



**Optimal Regulation and Infrastructure for Ground,
Air and Maritime Interfaces**

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FINAL TECHNICAL REPORT

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1 INTRODUCTION

1.1 MOTIVATION AND GENERAL OBJECTIVES

The ORIGAMI project was concerned with improvements in long-distance¹ door-to-door passenger transport chains through both improved co-modality and intermodality.

It started 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 would 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 to 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 been concerned solely with serving a local constituency.

ORIGAMI 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 encompassed 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.

The general focus of ORIGAMI was on all those long-distance journeys which might benefit from more effective co-operation and/or interconnection between modes and services, and on those situations where this is currently hampered by institutional barriers, lack of investment, or failure to innovate and which could benefit from a more enlightened approach. One particular focus of the project were the technical solutions to improved co-modality and, in particular, intermodality, and the project has shown examples of how good solutions found in one mode can be transferred to other modes.

The "solution" to current examples of poor co- and intermodality, whether caused by inadequate infrastructure, poor integration or ineffective competition, may come from several sources. For example, they might require:

- Provision of new or improved infrastructure or services (notably of new multi-modal interchange facilities, but perhaps also of specialist distribution networks with local hubs, dedicated feeder services, etc);
- Removal of barriers to effective competition (e.g. monopolistic ownership or franchising of infrastructure or services, market domination by established operators, inappropriate barriers to the entry of new competitors, etc);

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

- Removal of barriers to effective integration of public transport services (e.g. of restrictions designed to avoid anti-competitive practices and which limit or forbid the joint planning or marketing of services or ticketing initiatives);
- Encouragement of integration of services (e.g. by means of joint ticketing, integrated timetabling, sharing real-time information on service status, joint marketing of integrated services, etc);
- Removal of barriers of information for consistent travel information across modes;
- Harmonisation of infrastructure pricing policies to remove barriers to effective competition in the international travel market (e.g. by reducing the heterogeneity of rail track access charges);
- Removal of restrictions on the inclusion, in appraisal frameworks, of benefits which flow from integration (e.g. to allow community benefits and regional competitiveness to appear in the economic appraisal of infrastructure projects).

By reviewing potential solutions and assessing their applicability and usefulness in a range of scenarios for the medium- and long-term future, ORIGAMI was able to make a substantial contribution towards the formulation of future transport policies aimed at promoting co- and intermodality. Furthermore, the project contributed to the wider dissemination of best practice and a process of cross-fertilisation between modes.

1.2 SCIENTIFIC AND TECHNOLOGICAL OBJECTIVES

The work carried out in ORIGAMI did not have to start from scratch, but could build on a substantial body of knowledge on long-distance passenger transport already available from past and current projects, in particular COMPASS, KITE, LINK, INTERCONNECT, HERMES and CLOSER. From this basis, ORIGAMI's specific scientific and technological objectives were:

- To investigate current traveller behaviour and the differences in behaviour between countries and regions;
- To determine underlying factors that will influence future travel behaviour, such as demographics and social trends;
- To define the requirements that travellers have for a door-to-door transport system;
- To collect a substantial body of new data on the attitude of long-distance travellers to alternative future transport supplies;
- To establish the needs for improving co- and intermodality from the side of the transport system;
- To collate best practice examples for technical solutions;
- To collate solutions suggested in the literature, but not yet realised in practice;
- To investigate gaps and bottlenecks as assess how, and how far, they can be filled by transferring solutions and best practice found in one mode to others and to discuss this with relevant stakeholders;
- To build scenarios for alternative futures and pathways for a co-modal and intermodal transport system, to forecast the demand for these alternatives and to evaluate them against a set of transport policy criteria;
- To establish future research needs;
- To make recommendations for future policies and actions; and
- To disseminate the findings widely amongst policy makers and other stakeholders as well as researchers and the transport industry.

1.3 OVERALL STRATEGY OF THE WORKPLAN

ORIGAMI comprises nine workpackages, each consisting of one to four tasks. The workpackages are:

- WP1 Consortium Management

- WP2 Technical Co-ordination
- WP3 Identification of Travel Behaviour
- WP4 Identification of Needs
- WP5 Technical Solutions
- WP6 Cross-Fertilisation
- WP7 Scenarios
- WP8 Conclusions and Recommendations
- WP9 Dissemination and Exploitation.

