Optimal Regulation and Infrastructure for Ground, Air and Maritime Interfaces

DELIVERABLE 4.2

ANALYSIS OF SYSTEM REQUIREMENTS FOR CO- AND INTERMODALITY IN LONG-DISTANCE PASSENGER TRAVEL

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

The Deliverable 4.2 “Analysis of System Requirements for Co- and Intermodality in Long-Distance Passenger Travel” follows the results of the Deliverable 4.1, which was focused on the review of user needs. More specifically, Deliverable 4.2 is built on the identification of the user needs, reviewed in chapter 2, combined with the analysis of the transport system needs carried out in the ORIGAMI Working Paper MS3 and further developed in the chapter 3. In the context of the ORIGAMI project, the two concepts, i.e. user needs and system needs, are used in order to identify respectively the long-distance traveller needs (e.g. comfort, reduced travel time, etc) and the long-distance transport system needs (e.g. information, standardisation, technical integration, etc).

The final steps are to investigate the areas that are critical in the system needs to fulfil the user needs and to suggest the pre-conditions to address them (chapter 4).

This last objective is pursued through the indication of the pre-conditions of the transport system (technical and organisational) and to accommodate at best the most relevant user needs. The rationale of that is that the user needs should set the scene for the prioritisation of system requirements, due to the fact that the European transport system must put people at the heart of transport policies.

The conclusions (chapter 5), will look at the system requirements to meet the relevant user needs with reference to the entire trip transport chain, preparing the background to the identification of technical solutions, gaps and bottlenecks and the design of scenarios for meeting the future needs, to be respectively developed in WP5 and WP7 of the ORIGAMI project.

From the methodological point of view, the analysis of the long-distance intermodal and co-modal transport chain is carried out according to the following approach:

1. The analysis distinguishes three stages as essential components of the intermodal and co-modal transport chain: 1) the first/last mile, 2) the interchanges, 3) the main trip. Each component deserves a specific analysis since the user and system needs have different characteristics for each stage of the co- and intermodal long-distance transport chain.
2. The analysis considers the entire transport chain (all modes and interchange points) and the individual transport modes involved (i.e. air, rail, road, bus/coach and ferry), in order to differentiate the analysis of user and system needs by specific transport modes.

- Concerning the **first/last mile stage**, the comparison between user and system needs shows two critical areas in rail transport. In this sector, direct rail access is still not available for the majority of small and mid-size airports and ports in Europe. This despite the fact that improved accessibility through the reduction of access/egress time is increasingly addressed through the upgrading and the construction of new rail infrastructure integrating the rail network with interchanges points. Furthermore, on-trip information, e.g. dynamic information on delays and platform changes, is still not available.

  In the road transport sector, parking facilities are generally located near the main interchange points and nodes, and the procedures and services allowing safe payments and the provision of security standards have been developed by infrastructures managers and operators. Efficient road links with interchanges situated far from travellers’ origin/destination points such as airports are generally ensured by a dense infrastructure network of motorways and main roads. Congestion problems may however still cause high access/egress time.

  Coach/bus and public transport modes by road in general share the same characteristics of the private road transport, as far as the proximity of bus/coach terminals to interchanges points is generally given. Also the development of shuttle connections between the outlying interchanges, e.g. airports, and the city centre has become a standard service, improving the quality of service for travellers.

  Finally, the first/last mile stage may usually involve cycling and walking as transport modes. The most important user needs in such areas concern the availability of clear information in terms of the provision of efficient signs and indications (pedestrian), associated with a the availability of clean and safe cycle paths and footpaths to terminals. The provision of cycle paths and footpaths

at interchange points and nodes is not always sufficient, in particular as far as cycle paths are concerned which are only widely present in few countries.

- Concerning **interchange stage**, the critical areas for the system needs are related to the gaps in information provided to the passengers in rail stations, airports and ports and in time consuming procedures at check-in in airports.

  Where the car is used as the mode for the long-distance part of the journey interchanges are irrelevant, since the car is then generally used for the entire trip (with the possible but rare exception of a car being hired at a short-distance ferry port).

  The situation is different for coaches/bus interchange points, which can play an important role in the overall long-distance transport chain, but for which there is a substantial gap in the knowledge base of user requirements (Carreno M, 2011). This makes a comparison with the system needs difficult, despite the fact that on the system needs side, the provision of information about connections and the proximity to the connected transport modes can be considered as important requirements.

  In the rail transport sector, it is widely known that for long-distance rail journeys, significant proportions of journeys are known to start and/or to end with a car journey, a walk and/or a cycle ride. Therefore, system needs basically focus on the improved integration of rail stations with other infrastructures, in particular for disabled/older people. These user needs have been met by improving accessibility and integration through appropriate physical design, i.e. by reducing distances to reach gates, providing barrier free accessibility and interchanges for disabled persons, etc. The potential critical areas arise with reference to the information requirements: users would need to be informed in a rail station and in a long-distance transport chain about multimodal information on other modes at the rail destination station.

  In the air sector, user needs at interchanges (airports) concern quality aspects as reducing time at check-in and baggage handling, the provision of efficient infrastructure (short paths, reduced barriers for disabled/older people, business travellers services) and better information at the destination airport about surface transport services. With reference to quality aspects and infrastructure, the actual system needs are only in part efficiently addressed in terms of improved procedures for check-in, baggage drop-of, security checks, passport controls, infrastructure design to reduce distances of footpaths to cover, etc. Concerning the information requirements, i.e. the information about surface transport availability (rail station, car parking, coaches/bus terminal) the actual system requirements are often not being met through the provision of complete information at the destination airport. In fact, passengers who did not have the opportunity to inform themselves about that when preparing the trip, or in case of disruptions (late or diverted arrival flight, cancellation / late running of foreseen train for continuing the travel) would find it extremely helpful, if there were detailed information available about surface transport at the destination airport.

  In ports, the user needs are represented by a mix of quality (intermodal luggage handling, availability of baggage storage, barrier-free accessibility, convenient waiting conditions), integration with other modes (e.g. availability of parking) and information requirements (information at destination/information about arrival, departure and connection times). Concerning the information requirements, the system needs must be reconciled with the user needs, for example by improving the provision of the intermodal integration with other modes (frequencies, price, etc).

- Concerning the **main trip stage**, the critical areas concern information gaps for the on-trip rail journeys, the provision of information about interconnections to airports and in consequence also at the airport of destination in the air sector, and quality standards for coaches.

  An important caveat concerns road transport. In fact, user needs of long-distance main trips by car have not been adequately reviewed up to now (Carreno M, 2011), due to the fact that long trips by car are considered as alternative options to trips by rail, air or coaches. However, from the point of view of co-modality, a pure car trip should be considered. Despite the fact that user needs of long-distance travellers by car are intuitive and do not deserve specific analysis, it can

be said that they include at least safety, comfort and reliability of travel time. The system needs to ensure all that involve to a greater extent the application of Intelligent Transport System applications allowing the communication between road infrastructure and vehicles (for electronic payment, traffic count, etc), or vehicles and vehicles (reducing accidents), that in general require the adoption of a regulative framework at European level, as the Directive 2010/40 (EC, 2010).

The long-distance rail trips user needs have not been subject of detailed surveys. However, despite the paucity of information, the reviewed literature (Carreno M, 2011) has identified the need to ensure quality standards (comfort, train temperature, etc) and the need to provide dynamic, updated information during the trip (delays) as among the most important user needs. If compared with the system needs to ensure seamless rail trips, it can be said that the information requirements are not completely satisfied. Several European Commission directives and regulations, e.g. the regulation on the technical specification for interoperability relating to the subsystem "telematics applications for passenger services of the trans-European rail system" provides the framework for ensuring better interoperability and electronic ticketing. These directives and regulations, despite their importance in allowing seamless rail trips, do not address in itself the provision of up-to-date on-trip information. The efficient standardisation and interoperability, i.e. the implementation of the ERMTS programme, can develop common standards for managing information on long distance rail journeys (at pan European level), which can be further elaborated and transmitted to rail passengers.

In the main trip by air, the critical areas for long-distance system needs concern the provision of information about changes in departure and arrival time or possible cancellations (particularly in times of crisis). However, it should be noted that individual air transport operators do not necessarily have the intention to inform the potential traveller about travel options with other airlines and therefore focus in their own booking system on their own product and deal with other modes or air transport options only if they can work as a feeder for them. Furthermore, in case of a crisis (as the volcanic ash cloud crisis in 2010) the provision of information about alternative modes (ferries and/or rail) would be desirable.

In the coach/bus and public transport main trips, it has been stressed (Carreno, 2011) that the coach/bus long-distance travellers needs have been poorly studied. The most important user needs focus on quality of transport services (waiting times at stops, journey time, vehicle occupancy, cleanliness of vehicles, etc). The development in the system requirements seem to focus instead on the provision of information systems able to provide real-time traffic information, routes, timetables of several operators, etc. These developments in the sector, mainly driven by technological developments, can effectively address the assessment of journey time, but leave the quality standards still unaffected. For this purpose, an important system requirement is the application of the passenger rights to information, quality of trip, reimbursement, re-routeing, and assistance.

Shifting the analysis to the **entire transport chain** implies the combination of the conclusions drawn with reference to the three stages of the long-distance intermodal transport chain: the first/last mile, the interchanges and the main trips. In doing that, the aim is to identify the system requirements that allow establishing how the different stages interlink and interact and what is needed to make the transition from one to the other as smooth and comfortable for the passenger as possible.

Long-distance seamless intermodal and co-modal trips imply that the existing transport services must work together and have to be synchronised. This applies for example for the booking of the whole intermodal trip, supported by efficient procedures for liabilities and passenger rights as well as within the interface between the different transport modes at interchanges.

For the latter this means that there must be no break on the personal assistance offered at the interchange points and that the special facilities there must meet the different user requirements, including those of disabled/older people.

In order to realise all that, several system needs, under way or likely to be implemented in the light of future technological developments, have been identified:

- Multi-modal information systems and integrated ticketing;

- Physical design of infrastructures and interchanges, accessible, with services and information for long distance travellers: the presence of harmonised schedules of all modes available, the provision of major information to the passengers, etc;
- The presence of integrated transport infrastructures and networks (rail, road, local public transport) to the interchange point and terminals.

Table 5-1 summarises the system requirements to reconcile the system needs with the user needs in terms of updated information, integrated ticketing and service quality along the entire multimodal and co-modal long-distance passenger journeys. It can be observed that the informational gaps between user and system needs pointed out for interchanges and main trips stages also hold true for the entire long-distance intermodal trip chain.

The implications in terms of pre-conditions are the provision of technical standardisation for data exchange and applications and a co-operative framework among stakeholders (including public-private partnerships). As a result, passengers of long-distance journeys will benefit of major information and better interoperability.

Table 5-1 Pre-conditions for a seamless entire long-distance intermodal and co-modal transport chain

Instruments to address critical areas (system requirements)	Critical areas for user and system needs		
	Multimodal information systems	**Integrated ticketing**	**Service quality**
Standardisation and interoperability (industry, transport operators, infrastructure managers)	• Common guidelines for data provision and exchange (Road, Rail, Air) • Implementation of Protocols TAP-TSI, ERTMS, ETCS (Rail)	• Ensuring interoperability of applications: chip, payments means, etc (Road) • Implementation of Protocols TAP-TSI, ERTMS, ETCS (Rail)	
Regulation • Market openness • Passenger rights compliance with EC Regulations	• Opening markets to new operators and transport services (Rail/Air/Road)	• Opening market to new operators (Road/Rail/Air)	• Passenger right: quality of trip, assistance, comfort (Coach/Bus) • Regulation on enforcement of passenger rights in multimodal journeys
Stakeholder co-operation	• Public-Private partnerships (Road) • Co-operation among operators (Rail) • Co-operation among modes (Ferry/Air/Rail)	• Public-Private partnerships (Road) • Co-operation among modes (Ferry/Air/Rail)	

Concerning the individual transport modes, standardisation and interoperability will be need for rail and road, while market openness is required by the air, road and rail sectors. Stakeholder cooperation and regulation is a cross-cutting system requirement common to all transport modes (air, rail, road and ferry). Quality of service is mainly required for coach/bus.

1 INTRODUCTION

1.1 THE ORIGAMI PROJECT

ORIGAMI is concerned with improvements in long-distance[1] door-to-door passenger transport chains through both improved co-modality and intermodality.

It starts from the premise that, with the continuing increase in trip length in interregional travel, effective use of the available transport modes as well as the interconnection between trip legs will become increasingly important for a growing proportion of passenger journeys, particularly of those which contribute most to the regional and national economies. Any substantial investment in transport infrastructure should anticipate who will be using it and how - not only immediately once it is constructed, but for a much longer time horizon, which, given lengthy planning and construction phases for major projects, could stretch up to 30 years.

The topic has particular relevance at the European level because the European Transport Networks' role as integrated international networks is compromised by poor interconnectivity and because the next generation of European transport policies (for the Transport White Book 2010-2020 revision and TEN-T update) will have to be sensitive to the differences between short, medium and long-term transport markets and the market advantages of each transport mode. In this context, a realistic assessment of co-modal and intermodal opportunities is a key ingredient to future policy development. Effective co- and intermodality requires the provision of integrated networks and services which are attractive to potential users and this is likely to require co-operation between a range of authorities and providers in the public and private sectors and may necessitate a wider vision than might otherwise prevail. Moreover, the creation of effective co-operation and interconnection may sometimes conflict with the priorities of authorities and providers who have hitherto be concerned solely with serving a local constituency.

The proposal addresses the potential for greater efficiency and reduced environmental impact of passenger transport by judicious encouragement of integration, co-operation and, where appropriate, competition in the provision of these local connections. Thus the project encompasses physical characteristics of the network, characteristics of the modes, the co-ordination of operators as well as integration, and the cohesiveness of multi-modal networks.

On the other side of the coin are the users of the transport system, their demand for travel, their expectations and their reaction to the transport supply that will be on offer. The profile of users varies across European countries and regions and so will their actual and future travel behaviour. A number of factors, such as demographics and social groups, will influence this behaviour and these factors need to be taken into account when trying to assess the potential effectiveness of any intervention.

