INTERCONNECT

INTERCONNECTion Between
Short- and Long-Distance Transport Networks

DELIVERABLE D5.4

CONCLUSIONS AND RECOMMENDATIONS FROM THE INTERCONNECT PROJECT

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INTERCONNECT Project Office

Transport Research Institute
Edinburgh Napier University
Edinburgh, UK
Tel: + 44 131 455 2635
e-mail: h.condie@napier.ac.uk
Web: www.interconnect-project.eu

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EXECUTIVE SUMMARY

Interconnectivity in Europe

The statistical documentation concerning interconnectivity and long-, medium- and short-distance passenger transportation is not sufficient. There is a need for uniform principles in the EU for key definitions, surveys and gathering of statistical evidence.

The car is the dominant transport mode for passenger transport in the range of 100 - 400 km. However, in Switzerland rail carries nearly a quarter of all trips between 100 - 400 km, and in France, with its high-speed rail network, rail already carried nearly a quarter of all trips above 400 km in 1993.

It is argued that the fundamental problem areas of interconnectivity can be categorised as relating to legal, organisational, technical and financial issues.

Problems and solutions - studies of good practice

13 representative cases were selected form a larger number of possible interconnection nodes and analysed in relation to problems and solutions. The documentation of these case studies is a prime source of information for stakeholders working in the development of good interconnections. Some cases distinguish themselves as being particularly good examples with a significant reproduction potential in either methods applied and/or the tools used. The Frankfurt airport and the Helsingborg ferry terminal are examples of very different terminal purposes to be served, but in both several transport modes are interconnected in a comprehensive and innovative fashion, leading to substantial benefits for passengers and society.

The present EU policies and recommendations to the member states were analysed and reviewed in relation to the selected 13 representative cases. Some of the main results are that there is a need to further optimise the interfaces between transport networks and modes, addressing aspects related to design of interchanges, planning and services. In addition, stronger attention is needed to ensure a higher degree of adherence to the EU policies on the promotion of intermodality.

Strategic planning

National and EU strategic planning has been reviewed and analysed. There is a need for the EU to function as a driver of the development of better interconnections both at a strategic and a more practical level. Without a more active role of the EU and possibly the use of political instruments such as EU directives, this development will not ensure a coherent and cross-national strategic EU policy in passenger interconnections, safeguarding the integration and development of the EU, and ensuring the mobility needs of the EU citizens.

Tools for improvements

A comprehensive “toolkit” has been assembled following a systematic analysis of problems areas related to interconnectivity. The “toolkit” consists of 94 potential solutions to the identified problem areas systematised in seven solution categories.

Modelling interconnectivity

The possibilities to use modelling in the analysis of interconnections at an EU scale have been investigated, and the requirements for the development of such a tool have been elaborated. Following this analysis a specific modelling tool has been developed based on the EU “TRANS-TOOLS” model and used to take the analysis of interconnectivity further with a look into a possible future.

This exercise revealed some interesting issues and holds promise for further development. One key finding was that lowering the cost associated with an interconnection can, under certain conditions, lead to an increase in CO_2 emissions, and under other conditions (e.g. if favouring rail as transport mode) to a decrease in CO_2 emissions. This is an interesting result because it underlines the

importance of proper analysis of the consequences related to an interconnection, and also brings information on environmental and climate issues to the decision makers.

Recommendations for the future

Finally, a number of recommendations for the future are highlighted, derived from the overall work of the project and systematised in four categories: statistical evidence and data collection, future research and development, the possibilities of the EU and implementation of INTERCONNECT results.

1 GENERAL INTRODUCTION

Firstly, it is the intention of this deliverable D5.3 “Final Conclusions and Recommendations” to present a summary of the project’s main results in a brief form targeted at the EU stakeholders of interconnectivity. Second, the deliverable should be a guide to the documentation and substantial material available from the project amounting to around 2,000 pages of scientific and technical reports.

It must be underlined, that reading these “Final Conclusions and Recommendations” cannot be a substitute for the reader to study the original material in the form of the deliverables available from the project.

The INTERCONNECT project responded to the call for proposal addressing topic TPT.2008.13. (*New mobility/ organizational schemes: interconnection between short and long-distance transport networks*). The call identified five specific issues (reproduced below).

- “Enhancing co-ordination between decision-making levels on issues related to the interconnection of transport networks of different scales and modes, addressing institutional, legal, design, planning, technical and deployment aspects.”
- “Identifying the state of the art of interconnectivity between transport networks by analyzing current research results and “pre-deployment” activities in the field, in particular to present progress already made with regard to the interconnection of transport networks”.
- “Establishing good practices and explore key issues which have not yet been adequately addressed.”
- “Proposing future requirements and actions to be taken.”
- “Disseminating results to a broad range of actors in the transport field, specifically policymakers and transport operators at all levels.”

The project has responded to these objectives by working systematically over 24 months. Integrated in the work of the project were the following scientific and technical objectives:

- To produce quantitative evidence on the current and likely future extent and impacts of poor interconnectivity between long-distance and local/regional travel in Europe;
- To provide evidence on key stakeholders’ perceptions of the underlying causes of the problems and of the applicability of specified solutions;
- To identify and investigate gaps and apparent inconsistencies in the European and national strategic planning concerning interconnection;
- To provide an analysis of evidence on the nature and seriousness of identified barriers to effective interconnectivity;
- To provide an assessment of the effectiveness of available analytical tools for the assessment of problems and solutions in this domain;
- To provide an assessment of the performance of selected policy interventions designed to improve interconnectivity in specific situations;
- To provide evidence on the potential impact of improved interconnectivity on a European scale in particular, though not only, on
  - Decongesting overcrowded transport corridors,
  - Encouraging a shift towards the more sustainable transport modes, and
  - Reduction of Green House Gas (GHG) emissions;
- To provide policy guidance on good practice in implementation of improved interconnectivity; and
- To disseminate project findings widely to policy-makers

The detailed final report on these scientific and technical objectives will be a part of the formal project report to the EU Commission.

These “Final Conclusions and Recommendations” relate primarily to the overall objectives of the project as they are stated in the call for proposals above.

The project started with a review of published data on long-distance travel within Europe, combined with an analysis of literature on the problems of poor interconnection and on solutions which have been proposed or introduced. This was followed by a more detailed thematic consideration of potential solutions, by identification of case studies and test beds for solutions and a review of the state-of-the-art on strategic planning at the EU and the national levels. Finally, the project looked into the future by developing and using a modelling tool based in the EU TRANS-TOOLS model that allowed for the modelling of interconnections.

In the following chapters the project’s material and documentation is summarised with a focus on conclusions and recommendations.

At the start of each chapter there is a short introduction to the content and subject of the chapter. At the end of each chapter the possibilities of reading more and/or finding the original documentation are introduced through a reference to the relevant deliverable(s) or parts of deliverables from the INTERCONNECT project.

2 INTERCONNECTIVITY IN EUROPE

2.1 INTRODUCTION

The project started with a review of published data on long-distance travel within Europe, combined with an analysis of literature on the problems of poor interconnection and on solutions which have been proposed or introduced. This chapter summarises the main results of the review on quantitative and qualitative data, describing the present situation on interconnectivity in Europe.

2.2 INTERCONNECTIVITY IN EUROPE - THE CURRENT SITUATION

The analysis of the available statistical evidence on long-distance intermodal travel indicates that very few surveys have recorded detailed information about multimodal journeys. Despite this, the analysis of available data suggests that the car is the dominant mode of travel on trips shorter than 400km, with a market share between 70-80% in most European countries. On longer journeys its share stays below 45% (and is much lower in insular countries with limited international road links) with air transport taking a large proportion of trips.

Although rail travel does not generally attract more than around 10% of all trips, there are some notable exceptions. In Switzerland, well known for its comprehensive and well integrated public transport system, rail carries nearly a quarter of all trips between 100 and 400 km, whereas in France, with its high-speed rail network, rail already carried nearly a quarter of all trips above 400 km in 1993.

With respect to the access and egress portion of trips, active modes were found to be the dominant form of travel to reach coach services, especially at the destination end, which seems to suggest that the catchment area for this type of service is relatively limited. Travel to/from rail stations tends to rely on a more balanced range of modes, possibly reflecting better public transport accessibility and wider catchment areas. In most countries, urban public transport is preferred in 25% to 35% of trips. This proportion is usually higher at the origin and lower at the destination ends, which suggests that passengers prefer to use public transport networks they are more familiar with. Travel to/from airports relies heavily on car and taxi, although rail is used on over 10% of trips in the UK, Sweden and Germany. Overall, the analysis has shown that intermodality is present in a large proportion of long-distance journeys and is in fact critical for journeys above 400 km where the car is a less viable alternative.

Many of these journeys are also likely to cross international borders and therefore may need to overcome additional barriers such as language. While the dominance of the car may be seen as a symptom of the shortcomings of the existing public transport system, there are some encouraging signs regarding the extent to which well integrated public transport systems (e.g. Switzerland) can promote intermodal public transport trips.