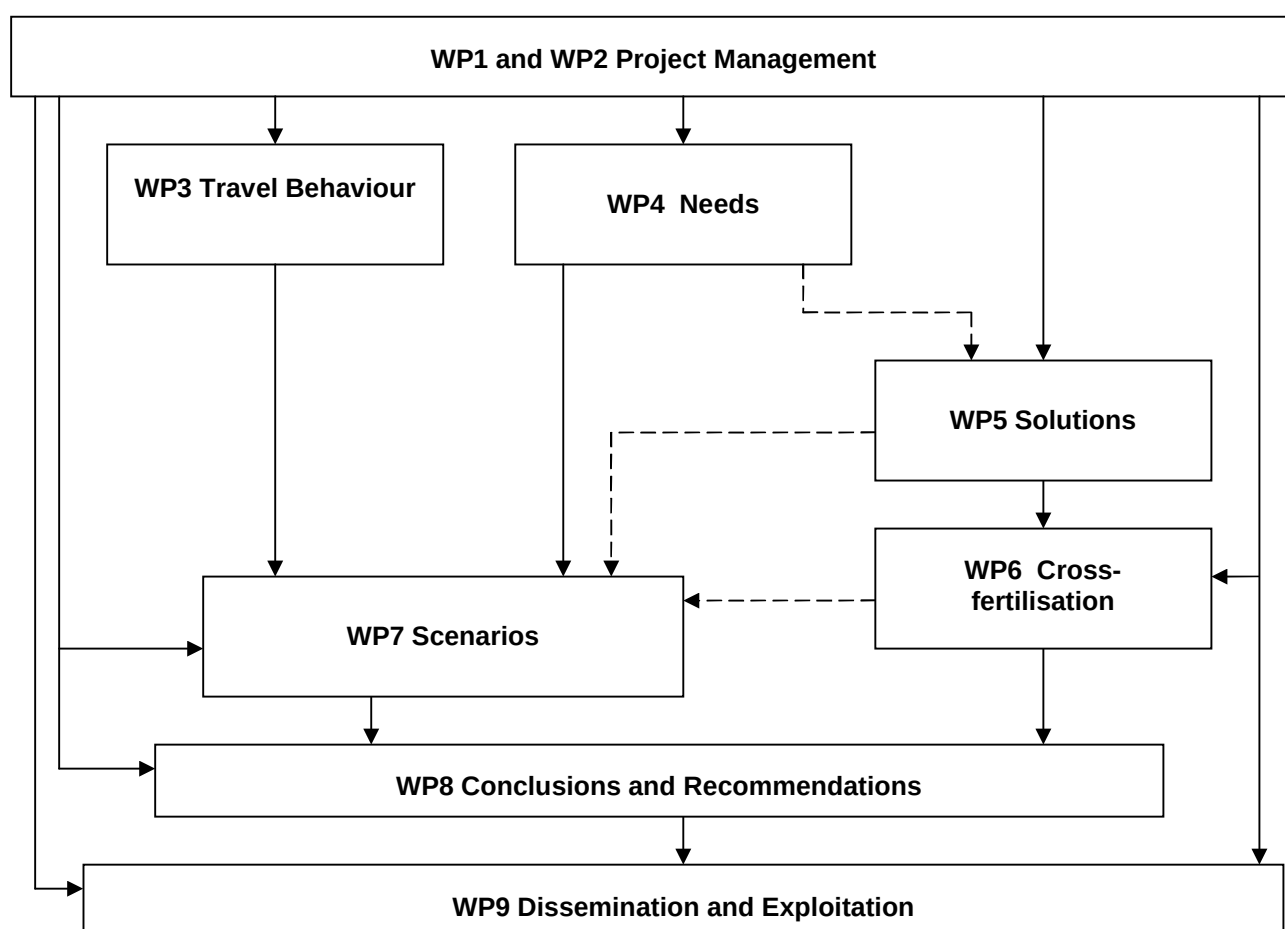


Figure 1-1 ORIGAMI Pert Chart

ORIGAMI addressed two separate tasks within the TPT work programme, which are connected to some extent, but in the main both very distinct. This is reflected in the workpackage structure, which shows two clear strands. The analysis of travel behaviour (WP3) and needs (WP4) feed directly into the scenarios (WP7), while the analysis of the solutions (WP5) informs the cross-fertilisation process (WP6). However, there are some cross-links since some of the system needs analysed in WP4 are also relevant for WP5 and WP6, while the two latter WPs – to some extent - also inform the scenarios. The findings in both WP6 and WP7 informed WP8, the final conclusions and recommendations.