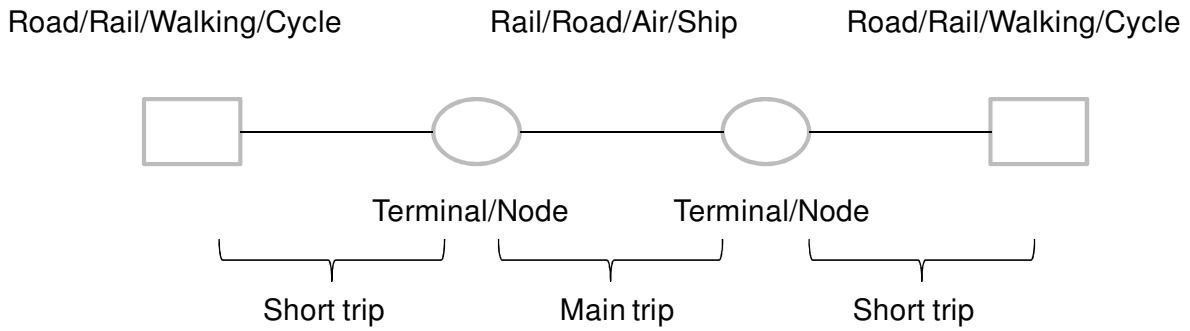
1.2 DELIVERABLE D4.2

The Deliverable 4.2 "Analysis of System Requirements for Co- and Intermodality in Long-Distance Passenger Travel" follows logically the results of the Deliverable 4.1 on the review of needs of long-distance travellers. To save the reader from reading D4.1 first, chapter 2 of this deliverable summarises the main results of D4.1. Chapter 3 then analyses the transport system requirements; this was initially carried out in the ORIGAMI Working Paper MS3 and was then further developed for this current deliverable. The final steps are to investigate the areas that are critical in the system needs to fulfil the user needs and to suggest the pre-conditions to address them (chapter 4). This last objective is pursued through the indication of the pre-conditions (technical and organisational) that could allow the transport system needs to best accommodate the relevant user needs. The analysis of the pre-conditions to improve the responsiveness of the intermodal transport system to the user needs will prepare the background to the identification of gaps and bottlenecks and the design of scenarios for meeting the future needs, to be respectively developed in WP5 and WP7 of the ORIGAMI project.

[1] Long-distance trips are, within ORIGAMI, defined as all trips over at least 100 km.

1.3 AN IMPORTANT METHODOLOGICAL ASSUMPTION: THE CO- AND INTERMODAL LONG-DISTANCE PASSENGER TRIP STAGES

Figure 1-1 depicts a representative stylised passenger long-distance journey, with two short-distance stages at the Origin and Destination points, generally by road/rail or cycling/walking modes, followed by two interchanges at terminals and one main trip.



Source: ISIS

Figure 1-1 A typical long-distance intermodal passenger journey

The physical elements of the long-distance intermodal passenger journey can be classified in three types of journey stages, each one part of the overall multi-modal door-to-door trip from the origin to the destination points:

1) The short-distance (first/last mile) feeder/distributor journey stage that can be situated at the origin or destination of the intermodal journey.
2) The interchange or transport node journey stage, in which the traveller has access to a distribution system or to transhipment / intermediary locations within a transport network. With reference to the passenger transport this function is mainly serviced by stations, transport terminals, airports and ports, where the transport flows originate, end or are being transhipped from one mode to the other.
3) The main trip journey stage, representing the lengthier segment of the trip that can be made by road (coach, bus, car), rail (train), air (airplane) or ship. In the context of this Deliverable we assume that in the long-distance trip[2] there is one main trip that can nevertheless be accompanied by broken travel chains in the same mode.

Where coming to the real word, the classification of the long-distance journeys in the three key segments (first/last mile, interchange point and main trip) could not be applied to more complex journeys, as shown in Figure 1-2 with relation to a long-distance journey from Lugano, Zürich Street (Switzerland) to Rome Central Termini Station (Italy), in which along the 5 hour duration of the intermodal journey involving bus, walking, intercity, urban train and High Speed train, the main trip stage by rail can be broken down in three segments: 1) the Intercity from Lugano to Chiasso, 2) the Urban train from Chiasso to Milan and 3) the High Speed train from Milan to Rome.

[2] In the ORIGAMI project, the long-distance travel is a journey over 100 km.

3	Station/Stop	Date	Time	Platform	Travel with	Occupancy	Comments
⊖	Lugano, Via Zurigo	Th, 01.12.11	dep 11:25		Bus 3		Low-floor bus Direction: Breganzona, Posta, BE
	Lugano, Via Ginevra		dep 11:26				
	Lugano, Centro		dep 11:27				
	Lugano, Via Ginevra		dep 11:30				
	Lugano, Via F. Pelli		dep 11:31				
	Lugano, ai Frati		dep 11:32				
	Lugano, Stazione Piazza Besso		arr 11:34				
	Lugano, Stazione Piazza Besso				walk		7 min., Y
	Lugano						
	Lugano		dep 11:48	2	ICN 665		IC-tilting train R FZ BZ RZ
	Chiasso		arr 12:11				
	Chiasso		dep 12:17	13	S 10861		Urban train
	Como S. Giovanni		dep 12:23				
	Albate-Camerlata		dep 12:29				
	Cucciago		dep 12:34				
	Cantù-Cermenate		dep 12:39				
	Carimate		dep 12:42				
	Camnago-Lentate		dep 12:47				
	Seregno		dep 12:52				
	Desio		dep 12:57				
	Lissone-Muggiò		dep 13:00				
	Monza		dep 13:05				
	Sesto S. Giovanni		dep 13:10				
	Milano Greco Pirelli		dep 13:14				
	Milano Porta Garibaldi		arr 13:22				
	Milano Porta Garibaldi				transfer		45 min., Y
	Milano Centrale						
	Milano Centrale		dep 14:15		ES 9521		Eurostar Italia R GP
	Bologna Centrale		dep 15:23				
	Firenze S. M. N.		dep 16:10				
	Roma Termini		arr 17:45				

Source: http://fahrplan.sbb.ch/bin

Figure 1-2 A real world example of an intermodal long-distance journey

However, despite the potential complexity of intermodal journeys, the system needs examined in this deliverable, i.e. passenger information and design of interchanges, integration of the overall transport chains and infrastructure technological upgrading, can apply as well as to complex situations.

In terms of transport modes involved in the transport chain, the ORIGAMI project also addresses the concept of co-modality, which implies the analysis of the system requirements to make the best use of each transport mode even if only a single mode of transport is used, for example a pure car journey. (The walk from the front door to the car is in this case not considered as a separate mode.)

The classification of the long-distance intermodal transport chain in journey stages leads to shaping the analysis of the user and transport system needs according to the following principles:

- The analysis on the entire co- and intermodal transport chain distinguishes as essential components: a) the first/last mile, b) the interchanges and c) the main trip. Each component deserves a specific analysis since the needs and system requirements are different.

- The analysis considers user needs and transport system requirements for intermodal trips both at a generic level (all modes and interchange points) and at an individual mode level (i.e. air, rail, bus/coach and ferry) in order to identify mode specific user and system needs.

2 REVIEW OF USER NEEDS

2.1 THE FIRST/LAST MILE STAGE

There is a lack of empirical evidence and studies on the relative importance of user needs for this journey stage (Carreno M, 2011). From those available (e.g. Givoni and Rietveld (2007), it can be derived that the user needs will be dependent on the individual modes used to access/egress transport terminals and interchanges.

In general, terminals and interchanges of means for long-distance transport are located relatively far from travellers' point of origin (e.g. home, with the exception of central rail stations in cases travellers live or work in the city centre). Therefore, in particular for air and ferry journeys, but in most cases also for rail and coach, getting to and from the terminals is an important part of any long-distance journey.

The most important user needs classified by transport modes are summarised in Table 2-1.

Table 2-1 First/last mile stage: user needs by transport modes

	Cycling/Walking	Car	Coach/Bus	Rail
User needs	• Quality of cycle paths. cleanliness of areas, footpaths • Readability of information	Free flow traffic condition, reducing access/egress travel time	• Free flow traffic condition, reducing access/egress travel time, • Safety and comfortable bus/coach stops	• Rail station accessibility, • In-vehicle comfort

2.2 INTERCHANGE STAGE

The literature reviewed (PIRATE, 2001 and KITE, 2009a) has stressed that safety and security must be considered among the most important needs. Soon after follow the availability of traffic and travel information systems (including ticketing), the presence of a good level of accessibility, car parking availability, interchange location and operational efficiency. The overall package of the interchange points characteristics has been classified as the total impression aspect, which encompasses safety and security, information, operational efficiency, accessibility (internal) and comfort (PIRATE, 2001).

A different classification (SWITCH, 2001) focused on the importance of psychological and social factors, in particular as far as personal security is concerned.

It is interesting to consider than in a survey involving interchange operators (rail, air and ferry), carried out by KITE (2009a), the perception of user needs also included the availability of cycle lanes to / from / passing interchange facilities, although their usefulness for travellers with luggage appears somewhat doubtful. More specifically, the emerging vision of travellers needs by transport modes was the following:

- **Rail:** Firstly, availability of information at destination, followed by availability of cycle parking, availability of cycle lanes, integration into road network and convenient waiting conditions;
- **Air:** Firstly, availability of cycle lanes, followed by availability of cycle parking, availability of information at destination, availability of baggage storage and barrier/free accessibility
- **Ferry:** Firstly, availability of cycle lanes/intermodal luggage handling/availability of baggage storage/barrier-free accessibility, followed by availability of cycle parking/availability of information at destination/information about arrival, departure and connection times, convenient waiting conditions/supply of shops/availability of taxis/feeling of safety/availability of public transport for access and egress and easy way-finding in interchange, distance required for transfer between modes/distance between modes and services/car parking availability, and transfer times between modes.

The different methodological approaches and scope underlying the surveys, i.e. different ranking methods, type of respondents etc, has led to the conclusion (Carreno M, 2011) "that no clear or consistent findings are available for which user aspects are most important for interchange facilities".

Given this conclusion, we can only make assumptions which user needs may be most relevant for the system needs, and these are listed in Table 2-2.

Table 2-2 Interchanges: user needs by type of terminal

	Rail station	Airport	Port
User needs	• Availability of information (multimodal) • Integration with other infrastructure (road, airports, ports) • Convenient waiting conditions • Accessibility, no barriers • Availability of secure, convenient and cheap parking areas	• Availability of information (multimodal) • Integration with other infrastructure (roads, public transport) • Efficient check-in/baggage handling • Efficient security procedures with short waiting times • Accessibility, no barriers • Availability of secure, convenient and cheap parking areas	• Availability of information (multimodal) • Integration with other infrastructure (roads, public transport) • Availability of secure, convenient and cheap parking areas

2.3 MAIN TRIP STAGE

2.3.1 Air Travellers

The literature review on long-distance air travellers needs (Gilbert and Wong, 2005, Pakdil and Aydin, 2007, Chen and Chang, 2005) allows the identification of several user needs, even if with some inconsistencies when a cross-comparison of the methodological assumptions is made.

The list of the most important inconsistencies relates to a) the cultural roots of the sample of respondents, departing from different airports such as Hong Kong and Ataturk in Turkey, b) the different identification of the relevant attributes, which can lead to problems in the harmonisation of the responses, c) relevant services: namely the user needs at airport facilities in one source (Gilbert and Wong, 2005, Pakdil and Aydin, 2007) and the ground service and in-flight user needs in another (Chen and Chang, 2005).

Despite the inconsistencies, aspects such as safety, on-time departure and arrival, behaviour of employees and employees' willingness to help customers were considered among the most important user needs.

2.3.2 Rail Travellers

Long-distance rail travellers needs have not been the subject of detailed surveys. However, despite the lack of specific findings, a long-distance user need classification for rail travellers was found through the identification of several generic rail users need.

Similar to air travellers' needs, it has been stressed that Crockett et al. (2004), Nathanail (2008) and Brons, Givoni and Rietveld (2009) have identified the level of assistance provided by staff, appearance, helpfulness and approachability/friendliness of staff as an important user need.

The other needs that have been indicated as relevant in all the reviewed literature are a) passenger information, i.e. the knowledge of and access to information to support preparation and undertaking of

the whole journey (information during the trip); b) comfort, train temperature, travel comfort; c) accessibility, i.e. the extent to which the whole journey is physically and financially accessible.

2.3.3 Coach/Bus Travellers

As for the rail sector, the coach/bus long-distance travellers needs have been poorly studied. Only one study attempted to rank which aspects were the most important, namely Del'Olio, Ibeas and Cecin (2010). Based on focus group research, they suggested waiting times (at stops), journey time, vehicle occupancy, cleanliness of vehicles, driver attitudes and comfort (on bus) are the most important user requirements. However, as with rail, this research focussed on coach/bus journeys generally, and for long-distance intermodal journeys additional considerations such as baggage handling, door-to-door information (etc.) are likely to affect these conclusions.

2.3.4 Ferry Travellers

As far as ferry services are concerned, only one study which examined the most important factors for ferry users was identified (Jørgensen, Mathisen and Solvoll, 2008). Overall, cost was identified as the most important aspect, followed by available discounts, and frequencies of service and departure times. However, it is important to stress that the study involved short-distance ferries (less than 100km) and whether a different ranking would be identified for long-distance ferry routes cannot be confirmed, especially as aspects including baggage handling that would be more relevant for longer distances were not included in the aspects users rated.

2.3.5 Conclusions

The following table summarises the most important user needs concerning the main stage journey by transport mode. The table warns that most of information is related to short-distance trips, at least for rail, coach/bus and ferry services and that the degree to which the short-distance findings can be transferred to long-distance trips remain unclear (Carreno, 2011).