A review of problems has identified a number of specific problem areas, namely:

- wasted time – delays to journeys caused by slow links, inefficient interchanges, etc;
- high costs – financial costs that are incurred because of poor interconnection;
- poor information – problems caused when information is poorly packaged or presented;
- poor quality of service – problems associated with poor quality links or interchange.

At a broad level it is argued that the fundamental problem areas can be categorised as relating to legal, organisational, technical and financial issues.

2.3 FURTHER INFORMATION

For further information on quantitative evidence and the analysis of the present situation in Europe please see:

- “Status-Quo in Interconnections for Passengers” (INTERCONNECT Deliverable 2.1)

3 PROBLEMS AND SOLUTIONS - STUDIES OF GOOD PRACTICE

3.1 INTRODUCTION

Based on the analysis of the present situation in Europe and the collected quantitative data, the INTERCONNECT project has investigated the present problems and solutions further through studies of good practice in Europe. A large number of case studies were identified in Europe and specific interesting examples were then analysed in-depth for specific issue areas in relation to interconnectivity.[1]

Following this general analysis of the specific cases they were further scrutinised in relation to present EU policies on transportation and interconnectivity. [2]

3.2 SOLUTIONS AND OPPORTUNITIES

3.2.1 Introduction to the Selected Case Studies

The goal of this part of the project was to identify existing good practice and potential solutions, analyse these solutions and establish their likely contribution to improved interconnectivity in European transport networks, and to identify existing problems still to be solved.

A total of 13 cases were selected in four groups, namely airports, train stations, ferry terminals and other case studies where several modes carry similar weights.

3.2.2 The Selected Case Studies

The ***Frankfurt airport interconnections*** case study analyses the state of land interconnections at Frankfurt airport, i.e. how the airport is interconnected with urban, regional and long-distance rail services and with the road network. It especially deals with the fact that besides the rich interconnection with the highway network, the incorporation of the airport into the high-speed rail system (HSR) has been a big step forward to increase the intermodality at the airport and this, together with the co-operation between air and rail operators for through-ticketing, constitutes an element of good practice. This case study argues that the improvement of the rail-airport interconnection and operator co-operation has resulted in substantial rail demand at the airport, allowing liberation of slots from no longer necessary feeder flights to be used for other long-haul flights, therefore improving transport co-modality.

The ***Catalan airport system interconnections: Barcelona, Girona, Reus and Lleida*** case study discusses the interconnections of Reus, Barcelona, Girona and Lleida airports with regional transport networks and also with their corresponding city centres. All airports are located within 200 km of each other, and the new HSR line will pass within reach of all of them. The interconnection of airports to the HSR is intended to create a network of specialised airports, with small airports being able to provide the capacity that Barcelona will lack sooner or later. But the interest and feasibility of these rail connections have always been under debate and now they are just partially achieved. This case study concludes that it is difficult to plan optimal solutions in a multiple stakeholder framework and a highly populated territory. It has also pointed to the fact that designing optimal interconnections requires ad-hoc solutions for choosing best transport modes in each case. Territorial impacts beyond optimisation of travel times and travel costs are to be taken into account in the long-term impact appraisal.

The ***Milanese airport system interconnections: Malpensa, Linate and Orio al Serio*** case study looks at the condition of interconnectivity at the airports of Malpensa, Linate and the low-cost airport of Orio al Serio. All are located around Milan within a radius of 60 km, at the core of the densely populated Lombardy region. Following the trends all around Europe, the passenger traffic of these airports, with the exception of Malpensa, has been growing during the last years, especially in Orio al Serio, which has become the main Ryanair hub in Italy and has climbed to the fourth position of Italy‘s

[1] “Factors affecting Interconnectivity in Passenger Networks” (Deliverable D4.1)
[2] “Impacts of improved Interconnectivity on a European Scale” (Deliverable D5.1)

busiest airports in 2009. The case study analyses the typology of air traffic in the airports, their connection with Milan and the rest of the region, their connection airport to airport, and their links with the long-distance national network. The case study concludes that the lack of adequate planning has resulted in poor interconnections in the Milan area, with long-distance rail network connections missing in Malpensa, an absence of reserved road infrastructure for public transport even when access roads to the airports in Milan are congested, and missing passenger facilities at terminals that would increase interconnection quality. Most worryingly, the completion of planned infrastructure is affected by great uncertainty.

The ***Scottish airport system interconnections: Edinburgh, Glasgow and Prestwick*** case study analyses the issues concerning the competition between the three Scottish airports, and more crucially, the connections between them, their connections with the conurbations of the so-called "central belt " around Glasgow and Edinburgh, where the majority of Scotland's 5 million inhabitants live, and the large but sparsely populated rest of Scotland. Although Scotland comprises a land area of nearly 80,000 km^2, Glasgow and Edinburgh airports are only 67 km apart from each other, and Prestwick, a third major airport, is just 41 km to the south-west of Glasgow. Glasgow and Edinburgh cater for all types of flight operators, while Prestwick focuses on low-cost airlines and holiday tour operators. Out of these three airports only Prestwick has a direct rail connection, and the three are only interconnected by very busy motorways. The current express bus services to Edinburgh and Glasgow airports are of high quality and attract large patronage, but the case study concludes that even if infrastructure costs are not likely to be recovered rail services serving airports can be profitable and would certainly significantly increase the use of public transport by air travellers.

The ***Leeds railway station*** case study deals with the interconnectivity of rail in one of Britain's most significant railway stations, which in the past decade has seen a number of enhancements designed to, or having the effect to, enhance interconnectivity via the improvement of access and egress. The rail reforms of the past 15 years have, throughout Europe, dismantled barriers to the new entry of operators into local, regional and national rail markets in order to promote competition and a more vibrant rail industry. In most cases there are now more – sometimes considerably more - actors involved in the planning, development and operation of rail services than ever before. Through the analysis of the case of Leeds station, this case study focuses on the interface between national, regional and local rail networks within this framework of increased competition and fragmentation of the industry, a process which has brought new opportunities in terms of competitiveness and innovation, and challenges particularly in relation to the maintenance of an interconnected network of rail services for passengers. The case study concludes that while passenger figures increased at Leeds railway station over the last 10 years, there is a lack of evidence that the observed growth is related to the enhancements undertaken at the station, while it is not clear whether or not competition promotes interconnectivity or detracts from it.

The ***Milan railways node*** case study analyses the current level of interconnectivity of rail networks in Milan and the existing plans concerning future connections with the new high-speed rail services, providing useful elements concerning good and bad practice from several points of view, in particular with the issues regarding interconnection at stations, accessibility of stations, services for the airports and integration of fares***.*** Milan is a key node of the rail network in northern Italy, linking long-distance routes to the regional network (operated by two separate companies on two independent infrastructures), to the local transit system of the main business metropolitan area in Italy and, in principle, also to the Milan airports. Continuous efforts have been made for improving the interconnections with local public transport as well as with the underground network, so that all the main rail stations are currently reachable by at least one metro line and by bus or tramway. On the other hand, the lack of harmonisation between the services of the multiple providers, a minimum-stage ticketing integration and the lack of user information and scarcity of facilities to reduce transfer times at interchange points, leaves room for improvement in the future.

The ***dual-mode railway system: the Karlsruhe model*** case study analyses the solutions of interconnectivity established in Karlsruhe concerning the urban tram system and its integration on the suburban railway network through TramTrains, constituting a case of good practice in interconnectivity. Karlsruhe trams run on the urban light rail system and on the heavy rail tracks of the German railways (Deutsche Bahn), allowing for tramway and suburban rail networks to operate together with relatively moderate investment requirements. In addition to the technical aspects concerning the tracks and the vehicles, this case study analyses the advantages, limitations and

shortages of the model, concluding that it fits mostly in medium-sized urban areas with non-centrally located rail stations, resulting in important growth of passenger figures - including substantial catchment from private modes - and providing excellent cost- benefit ratios and helping relieve deficits of public transport.

The ***train-taxi and feeder bus services*** case study focuses on different concepts developed in the attempt to encourage travellers to take the train instead of the car in long-distance and inter-regional journeys, by providing information and services that would help these travellers to overcome a key barrier, the "final few miles", corresponding to access and egress to and from train stations. The UK train-taxi (T-T) service provides on-line information about taxi services serving the UK's rail, tram and underground stations, while the Dutch T-T version provides discounts on the costs of taxi travel, if journeys are shared both to and from the train station. More recently, Plusbus in the UK offers an optional ticketing add-on when purchasing a train ticket, which allows a train traveller unlimited travel on the buses serving both the origin and destination urban area on the day of travel. This case study concludes that where services are relatively inexpensive to operate, such as UK's T-T and Plusbus, they have been successful in the past, while high costs have made the Dutch T-T system difficult to sustain, resulting in a 65% offer reduction over the last 15 years. Large scale network coverage is usually beneficial for these schemes to be functional and attractive to customers.