WP1, WP2 and WP9 are horizontal activities, which were on-going throughout the project. Project management comprised general co-ordination and management tasks as well as quality control.

WP3, which kick-started the project, initially identified current traveller behaviour for long-distance trips - based on existing research and data – and investigated differences in the behaviour across Europe. The second task in WP3 was to collect data on the social trends and demographics that will influence

future transport demand and needs. The final task was the collection of a substantial body of new data through surveys of long-distance travellers to establish their current mode usage and how this might change given different assumptions about future provision.

WP4, which also started right at the beginning of the project, comprised two tasks. The first one identified the different traveller needs for transport interfaces and combined operations based on existing research and assessed how these needs may be affected by future trends. The second, parallel, task was supposed to start from a different angle and identify the needs for improving co-modal and intermodal transport from the transport supply management view. However, as work progressed, it became clear that the traveller needs had to remain at the centre of attention of both tasks.

WP5 built on past projects, most notably KITE, LINK and INTERCONNECT, to collect best-practice examples for technical solutions for door-to-door transport across all modes and identify capacity and efficiency solutions of modes and their interfaces. A parallel activity looked at solutions identified in the literature or suggested by on-going research, in particular the CLOSER project, that have not yet been implemented anywhere and where there is therefore no practical experience concerning their potential success. Based on both of these tasks, a third task then tried to identify gaps and bottlenecks that need to be addressed in future activities, although in the event, no crucial bottlenecks were found.

WP6 then investigated the applicability of technical solutions for one mode or one type of interface to other modes and interfaces and discussed this with selected stakeholders.

WP7 comprised the largest body of work. The first task provide the framework for the scenarios by defining in detail the dimensions that they would have, or in other words the aspects that had to be taken into account. Then this framework was filled with different sets of assumptions, based on the knowledge and experience that the partners have, in particular from the INTERCONNECT project. The main task in WP7 was then to produce and evaluate forecasts of transport outcomes for a range of scenarios for the years 2030 and 2050.

Finally WP8 identified future research needs and provide general conclusions and recommendations.

1.4 COVERAGE OF THE FINAL TECHNICAL REPORT

The present report will describe in brief the work carried out in each of the technical workpackages WP3 to WP7 and then highlight the main outcomes and results of each of them. In some cases, where the tasks within a workpackage are very closely interlinked, as for instance in WP7, this description will be given across two or more tasks, in other cases on a task by task level. For more detailed and in-depth information, the relevant deliverables are available on the ORIGAMI website (www.origami-project.eu).

As mentioned above, part of WP8 was the identification of future research needs, based both on findings directly from within ORIGAMI as well as some found in related literature, and this will be discussed in the next part of this report.

The report will close with some general conclusions drawn from the work carried out during the lifetime of the ORIGAMI project.

More detailed coverage of the issues raised in this report can be found in the various ORIGAMI deliverables on www.origami-project.eu.

2 THE CURRENT PATTERN OF LONG-DISTANCE TRIP MAKING

2.1 OBJECTIVES

There is shortage of data on long-distance travel across Europe, and the first aim of this task was to bring together what can be found at different sources and make that available to the wider research and modelling community. However, the main motivation behind this research was that the data gained from this would be necessary to develop the LUNA model and the scenarios for 2050 (chapter 9 of this report).

2.2 DATA SOURCES

In an extensive literature and project review the following three main data sources have been identified as more relevant for long-distance travel analysis:

- The Eurostat tourism demand database (Eurostat 2011c);
- A household survey from the project DATELINE² - Design and Application of a Travel Survey for European Long-distance Trips based on an International Network of Expertise (DATELINE Consortium 2004); and
- A set of different National Travel Surveys (Department for Transport 2011, infas Institut für angewandte Sozialwissenschaft GmbH 2010, Ministère de l'Ecologie du Développement durable des Transports et du Logement 2010, Ministerio de Fomento 2007, Ministry of Transport and Communications Finland, et al. 2006, Swedish Institute for Transport and Communications Analysis (SIKA) 2007).

Eurostat is collecting data from household surveys in the EU27 plus Norway and Switzerland. Nevertheless there are still some data sets missing for some countries and years; for instance there is no data available from the Netherlands about business trips with a duration of one night and over. Furthermore, the statistic (Eurostat 2011c) defines tourism as *activity of persons travelling to and staying in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes*. Strictly speaking the data are not exactly about long-distance travel. Rather than by distance data are reported by duration of stay (one night and more and four nights and more). Nevertheless it seems appropriate to assume that journeys with four or more overnight stays are mainly long-distance trips. The Eurostat database distinguishes between the journey purposes holiday, visiting friends and family, and business. The Eurostat tourism database is the most comprehensive and complete database identified in the literature and project review.