Table 2-3 Main trip stage: user needs by transport modes

	Air	Rail (*)	Coach/Bus (*)	Ferry (*)
User needs	• Safety • On-time departure and arrival	• Passenger information during the trip, dynamic information on delays • Comfort, travel comfort, train temperature, seat comfort	• Waiting times (at stops), • Journey time, vehicle occupancy • Cleanliness of vehicles, driver attitudes and comfort	• Fares • Service quality

(*) Generally lack of information on long-distance trips

Despite these caveats, the table allows identifying the importance of passenger information, which has also been stressed as an important component of interchanges user needs (see Table 2-2). Accordingly, the user needs classification reviewed with reference to the long-distance trips seem to confirm those suggested for the interchanges for intermodal journeys generically.

In such a context, there are transport mode-specific needs, with the added inclusions of efficient in (baggage handling for air services and waiting times for coach/bus services.

2.4 USERS WITH SPECIFIC NEEDS

The assessment of how the personal factors, i.e. mobility-impaired travellers, older people, etc, and the trip purpose can change the list of the most important user needs, represents a further important issue that must be taken into account.

The analysis focuses on mobility-impaired people and older people by the trip stage and purpose.

With reference to the fist/last mile stage and interchanges, some of the user needs attributes have more importance than others. For example, in relation to accessibility issues, this would include aspects such as low floor access to feeder and main mode vehicles, staff disability awareness training, information provided in special formats (Braille, talking maps etc.) and barrier-free access at interchange facilities.

With reference to the main trip stage, the studies are available mainly for the air sector. Wolfe (2003) has identified six unique' needs of older air travellers, which were linked to age-related decline in physical, sensory and mobility impairments. These specific needs include:

1. Many older people experience problems with their vision which would affect their ability to read direction signs and information boards at airports - and would require adapted signage (e.g. large print);
2. Many older people experience hearing problems which makes it hard for them to hear flight announcements/boarding gate information etc. - and would need assistance;
3. Many older people experience a decline in cognitive abilities, which could result in restricted way-finding at airports - and may need assistance to navigate airports;
4. Many older people experience a decline in physical strength, which makes it difficult for them to wait in-line (for any length of time) at check-in and security gates, and carrying luggage - and would need assistance/priority access;
5. Many older people have limited mobility which would prevent them from walking long-distances within airport - and would need assistance;
6. Due to cognitive and physical limitations, many older people would experience difficulties understanding 'safety information' provided on-planes, and some of the actions required for emergency situations may be beyond their physical capabilities (e.g. emergency evacuation) - and again would need assistance.

In a different study by Chang and Chen (2011b) asked to rate the importance of older peoples' needs concerning airline service aspects. Restrooms at airports and user friendly information (flights, on-board, directions, etc) have been the most important needs.

Similarly, with reference to ferries, DPTAC (2000) provided the list of needs for impaired/older people, according to which the provision of information and good accessibility ranked among the most important ones.

Concerning the trip purposes, studies concerning the air sector, Gilbert and Wong (205), examined how user needs differ according to trip purpose, using a distinction between business travellers, and holiday makers together with passengers visiting friends/relatives. It turned out that travellers for business purposes have relatively higher expectations of internet/email/fax/phone and travel related partners of airlines. They also have higher expectations of waiting lounges, convenient schedules and flight frequencies, and loyalty and frequent flyer programmes than others. Diversely, leisure travellers consider as important fares and in-flight entertainment facilities/programmes.

The same pattern was found with reference to rail trips (Crockett et al., 2004): business travellers are mainly interested in timely information provision, travel times and comfort; for leisure travellers fares and information are important needs.

Table 2-4 summarises the results of the relationships between personal factors and user needs.

Table 2-4 Personal factors and user needs

	Impaired-Older people	Trip purpose
User needs	• First/last mile stage and interchanges: information provision, accessibility • Main trip: (Air sector) user friendly and accessible information (flights, on-board, directions), reducing wait in-line at check in and security gates	• Business travellers: (Air sector) Internet/email/fax/phone and travel related partners of airlines,): (Rail sector) business travellers are mainly interested in timely information provision • Leisure travellers: (Air sector) fares and in-flight entertainment facilities/programmes; (Rail sector) fares and information

3 ANALYSIS OF SYSTEM NEEDS

3.1 FIRST/LAST MILE STAGE

3.1.1 General Considerations

The system needs of the first/last mile journey stage include all the transport system infrastructures (interfaces) and information requirements (information about how and when to access transport infrastructure) connecting interchanges and transport infrastructures "before" and "after" the planned long-distance journey. Therefore, they may concern both technical and organisational specifications of transport infrastructures, to the extent that they affect:

1) The local link infrastructure to interchanges points.

2) The provision of local transport services serving intermodal long-distance journeys.

How recently stressed, (EC,2009b), despite the relevant technological developments, e.g. the set up of High Speed Rail services, "there is room to better integrate the different modes to make seamless journeys possible, as passengers waste significant time and effort at interchanges. When long-distance travellers reach their destination, they have to use urban transport systems that they do not know well. The availability of multimodal stations where passengers can easily change modes, quickly access information, and feel safe, secure and comfortable will save time for users, thereby making public transport more attractive".

The EU projects INTERCONNECT (2009) and CLOSER (2009) specifically related to the analysis of the role of local and regional interconnections in the context of longer distance passenger journeys in Europe, classify the infrastructure requirements of the first/last mile respectively as:

- Those infrastructure requirements which seek to address the problem of inadequate infrastructure for the link between an interchange (such as an airport) and the point of departure/arrival (e.g. from the departure/destination point to the airport/station by car/bus/walking/local train). These components involve the updating and upgrading of existing infrastructure or the set up of new infrastructure.
- Those infrastructure requirements which concern improvements to the organisation of local transport services which in some cases may be achieved without major investment in new infrastructure of the local transport services. In such a case, organisational measures are basically involved.

It is worthwhile to add that more in general, both the aspects of the local link infrastructures, other than to favour intermodal transport solutions, also address strategic factors for improving the competitiveness of the local and national transport system. For example, they allow efficient access to the main (international) network from rail or road and to main ports or airports, which could be a valuable asset for the city. The range of interventions on transport infrastructures which can improve the interaction of local collective transport services with long-distance travel patterns is wide. Some examples are listed below:

- The provision of Park&Ride infrastructures (for long-distance train or shared car trips);
- The development of a fleet devoted to car sharing;
- The supply of a network of cycle paths, bikes to rent, etc;
- The improvement of the public transport supply and frequency serving the connection with car, rail, air, coach and ship interchanges (for long-distance trips);

On the informational side, the availability to the user of information about travelling time and connections with transport infrastructures is highly relevant to ensure seamless door-to-door mobility patterns. The best bus or rail connections, for instance to an airport, might not be used, if the travellers are not aware of them and the travel opportunities they offer, and if they may not even know where to get information about public transport feeder services to the airport, concerning their routes, schedules or pricing structure. But also when using a private car, information can be a relevant issue,

e.g. at big hubs where passengers may park their car in a parking lot, which is located quite inconveniently to the terminal to be used, if they are not aware which one to choose best. This is particularly critical for those who still do not use the internet, whether because of age, disability, lack of access or inclination, because much of this information can nowadays be found there. Furthermore, real-time status information for public transport (e.g. bus, metro, and rail) and multimodal real-time traffic information systems exist in several urban and extra-urban areas in Europe and worldwide, both in the form of prototypes and as fully operational systems.

3.1.2 Road

Usually, most of the transport infrastructures, nodes and interchanges are connected to the road network, i.e. this system need to use a car as the mode of transport to reach a given infrastructure is generally satisfied. However, the connection is not always efficient in terms of time, e.g. if an airport is connected to the highway network only via a secondary road, which in the worst case crosses multiple settlements allowing only limited speed, or if the connecting road is very congested at peak periods, the resulting travel times by car will be poor.

3.1.3 Coach/Bus

Passengers on an intermodal trip chain have to overcome the necessary changes within the feeder modes, between feeder mode and the interchange point and often also within the feeder modes part of the chain at intermediate transfer points. Every change of vehicles which can be avoided improves the quality of the trip chain. This especially applies for changes between different modes. For example, as car usage to access/egress the airports limits the necessary changes to those between the modes and those within air transport, public transport as feeder service should be competitive also concerning this topic to enable higher acceptance. For this reason, the linkage of airports to the rail network by direct rail services is superior to shuttle bus services between existing railway stations in the airports' vicinity or from the central station in the city centre from the consumers' point of view. Offering just commuting trains between an airport and the city centre may be a first step to improving the consumers' acceptance of rail as access mode for air trips, but only direct long-distance services to the airport can boost these passengers figures, as happened at Frankfurt Airport. With the introduction of direct High Speed Rail services to the airport, the number of long-distance rail travellers to and from the airport increased from 9,000 to 12,000 per day within a few years.

A long-distance coach feeder to an airport, serving multiple towns on its route, for which at each of them the bus has to leave the motorway to serve a central bus stop, may show quite a long travel time when compared with private car usage.

Safe and comfortable stops represent other important system needs, to the extent that they allow the coach/bus network to serve long-distance travellers efficiently.

3.1.4 Rail

The information-related system needs in the first/last phase appear to be focused firstly on the 'pre-trip' or planning phase. Perhaps surprisingly, a systematic review of rail-related information services does not exist, so the following draws on a number of limited sources.

For the 'pre-trip' phase, it is relatively common for rail service information at the national level to be made available via the web and for this to encompass timing, price and journey conditions. However, in the situation where national rail services are provided by multiple operators, cooperation is required to ensure that comprehensive information is provided in a single place; it is understood that this does not always occur.

Besides, it should be considered that the rail network in Europe in the majority was built in the second half on the 19th century, while today's airports were built about 100 years later. Rail connections to airports for passengers appeared not before the 1970s and were introduced more and more in the last 20 years. As rail infrastructure is very costly, only its extensive usage can justify the construction of rail links to airports, meaning that a sufficient demand for rail services must exit. For that reason still

the majority of small and medium sized airports in Europe do not have direct access to the rail network. Therefore in the first/last mile an efficient rail connection to interchanges can be considered an important system need.

3.1.5 Walking & Cycling

The system needs for walking & cycling modes basically address infrastructure provision:

- Cycling: Existence of cycle lanes leading to/from terminals and available, cheap and secure parking facilities at terminals;
- Pedestrian: Crossing facilities (number of crossing facilities; safety of crossing facilities; amount of available crossing time; audibility of crossing signals).
- Pedestrian: Ease of movement (condition of pavement surface; amount of tactile paving; amount of low kerbing; amount of obstacles);
- Pedestrian and Cycling: Information provision (number of information signs; readability of information signs).

3.1.6 Conclusions

The following table summarises the results of the first/last mile journey stage system needs by transport modes.

Table 3-1 First/last mile stage: system needs by transport modes

	Road	Coach/Bus	Rail	Cycling/Walking
System needs	• Efficient connections with the interchange point • Reducing congestion and travel time	• Efficient connections: minimising changes and number of stops; safe and comfortable stops • Reducing congestion and travel time	• Information needs: rail service information to be made available via the web and for this to encompass timing, price and journey conditions • Enhancements to the connections to rail stations	• Efficient connections with terminals : cycle paths, footpaths • Information provision (signs, etc)

3.2 INTERCHANGE STAGE

3.2.1 General Considerations

Transport infrastructure, e.g. stations, airports, road and rail networks, etc. represent the backbone of transport flows and mobility. In particular, as far as the intermodal passenger transport is concerned, interchange points, i.e. the transport infrastructures where people can change between public and private transport as well as between and within public transport modes, are essential to ensure seamless trips. It should be stressed that a proper interchange point design would also be able to ensure the integration with the first/last mile stage, discussed in the previous chapter.

Several EU projects, e.g. INTERCONNECT (2009), LINK (2009), KITE (2009), have stressed the importance of a proper physical design of interchange infrastructures, to be conceived as an important role in supporting the development of intermodal transport.

The list of interchange infrastructure requirements for favouring seamless trips basically addresses the physical design of infrastructure, with relevant implications on transport operations, transport services, additional services and provision of major information to the passengers. Examples of the physical design of interchange infrastructure and their implications on intermodal passenger services, operations and information include the following:

- A physical design of interchanges so as the walking distance should be as short as possible;
- The presence of escalators and elevators, if any, should be provided for comfort and speed;
- The technical design should allow a good visibility: the axis between main destinations (platforms, entrances and exits) within the stations should improve orientation and safety;
- The protection from the elements should be self-evident;
- The accessibility for handicapped and elderly passengers should be guaranteed;
- The natural and artificial light and cleanliness should give the passenger the feeling of safety and comfort;
- The presence of wide spaces on platforms and in aisles should make passengers feel comfortable;
- In terms of passenger service information, the presence of harmonised schedules of all modes available at the interchange should be provided for short transfers and waiting times;
- The presence of access to tickets in multimodal networks, including long-distance and local/regional services, should be ensured as an essential component to favour seamless travel;
- A proper access to and from the complete system of services in the interchange point should be required in order to provide a smooth interchange.

The above specifications should also be associated with the improvement of transport service quality and reliability. In fact, as stressed in the LINK project, (LINK, 2009a) the above requirements may be viewed as a component of the quality of intermodal transport, addressing the so-called “interchange quality triangle”, focused on the following aspects: a) passenger well-being, b) organisation and management of transport services at interchange level and c) the physical (or technical) efficiency of transport services.

Ensuring better quality in intermodal transport services is deemed to be an aspect that will gain increasing importance in the coming years, in view of the ageing of the population and of the need to promote more resource efficient public transport. In fact, the chapter on the analysis of user needs by personal factors, i.e. mobility-impaired travellers and older people, has shown that accessibility and better services at interchange points, e.g. targeted information at stations, airports, etc, will be among the most important user needs.

In such a context, the EC White Paper (EC, 2011d) points out that “Attractive frequencies, reliability and intermodal integration are the main characteristics of service quality. The availability of information over travelling time and routeing alternatives is equally relevant. Finally, quality consists also of the ability to provide the elderly, disabled persons and transport users with special needs with a high-standard level of services”.

Summing up, comfort, security and quality of transport services must be considered as important system requirements to ensure seamless long distance intermodal trips. They are part of the more general attributes making the long-distance intermodal trips attractive to the users: high frequencies, comfort, easy access, reliability of services, etc.