The ***Amsterdam ferry services*** case study focuses on the efforts that are being made in the Netherlands to increase the interoperability of different transport services and to co-ordinate and synchronise tariff and ticket systems. The geographic location of Amsterdam has traditionally allowed the development of waterborne and land transport in parallel, creating a high level of accessibility, but resulting also in a significant number of different operators. A mobility card has been introduced, allowing seamless transfer between modes to overcome barriers to interconnection, and provides at the same time new technological possibilities to assess and manage mobility. The top-down approach in the process of transport integration, which has been driven from a national perspective so as to integrate all public transport within the Netherlands, has resulted in the need for a synchronisation between large numbers of parties, but there seems to be a high notion of co-operation between these parties towards a single goal. This case study concludes that ticketing in Amsterdam is moving from a modal or operator led approach towards a mobility approach, but it also questions who is the overall beneficiary of the new system, even when integration and interconnection between operators has the potential to increase services and to expand the reach of the transport network, pointing out that emphasis should be placed on the analysis of the user benefits of current developments.

The ***Lisbon ferry services*** case study aims at exploring the driving forces that have maintained the ferry services in the Tagus river, even after the construction of bridges which brought significant competition from road and rail traffic. Lisbon has an intensive network of ferry services across the river, despite the imposing Ponte 25 de Abril bridge which links the two sides of the city and carries both rail and road traffic. Even a car ferry service has survived the arrival of the bridge, unusual in such circumstances. The case study identifies diverse elements of good practice which can help explain the survival of ferries, among them the co-operation (and finally merging) of the two operating ferry companies, the improvement of terminals for easier interconnection to other means of transport, the investment in boat renewal, which has resulted in decreased travel times, and the introduction of smart cards to overcome a complex fare system.

The ***ferry terminal of Helsingborg*** case study focuses on the strategies which have made the ferry services between Helsingborg and Elsinore a competitive means of transport, even after the construction of the Øresund bridge. With more than 11 million annual passengers, the port of Helsingborg is one of the busiest ferry ports in the world. In the 1980s a decision was made to create a central terminal for all modes of public transportation in Helsingborg, located right at the port, facilitating direct and rapid interchange between the ferries and all modes of public transportation. The terminal incorporates two former train stations, the central bus station and the ferry terminal, and currently serves local, regional and national trains and buses to and from Helsingborg, and boat services to Elsinore. This case study concludes that the project was only possible due to intense institutional co-operation and understanding, and identifies additional elements of good practice such as the design concept of the terminal which targeted easy interconnectivity, and the co-operation of ferry operators to take account of each other's timetables and to increase service quality.

The ***ferry terminal of Rostock*** case study analyses the case of Rostock as an example of a harbour where interconnectivity of transport networks for non-motorised passengers has for a long time been neglected as the majority of passengers travel by car or bus. This case study argues that the lack of investment made to improve conditions for the non-motorised segment in the terminal has led to decline and poor conditions of access to and egress from the terminal. The case study explores solutions that have been more recently implemented or which are being planned for the future to improve this situation. A shuttle bus link connecting the passenger terminal with the city centre and the rail station is planned, saving non-motorised passengers at least 20 minutes of travelling and waiting time. The shuttle will run during a trial period from May 2011 until December 2011. A joint ticketing scheme will be in place with one ticket valid for both the ferry and the buses on both shores.

The ***Tri-City: Gdansk / Sopot / Gdynia*** case study focuses on the discussion of the many interconnectivity challenges that the Tri-City region is facing in the next years, identifying potential solutions already envisaged. The analysis involves several transport networks in this dense Polish urban agglomeration. The Tri-City and its metropolitan area concentrate 55% of the region's population; two Pan-European transport corridors run through the region, and although there are two major seaports in Gdansk and Gdynia, ferry links are not very well developed and many direct connections were abandoned during the economic transformation. Lech Walesa airport operates domestic connections to Warsaw and direct international links to European airports served by 13 airlines; a new terminal and airside constructions are underway and a direct rail link to the airport is planned. Urban public transport requires improvement to increase efficiency, as do the rail and the road networks. The case study shows that interconnectivity is a priority for local and central administrations, having a clear vision that there is a need to improve services to increase regional attractiveness. Financial requirements are seen as the most important barrier to improvement, with rivalries between the two major cities of Gdansk and Gdynia being another barrier.

3.2.3 Conclusions on the Analysis of Case Studies

Following the review of the 13 cases and other studies, conclusions can be categorised as follows in four result clusters.

Conclusions on infrastructure planning

Interconnections typically involve significant resources; integrated planning and management of interconnections is a key element to properly achieve social and economic profitability of investments and positive network effects, especially in small and medium-sized terminals.

Interchanges between long-distance rail and airports are effective in large international airports with large catchment areas and can be financially sustainable and reinforce co-modality. Interconnections need to be well designed to minimise travel time increases to other rail users with non-airport related trips. The cost and complexity of implementing new rail connections to airports from city centres makes them difficult in small and medium-sized airports. However, if properly planned and managed, positive network effects can be achieved. New and upgraded rail connections to cities tend to be effective for large airports, but involve complex planning decisions because of intensively occupied urban and peripheral-urban areas (e.g. Barcelona, Malpensa).

New rail interconnections between airports within a region have a marginal interest, even when involving large airports (e.g. Scottish, Catalan and Milanese airports).

There is a need for building segregated public transport infrastructure (bus platforms, metro extensions) in dense metropolitan areas with congested motorways, in order to make public transport more efficient, even if demand is relatively low. The infrastructure cost is unlikely to be recovered in the case of investments related just to provide missing interconnections.

Conclusions on service management

It is necessary to favour co-modality through serving interconnections with the most efficient travel modes in each case and thinking of specific solutions for different situations. Interconnections are to be served with most efficient travel modes in each case. The use of rail, tramway, bus, or demand-responsive solutions in interconnections needs to respond to specific demand requirements in order to be economically sustainable in their operation. Heavily subsidised systems are vulnerable to general economic cycles (e.g. Dutch T-T concept).

Conclusions on organisational issues: institutional complexity and stakeholders goals

Organisational issues in planning interconnections when negotiation involves multiple stakeholders can become difficult. Strong political debate on this kind of project results in cost increases and substantial delays in project timing. Integrated transport systems can provide frameworks for different kinds of co-operation among transport operators. In Lisbon where the regulatory framework was not sufficiently developed, the OTLIS framework provided a supra-operator organisation to co-ordinate issues in each market to the successful implementation an intermodal system. In Helsingborg the two ferry operators co-operated to provide a more efficient service to compete with the Øresund bridge link. The example of the Tri-City in Poland nevertheless shows that financial requirements are often an important barrier to integration.

Conclusions on intelligent transport systems

ITS can provide effective tools to improve interconnectivity and service quality. In Amsterdam smart cards allow for more efficient ticketing schemes, encouraging the use of public transport and increasing the interoperability on all Dutch public transport services, but also improving service management e.g. with line operation (via GPS) data, vehicle occupation and passenger flows. In Lisbon, smart cards have been a tool to overcome very complex fare systems.

3.3 CASE STUDIES AND EU POLICIES ON TRANSPORT AND INTERCONNECTIVITY

3.3.1 Overview of Themes and Case Studies

The selected case studies were reviewed on the degree of consistency with the EU interventions in the field of transport interconnectivity, while eventually identifying the most significant deficiencies, gaps and areas requiring future further intervention on transport interconnectivity.

The cases are discussed in relation to the following five main themes for the EU policies:

- network and infrastructure;
- quality of the interchange;
- integration of transport operators;
- planning process;
- promotion of intermodality.

The main findings of the cross-comparison between themes are summarised in Table 3-1.

Table 3-1 Overview per theme and case study

Case study	Network and infrastructure	Quality of interchange	Integration of PT operators	Planning process	Promotion of intermodality
Frankfurt Airport Interconnections	High	High	Medium	High	High
Catalan airport system interconnections	Medium	Medium	Low	Medium	Medium
Milanese airport system interconnections	Medium	Low	None	Low	None
Scottish airport system interconnections	Medium	Low	Low	Low	Low
Interconnectivity of rail at Leeds railway station	Medium	Medium	Medium	Low	None
The Milan railways node	Medium	Low	Medium	Low	None
The dual-mode railway system: the Karlsruhe model	High	High	High	High	High
Train-Taxi and feeder bus services	Low	Medium	Medium	Not relevant	High
Amsterdam ferry services	High	Medium	Medium	High	Medium
Lisbon ferry services	Medium	Medium	Medium	Medium	Low
Helsingborg ferry terminal	High	High	High	High	High
Rostock ferry terminal	Low	Low	Low	Low	None
Tri-City Gdansk / Sopot / Gdynia	Medium	Low	Low	Medium	Low

3.3.2 Results of the Analysis

The results achieved through the cross-comparison revealed the major critical issues to identify best practices and to outline domains where future actions are advisable.

Network and infrastructure

Creating a converged infrastructure backbone enables interchanges to be strongly interlinked and accessible not only at a micro-level (regional/local network) but also at a macro-level (TEN-T network). Given that many of the case studies concern airport infrastructure, the issue of their interconnection with the short- and long-distance networks is key because of the need not just for making the airports accessible, but more remarkably to make them a core and functional part of the network as a whole.

Besides encouraging travellers to shift from car to rail for reaching the airports, this would also allow a greater degree of integration between air and rail, where the former might benefit from the availability of long-distance rail or HSR services departing from and arriving at the airports.