A household and person level survey on long-distance travel of 86,000 residents in the EU15 countries plus Switzerland has been carried out in DATELINE (DATELINE Consortium 2003, 2004). The survey took place from October 2001 through to October 2002. The dataset contains travel date, destination, duration, travel mode and distance bands. Residents aged 15 years and over reported long-distance-travel of over 100 km crow-fly distance for the purposes holiday, private, business and commuting.

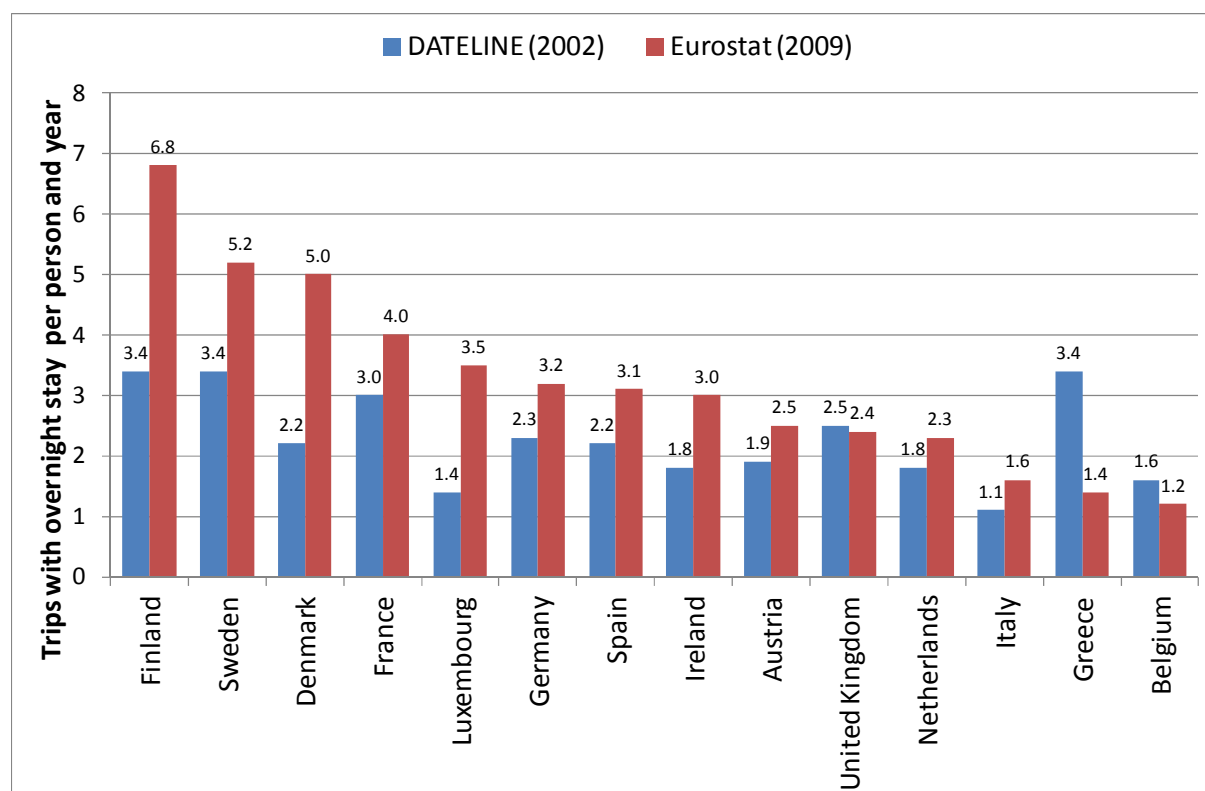
Additional data about long-distance travel is available from national travel surveys in Finland, France, Germany, Spain, Sweden and the United Kingdom. The disadvantage of this set of data for the use in ORIGAMI is that the surveys have not been carried out in a consistent way. For instance the definitions of distance bands are not the same.