In particular, improved procedures for check-in and baggage handling (mainly at airport nodes, see below for details) are relevant. Depending on the specific travellers needs, this may comprise a full door-to-door-service for the whole trip, or at least parts of it, e.g. for the feeder train or bus (baggage check-in at the railway station / bus terminal) and the flight. The availability of baggage trolleys not only at the airport, but within the whole interchange point (i.e. to/from the platforms of the airports railway station and the parking lots) form a minimum requirement concerning comfortable baggage transport.

This topic has been stressed by the European Commission in the accompanying staff papers to the White Paper: “the Commission is in general looking for smarter ways of applying controls to passengers and their luggage, it also works on the development of more effective and efficient technology such as modern scanners for luggage” (EC, 2011l).

The efficient management of baggage services in the direction of reducing queues and waiting times addresses two aspects:

1) A better design and functional services at interchanges;

2) Improved procedures allowing safety and security.

Both aspects involve to some extent the extensive application of innovative technologies to infrastructure and new equipments. For example, it has been stressed (EC, 2011l) how the currently available security scanners have the potential for enhancing the quality and efficiency of security checks, reducing time involved in the control procedures as well.

3.2.2 Coach/Bus Station

At coach and bus terminals, the system needs concern the provision of information about the following topics:

- Information about cities and locations connected;
- Harmonised information that is necessary to meet the customer demand (e.g. selection of transport modes, with clear categories and symbol codes);

All that should increase the opportunities for supporting co-modality, thereby making it easier for the citizens to use and plan longer, cross-border travel with various types of public transport.

3.2.3 Rail Stations

Much research has been undertaken into the design attributes of rail stations for the purposes of making access, interchange and egress easier and less unpleasant, and this has resulted in a number of design guides and assessment tools being produced. For example, INTERCONNECT included a host of examples of potential physical infrastructure enhancements and LINK produced a series of recommendations relating to ‘Intermodal Networks and Interchanges’, in particular a recommendation to develop a toolkit for the good design of an interchange.

As well as all-encompassing guidelines on what constitutes good design for railway stations, there are also specific sets of guidelines addressing issues of accessibility for disabled people (or persons with reduced mobility). A number of these exist at Member State level, and some Member States have implemented programmes of works to upgrade their stations so as to increase the number complying with the guidelines.

As well as physical design of infrastructure, there are also operational functions that can be implemented so as to ease access, interchange and egress. These include the management of arriving and departing trains so as to minimise walk and wait times (e.g. by managing platform-usage) and the provision of assistance for those with luggage or those with reduced mobility. Indeed, the latter of these is now a requirement under Regulation (EC) 1371/2007 on Rail Passenger rights and Obligations.

Concerning the information provision, information via the web is probably the most important source for pre-journey information, though information via print, over the phone and in-person at selected stations are also available. Some telephone information services can provide multimodal information, but multimodal information in print or in person in rail stations is only available in exceptional cases. Better information on other modes at the destination rail station would be required.

3.2.4 Ports

The identification of system needs at terminals must consider that ferry infrastructures are relatively basic but highly functional and robust. For short-distance crossings, the ferries and the shoreside infrastructure are designed for rapid turnaround, aided by an almost full width ships' ramp which facilitates fast discharge and loading of passengers by foot, cycle/moped and car. Larger ferries for longer distance usually allow up to two or three hours for loading, so there are no system requirements related to loading speed.

Passenger waiting facilities in the terminals are generally quite basic, but foot passengers can board the ships long before departure time so that they can use the cabin or lounge facilities on board, while car passengers usually spend their waiting time in the car ready to board when it is their turn. For short-distance terminals in urban areas land may be limited, so space for passenger waiting area would also be limited, but waiting areas should at least be covered to avoid making the travel experience very poor in bad weather conditions. Service quality could be enhanced by attractive ferry frequencies for short-distance crossings, and by reliability and intermodal integration for all ferry services. Interchanges should employ inter-connecting walkways between the ferry terminals and adjacent railway stations and bus stops ensuring rapid transfers and access.

In terms of integration with other modes, all ports and terminals should have good bus connections, and where these exist also tram and metro connections. Terminals in urban areas should also have facilities for cycle parking, although the ferries should also allow cycle transport. Larger terminals, either for large long-distance ferries or where ferries depart at high frequencies, should ideally also have a rail connection.

A good example for a high degree of integration is the 5km crossing between Helsingør in Denmark and Helsingborg in Sweden. In Helsingør bus and local train services are connected with the ferry lines departure points; these services include: two local railways, six regional bus routes, five local bus routes, three 'service' buses, and three night bus lines. The traffic company Movia owned by the Zealand municipalities ensures coordination of bus services between municipalities. In Helsingborg practically all public transport goes through the train/ferry terminal Knutpunkten including regional and long-distance trains and buses as well as local buses. Helsingborg is easily reached by rail from the Copenhagen airport (Kastrup) and has good rail connections to Malmö, Lund, and Gothenburg. Such a degree of integration is exemplary and should set the standards for other ports as well.

3.2.5 Airports

An important system need in airports concerns information about surface transport (for egress from destination airport) at the destination airport. Passengers who did not have the opportunity to inform themselves about that when preparing the trip, or in case of disruptions (late or diverted arrival flight, cancellation / late running of foreseen train for continuing the travel) may find it extremely helpful, when there is detailed information available about surface transport at the airport of destination. Other aspects are the following:

- Travel times: The necessary procedures to be undertaken at the airports enabling the passenger to get onto the plane, to change between planes at an intermediate airport and to leave the aircraft at the airport of arrival (including check-in, baggage drop-of, security checks, passport controls and the distances of footpaths to cover….) are time consuming and together with the times for access and egress may take longer than the actual flight. So optimising or even avoiding them (e.g. by check-in via mobile phone instead of doing that at a staffed desk in the airport) can help to improve to co-modality of air transport, making it more attractive on short or medium distances against the usage of e.g. a private car for a whole trip.
- Enabling intermodal trips for disabled travellers: The different operators of transport services often have foreseen specific procedures, staff and equipment at their access/egress points to allow the usage of their transport mode by disabled people. Concerning intermodal trips this means that these existing services must work together and have to be synchronised. This applies for the booking of the whole intermodal trip as well as within the interface between surface and air transport. For the latter this means that there must be no break on the personal assistance offered at the interchange point and that the special facilities there (like tactile

guidance systems) stretch to all parts of the interchange point, the airside as well as an airport's railway station or bus terminal.

- Improving security: similar to comfort this aspect mainly concerns the interchange point, the public access/egress modes and the parking facilities when looking at intermodal transport. Increased provision of staff is considered as helpful not only for information purposes but also to enable a secure ambiance. This may be complemented by improved lighting on the paths between airports terminal(s) and railway station or parking facilities and the provision of monitoring cameras or / and security staff.
- Accessibility to other transport modes facilities: Usually all airports are connected to the road network, i.e. this pre-condition to use a car as the mode of transport to reach an airport is given in principal. Nevertheless for using road transport as a feeder, the airport should be connected to the motorway network with a direct link to a dedicated exit of the motorway avoiding a passage through any settlements. The local road construction authority might be considered to be responsible to enable this in the first place. Nevertheless, depending on the degree of importance of an airport, a regional or even national authority might be involved, too. Also the airport should have a serious interest in such direct links, concerning its accessibility as well as its local acceptance and therefore could be in charge on this issue. Also the capacity question is a matter of interest for the airport so that bottlenecks are avoided and an efficient traffic flow is ensured. At the airport available car parking facilities should be differentiated for long-term or short-term usage, which can be enabled by applying different tariff schemes for them. Short-term parking in general should be located quite close to the air terminal, while for long-term parking longer walking paths, buses or people mover systems are accepted when this comes together with a noticeable variation in the parking fees. In addition parking space directly at the terminal to drop-off passengers has to be foreseen, although the drop-off option is least favoured by airports, because it creates the biggest travel volume per passenger.
- Check-in, baggage drop-off, security checks, passport controls and the distances of footpaths to cover are time consuming and together with the times for access and egress may take longer than the actual flight. So optimizing or even avoiding them (e.g. by check-in via mobile phone instead of doing that at an staffed desk in the airport) can help to improve to co-modality of air transport, making it more attractive on short or medium distances against the usage of e.g. a private car for a whole trip. Regulation represents an important instrument and the European Commission is in general looking for smarter ways of applying controls to passengers and their luggage, and it also works on the development of more effective and efficient technology such as modern scanners for luggage.

3.2.6 Conclusions

The following table summarises the results of the most important system needs by transport modes at interchange points.

Table 3-2 Interchanges: system needs by transport modes

	Coach/bus station	Rail station	Port	Airport
System needs	• Information about cities and locations connected, • Proximity to the other transport modes	• Making access, interchange and egress easy and pleasant • Physical design of infrastructure to improve accessibility and usage for disabled people • Information provision on multi-modal connections (coach/air/ferry)	• Rapid turnaround for short-distance ferries • Minimum comfort for waiting and connection areas • Integration with other modes	• Information about surface transport (rail station, car parking, coaches/bus terminal) • Physical design of infrastructure to improve accessibility and usage for disabled people • Security and waiting time at check in • Accessibility to other modes (e.g. rail stations, car parking)

3.3 MAIN TRIP STAGE

3.3.1 General Considerations

The main trip journey stage is assumed to be the lengthier segment of the trip that can be made by road (coach, bus, car), rail (train), air (airplane) or ship. As specified in the introduction (chapter 1.3) in the context of this deliverable it is assumed that in the long-distance trip there is one main trip that can nevertheless be accompanied by broken travel chains in the same mode. For example, the main trip by rail may be divided in two or more journeys by rail, due to lack of direct connections in the railway network, or the bus trip divided in several legs, due to the complexity of the journey.

Passenger information

The availability of information about travelling time and routeing alternatives is relevant to ensure seamless door-to-door long-distance mobility patterns. According to the European Commission (EC, 2011 a), establishing by 2020 the framework for a European multimodal transport information, management and payment system is a key component of the overall strategy to optimise the performance of multimodal chains.

Real-time status information for public transport (e.g. bus, metro, and rail) and multimodal real-time traffic information systems exist in several urban and extra urban areas in Europe and worldwide, both in the form of prototypes and fully operational systems.

Table 3-3 shows examples in Europe of multi-modal journey planners (short and long- distance).

Table 3-3 Examples of European multi-modal journey planners

Country	Planner	Operator	Transport mode involved
Austria	SCOTTY journey planner	Austrian Federal Railways	Rail, public transport, walking
	VERKEHRSPILOT	Austrian Federal Railways, ASFINAG and Austrocontrol	Rail, public transport, car, air, walking
Belgium	NMBS-SNCB	National Railway Company of Belgium	Rail, public transport, walking
	INFOTEC	Walloon Public Transport	Rail, public transport, walking
Czech Republic	IDOS	Chapman Ltd (for Ministry of Transport).	Rail, public transport, air, walking.
Denmark	BilRejseplanen	Rejseplanen.	Rail, public transport, ferry, cycling, car, walking.
Estonia	Peatus.ee	Estonian Road Administration	Rail, public transport, ferry, walking.
Finland	Journey.fi	Finnish Transport Agency.	Rail, public transport, ferry, air, walking.
Germany	DELFI	DELFI Network	Rail, public transport, ferry, air, walking.
	Reiseauskunft	Deutsche Bahn AG.	Rail, public transport, ferry, air, walking.
Luxemburg	Mobilitéitszentral	Communauté des Transports.	Rail, public transport, ferry, car, walking.
The Netherlands	9292	REISinformatiegroep.	Rail, public transport, ferry, car, walking.
Poland	SITkol	TK Telekom	Rail, public transport, walking
Portugal	TransPOR	Instituto da Mobilidade e dos Transportes Terrestres	Rail, public transport, ferry, air, walking.

Country	Planner	Operator	Transport mode involved
Sweden	RESROBOT	Samtrafiken	Rail, public transport, ferry, air, walking.
United Kingdom	Transport Direct	UK Department for Transport, Welsh Assembly Government and Scottish Government	Rail, public transport, ferry, cycling, car, walking.
Norway	Rutebok.no	Norsk Reiseinformasjon	Rail, public transport, ferry, cycling, air, walking.
Switzerland	SBB Online Fahrplan	Swiss Federal Railways	Rail, public transport, ferry, car, taxi, walking.

Source: Adaptation from DG TREN, http://ec.europa.eu/transport/its/multimodal-planners/index_en.htm

The table shows that there are many journey planners across Europe, covering several transport modes. However, it must be stressed that the current offer is far from allowing the user to find door-to-door information or book a ticket for a journey within Europe regardless of the number of countries or transport modes involved.

To indicate at least one example in a non-European context, in March 2010, Singapore's Land Transport Authority (LTA) has begun to disseminate real-time bus arrival information to all bus stops island-wide via various mobile platforms. In July 2008, LTA launched a public transport journey planner with basic map features that advises commuters on optimal public transport travel routes from origin to destination. In the governmental plans, this should be followed by the implementation of an Integrated Multi-Modal Travel Information system (IMTI), which should provide commuters with comprehensive travel information on different platforms such as the mobile phone and the Internet, via GRPS, WAP, and WIFI (ITIF, 2010).

