ breakdown - due to difficulties in walking to a phone	4											4	YES	e.g. Mobile phones, and Emergency vehicle location and call. Such systems should be designed to be usable by all Elderly and Disabled people.
Improved/alternative means of contacting emergency services in the event of an accident/ breakdown - due to difficulties in using phone									4	4		4	YES	e.g. Emergency vehicle location and call. Such systems need to be accessible via text telephones, e.g., Minicom-) In collaboration with **ADEPT II**, TELSCAN has suggested that a smart card could be used to make a call from an emergency phone to a specific number.
Means of gaining orientation following an accident/breakdown								4			4	4	YES	e.g. In-vehicle navigation systems. A map view will be required to aid in orientation when stationary.

User Requirements	Relevant User Groups												Existing or R&D solution?	Example / Modifications / New solutions
	LL	UL	UB	A	C/D	F	SL	V	H	L/S	C	E		
Non-verbal information regarding other drivers' emergencies or detecting presence of emergency vehicles and their location									4	4		4	YES	e.g. Co-operative driving systems. Information needs to be provided in both visual and auditory modalities. In TELSCAN co-operation with IN-RESPONSE, suggestions were made on enhancing the emergency centre's database so that it contains more detailed data concerning incidents with drivers with special needs.
Advanced warning of potential hazards (e.g. slowing down traffic)											4	4	YES	e.g. Co-operative driving systems, designed with needs of Elderly and Disabled in mind. In collaborative testing of the collision warning and avoidance system of **AC-ASSIST,** subjective ratings showed that elderly drivers were well supported by AC-ASSIST, and the system positively influenced their driving behaviour. Collisions only occurred without ACA. In collaborative testing with **SAVE**, it was found that, compared to younger drivers, older drivers have smaller safety margins, and that their performance deteriorates more as a function of time-on-task.
Means of informing authorities of Elderly and Disabled requirements prior to travel to ensure suitable facilities are available in an emergency situation (e.g. an evacuation)	4	4	4	4	4	4	4	4	4	4	4	4	NO	A pre-trip planning system (accessible from home) which is linked to different public transport authorities may provide an integrated solution to this problem.
Visual and auditory notification of an emergency situation and action to be taken - both prior to and during an emergency								4	4	4		4	NO	Advice/Warnings, in visual and auditory modes, given within a portable travel device is a potential solution.
8. Ticketing/Payment														
Improved/alternative means of ticketing/payment - due to problems in cognitive interaction with ticket machines, e.g. understanding instructions, poor memory, calculating costs										4	4	4	YES	e.g. The **PROMISE** system provides the ability to be able to reserve tickets. This system could be linked with a smart/contactless card to enable automatic debiting.
Improved/alternative means of ticketing/payment - due to problems in communication with ticket staff									4	4		4	YES	e.g. Intelligent ticketing systems are available. Suitable information presented within both the visual and auditory modalities is required.
Improved/alternative means of ticketing/payment - due to problems in reading instructions on ticket machines								4		4		4	YES	e.g. Intelligent ticketing systems are available. Suitable use of icons/graphics will reduce the need to read instructions.
Improved/alternative means of ticketing/payment - due to problems in physical interaction with ticket machines, e.g. pressing buttons, reaching controls	4	4	4	4	4	4						4	YES	e.g. The **ICARE** contactless card will enable automatic ticketing. Careful consideration should be given to the design of the card to ensure easy use by Elderly and Disabled people.

User Requirements	Relevant User Groups												Existing or R&D solution?	Example / Modifications / New solutions
	LL	UL	UB	A	C/D	F	SL	V	H	L/S	C	E		
Improved/alternative means of ticketing/payment - due to problems in locating ticket machine/desk/window								4					YES	e.g. Personal navigation devices may aid the user in locating the ticket machine/desk/window.
Improved/alternative means of ticketing/payment - due to problems in waiting in queues, particularly during rush hours	4											4	YES	e.g. Pre-booking of tickets via travel agents or a home/office-based system would eliminate 'waiting' problems. In collaboration with the **ADEPT II** project, TELSCAN has suggested special fields for the smart card to include information regarding passengers' impairment, possible reduction in fare, and other useful information for Elderly and Disabled.
9. Toll Collection														
Improved/alternative means of toll collection - due to problems in passing money through window at toll plaza		4	4	4	4							4	YES	e.g. Contactless card systems will enable drivers to pay tolls without having to stop.
Improved/alternative means of toll collection that can account for discount rates for disabled drivers	4	4	4	4	4	4	4	4	4	4	4	4	NO	Contactless cards could also be 'smart' and include information regarding discount rates. **ADEPT II** supports the interoperability of payment systems for different transport services, which is beneficial for Elderly and Disabled, especially the contactless type of payment. In collaboration with the **ADEPT II** project, TELSCAN has suggested special fields for a smart card to include information regarding passengers' impairment, possible reduction in fare, and other useful information for Elderly and Disabled.
Improved means of signalling the correct toll booth to take								4			4	4	NO	In-vehicle navigation systems could be linked to toll plazas, thus signalling which booth to approach.