Improving the network and its infrastructure, and consequently the integration between transport modes for both short- and long-distance journeys, is a key issue for a number of case studies, such as the cases of the Amsterdam and Lisbon ferry services, and the TramTrain system in Karlsruhe. Here high relevance is given to the integration of terminals' interchanges, which is viewed as a major path for offering multimodal travel options.

Quality of the interchange

Interchanges are a crucial "break" in the trip chain as they produce important effects on how travellers perceive the overall quality and smoothness of their journey. This applies to not only the amount of time travellers spend waiting and/or transferring between modes, but also to what extent the interchange is designed to make the transfer from one mode to another easy and convenient accessible.

Quick and easy interchanges are also essential to increase the attractiveness of interconnected transport services as an alternative to car usage for an entire long-distance trip. This calls for the implementation of more integrated timetables, availability of door-to-door information (pre-trip and on trip), integrated ticketing and fares, integrated booking and payment systems, and handling of luggage.

These requirements are fully and optimally embedded in: the interconnections at Frankfurt airport, the Helsingborg ferry terminal, and the Karlsruhe model of dual-mode railway system case studies, which might be viewed as the best case studies for this theme. Here, an ideal interlinking between the "hard-side" and the "soft-side" of the infrastructure is present, since not only easy and conveniently-designed access to a range of interlinking modes is provided, but also a vast array of through-services are implemented to provide travellers with the experience of a seamless journey.

As shown by the Helsingborg case study, appropriate design of terminals and high-quality facilities available to both passengers and operators (for instance by making use of horizontal layers making interconnection to different transport modes), is a way to encourage integration.

When compared to the EU policy work aiming at improving quality of interchanges, and consequently interconnectivity between short- and long-distance journeys, shortcomings can be noted in the existing practice related to five other case studies: the Catalan airports, the interconnectivity at Leeds railway station, the Train-Taxi and feeder bus services, and the Amsterdam and Lisbon ferry services. For these case studies the quality of both design of interchanges and services might be generally rated as good, but significant improvements are possible.

Integration of transport operators

In general the case studies highlight a growing attention to this theme. Even though an effective integration of all transport operators is still not completely achieved, the cases generally reveal the existence of different forms and degree of integration; only five of them perform poorly in this respect.

Complementary to the integration at the level of services (ticketing, luggage handling, information etc.), the organisational integration among transport operators is a further key element for making interconnectivity successful and for achieving a shift from a modal/operator-oriented approach to a broader and more comprehensive "*mobility approach*".

Though not easy to achieve, solid and fair joint partnerships and voluntary agreements enable transport operators to increase patronage and quality of transport services by optimising their provision. A further advantage is the possibility to exactly frame the division of traffic revenues between operators, which might result in increased transparency in the fare system.

Moreover, integration offers transport operators the opportunity to plan and market their transport services as a unified whole under a common brand image, thus increasing their attractiveness to the general public and presenting a co-ordinated transport strategy and vision as well. Finally, where integration works at the level of networks, information and ticketing systems and involves all combinations of local/medium/long-distance transport options, there is also the important advantage to always provide travellers with alternative transport solutions and the possibility to use another mode/operator if there are delays, or if a passenger is late for a connection.

Planning process

The "planning process" refers to the need to set up organisational structures that should ensure an integrated planning approach, to make the interplay between networks easier. This calls for a large involvement of all relevant stakeholders, not only including authorities and transport companies

traditionally responsible for the development and ownership of the interchanges, but also of other stakeholders that could contribute to the further development of the interchanges.

In this regard, four case studies (the Frankfurt airport system, the Karlsruhe TramTrain, the Helsingborg ferry terminal and the Amsterdam ferry services) score a "high" value and, thus, might be taken as reference as best practices for implementing a sound planning approach, which is able to deliver a balanced development of transport infrastructures and interconnections. The Amsterdam case study is also of particular interest in this respect, as here integrating ticketing was one of the main levers for promoting a multi-stakeholder approach, involving both public and private actors.

Conversely, with the exception of the Train-Taxi feeder services for which the theme was judged as not relevant, the other case studies show several rooms of improvement. Deficiencies are primarily due to:

- a lack of a comprehensive planning approach and the subsequent low degree of cohesiveness;
- a lack of co-ordinating authorities even when plans, objectives and targets are set out;
- a different timing and scheduling between the responses from the public authorities and the investment choices made by private actors;
- differences in interests between local and national stakeholders, reflecting their different and sometimes conflicting priorities in terms of prioritisation between accessibility (referring to short-distance travels) and interconnection (referring to long-distance travel).

Promotion of intermodality.

Promotion of Intermodality offers a fairly patchy situation and highlights the need for additional efforts. Intermodality needs to be properly advertised and promoted in order to enable users to improve their knowledge about not only the existence of intermodal and interconnected transport services, but also the opportunities they may offer (reduced travel time, reduced waiting time at interchanges, more comfort, etc.).

Broadly, the extent to which promotion of intermodality is achieved is dependent upon two main factors:

- the existing degree of integration among transport operators; and
- the availability of a vast range of services travellers are provided with.

Therefore, it is not a surprise that those case studies that perform the best in the two domains listed above are also the case studies scoring "high" values as far as the promotion of intermodality is concerned (the Frankfurt airport system, the Karlsruhe TramTrain, and the Helsingborg ferry terminal).

Important advances in this area are achieved by two other case studies: the Train-Taxi feeder service and the Catalan airport system. The former provides a good example of promotion and marketing of intermodality by partners from different modes of transport, where emphasising a single brand has enabled the transport operators involved to make their branding and promotion stronger, whilst benefiting from cost economies at the same time. The latter has similarly put in place some efforts for establishing a common corporate image for all transport operators within the regional framework, even though further interventions are needed for improving users' awareness of public transport and information services.

Conversely, in the remaining case studies promotion of intermodality does not emerge as a first priority. This is confirmed by the fact that for four of them (the Interconnectivity of rail at Leeds railway station, the Milan airport system, the Milan railways node and the Rostock ferry terminal) no promotion of intermodality exists, while for the remaining ones (the Scottish airport system, the Lisbon ferry services and Tri-City) advertising is limited if existing at all.

3.3.3 Conclusion on EU Policies and Cases

The following recommendations can be drawn from the analysis of the cases:

- There is a need to further optimise the interfaces between transport networks and modes, addressing aspects related to design of interchanges, planning and services.
- Interchanges are a core and functional part of the network as a whole. Accessibility itself is not enough.
- Voluntary agreements and/or co-operation schemes where operators see win-win situations might be intermediate formulae that allow different transport actors to achieve a common strategy although maintaining the possibility to act independently.
- Interconnections between short- and long-distance legs and the related land-use developments should be incorporated in the planning process as early as possible in a planning process.
- Public authorities need to secure consistency and timing in decision-making in relation to investment choices, land use and involvement of operators.
- Stronger attention is needed to ensure a higher degree of adherence to the EU policies on promotion of intermodality.

3.4 FURTHER INFORMATION

For further information on the analysis of the present problems and solutions please see:

- On analysis of the present situation in Europe, studies of good practice in Europe (case studies) and in-depth analysis for specific issues in relation to interconnectivity: “Factors affecting Interconnectivity in Passenger Networks” (INTERCONNECT Deliverable 4.1)
- On selected cases scrutinised in relation to the present EU policies on transportation and Interconnectivity: “Impacts of improved Interconnectivity on a European Scale” (INTERCONNECT Deliverable D5.1 chapters 1 to 4.)”

4 STRATEGIC PLANNING

4.1 INTRODUCTION

In collaboration with the EU HERMES project, the state-of-the art of policy and strategic planning in the EU has been investigated. National planning documents from all EU countries, and all relevant policy recommendations, policy decisions and similar documents in the EU have been investigated.

There are two organisational levels engaged in policy and strategic planning on interconnection: the EU and the EU member state level. The EU has a key role in defining the policy objectives (which may be transformed into legislation) and the technical standards creating the base for interconnectivity. The member states contribute to the extent they align with and transform into their respective legislation the policies and standards of EU established framework (the principle of Subsidiarity). On the issues related to passenger transport interconnectivity, EU directives and similar more formal EU policy enforcement tools have been used only to a very limited extent up to present time.

4.2 STRATEGIC PLANNING AND POLICY-MAKING

There is substantial scope for improvement of the interconnections between the long-distance and the medium/short-distance passenger transport systems in the EU, although most key European transport nodes have good interconnections to both local/regional and long-distance networks.

The strategic policies of the individual member states of the EU are hardly sufficient to cater for the needs of EU-wide intermodal passenger transport. Formal EU policy decisions could therefore serve two different purposes: first of all to mend the consequences of the present inability to formulate relevant national strategic policies, and further, to ensure a coherent and cross-national strategic policy covering the entire EU, to safeguard the integration and development of the more peripheral areas, and to take account of the needs of the EU citizens without access to a private car.

In addition to the formulation of overall EU strategic policies, there is a need for intermodal initiatives to improve the passenger transport systems of Europe. Three areas are of specific importance: improved physical infrastructure (especially intermodal terminals); technology facilitating passenger intermodality; and policy and legal frameworks facilitating intermodal co-operation.