Integrated ticketing

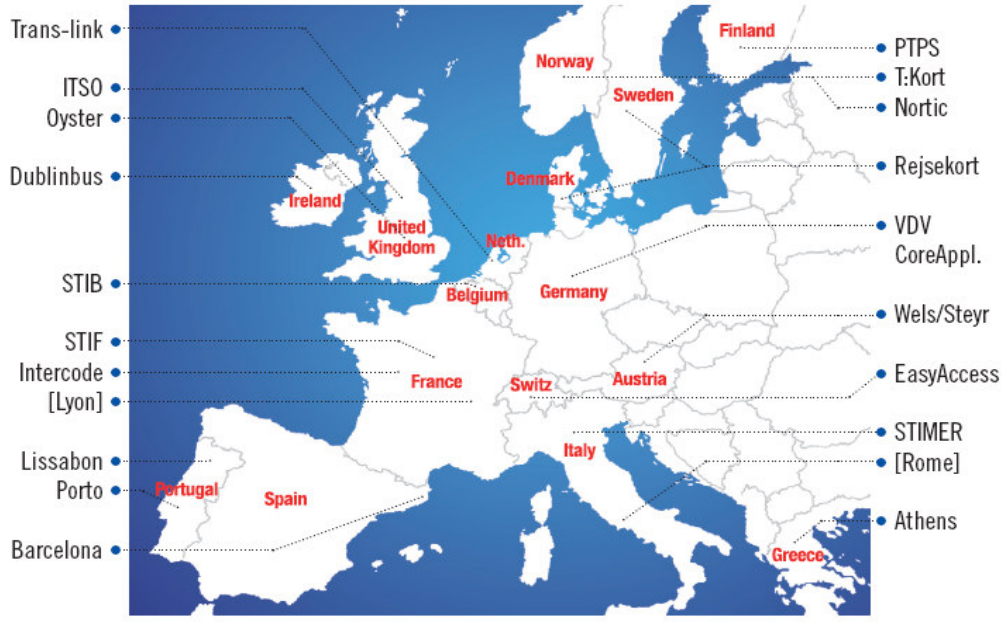
The full exploitation of new forms of electronic ticketing on mobile devices (smart cards, mobile phones, etc.) is considered an important step towards the realisation of a seamless inter-modal transport system. The set-up of interoperable systems across modes and countries is one important pre-condition as stressed, for example, in the "Seamless multimodal travelling and integrated ticketing" section in the Commission Staff Working Document accompanying the White Paper - Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system (EC, 2011 b). It could also be said that a common inter-modal payment system would be the natural complement to the full availability of multi-modal passenger information services (pre- and on-trip), discussed in the previous section. In fact, the establishment of the European Integrated Multimodal Information and Management Plan (EIMIP), which is considered an integral part of the European strategy towards the provision of a more integrated transport system (EC, 2011 c), has conceived the existence of integrated ticketing as a basic pre-requisite in that direction.

The following example concerns how an integrated ticketing in intermodal transport (based on Public Transport links) could function:

- The passenger takes a bus from A to B in a city X towards the train;
- The train leads the passenger to the another European city Y (in a different country);
- After that, the passenger takes the underground train in the city Y to the taxi to the hotel.

All these trips should be covered by one ticketing application. The first dimension of complexity is that the application for this resides on a chip, which again is embedded in a carrier medium. It is assumed the separation of carrier medium, i.e. each chip and application runs in autonomous units, independent of each other. Furthermore, the second dimension of complexity in interoperability and integrated ticket arises at network operator level. In fact, in the above example, the cross-border acceptance of the access medium requires contractual relationships between network operators and should be automatically followed by cross-border clearing. The intrinsic complexity of the "single ticket" service may lead to the conclusion that the task of a full European integrated ticketing system is

hard to achieve. The fact that nowadays the European landscape is characterised by several examples of electronic ticketing (Figure 3-1) does not imply, in itself, the fulfilment of the inter-country integration requirements.



Source: kontiki (2008)

Figure 3-1 Electronic ticketing in Europe

In fact, integrated electronic ticketing is not simply ensured by the wide use of standardised chip cards and mobile phones (though they represent important pre-conditions). The other pre-condition is that all the networks which have chosen them share the same system architecture. As effectively stressed by Gilles de Chantérac, Consultant, Member of UITP IT&I Commission, "using the same card and the same security keys is not enough to permit interoperability – data models and back-office processes must also be compatible, in much the same way as two identical computers can only work on the same file if they have compatible programs" (Gilles de Chantérac, 2009a).

This is also the reason why, according to the LINK Forum on Intermodal passenger transport "The vision of a centralised, standardised European intermodal door-to-door information and ticketing system is really quite unrealistic due to the organisational barriers and huge data management hurdles that would have to be overcome" (LINK, 2009).

In the field of air-rail relationships, examples of European integration between air-rail ticketing exist in several cases on a case specific basis (EC, 2008a). Recently, in Italy, the agreement between the national railways operator Trenitalia and Meridiana fly has established several integrated ticket options between the trips by air and the Milan-Rome High Speed Rail link.

3.3.2 Road

In road transport, the system needs (service specifications and technical pre-conditions) to ensure multimodal and co-modal seamless trips have been specified respectively in the ITS Action Plan (EC, 2008) and, following the adoption of the necessary specifications, in the ITS Directive in support of EU-wide multimodal travel information services (EC, 2010).

In general, the above Directive and Action Plan have widely acknowledged that many applications of ICT (Information and Communication Technology) to transport can prove their utility in making transport activities: a) cleaner, b) more efficient, including energy efficient and c) safer and more secure.

More specifically related to multimodal trips, pursuing the efficiency side of the expected impacts from the deployment of Intelligent Transport Systems applications can also address the capability to remove "the lack of interoperability and harmonise administrative procedures reducing the cost associated to trans-border operations" (EC, 2011i). The ITS Action Plan (EC, 2008), suggesting the actions for a quick adoption of ITS applications, indicates the "promotion of the development of national multimodal door-to-door journey planners, taking in due account of public transport alternatives, and their interconnection across Europe". In terms of promotion of intermodal and co-modal long- distance journeys, the implications from the widespread adoption of Intelligent Transport Systems are evident.

The Directive 2010/40 (EC, 2010) has set out the following priority areas for the development of Intelligent Transport Systems in the field of road transport and their interface with other transport modes (art. 2):

1. Optimal use of road, traffic and travel data.
2. Continuity of traffic and freight management ITS services.
3. ITS road safety and security applications.
4. Linking the vehicle with the transport infrastructure.

With reference to long-distance passenger road transport, the first and the fourth priority areas are of particular relevance for the definition of the road transport system needs.

Table 3-4 shows the most relevant system needs that can be derived from the priority areas 1 and 4.

Table 3-4 Seamless trips in road transport: system needs

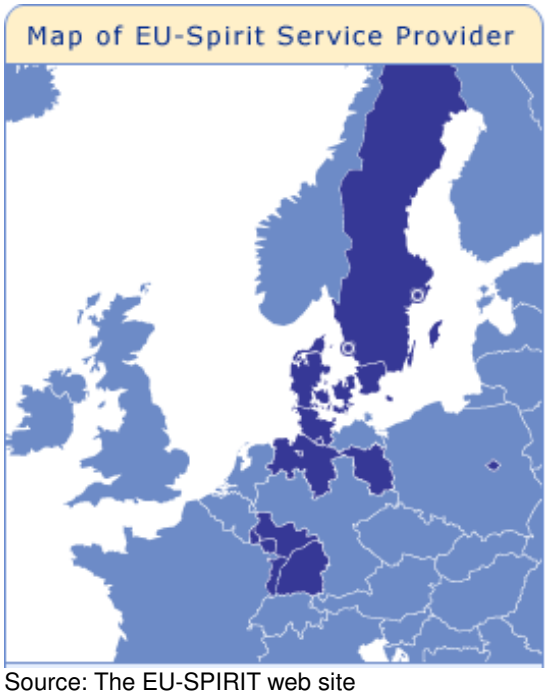
Priority Area specifications	System needs
Priority area I: Optimal use of road, traffic and travel data	
The definition of the necessary requirements to make EU-wide multimodal travel information/ real-time traffic information services accurate and available across borders to ITS users	The availability and accessibility of existing and accurate **road and real-time traffic data used for multimodal travel information/real-time traffic data** to ITS service providers without prejudice to safety and transport management constraints
	The facilitation of the **electronic data exchange** between the relevant public authorities and stakeholders and the relevant ITS service providers, across borders
	The **timely updating of available road and traffic data** used for multimodal travel information and real-time traffic data by the relevant public authorities and stakeholders
	The **timely updating of multimodal travel information/real-time traffic data** by the ITS service providers
Priority area IV: Linking the vehicle with the transport infrastructure	
The definition of necessary measures to integrate different ITS applications on an open in-vehicle platform	The identification of **functional requirements of existing or planned ITS applications**
	The definition of an **open-system architecture** which defines the functionalities and interfaces necessary for the interoperability/interconnection with infrastructure systems and facilities
	The **integration of future new or upgraded ITS applications in a 'plug and play'** manner into an open in- vehicle platform
	The use of a **standardisation process** for the

Priority Area specifications	System needs
	adoption of the architecture, and the open in-vehicle specifications
The definition of necessary measures to further progress the development and implementation of cooperative (vehicle-vehicle, vehicle-infrastructure, infrastructure-infrastructure) systems	The facilitation of the **exchange of data or information between vehicles**, infrastructures and between vehicle and infrastructure
	The **availability of the relevant data or information** to be exchanged to the respective vehicle or road infrastructure parties
	The use of **a standardised message format for the exchange** of data or information between the vehicle and the infrastructure
	The definition of a **communication infrastructure for data** or information exchange between vehicles, infrastructures and between vehicle and infrastructure
	The use of **standardisation processes** to adopt the respective architectures

The table shows that the provision of multi-modal journey planners must be supported by exhaustive and updated traffic and travel information, standardisation processes, data specifications, etc, representing as a whole the relevant system needs for ensuring seamless road journeys.

3.3.3 Coach/Bus

The system needs for road public transport (coaches, bus, light rail) in terms of information and integrated ticketing are exemplified through several European travel information systems, offering the calculation of itineraries between European cities and regions with regard to public transport. For example, the EU-SPIRIT services are relevant for road transport as far as they involve buses and coaches. Specifically focused on the cross-border intermodal trips, the EU-SPIRIT service (http://www.eu-spirit.com/) is based on the connection of existing time table services. The travel itinerary information is created by composing information of all participating services via open interfaces and meta information. The countries in which the service is operating in all or part of the country are Denmark, Germany, Luxembourg, Sweden, Poland and France (Figure 3-2).



Source: The EU-SPIRIT web site

Figure 3-2 The EU-SPIRIT service

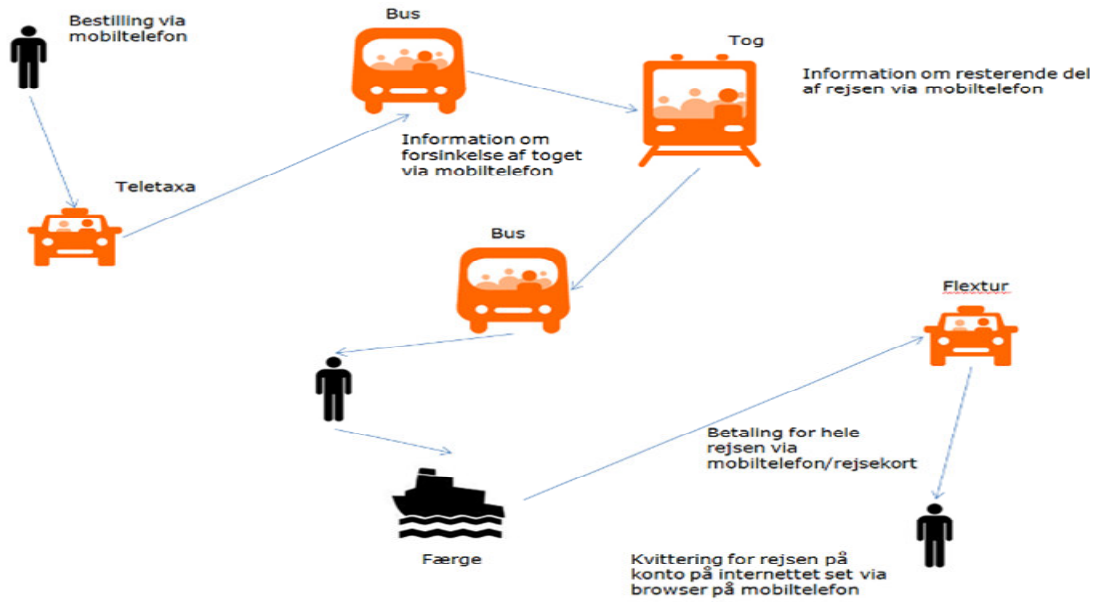
The EU-SPIRIT approach is based on the connection of existing time table services from several operators. Travel itinerary information is created by composing information of all participating services via open interfaces and harmonised meta information. The adhesion to the service of public transport operators from participating countries and regions make the service available for providing information on the public transport connections (bus, metro, train) across these countries with a long-distance perspective.

The system needs for ensuring the service are the following:

1) Software architecture to connect existing travel information systems. The formerly isolated individual systems are linked via central components so that continuous information can be calculated. Optimisation technologies are then used in order to fulfil customer requirements. The components of the architecture are the following:
    - RODI – the Ring origin destination identification tool, matching the user input to origin and destination locations.
    - RCC – the Ring connection composer, merging the partial information through open interfaces.
    - RRDB – the Ring Reference database, in which all the transition stations are stored. The transition stations are points where an interchange between two local systems or between a local system and an interregional system (e.g. national railway) is possible.
2) A common interface, using algorithms and database structures in order to display international itineraries in their local format.
3) Background process harmonising definition, symbols and data in order to generate itineraries. The process covers the definition or redefinition of central data. This data is stored in the RRDB and consists of:
    - List of city and town names within the participating regions.
    - Information about participating servers.
    - Harmonised data that are necessary to meet the customer demand (e.g. selection of train categories and symbol codes).
    - Transition points (nodes where different partial itineraries from the participating information systems must be connected in order to retrieve optimal itineraries).
4) On-line processing, so that the customer can enter the whole international system via the Internet by contacting any of the participating information systems on which all information can be displayed.

The aim of the IMIKASK project (2010-2013) is to connect urban and rural areas via increasing the opportunities for supporting co-modality. IMIKASK has been designed to increase the possibilities for cross-border public transport (coaches and busses, for the road transport) by increasing the opportunities for supporting co-modality, thereby making it easier for the citizens to use and plan longer, cross-border travels with various types of public transport. Figure 3-3 shows an example of the transport modes involved (mainly road transport).

The implementation of applications able to inform travellers about timing, journey time, interconnections, etc will also address important user needs as optimisation waiting times at stops, allowing in such a way the general improvement of the quality of road public transport (comfort).



Source: Svend Tøfting (IMIKASK co-ordinator) presentation Allborg University

Figure 3-3 The overall vision of the IMIKASK project

The specific objective is to provide the transport users with a total overview and information on their journey – also across borders. For instance the citizens shall be able to book a journey beginning in Sweden and ending in Denmark.

According to the intended project outcomes, the partners shall develop a tool that gives the citizens the possibility to make reservations, book and pay for journeys across administrative and national borders in a simple way independent of who is responsible for the transport and the mode of transport. This means that the long-distance passenger shall be able to book a trip, get information about the trip before, during (real time) and after the trip, as well as pay for the trip, as if the trip was provided by one company.

The system requirements to reach all that are:

- A system that connects existing systems making the citizens able to carry out co-modality between different means of transport in one booking.
- Smart-phones as the ITS platform to get info before and after the trip and pay for the trip.
- Integrated traveller planner tools, in order to inform the passenger about the trip paths available.

The IMIKASK project raises the issue of the integrated ticketing as an important system. Despite the relevance of this system need, it should be stressed that concerning long–distance passenger transport, the conclusions of the LINK project pointed out that the first priority in long-distance intermodal ticketing is information (where and how to buy several tickets) rather than to buy a single ticket (perceived too risky)[3].

3.3.4 Rail

In the context of rail, there are three dimensions to integrated ticketing. Firstly, there is the integration of ticketing within the national rail system; particularly an issue where there are multiple train operators within a single country where the issue also merges into one of 'inter-availability' of tickets across different operators. Secondly, there are issues of integration of ticketing within rail but across different

[3] Paul Riley, Jacobs Consultancy, Roger Slevin, DfT "Door-to-door information and ticketing", Final Conference, 30 March 2010, Brussels

Member States. Thirdly, there is the issue of integrating ticketing between rail and other modes. What has emerged is not dissimilar to the picture relating to information services. That is, integration of rail ticketing within a particular Member State is generally achievable (though still not always the praxis). Whilst it is relevant to long-distance travel only in so far as it can be purchased as an add-on to a rail ticket, perhaps the best example of an integrated ticket is the London Travelcard which permits travel on London Underground, London buses, national rail services within London, the Docklands Light Railway and the Croydon Tramlink (as well as providing a 33% discount on London River Services). So despite a consensus view that greater ticketing integration would be desirable there has been a general lack of practical progress towards integrated ticketing over the past ten years.

For some years now, the aspiration has been to integrate ticketing via the use of 'smartcard' ticketing systems. Smartcard ticketing is increasing in its usage, though it appears some way off providing a means of integrated ticketing, particularly for long-distance journeys. A technical standard – ITSO – has been developed and, for example, passes for the national concessionary travel scheme in England are issued as ITSO-compliant smartcards (of which it is estimated there are at least 11 million in circulation). However, the equipment to read these as smartcards is not widely deployed. Furthermore, the fact that the London Oyster system – by far the largest operational Smartcard ticketing system in the UK, and widely viewed as a success – predates ITSO and is currently not compatible with it, poses major problems in relation to integrating smartcard ticketing for travel within and outside of London.

A strong direction towards the possibility to enhance the use of integrated trans-European rail tickets will be provided by the implementation of the European Commission Regulation "on the technical specification for interoperability relating to the subsystem 'telematics applications for passenger services' of the trans-European rail system" (Brussels, 5.5.2011 C(2011) 2962 final).

Perhaps the next innovation to enjoy more widespread implementation and provide the technological opportunity for increased integrated ticketing will be Mobile Ticketing, delivered as e-tickets direct to the mobile phone. For example, following some trials conducted by different airlines, Indian Railways have recently launched the facility to receive a ticket via text message.

Information on the 'on-trip phase' has traditionally been limited to the use of screens and/or announcements in the station or on the train. The best examples of these are in 'real-time', are multimodal and, in the event of an incident or disruption of some sort, provide suggested amendments to onward travel arrangements. This best practice, which is now the exception, should become the rule. Increasingly, the trend is to supplement these traditional means (both where they do and where they do not exist already) by providing 'on-trip' information direct to individuals' mobile devices, e.g. via text messaging and/or via mobile phone applications. The very latest trend to emerge is to allow two-way flows of information, not only from train operator to passenger but from passenger to train operator and from passenger to passenger. For example, First Capital Connect (FCC) in Britain has a 'Twitter Manager' who provides and receives information via a live Twitter feed.

Quality of the long-distance trip by rail (comfort, seat capacity, etc) represents another important system need. The system requirements also address baggage handling, space availability in wagons, and service provision for particular users (web services, etc).

3.3.5 Ferry

Most long-distance ferry routes operate on a once per day basis. Information about timing and ticket costs are generally available on-line and travel can be booked on-line; travellers without internet access can book via travel agents.

Information on onward travel is generally not available since it is assumed that all users travel either by private car or by coach, and indeed many ports have no direct public transport connection. Even where there is rail access to the port, as for instance in Ancona, the Superfast website that offers services from there, says nothing about how to get to the port.

However, integrated tickets are available for a variety of crossings that have direct rail access and should really be the norm. The Scandlines travel tickets on the Helsingborg-Helsingør route can also

include the crossing Rødby-Puttgarden or Rostock-Gedser as a 'Sweden' ticket. Integrated ticketing inclusive of ferry and rail travel is also possible for many destinations between the continent and Scandinavia. The SailRail service by rail and ferry provides city to city travel for passengers wishing to travel between Britain and Ireland and covers all UK rail stations and a wide range of Irish destinations, and their website also includes a journey planner. Stena Line's Dutchflyer service provides city-to-city travel for passengers wishing to travel from Britain to Holland and covers all Dutch rail stations and in the UK departure points are London Liverpool Street, Ipswich, Colchester, Norwich and Cambridge.

3.3.6 Air

Safety is valued as an important user need, despite the best performance of air transport in terms of fatalities compared to the road and rail passenger transport over the past years: the average number of fatalities per billion of passenger kilometres at EU 27 level over the period 2005-2009 is 0.19 (air transport), 0.20 (rail transport) and 8.6 (road transport, passenger cars)[4].

Concerning the implications for the system needs, the European Aviation Safety Agency (2011) has indicated the most important challenges:

- To adapt training requirements in ways which respond to the strong demand for pilots, while maintaining or improving the level of safety. First priority should be to evaluate training methods and philosophies for pilots as well as certifying staff involved in the maintenance of aircraft with the aim to enable aviation personnel to meet the demands of new procedures and increasingly complex technologies in a developing market.
- To adopt new technologies. In fact aviation is also becoming more and more integrated and daily relying on real-time digital technologies. This trend will be accelerated by SESAR in Europe and NextGen in the US, which will introduce new technical solutions.
- New management of Air Traffic Movement (ATM). Changes in the field of Air Traffic Management (ATM) and Air Navigation Services (ANS) may also require the modernisation of training and competence provisions. These competence schemes will in general be under the responsibility of the respective employers. This presents a need for high level provisions for the service providers, to ensure that their personnel are suitable and qualified for the tasks in question and that procedures are established in respect of their training and continuing competence.

For a decision of the consumer which mode of transport to be taken between true trip origin and starting airport or respectively between the destination airport and the true destination, the availability and the attributes of existing surface transport modes are a core issue. This may also apply concerning the choice of origin or destination airport.

The first of these two points is just a form of mode choice, where the consumers weighs the attributes of the available alternative for the trip specific decision, while for the second point (airport and route choice) one can well imagine that a consumer may prefer a nonstop-flight starting from an airport within a longer access distance from the true trip origin than an air service from the airport 'just around the corner' which inquires at least one transfer between flights at an intermediate airport and may result in less attractive overall costs, travel times or a schedule not fitting well to the travellers itinerary.

To assist the consumer in his/her decision about the trip a convenient booking/information interface is a necessity. This interface must be a one-stop-shop for the consumer. Classically this has been the travel agency, where experts first informed the consumer about all aspects of the different travel opportunities if wished by the consumer (schedules, prices, alternatives) or just booked the flight and may also have sold the train tickets to/from the airport, book a rental car, or the hotel for the stay at the destination, depending on the consumers' needs. The service given by the travel agency may be biased depending on the experts' knowledge or experiences. Also distinct marketing directives (e.g. preferred selling of tickets for a specific airline or a hotel chain, tendering of airport transfer services ...) of the travel agency might have influence.

[4] Elaborations on Transport Statistical pocketbook 2011, DG MOVE web site

Today when booking via internet has become very common, a good booking website should be able to emulate such travel agency; namely concerning the aspect of being a one-stop-shop, i.e. all aspects concerning a trip from door-to-door should be given via this website. This does not necessarily mean all information, or issuing of all tickets concerning a trip must be done via the company running this website. It may be sufficient to link the customer to the websites of other companies offering the services or information additionally needed by the customer for the air trip.

Such a system may also not be limited to be used by the end customer. Systems offering links to specific information (e.g. about public transport at the airport of destination, or the layout plan of the transfer airport) may be also useful for the experts in a travel agency since not many travel agents in Europe know by heart the layout of the transfer area at Kuala Lumpur or the bus schedules to connect from Hong Kong airport to a distinct hotel.

The information available may also influence the decision which main mode to take. Full information door-to-door about the transport chain can make the consumer opt for intermodal travelling, instead of using the private car, which per se allows through-travelling (within Europe).

It should be noted that individual air transport operators not necessarily have the intention to inform the potential traveller travel options with other airlines and therefore focus in their own booking system on their own product and deal with other modes or air transport options only if they can work as a feeder for them.

Another important system need is to ensure on-time departure and arrival, which also depends on the capacity of an airport. In the case of airport capacity constraints (i.e. insufficient slot allocation at least at peak hours) airlines and also affected airports might be motivated to cease short-haul feeder flights, if this feeder role could be taken on by direct rail services to the airport, running in sufficient frequency or with a timetable co-ordinated to the flight schedules. This motivation for replacing feeder flights by surface transport modes is market driven and would be strengthened by slot-trading, i.e. slots as a very valuable good would not be ‘wasted’ by short-haul flights in favour of more profitable long-haul intercontinental flights. Regulations from the airport or by the authorities concerning either landing or passenger fees, can push further such a trend of slot usage.

Finally, as prerequisites for an airport to ensure on-time departure/arrivals, it should be also considered the availability of space and assets for the different modes concerned and as well the willingness to provide such services with the required organisational structure to enable passengers a smooth and seamless transfer between modes within one transport chain from home to home.

3.3.7 Conclusions

The following table summarises the results of the most important system needs by transport modes concerning the main trip journey stage.

Table 3-5 Main trip journey stage: system needs by transport modes

	Road	Coach/Bus	Rail	Ferry	Air
System needs	• Availability of timely updated road and real-time traffic data • The definition of a communication infrastructure for data or information exchange between vehicles, infrastructures and between vehicle and infrastructure	• Software architecture to connect existing travel information systems • Quality of trip (waiting times, travel times, comfort, etc) •	• Development of international standards for integrated ticketing (implementation of the EC TAP-TSI Directive) • Dynamic on-trip information • Comfort and quality of service	• Integrated ferry and rail tickets	• Availability of a convenient booking/information interface (schedules, prices, alternatives)[5] with other transport modes • On time departure/arrival

The table shows that the system needs of long-distance multimodal trips in which the main journey stage involves one of the above transport modes are characterised by the provision of all the information requirements allowing the user to be timely informed about interconnections timetables, travel time, route alternatives, possibly having access to integrated tickets.

In particular, the system needs are the following:

- Road transport (including coaches and bus) information systems should provide the user with updated information on traffic conditions, developing common standard for the relevant data exchange. In such a direction, the Directive 2010/40 (EC, 2010).
- Rail transport should implement the European Commission Directive on the technical specifications the subsystem relating to telematics applications for passenger services, in order to meet the essential requirements and ensure the interoperability of the rail system. The efficient interconnection of the information and communication systems of the different infrastructure managers and railway undertakings is considered to be important, in particular for the provision of up-to-date information and ticketing services to passengers.
- Air transport system needs should develop the necessary interfaces to display travel options, interconnections and price information for air transport services when these are offered to consumers. In doing that, the Regulation (EC) No 1008/2008 on common rules for the operation of air services in the Community and Regulation (EC) No 80/2009 on a Code of Conduct for Computerised Reservation Systems (CRS) can provide an important regulative framework.

[5] In the air sector, best practices examples moving in this direction can be found in the ORIGAMI best examples Web site: http://80.33.141.76/origami/. In particular the "Common Use Passenger Processing System (CUPPS)" in some US airports

4 THE IDENTIFICATION OF CRITICAL AREAS IN THE SYSTEM NEEDS

4.1.1 Introduction

The next three sections of this chapter will analyse the system needs with the objective to identify the main critical areas, for which the current systems still fail to be fully operational.

The analysis is developed by each fundamental stage of the intermodal and co-modal long-distance trip chain, classifying the critical areas by the criticality level: low (√), medium (√√) and high (√√√).

4.1.2 First/Last Mile Stage

Table 4-1 shows the critical areas in the system needs related to the firs/last mile stage.

Table 4-1 First/last mile stage: critical areas in the system needs

Mode	System needs	Critical areas
Road (car)	•Efficient connections with the interchange point •Reducing congestion and travel time	√ √ √ √
Coaches/Bus	•Free flow traffic condition, reducing access/egress travel time, •Safety and comfortable bus/coach stops	√ √ √ √
Rail	•Information needs: rail service information to be made available via the web, including price and journey conditions •Enhancements of connections from rail stations to other modes	√ √ √ √ √
Cycling/walking	•Efficient connections with terminals : cycle paths, footpaths •Information provision (signs, etc)	√ √ √

In the road transport sector, parking facilities are generally located near the main interchanges points and nodes and the procedures and services allowing safe payments and the provision of security standards have been developed by infrastructures managers and operators. Efficient road links with interchanges situated far from traveller's origin/destination points such as airports are generally ensured by a dense infrastructure network of motorways and main roads. Congestion problems may however still cause high access/egress time.

Coach/bus and public transport modes by road in general share the same characteristics of the private road transport, as far as the proximity of bus/coach terminals to interchanges points is generally provided. Recently, the development of shuttle connections between the more outlying interchanges, e.g. airports, and the city centre has becoming a standard service, improving the quality of service for

travellers. However, congestion may reduce the efficiency and reliability of the service and the quality of service could often be improved.