The joint work of the two projects HERMES and INTERCONNECT documents a lack of focus and need for formal authoritative decisions on interconnections in passenger transport at both the EU and the national level.

Furthermore, this lack of focus has negative consequences on the coherence of passenger transport in the EU. In addition, it is also shown that there is a substantial scope for improvements to the interconnections of passenger transport in a number of strategic areas, and the essential elements of strategic policies at each of these areas are highlighted.

In the following a summary of main findings are given relating to:

- general EU policy review;
- special aspects of EU policy;
- national policy review.

4.3 GENERAL EU POLICY REVIEW

A selection of relevant EU policy issues was investigated, and focal points derived from an analysis of formal authoritative decisions (EU Directives, formal decisions form the EU Council etc) and other forms of EU policy related material, such as “green papers”, action plans, guidelines, “white papers” and similar.

These focal points are:

- pushing major infrastructure projects;
- fostering the development of a European high-speed rail network;
- improving railway interoperability;
- integrating network planning and spatial planning;
- integrating European and regional transport networks;
- enhancing airport accessibility;
- enhancing regional accessibility;
- improving intermodality at terminals;
- fostering co-modality and complementarity among modes;
- aiming to achieve ease of intermodal trips;
- motivating the use of Intelligent Transport Systems (ITS);
- enforcing passenger rights.

The state-of-the art on the interconnectivity between transport networks was identified. An assessment of network performance was made by analysing current research results and applied activities in the field of interconnection of transport networks. Furthermore, the most crucial barriers and the emerging policies which must be further promoted were identified and analysed. This was also done with respect to the main business models presently used for upgrading the international passenger intermodal system.

The findings can be summarised as follows:

In general, the present gap between formal and authoritative strategic policy decisions, and the actual EU strategic policy issues concerning passenger intermodality and interconnections highlight the need for an overall and formal strategic EU policy in three strategic areas:

- *Physical infrastructure* (especially intermodal terminals).

  There are substantial differences in the quality of the passenger infrastructure in the EU. A terminal for intermodal exchange of passengers cannot be isolated from the development of passenger transport modes, and visa versa. In general an EU policy driving the development of infrastructure and the related intermodality could be a driver for the integration of EU.

- *Technology* facilitating passenger intermodality.

  An example is the success of computer reservation systems of the airline industry. A similar system covering several or preferably all inter-EU passenger transport modes would be a substantial advantage.

- *Policy and legal frameworks* facilitating intermodal co-operation.

  An example is the creation of common EU standards to facilitate technological development and preventing the development of national suboptimal standards, especially concerning passenger ticketing, passenger information and passenger reservation systems. Another example is to set up minimum standards for the intermodal connection terminals important to cross-national passenger movements, as well as for interconnections of national importance, thereby creating a feeder system facilitating international passenger mobility.

4.4 SPECIAL ASPECTS OF EU POLICY

A selection of specific EU policy issues has been investigated:

- The first is the social cohesion and accessibility and addresses the present provisions of interconnection between local and intercontinental networks by European transport networks.

- The second is the interconnections in key European transport nodes, and addresses the quality of interconnections between key European transport nodes and local/regional and long-distance networks.
- The third is on TEN[3] in relation to rail and coach services and addresses consequences for effective interconnection of major rail terminals and of long-distance coach services, if they are included in or excluded from the designated TEN.
- The fourth is the effects of the "Open Skies Policy", to the de facto hub and spoke structure of European airports and the airports interconnections.

The findings can be summarised as follows:

- Access to passenger interconnections is important for development of the peripheral regions and the cohesion in the EU.
- Major key European passenger transport nodes have good interconnections to both local/regional and long-distance passenger transport networks.
- Exclusion of rail and coach modes from the designated TEN would reduce accessibility in the EU and the free movements of EU citizens, especially in peripheral areas and for people who depend on public transport.
- The "Open Skies Policy" does not change the hub and spoke structure of airports, but growth of low cost carriers at secondary airports is a challenge to improved interconnectivity between passenger transport modes.

4.5 REVIEW OF NATIONAL STRATEGIC POLICIES ON INTERCONNECTION

The review of the national strategic policy documents has been made on a country-by-country basis. This included four elements; first a review of relevant documents, including a short description of elements of relevance to interconnection; secondly an assessment of the level of focus on interconnection in national policies; thirdly a review of whether there are any relations to TEN in the policy documents; and finally a classification of the documents in relation to six strategic characteristics of interconnection, and the relevant modes of transport. These systematic national reviews constituted the basis of the analysis and the following conclusions on the present national strategic policy of the EU countries.

The findings can be summarised as follows:

- In general, there is a lack of focus on interconnections in national policy documents.
- New/improved links seem to attract more attention compared to e.g. legal and organisational arrangements.
- There is more focus on interconnections to rail and air than to ferries.
- The overall lack of focus in national strategic policy formulation leads to a rather uniform situation within the member states of the EU, with no major differences between countries: passenger interconnections are made without an overall strategic guidance.

4.6 FURTHER INFORMATION

Further information, details of the analysis and documentation can be found in:

- "The Role of the European and National Policies in Improving Interconnectivity for Passengers" (INTERCONNECT Deliverable 2.2)
- "Impacts of improved Interconnectivity on a European Scale" (INTERCONNECT Deliverable D5.1 - Chapter 2: "Domains of EU Policies and Activities Impacting on Interconnectivity")

[3] TEN - Trans European Networks (http://ec.europa.eu/ten/index_en.html)

5 TOOLS FOR IMPROVEMENT IN INTERCONNECTIVITY

5.1 INTRODUCTION

Derived from the analysis of the qualitative and quantitative evidence on interconnectivity in Europe and the thorough analysis of the large number of case studies, the investigation was taken further by creating a toolkit for interconnectivity stakeholders with the ambition of collecting and presenting all relevant information on the concrete aspects of interconnectivity.

5.2 THE TOOLKIT OF SOLUTIONS

The INTERCONNECT scope is by definition limited to trips of at least 100 km which include use of at least one short-distance feeder/distributor journey stage. This part of the project is concerned with improvements to the short-distance feeder stage(s) and with their interconnection with the long-distance stage. Improvements to the long-distance stage are out-of-scope, as are any improvements at airports that are not on land-side, including all security procedures.

The key problems of poor connectivity are associated with:

a. Non provision (or inadequate standard) of the infrastructure for local links
b. Poor design, maintenance or operation of modal interchange points
c. Inefficient procedures for interchange (e.g. delays while waiting for luggage)
d. Inadequate provision of local transport services (e.g. no fast public transport from an airport to city centre)
e. Local transport services exist but do not serve the needs of connecting long-distance travellers (e.g. timetables are unco-ordinated, nearest bus stop requires a long walk)
f. Inadequate provision of information
g. Unavailability of integrated tickets (covering the local as well as the long-distance parts of the journey)

A set of assessment matrices which summarise each category of solutions in matrix form, has been developed and the assessment criteria is as follows:

1. Indicative cost of implementing the solution
2. Technical feasibility
3. Financial feasibility
4. Organisational/legal feasibility
5. Acceptance by users
6. Other aspects of political acceptability (in addition to expected acceptance by users)
7. Impact on users' door to door travel time
8. Impact on users' door to door travel cost
9. Initial impact on comfort or convenience of the users' journey
10. Any detectable increase in users' safety
11. Any detectable increase in users' personal security
12. Any detectable increased access for people with reduced mobility

In an attempt to help policy makers address these key problem areas a toolkit of 94 potential solutions has been developed.

For each solution a rating score is given for each of the assessment criteria. In this way the reader is able to absorb the key characteristics of the solutions in a time effective way.

The toolkit's 94 solutions are organised in the following seven solution categories:

1. Local link infrastructure
2. Local transport services
3. Improvements at the interchange point
4. Check-in and luggage transfer
5. Ticketing and pricing
6. Marketing, information and sales
7. Enabling solutions

5.3 FURTHER INFORMATION

For further information on the toolkit for improvements in interconnectivity please see:

- "An Analysis of Potential Solutions for Improving Interconnectivity of Passenger Networks" (INTERCONNECT Deliverable 3.1 - "The Toolkit")

6 MODELLING INTERCONNECTIVITY

6.1 INTRODUCTION

The work of the INTERCONNECT project is completed by the investigation of the state-of-the-art of modelling interconnectivity, and by a look into a possible future of transport and interconnectivity. The INTERCONNECT project has enhanced the TRANS-TOOLS model with a new module to cater for interconnectivity, and simulated a possible future and choices the EU is facing.

6.2 MODELLING - REQUIREMENTS FOR THE DEVELOPMENT OF A TOOL

Traditional transportation modelling approaches are in general not oriented to deal with interconnectivity and multimodality. Often the definition of "multimodal model" is adopted if the model just covers more than one transport mode, regardless of its capability of dealing with trips composed of different transport modes on multimodal paths.