In the rail transport sector direct rail access is still not available for the majority of small and mid-size airports and ports in Europe. This despite the fact that improved accessibility through the reduction of access/egress time is increasingly addressed through the upgrading and the construction of new rail infrastructure integrating the rail network with interchanges points. Furthermore, on-trip information, e.g. dynamic information on delays and platform changes, is still not available.

Finally, the first/last mile stage may usually involve cycling and walking as transport modes. The most important user needs in such areas concern the availability of clear information in terms of the provision of efficient signs and indications (pedestrian), associated with a the availability of clean and safe cycle paths and footpaths to terminals. The provision of cycle paths and footpaths at interchange points and nodes is not always sufficient, and in particular as far as cycle paths are concerned, only widely present in few countries.

4.1.3 Interchange stage

Table 4-2 shows the critical areas in the system needs at interchanges (ports, airports and rail stations).

The table allows to identify the presence of potential critical areas in the system needs provision, mainly related to lack of information in rail stations, airports and ports. The lack of quality of services, e.g. efficient and time saving procedures at check–in and baggage handling in airports must also be included.

Concerning the road transport sector, the key user needs at interchanges concern the availability of secure, cheap and efficient parking areas. These needs are met by the provision of parking areas at the interchanges generally available at airports, rail station and ports; where conveniently located parking areas are expensive to use, there are usually cheaper alternatives at a less convenient location.

The situation is different for coaches/bus interchange points, which can play an important role in the overall long-distance transport chain, but for which there is a substantial gap in the knowledge base of user needs requirements (Carreno M, 2011). This makes the analysis of system needs difficult to work out, despite the fact that on the system needs side, the provision of information about connections and the proximity to the connected transport modes, can be considered as important requirements.

In the rail transport sector, it is widely known that for long-distance rail journeys, significant proportions of journeys are known to start and/or to end with a car journey, a walk journey and/or a cycle journey. Therefore, system needs basically focus on the improved integration of rail stations with other infrastructures, in particular for disabled/older people. These needs are being served by improving accessibility and integration through appropriate physical design, i.e. reducing distances to reach gates, providing barrier free accessibility and interchange for disabled persons, etc. The potential critical area with reference to the information requirements is the need to provide users with multimodal information at the rail stations..

In the air sector, user needs at interchanges (airports) concern quality aspects such as reducing time at check-in and for baggage handling, the provision of efficient infrastructure (short paths, low or no barriers for disabled/older people, services for business travellers) and better information at the destination airport about surface transport services. With reference to quality aspects and infrastructure, the actual system needs are only in part addressed in terms of improved procedures for check-in, baggage drop-of, security checks, passport controls, infrastructure design to reduce distances of footpaths to cover, etc. Concerning the information requirements, i.e. the information about surface transport availability (rail station, car parking, coach / bus terminal) the actual systems seem to fail in providing complete information at the destination airport. In fact, passengers who did not have the opportunity to inform themselves about that when preparing the trip, or in case of disruptions (late or diverted arrival flight, cancellation / late running of foreseen train for continuing the

travel) will need detailed and comprehensive information available about surface transport at the airport of destination or, failing that, will simply use taxis as long as their onward trip is not too long.

Table 4-2 Interchanges: critical areas in the system needs

Mode	System needs	Critical areas
Ports	•Rapid turnaround for short-distance ferries	√
	•Minimum comfort for waiting and connection areas	√
	•Integration with other modes, i.e. information	√ √
Airports	•Information about surface transport	√ √ √
	•Physical design of infrastructure to improve accessibility and usage for disabled people	√
	• Security and reduced waiting time at check -in	√ √
	•Accessibility to other modes (rail station, car parking, etc)	√
Rail stations	•Making access, interchange and egress easy and pleasant	√
	•Physical design of infrastructure to improve accessibility and usage for disabled people	√
	•Information provision on multi-modal connections (coach/air/ferry)	√ √ √

In ports, the user needs are represented by a mix of service quality (availability of cycle lanes/intermodal luggage handling/availability of baggage storage/barrier-free accessibility), integration with other modes (availability of cycle parking/availability) and information requirements (information at destination/information about arrival, departure and connection times, convenient waiting conditions). Concerning the information requirements, the main need is related to the intermodal integration with other modes (frequencies, price, etc).

4.1.4 Main Trip Stage

The main trip stage critical areas are shown in Table 4-3.

Table 4-3 Main trip stage: critical areas in the system needs

Mode	System needs	Critical areas
Rail	•Passenger information during the trip, dynamic information on delays , etc •Comfort, travel comfort, train temperature, seat comfort •Development of international standards for integrated ticketing (implementation of the EC TAP-TSI Directive	√ √ √ √ √
Air	•Availability of a convenient booking/information interface (schedules, prices, alternatives) with other transport modes •On-time departure and arrival	√ √ √ √
Coach/bus	•Software architecture to connect existing travel information systems •Quality of trips (journey time, vehicle occupancy, waiting time at stops, cleanliness of vehicles, driver attitudes and comfort	√ √ √

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An important caveat concerns road transport. In fact, user needs of long-distance main trips by car have not been reviewed (Carreno M, 2011), due to the fact that long trips by car are considered as alternative options to trips by rail, air or coaches. However, from the point of view of co-modality, a pure car trip should be considered. Despite the fact that user needs of long-distance travellers by car are intuitive and do not deserve specific analysis, it can be said that they include safety, comfort and reliability in travel time, including real-time traffic information. The system needs to ensure all that involve to a greater extent the application of Intelligent Transport System applications allowing the communication between road infrastructure and vehicles (for electronic payment, traffic count, etc), or vehicles and vehicles (reducing accidents), that in general require the adoption of regulative framework at European level, as the Directive 2010/40 (EC, 2010).

The long-distance rail trips user needs have not been subjected to detailed surveys. However, despite the paucity of information, the reviewed literature (Carreno M, 2011) has identified the need to ensure quality standards (comfort, train temperature, etc) and in the need to provide dynamic, updated information during the trip (delays) as among the most important user needs. Concerning the corresponding system needs, it can be said that the information requirements are not completely satisfied. Several European Commission Directives and Regulation, e.g. the Regulation on the technical specification for interoperability relating to the subsystem 'telematics applications for passenger services' of the trans-European rail system" are providing the framework for ensuring better interoperability and electronic ticketing. These Directives and Regulations, despite their importance in allowing seamless rail trips, do not address in itself the provision of update on-trip information.

In the main trip by air, in terms of long-distance system needs, the provision of information about changes between the access mode to the airport and the air transport and in consequence also at the airport of destination are a prerequisite to travel by air. However, it should be noted that individual air transport operators not necessarily have the intention to inform the potential traveller travel options with other airlines and therefore focus in their own booking system on their own product and deal with other modes or air transport options only if they can work as a feeder for them. Furthermore. the provision of information offering links to other modes (e.g. about public transport at the airport of destination, or the layout plan of the transfer airport) are relevant.

In the coach/bus and public transport main trips, it has been stressed (Carreno, 2011) that the coach/bus long distance travellers needs have been poorly studied. The most important user needs identified focus on quality of transport services (waiting times at stops, journey time, vehicle occupancy, cleanliness of vehicles, etc). The current system developments seem to focus instead on the provision of information systems able to provide real-time traffic information, routes, timetables of several operators, etc. These developments in the sector, mainly driven by technological developments, can effectively address the assessment of journey time.

In general, it can be observed that the most critical areas in system needs tend to involve “soft infrastructures”, rather than “hard infrastructures” provision.

The hard infrastructures imply the consideration of capital assets supporting the transportation, e.g. interchanges, transport-related information equipments and constructions, tracks, roads, etc, that form the network composed of links and nodes.

The “soft” infrastructures are generally relating to ITS applications (EC, 2009a), such as intelligent transport systems for road (EC, 2008), traffic management systems for rail (EC, 2005) and aviation (e.g. involved in the single European sky’s SESAR initiative).

Examples of the soft infrastructures, also identified as “smart infrastructure”, include:

- Traffic management tools tracing vehicles along the links.
- Common standards for managing information, allowing interoperability and information sharing between operators, vehicles and infrastructure.
- Control systems and software required to operate, manage and monitor the transport flows.
- Interfaces for communication between fixed infrastructure and vehicles.
- The structures, procedures and processes for planning, coordination and monitoring of network capacities.
- Communication platforms between vehicles, infrastructures and administrations.

The prevailing use of soft infrastructures in the main trips stage can be explained by the major concentration of hard infrastructure at interchanges (nodes, terminals) and in the first/end mile, due to the need to integrate different transport infrastructures.

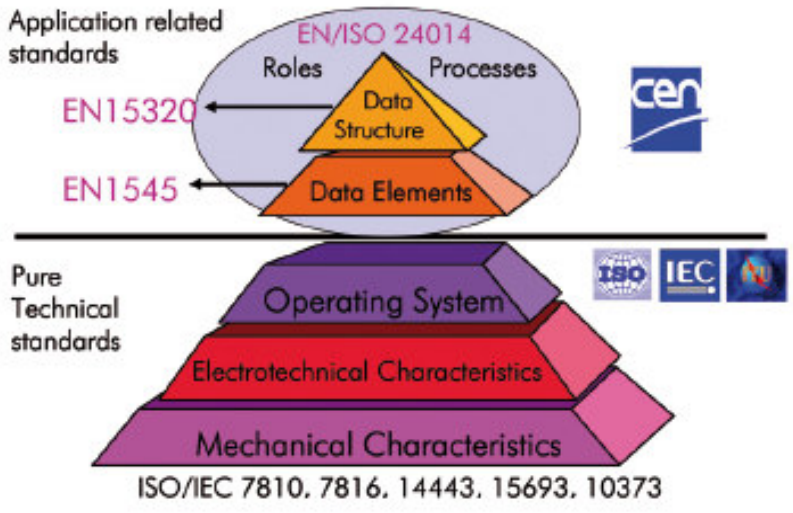
4.2 PRECONDITIONS TO ADDRESS THE CRITICAL AREAS IN THE SYSTEM NEEDS

4.2.1 Standardisation and Interoperability

It is widely acknowledged that “Standardisation and interoperability requirements, including at international level, will avoid technological fragmentation and enable European businesses to fully benefit from the entire European transport market, and to create worldwide market opportunities” (EC, 2011e).

With reference to integrated ticketing, one of the important pre-conditions for ensuring seamless long-distance intermodal trips (as stressed above with reference to rail and road transport) is standardisation, interoperability and cross-border acceptance of the applications and carrier medium (chip, GSM, etc).

As shown in the next figure, the pure technical guidelines for the standardisation of chips and cards have been published and are available. On the access medium side, two European standards exist, the toolbox of standardised data element (EN1545) and the general application standard framework (EN15320). However, to ensure the full interoperability, it is necessary to standardise the background system specifications of the clearing process, i.e. to set up an interoperable fare management architecture (roles and models).



Source: kontiki (2008)

Figure 4-1 The framework for European interoperability (Cards standards for the electronic ticketing system)

Focused on public transport, the IFM project (IFM, 2009) has tried to set up a road map to European interoperability, showing the interoperability of three main national systems (UK, F and D). The approach is based on reaching compatibility rather than trying to realise standardisation. The international standard ISO 24014 “Public Transport – Interoperable Fare Management System”, devised essentially by European experts from CEN, was published in 2007 and it was the first to indicate a path in this direction by offering actors an organisational model for building interoperability, irrespective of its content.

The cooperative approach of the IFM project is promising. According to this approach, the solutions and architectures envisaged must respect the independence of commercial policies, allowing at the same time all forms of cooperation that meet market needs, “to be gradually built up in step with political decision-making (bottom up) rather than by seeking to override the decentralised character of public transport by putting forward ‘one-size-fits-all’ solutions” (Gilles de Chantérac, 2009b).

The emphasis on cooperation and bottom-up approaches addresses one of the crucial pre-conditions stressed in previous research projects and studies (e.g. ILS, 2004), according to which, although the idea of having a common European standard for data exchange is seen as an important step for the supporting long-distance intermodal transport (in terms of easy exchange of timetable, routeing and tariffs), the challenging task is the capability to involve the stakeholders (see below section 4.2.4 for detail).

In terms of standardisation, the important actions established by the European Union under the ITS Action Plan (EC, 2008) and following the adoption of the necessary specifications under the ITS Directive in support of EU-wide multimodal travel information services (EC, 2010) should be noted.

The actions envisaged in such a context address the following topics (Priority Area 1), highly relevant for the standardisation and interoperability of intermodal transport services:

- Definition of procedures for the provision of EU-wide real-time traffic and travel information services.
- Optimisation of the collection and provision of road data and traffic circulation plans, traffic regulations and recommended routes (in particular for heavy goods vehicles).
- Definition of specifications for data and procedures for the free provision of minimum universal traffic information services (including definition of the repository of messages to be provided) .
- Promotion of the development of national multimodal door-to-door journey planners, taking due account of public transport alternatives, and their interconnection across Europe.

Concerning rail transport, an important step towards the pursuing of major standardisation in data exchange between operators and infrastructure managers has been realised through the European Commission Directive on TAP-TSI procedures and interfaces, the implementation of which has been indicated as one important system need for ensuring the interoperability of long-distance rail trips.

The European Railway Agency recommendation on adopting TSI for Telematics Applications for Passenger services (ERA, 2010) has identified the following areas of interest addressed by the EC Directive:

- The provision of the passenger with information before and during the journey;
- Issuing of tickets via ticket offices or selling machines or telephone or internet or any other widely available information technology;
- Luggage management.

However, in terms of a multi-modal view, it is important to stress that the recommendations are not extended to other transport modes, unless these “Services are operated directly by or for the Railway Undertakings” (ERA, 2010).

4.2.2 Regulation

Market openness

The regulative organisational preconditions address in general the legal and institutional conditions considered as decisive in allowing the development of an efficient intermodal market for passengers (market openness and competition).