Passenger intermodality is present in a large proportion of long-distance journeys, especially for journeys above 400 km. This evidence confirms the utility for European-scale models to deal with this aspect of passenger transport. At a general level, the recommended framework to enable the proper modelling encompasses:

- The use of a network-based representation of alternative routes and modes within the transport model, where the network model should employ appropriate multi-path algorithms to construct alternative routes through the network between origin-destination pairs.
- The transport model should employ some form of choice model which estimates the demand on each mode combination/route based on the generalised costs of the different alternatives.
- The generalised cost formulation used in the transport model should include an explicit representation of costs of modal transfer.

These requirements apply equally to models designed to assess the impacts both at European and local scale, but it is implicitly recognised that for highly strategic applications, where the geographical coverage and the possible alternatives heavily increase the complexity of the model, a certain kind of simplification of the problems to be investigated is needed.

Apart from the theoretical requirements, the implementation of transport models requires the availability of data for both implementation and calibration purposes. Since intermodal passenger transport deals with door-to-door journeys, there is the need for door-to-door data. However, this data is generally not available: the modal structure of the passenger transport industry is reflected in the nature of collected data that is itself uni-modal.

The review of available statistics on long-distance travel indicates that very few surveys have recorded detailed information about multimodal journeys. Furthermore, even when available, this data differs to a large extent from county to country as to quantity and level of detail and contains little information on travellers' characteristics.

This lack of data, reflected in the absence of EUROSTAT statistics, poses strong limitations in the development of multimodal passenger transport modelling at European level.

Even though it is recognised that in budgetary terms and terms of effort the cost of collecting data is considerable, it appears anyhow essential to make national institutions more sensitive to the importance of this task.

In this respect the European Commission could play a relevant role both in harmonising the existing available information and publishing European-level basic data as well in encouraging future data collection at national level and drawing guidelines for harmonised surveys on long-distance multimodal trips.

As mentioned before, European-scale models generally require a compromise between the geographical scope of the model and the level of detail of the modelling framework; this compromise

generally leads to a simplification of the modelling framework in terms of demand segmentation, networks representation, transfer modelling, etc.

Therefore, it can be expected that policies which have a very local nature could be not properly analysed by these applications and their (small) impacts would be hardly captured and reflected by European models results. In fact, even though a policy implemented in a certain interchange would lead to a substantial reduction of transfer times or costs, its local benefits are likely to not change substantially the European level results.

Nevertheless, it can be expected that multimodal European models could be able to investigate the impacts of policies, which are globally applied to all main interchanges all over Europe.

6.3 INTERCONNECTIVITY IN EUROPE - A LOOK INTO A POSSIBLE FUTURE

6.3.1 Introduction

The analysis of the present situation has been complemented by an analysis of the future by the development of a new modelling tool. The conclusions are systematised into: the potential impacts of reducing interconnectivity costs in EU transport networks, on travellers, on modal shares and at an overall EU level.

The modelling module developed by INTERCONNECT provides an integrated modal split and traffic assignment procedure on top of TRANS-TOOLS[4] passenger trip matrices 2005 for four trip purposes, and uses TRANS-TOOLS transport networks to model interconnections between long-distance services and local networks to long-distance terminals[5]. The large volume of output produced by the modelling tool (named IC MSA Module) is processed by meta-model routines developed in order to compute specific assessment indicators as well as to carry out sensitivity analyses.

When working with modelling it should always be noted that this type of work offers the possibility to understand a possible future scenario, and not the future as such. All models of this kind are dependent on assumptions, e.g. on transport behaviour and on the technology available and in use.

6.3.2 Scenarios of Reducing Costs on the EU Transport Networks

Three alternative scenarios based on reducing interconnectivity costs were tested using the IC MSA Module. The first two (A and B), mostly theoretically, aim to measure the overall impact of just reducing all interconnectivity costs in Europe, all together:

- *Scenario A,* which lowers the cost of all interconnections by 50% of today's values. This reduction affects all connections between all transport modes, regardless of the modes (rail connections to airports, road access to airports and rail stations, road access to cities and rail access to cities)
- *Scenario B*, which lowers the cost of all interconnections to zero
- *Scenario C* lowers only the costs of access and egress to rail terminals to zero

6.3.3 Potential Impacts on Travellers

Upgrading interconnections results in savings for travellers: with general reductions of 50% and 100% in interconnection costs, the overall travel costs may decrease 3.0% and 5.4% respectively, which translates to a € 11,000 million and a theoretical maximum of € 20,000 million savings per year, using average value of time. Considering higher waiting and transfer values of time, this figure will grow substantially. Users have net savings in time and/or infrastructure use costs, which are higher than

[4] An EU model for simulation of transportation in Europe (see: http://energy.jrc.ec.europa.eu/TRANS-TOOLS)

[5] The definition of "long-distance trips" in this model exercise follow the TRANS-TOOLS definition. Long-distance trips are here defined as trips between NUTS3 zones. Because NUTS3 zones are much smaller in some countries than on the others (e.g. in Germany), trips between NUTS3 also include commuter trips at medium and short distance. Trips between NUTS3 have an average distance of 202 km European figures always refer to the European space defined in TRANS-TOOLS (EU27 plus neighbouring countries; Balkans, Switzerland, Norway, Iceland, Turkey, Ukraine, Belarus, and European Russia). Trips between Europe and the rest of the World not included.

the interconnection costs applied. This saving mostly results from improving connections to airports (just reducing rail interconnections provides savings of only -0.3%).

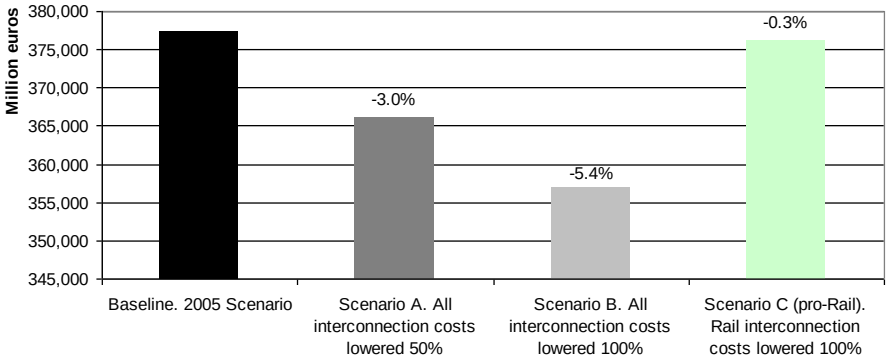


Figure 6-1 Transport costs of different scenarios with alternative hypotheses on interconnection improvements

The users that benefit more from reducing the costs of interconnection are those with lower values of time, like tourists. Users with the highest values of time, like business travellers, tend to use optimal paths from a *time* point of view even if more expensive, i.e. itineraries that are characterised by a lower number of interconnections.

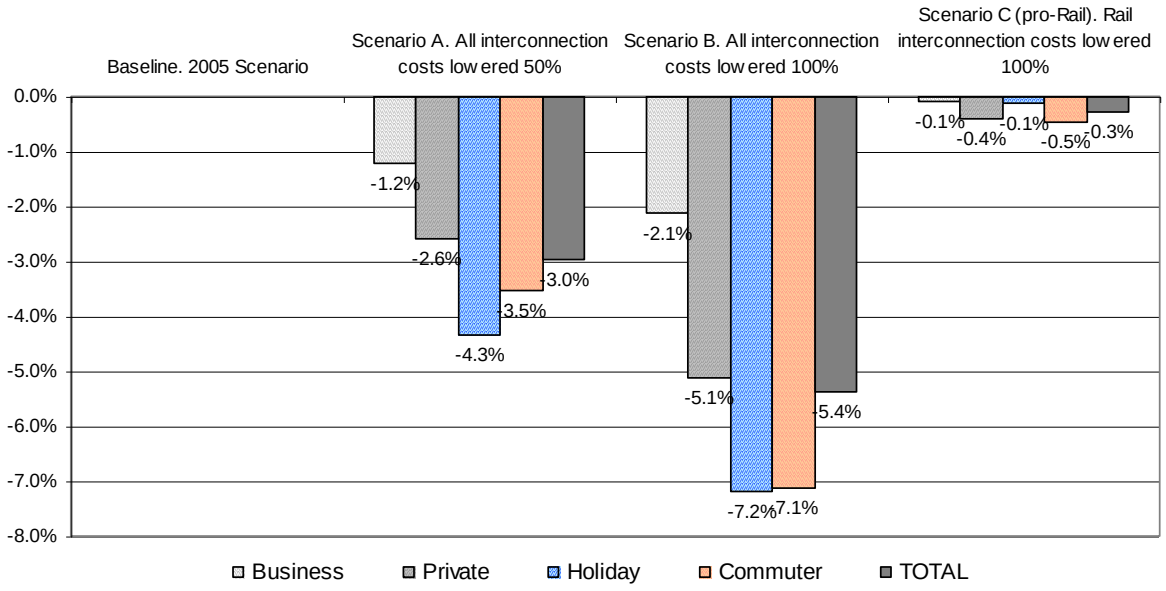


Figure 6-2 Cost variations by trip purpose

6.3.4 Potential Impacts on Modal Shares

The reduction of costs of interconnections mostly increases the share of the air mode. Air may increase by up to 7.6%, if all interconnection costs are eliminated. This is expected as aviation currently suffers from higher interconnection costs than rail or, needless to say, road.