For example, the European White Paper, with reference to the initiatives to be pursued in the next future, has identified, under the initiative 22. Seamless door-to-door mobility, the following objectives: “Create the framework conditions to promote the development and use of intelligent systems for interoperable and multimodal scheduling, information, online reservation systems and smart ticketing. This could include a legislative proposal to ensure access of private service providers to travel and real time traffic information” (EC, 2011f).

The concept has been stressed again in fulfilling the objective, for the next decade, “to create a genuine Single European Transport Area by eliminating all residual barriers between modes and national systems, easing the process of integration and facilitating the emergence of multinational and multimodal operators” (EC, 2011e).

The important role for a proper market regulation emerges from the fact that the unregulated competition between operators may represent a potential barrier to intermodal co-operation in the areas of tickets, travel information and fares, and this is going to become more relevant to the extent that competition is progressively introduced into transport services, e.g. rail.

To serve the purpose of efficient market regulation, the appropriate legal and regulatory framework should favour market access and competition, ensuring level playing fields to operators and contrasting, at the same time, the formation of monopolistic positions arising from market concentration (i.e. fine tuning of antitrust laws).

Several initiatives, suggested by research projects and studies (e.g. INTERCONNECT, 2010a, ILS, 2004, LINK, KITE) may be envisaged in such a context:

- The development of a legislative framework supporting intermodal transport and integration (contractual agreements and co-operation among operators);
- The establishment of independent regulatory bodies, which could favour market openness;
- The development of a liability regime for operators and mobility providers;
- The design of an efficient tendering/franchising/concessionary regime.

Innovation and financing

Another area in which the regulative framework can support the development of intermodal transport is innovation and financing.

The presence of a multi-stakeholders environment (different operators dealing with different modes) makes the uptake of innovative solutions a risky and costly activity, with high co-ordination costs. Some obstacles may be overcome through the support innovation in regulatory structures and transport operators.

The International Transport Forum (ITF, 2010), an expert panel on passenger transport, pointed out that innovation amongst information services and network providers has generally outpaced innovation in the regulatory environment, in management structures and within transport service providers. All this requires strong political leadership and buy-in from key transport operators. New rules and management structures must be flexible enough to evolve rapidly. The European, national and regional regulative framework should take all this into account.

In fact, it has been stressed (EC, 2011g) that "technological research needs to be complemented with a systems' approach, taking care of infrastructure and regulatory requirements, coordination of multiple actors and large demonstration projects to encourage market take-up".

In such a context, and with reference to the European Union commitments, the set-up of the Strategic Energy Technology Plan (SET-plan), with which identifying appropriate governance and financing instruments in order to ensure a rapid deployment of research results, can represent an important step.

Passenger rights

An important aspect of the regulative preconditions to develop intermodal transport is the setting up of a regulative framework ensuring a better enforcement of passenger rights. Previous studies have already emphasised that the legal and regulatory framework may "favour or inhibit" passenger intermodal transport (ILS, 2004a).

In particular, it must be stressed that currently the general passenger rights, including the rights of disabled passengers and passengers with reduced mobility, are regulated according to a consistent and homogenous approach across air, rail, sea and inland waterways transport modes, as well as for transport by bus and coach. Despite the fact that the specific rights may vary due to the characteristics of the different transport modes and their markets, it can be said that the typology of rights guaranteed by the four existing regulations for transport are comparable, e.g. the right to information, reimbursement, re-routeing, assistance while waiting to travel, and compensation under certain conditions.

However, as pointed out in the (EC, 2011h) "there is no European legislation on the rights of passengers which, in the course of one journey, use two or more transport modes and have bought the different tickets under a single purchase contract. Such travellers may be exposed to higher costs in the case of delays (because of missed connections) or loss of luggage (because the final destination is not at the end of the route on which the luggage was lost). The Commission will work on promoting and developing the concept of integrated tickets and may, therefore, propose to include the question of the rights of passengers with integrated tickets on multimodal journeys on any of the current or future legislative frameworks".

The relevance for the intermodal passenger transport of future regulative frameworks moving towards the direction of better guarantees in presence of multimodal trips is evident and should be pursued decisively.

4.2.3 Infrastructure Upgrading

Infrastructure technological upgrading, e.g. to be obtained through a full deployment of many applications of ICT (Information and Communication Technology), is considered (EC, 2011i) to play an important role in improving:

- Modal transport efficiency, by making vehicles and the infrastructure more intelligent;
- Market integration, since technological upgrading is essential to transport operations and the lack of interoperability creates a barrier between borders;
- Simplify and harmonise administrative procedures and thus reduce the cost associated with trans-border operations.

The implications of the technological upgrading affect all transport modes. In road transport, the application of ITS solutions to road infrastructure may lower congestion levels, making the journey safer and quicker. The development towards co-operative ITS systems based on an exchange of information within the road infrastructure (infrastructure to infrastructure (I2I), between vehicle and infrastructure (V2I) and vehicle to vehicle (V2V) communications), may lead in the near future to a wide exchange of information among road users, infrastructure managers and telecom operators. Implications on automatic tolling, availability of dynamic information on weather events, congestion and traffic conditions are to be expected.

In rail transport, the infrastructure upgrading will improve interoperability at cross-borders and safety considerably. Furthermore, the next generation of rail traffic management systems will contribute to transforming the present technologies into an integrated rail traffic management system, favouring ultimately the possibility to plan long-distance trips across countries.

Also planning and management of long trips in waterborne transport for passengers (ferry and cruise) may benefit from the use of ICT tools (in particular for safer trips), even if the most significant benefits are expected with reference to freight transport, i.e. from the River Information Services (RIS) applications, providing geographical, hydrological and administrative information on the waterway and enabling the electronic reporting of cargo and voyage data and the tracking and tracing of vessels.

Concerning aviation, the SESAR EU initiative in the context of the Single European Sky will improve technological infrastructures for the management of air transport movement (ATM). Major interoperability and infrastructure capacity in the management of intercontinental long-distance journeys may be expected.

It should be stressed that upgraded, smart and modern infrastructures may improve the main or long-distance leg of the intermodal journey as well as favour integration among modes, supporting in such a way the development of co-modal and intermodal solutions as well.

4.2.4 Stakeholder Cooperation

The multi-modal trip by definition involves several transport modes and services (transport operators, infrastructure managers, regulative bodies, industries, municipalities, etc). Therefore, it is natural that the issues of an efficient co-ordination among the stakeholders involved in the transport chain become an important pre-condition to seamless trips.

This is the reason why experts and international fora on intermodal passenger transport (e.g. LINK, (2009), ITF (2010) have pointed out that partnerships among transport operators and network operators are essential.

The objectives to be pursued in ensuring better stakeholder cooperation are the following:

- To allow private sector innovators to participate in the development of new mobility services that require innovative new arrangements.
- To define responsibilities for service performance, investment responsibilities and potential liability issues, aiming at removing uncertainties and encouraging clear and transparent participation.
- To set clear rules to manage multiple partnerships, involving in that, other than public and private service providers, national authorities in the establishment of a supportive regulatory framework.

The INTERCONNECT project (INTERCONNECT (2010b) raised the issue of establishing voluntary arrangements amongst authorities and other stakeholders, in order to join the efforts to promote a strategy and to combine resources. From the methodological point of view, it is also said that rather than as a result of a top-down direction (e.g. from the European Commission decision), such partnerships could emerge from bottom-up initiatives, for example from one or more organisations identifying an opportunity for achieving a better outcome by working together.

At any rate, independently from the institutional framework adopted (top-down vs bottom-up), there is the need to cope with fragmented decision-making processes at the strategic or operations level, which may lead to failure in developing and enacting truly comprehensive and cohesive strategy assisting long-distance travellers needs.

5 CONCLUSIONS

The consideration of the entire trip transport chain implies the combination of the conclusions drawn with reference to the three stages of the long-distance intermodal transport chain: the first/last mile, the interchanges and the main trips. In doing that, the aim is to identify the system requirements that allow establishing how the different stages interlink and interact and what is needed to make the transition from one to the other as smooth and comfortable for the passenger as possible.

Looking at the entire transport chain, long-distance seamless intermodal and co-modal trips imply that the existing transport services must work together and have to be synchronised. This applies for example for the booking of the whole intermodal trip, supported by efficient procedures for liabilities and passenger rights as well as within the interface between the different transport modes at interchanges.

For the latter this means that there must be no break on the personal assistance offered at the interchange points and that the special facilities there must meet the different user requirements, including those of disabled/older people.

In order to realise all that, several system needs, for which developments are under way or are likely to be implemented in the light of future technological developments, have been identified and discussed in the chapter 3:

- Multi-modal information systems and integrated ticketing;
- Physical design of infrastructures and interchanges, accessible, with services and information for long-distance travellers, the presence of harmonised schedules of all modes available, the provision of major information to the passengers, etc.;
- The presence of integrated transport infrastructures and networks (rail, road, local public transport) at the interchange point and terminals.

The system needs identified above can be considered in turn as single components of the same unitary process underpinning the provision of seamless long-distance multimodal and co-modal services. However, it should be stressed that the user needs should set the scene for the prioritisation of system requirements, due to the fact that the European transport system must put people at the heart of transport policies. This is the reason why the final steps have been to investigate the areas that are critical in the system needs to fulfil the user needs and to suggest the pre-conditions to address them (chapter 4).

More specifically, the analysis of the system needs at interchange points and terminals has shown that in spite of the steps forwards towards the fulfilment of important user needs (through the improvement of physical design of infrastructure, major accessibility and integration with transport infrastructures) there are other user needs still unfulfilled (the provision of multimodal information requirements, i.e. timetables, arrivals, departures, connections).

Concerning the main trips of the intermodal transport chain, the provision of on-trip multimodal dynamic information about real-time delays, alternative routes, connections with other modes, all relevant user needs, must still be addressed by relevant developments, at least for rail and air main trips. Quality requirements for long trips by coach/bus must be addressed by reinforcing passenger rights, and the user need for integrated ticketing is currently addressed only partially for rail transport, through the development of international technical standards and through a small number of best practice cases (air/rail combined tickets) for air transport.

Looking at the entire transport chain, the information needs and the corresponding system requirements in long-distance passenger co-modal and multimodal transport solutions can be in turn identified as follows:

- Informational system needs, i.e. extensive data (traffic flows, time tables, weather, accidents, incidents), dynamically linked to events and flows to calculate updated travel time; information on connections, next interchanges on routes, timetables;

- Technological system requirements, in order to provide on-line platforms for application development, standardisation in communication, and implementation of co-operative vehicle-to-vehicle, vehicle-to-infrastructure and infrastructure-to-infrastructure systems.

Furthermore, it should be stressed that the multimodal transport system implies the presence of several stakeholders (transport operators) and institutions (public and private), and therefore finding the appropriate framework for ensuring the co-operation between the stakeholders represents the basic pre-condition to realise the system needs.

The lessons drawn from previous projects and studies, (e.g. ILS, 2004a, LINK, 2009c) have shown that the context conditions for ensuring co-operation between stakeholders can be categorised as follows:

- Framework conditions for enforcing competition rules, allowing new entrants and favouring new transport products and services (market regulation);
- Setting common rules (standardisation) aiming at ensuring interoperability of applications.

For example, concerning road transport, the European Commission has already taken legislative steps toward this direction, e.g. the Directive 2010/40/EU on the framework for the deployment of Intelligent Transport Systems, with particular reference to the framework conditions towards standardisation.

In doing that, also the insights from European and world-wide best practices may be useful. For example, the Japanese VICS (Vehicle Information and Communication System) programme, with about 24 million on-board units providing a broad range of road traffic information services, including electronic charging, warnings about traffic restrictions, congestion data, weather conditions on roads and repair activity, has been implemented as a result of a coherent strategy. It has been stressed (CONDUITS, 2011) that the leadership of the national government has been crucial in developing the VICS programme through the coordination of a national public-private architecture with uniform communication protocols, and the development of a nationwide traffic digital network. In fact, the public-industry-academic coordination, initiated by the public sector, has been decisive in the success of VICS. The main reason behind the success of the Japanese traffic information system is the division of responsibilities between the public and private sectors.

In general, the overall strategy favouring the realisation of system needs in line with user needs should be focused on the capability to create win-win situations of co-operation among stakeholders, involving the co-ordination between public and private partners. It may be concluded that success stories deploying ITS applications have designed a triple helix approach based on a) public authorities (for funding and strategy), b) private sector (for development of solutions) and c) universities (for research).

Table 5-1 summarises the system requirements to reconcile the system needs with the user needs in terms of updated information, integrated ticketing and service quality along the entire multimodal and co-modal long-distance passenger journeys.

The implications in terms of pre-conditions are the provision of technical standardisation for data exchange and applications and a co-operative framework among stakeholders (including public-private partnerships). As a result, passengers of long-distance journeys will benefit from major information and better interoperability.

Table 5-1 Pre-conditions for a seamless entire long-distance intermodal and co-modal transport chain

Instruments to address critical areas (system requirements)	Critical areas for user and system needs		
	Multimodal information systems	**Integrated ticketing**	**Service quality**
Standardisation and interoperability (industry, transport operators, infrastructure managers)	• Common guidelines for data provision and exchange (Road, Rail, Air) • Implementation of Protocols TAP-TSI, ERTMS, ETCS (Rail)	• Ensuring interoperability of applications: chip, payments means, etc (Road) • Implementation of Protocols TAP-TSI, ERTMS, ETCS (Rail)	
Regulation • Market openness • Passenger rights compliance with EC Regulations	• Opening markets to new operators and transport services (Rail/Air/Road)	• Opening market to new operators (Road/Rail/Air)	• Passenger right: quality of trip, assistance, comfort (Coach/Bus) • Regulation on enforcement passenger rights in multimodal journeys
Stakeholder co-operation	• Public-Private partnerships (Road) • Co-operation among operators (Rail) • Co-operation among modes (Ferry/Air/Rail)	• Public-Private partnerships (Road) • Co-operation among modes (Ferry/Air/Rail)	

Concerning the individual transport modes, upgraded quality of service is mainly required for coaches and buses. Standardisation and interoperability will be needed for rail and road, while market openness is required by the air, road and rail sectors. Stakeholder cooperation and regulation is a cross-cutting system requirement common to all transport modes (air, rail, road and ferry).

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