The reduction of costs of interconnection increases the share of multimodal trips, but the increase is relatively small, as expected: if costs of interconnections are eliminated altogether, multimodal trips' share of long-distance trips increases by 2%, reaching 22%. By selectively reducing the cost of interconnections to favour the increase of the rail share, the share of multimodal trips increases by 3%, reaching 23%, and rail share increases by just 0.3%.

Improving interconnections is likely to cause changes in the services provided by air and rail operators, leading to a redefinition of the hub and spoke role of long-distance terminals in the networks[6]. Some small airports may become more accessible and competitive in relation to larger airports. These changes, not included in the modelling exercise carried out but analysed as specific case studies in the INTERCONNECT project, may result in a larger impact of interconnectivity improvements and larger gains of efficiency which is impossible to measure at this stage[7].

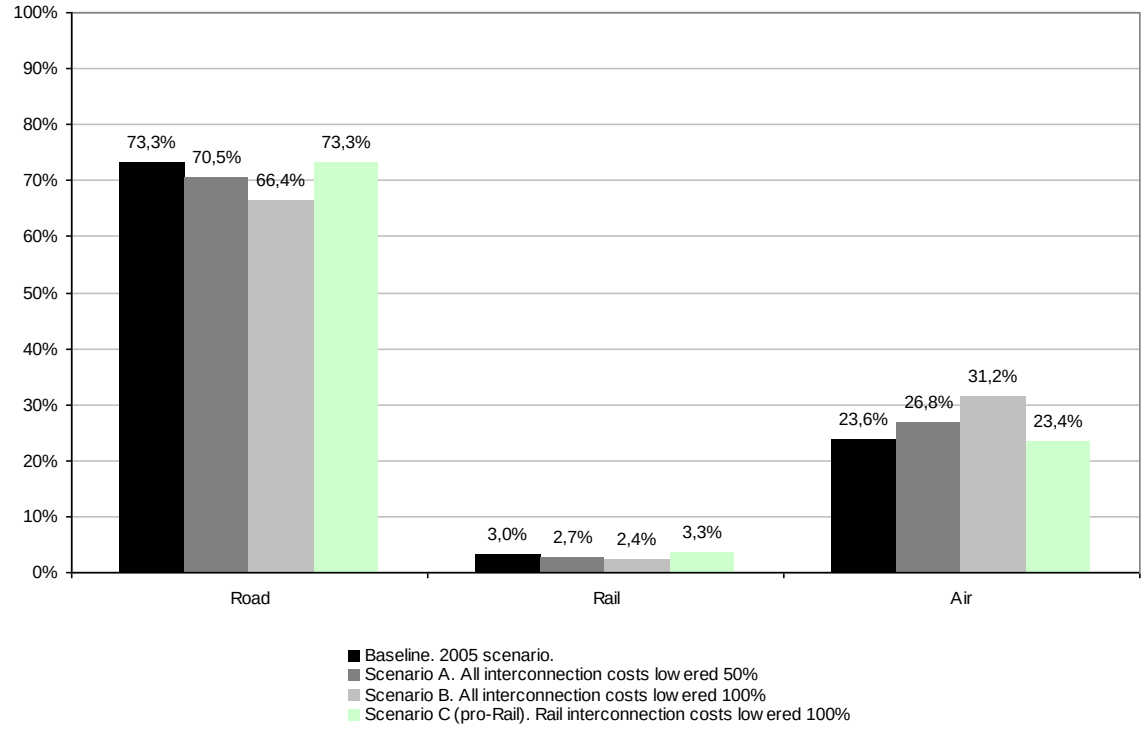


Figure 6-3 Improving interconnections: impact on modal split (in trip-kilometres)

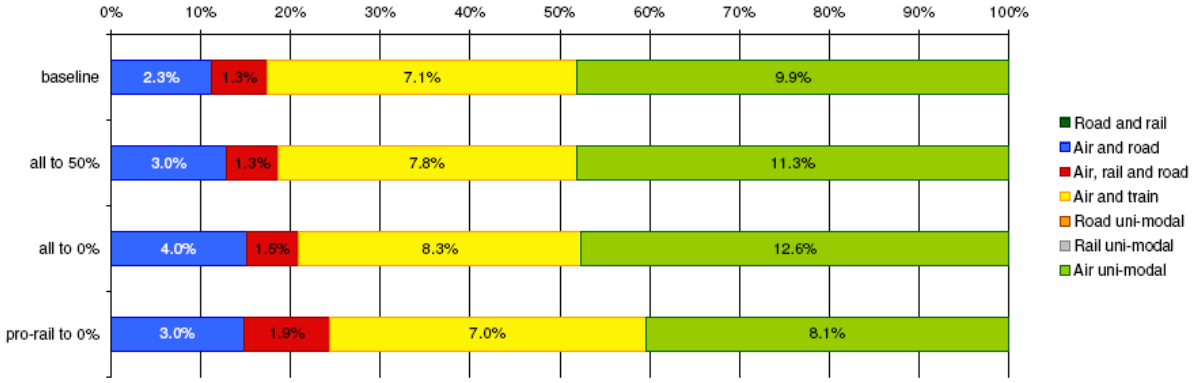
The share of the road mode is dominant in long-distance travel. The modal share of road in long-distance travel is of 73% (in trip-kilometres), almost 88% in uni-modal chains and approximately 34% in multimodal chains.

The modal share of the rail mode is very limited in long-distance travel. The modal share of rail in long-distance travel is 3% (in trip-kilometres), 1% in uni-modal chains and 13% in multimodal chains. Most trip-kilometres on rail are allocated in multimodal chains, approximately 70% of total trip-kilometres for rail mode.

The modal share of the air mode in long-distance travel is 24% (in trip-kilometres), approximately 11% in uni-modal chains and 53% in multimodal chains. The air mode is mostly used in air uni-modal chains (46% of air trip-kilometres) and air-rail multimodal chains (36% of air trip-kilometres). Air-train multimodal chains include all trips using rail to access an airport, regardless of the length of the rail stretch.

[6] Improvement of rail-airport interconnection resulted at Frankfurt airport in increased rail demand. This allowed for more efficient use of air and rail infrastructure (co-modality), as the slots no longer needed for the feeder flights were immediately used by the network carriers for additional (long-haul) flights using the full capacity of Frankfurt airport. The use of each mode was therefore optimised.

[7] Transport service operators, e.g. rail operators and airlines, can be interested in improving interconnectivity as it helps to make their services more attractive for passengers. In this context, many initiatives arise such as the onboard bus ticket sales by Ryanair, the easyBus from easyJet or the many rail-airline operator co-operations such as AIRail by Lufthansa and DB, the TGVAir in France or 50% to 100% ticketing discounts to travel in Scottish railways in combination with flights in Scottish airports. In the case of alliances between different service providers, e.g. in the aviation sector, interconnections between services within companies of the same alliance are promoted, while interconnections with other services are restricted. The planning debate concerning the interconnection between the two terminals in the airport of Barcelona has been deeply influenced by these considerations.



Note: the relative magnitude in relation to total long-distance trip-kilometres in Europe is shown inside the bar

Figure 6-4 Trip-kilometres by air in all transport chains

6.3.5 Potential Impacts at Overall EU Level

The reduction of costs of interconnections provides reductions in the overall volume of trip-kilometres travelled, implying that more efficient routes are chosen. With reductions of 50% and 100% in interconnection costs, volumes of trips-km decrease 2.2% and 1.1% respectively (2,600 and 13,000 million passenger-kilometres respectively). The average trip length for each transport chain becomes substantially lower, even if there is a net transfer from shorter transport chains to longer ones (e.g. from road to air).

The reduction of interconnectivity costs may produce a small shift from road to rail, but the most likely impact is the increase in uni-modal air trips (mostly due to the improvement of local connections to airports), and an increase on multimodal long-distance trips, mostly combinations between air and rail (due to improvements in intermodal connections).

Overall, the reduction of costs of interconnection may cause long-distance traffic CO_2 emissions to increase up to 0.9% (1.9 million tonnes of CO_2) in scenarios with simultaneous reductions of costs of all interconnections, and to decrease 0.5% in scenarios favouring rail. Emission factors per passenger were taken from the TRANSVISION study, in line with TRANS-TOOLS[8].

Upgrading connections between long-distance transport networks (e.g. linking all HSR lines to core airports) provides network benefits spread to travellers all across Europe, but no direct benefits to local travellers, who are not likely to transfer in their own city. Therefore, improving interconnections between long-distance terminals is more likely to be of European interest than of local or regional or even national interest. It is a genuine European-scale policy, since most users will be not just long-distance but also international travellers

Effective interconnection requires the provision of integrated networks and services and involves close co-operation between a range of authorities and infrastructure and service providers in the public and private sectors, often with contradictory and competing business and political goals[9]. The creation of effective interconnections may sometimes conflict with the priorities of transport infrastructure

[8] Considered emission factors are the following, in grams / passenger-kilometre (or trip·kilometre): Road mode, 115 gr/pax·km; Rail mode, 22 gr/pax·km; Air mode, 130 gr/pax·km.

[9] The case studies of Amsterdam, Lisbon and Helsingborg showed how the collaboration between different stakeholders is crucial to increase the level of interconnectivity, interoperability and integration of different transport systems. In Helsingborg, 10 different institutions and private companies collaborated together, in the view of new Øresund fixed link competition, to make the Knutpunkten intermodal terminal in Helsingborg a reality –rail, bus and ferry. Integration in Amsterdam is driven from a national perspective even at the constraint that such an approach results in the need for a synchronisation between large numbers of parties, whereas in the Lisbon case the approach was a bottom up development, as competing transport operators have agreed to use the OTLIS framework to work in a co-operation environment. The success of non-formalised frameworks of negotiation stands out between state government and the private sector and between central government and regional or local interests. Further investigation, however, is required to determine if optimal interconnectivity is compatible with competitiveness between operators.

managers, service providers and infrastructure planners (and market regulators). Additional to the investment costs, the difficulty is also legal or commercial.

Infrastructure managers, e.g. private airport operators, may have a limited interest in improving interconnections in long-distance networks, an important part of their business being generated in the shopping areas within the terminals and the car parking lots, and their business interest is therefore to maximise the time spent by users within terminals while having important private car access shares to the airport. Only when the traveller welfare is obviously reduced or there is a real competition between neighbouring airports, private operators may prefer to improve interconnections onto other transport networks, as happened in the case of the Heathrow Express[10].

Interconnections can provide positive market and regulatory impacts beyond the optimisation of travel times and travel convenience for users, since often they require complex public and private partnership agreements and more advanced co-operation strategies among transport operators and infrastructure managers.

Infrastructure planners are mostly interested in assuring the efficiency of interconnections, which are mostly going to be used by travellers in their domain of competence. National planners are mostly concerned about national citizens, while regional administrations are more likely to be concerned about local residents and taxpayers. With the increasing scarcity of budgets, local planners are usually not eager to spend funds on facilities that are not intended to serve local users. Therefore, there is a need for a common European policy to encourage interconnectivity improvements in long-distance networks[11].

The assessment carried out at European level proves that interconnectivity improvements can be cost-effective and result in more efficient transport (less trip-km, more time savings for users), if policies target specific missing or poor connections, first in relation to local access to long-distance terminals, then in relation to long-distance terminals, from a bottom-up approach, case by case. If all interconnection costs were reduced by a similar proportion, air trips would increase more than those by other modes since aviation currently faces higher interconnection costs than other modes. If this were to happen it would result in relatively higher CO_2emissions in the short-term. The application of policies specifically targeting emissions would result in a different outcome, as the reduction of interconnection costs would then be targeted so as to favour the least polluting modes. Hence, only the improvement of interconnectivity in intermodal trip chains concerning rail transport leads to reduced travel times and costs while simultaneously avoiding increased CO_2 emissions.

6.4 FURTHER INFORMATION

For further information on models in the analysis of transport and interconnectivity please see:

- "Impacts of improved Interconnectivity on a European Scale" (INTERCONNECT Deliverable D5.1 Chapter 5: "Modelling Interconnectivity at a European Scale".)
- "Meta-models for the analysis of Interconnectivity" (INTERCONNECT Deliverable 5.2)
- "Modelling Module for Interconnectivity" (INTERCONNECT Deliverable D 5.3)

[10] Heathrow Express is an airport rail link from London Heathrow Airport to London Paddington station in London operated by the Heathrow Express Operating Authority, a wholly owned subsidiary of BAA.

[11] This analysis was carried out in the case of the high-speed train connection to the airports of Girona and Reus based on the Rail Pack methodology for assessment developed by the European Investment Bank .

7 RECOMMENDATIONS FOR THE FUTURE

7.1 INTRODUCTION

In this chapter it is the intention to give a condensed summary of the main recommendations for the future.

These recommendations are categorised along the following headlines:

- Statistical Evidence and Data Collection
- Future Research and Development
- The Possibilities of the EU
- Implementation of INTERCONNECT results

7.2 STATISTICAL EVIDENCE AND DATA COLLECTION

Both in analysis of the present situation and in the project's work on modelling, the importance and need for a higher quality of empirical data and statistics covering the key elements of interconnection, have been underlined. Specifically, there is a need for better data on multimodal journeys, a better coverage of all EU countries, and data generated in accordance with uniform common EU standards. This would allow a much fuller analysis of the current status of multimodal travel than is currently possible, enable comparisons between countries, make calibrations of models significantly easier and improve overall quality and reliability of results.

7.3 FUTURE RESEARCH AND DEVELOPMENT

The INTERCONECT project has documented the need for further research and development on several issues. A few of the most interesting and most promising areas for such endeavours are mentioned in the following.

Infrastructure planning plays a significant role in the development of interconnections. However, the present tools and knowledge available cannot answer questions on how infrastructure planning as a process in a political system could contribute to an improved interconnection.

Organisational issues have proved to be of importance in the development of interconnection, sometimes leading to success and in other examples leading to failure. A better understanding of organisational behaviour and the structural elements in organising interconnections in complex political and economical structures is needed.

Financial and economic issues have been found to often interact with organisational issues and to create complicated barriers to improved interconnection, as problems at different political, organisational and economic levels need to be solved by actors with conflicting interests. Possibly, a better understanding of such situations could lead to guidance and/or general solutions or models, which could be implemented in the EU.

In some case study reviews it has been observed that a combination of passenger-related elements of a technical, commercial and practical nature seems to have a reinforcing and complementary potential, which can significantly contribute to the success of a terminal and/or interconnection project. A better knowledge in this domain could lead more successful interconnection projects and an optimising of resources in relation to effects.

Intelligent Transport Systems and overall the possibilities of using new information technology, mobile- and smart-phones as an active element supporting interconnection, holds a promising potential to become a driver for the development of interconnection. Research and development in this area also has potential for the ITS and IT industry in Europe to develop new products and/or systems to be used and exploited as business opportunities in the rest of the world.

The analysis of the IINTERCONNECT project has documented significant differences between the roles of different modes of transportation in different countries. There are also indications that different income and economic and financial possibilities for individuals influence the choice of transport mode independently. However, it was not yet possible to uncover the underlining drivers or social structures leading to such observable phenomena.

The toolkit of Deliverable 3.1: "An Analysis of Potential Solutions for Improving Interconnectivity of Passenger Networks" offers an impressive overview of what can be done in the field of improving interconnections, but it has not been possible to model or simulate the different tools of the toolkit. In other areas of transportation science, qualitative and economic methods such as price and demand elasticities have enlightened decision-makers and improved rational decision and conscious political choices. There is substantial scope to develop similar methods to cover the main categories and/or individual tools of the toolkit.

7.4 THE POSSIBILITIES OF THE EU AS A DRIVER OF FUTURE DEVELOPMENT

The results of the INTERCONNECT project have highlighted the possibilities for the EU to function as a driver for the development of interconnectivity at very different scales.

At the strategic level the analysis has revealed that on interconnectivity there is an overall lack of focus in national strategic policies documents, and that the actual EU strategic policy issues concerning passenger intermodality and interconnections call for a more active role of the EU, and highlight the potential for more formal and authoritative strategic policy decisions binding for the member states, in order to ensure a coherent and cross-national strategic EU policy in passenger interconnections, safeguarding the integration and development of the EU, and ensuring the mobility needs of the EU citizens.

At a more practical level the EU has an important role to fulfil through the creation of common EU standards to facilitate technological development and prevent the development of national suboptimal standards, especially concerning passenger ticketing, passenger information and passenger reservation systems. Another example could be to set up minimum standards for the intermodal connection terminals important to cross-national passenger movements as well as for interconnections of national importance, thereby creating a feeder system facilitating international passenger mobility. Already the importance of the EU in ensuring relevant and transparent statistical evidence has been mentioned in chapter 7.2.

7.5 IMPLEMENTATION AND MAINTENANCE OF THE INTERCONNECT RESULTS

The INTERCONNECT output has the potential to be used as a policy and knowledge lever. Key actions are indicated and the capacity is built to engage public administrations, private industry and general stakeholders to sponsor/plan/oversee interconnection projects. In addition, political leaders and administrative staff can gain the knowledge and skills they need to plan for and implement new types of interconnectivity solutions.

A key element in developing the results of the project to become a significant policy lever is the toolkit of Deliverable 3.1 and it will remain accessible to all in the project website at www.interconnect-project.eu.

Any stakeholder or individual engaged in an interconnection project has never before had such direct access to such systematic knowledge on the problems and solutions of interconnectivity. Combined with the description of the case studies, the project provides guidance to the stakeholders and the future development of interconnection terminals, which is of paramount importance. However, the knowledge needs to be regularly updated to maintain its relevance and potential.

Therefore, the results and documentation of the INTERCONNECT project will be kept accessible over the coming years. However, the continued usefulness of the toolkit could potentially be improved by an annual update reflecting the experience generated by the practical use of the toolkit and the possible developments in the facilities and function of the terminals and new emerging solutions.