2.3 LONG-DISTANCE TRIPS PER PERSON AND YEAR

Figure 2-1 shows a comparison of the number of trips per person and year for journeys with an overnight stay from the DATELINE and the Eurostat databases. For the majority of the countries where data is available from both sources Eurostat reports higher trip rates. The exceptions are the UK, Belgium and Greece. The ranking among countries is relatively consistent. The most significant outliers are Greece, where DATELINE reports 2 trips with overnight stay per year more than Eurostat,

² Unfortunately DATELINE does not include surveys of the new Member States and has not been updated by the EC to allow for monitoring mobility behaviour.

while for Finland (3.4 trips/year), Sweden (1.8), Denmark (2.8) and Luxembourg (2.1) Eurostat reported significant higher trip rates.



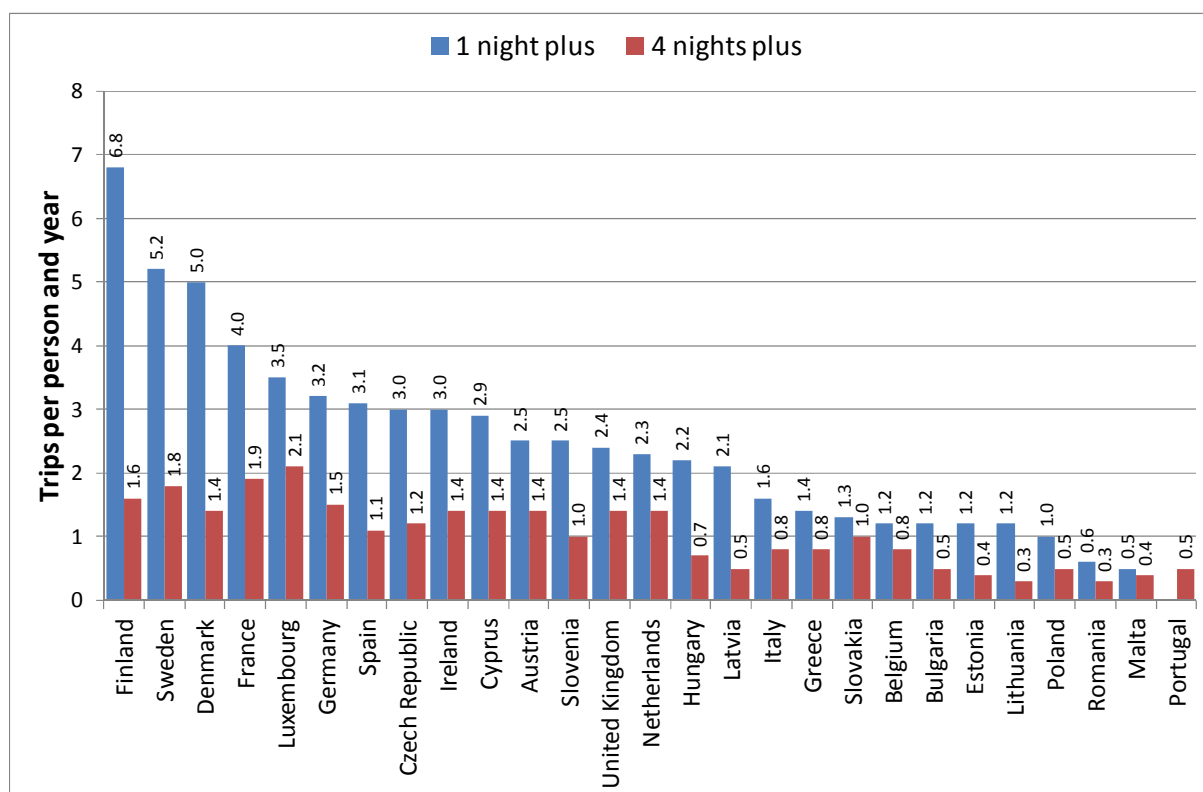
Source: (KITE 2007) based on DATELINE survey, (Eurostat 2011d), own calculation

Figure 2-1 Comparison of trip rates with at least one overnight stay DATELINE - Eurostat

Figure 2-2 shows a comparison of the holiday trip rates with at least one overnight stay and at least four overnight stays from the Eurostat tourism database. The number of holiday trips with one or more nights per capita ranges from 0.5 trips per year in Malta to 6.8 trips per year in Finland. The number of holiday trips with four or more nights per capita ranges from 0.3 trips per year in Romania and Lithuania to 2.1 trips per year in Luxembourg.

Figure 2-3 shows a map of the holiday trip rates with four or more nights for the EU27 countries. It can be seen that holiday trip rates are high in the Nordic and Central European countries while they are low in the Southern and Eastern countries.

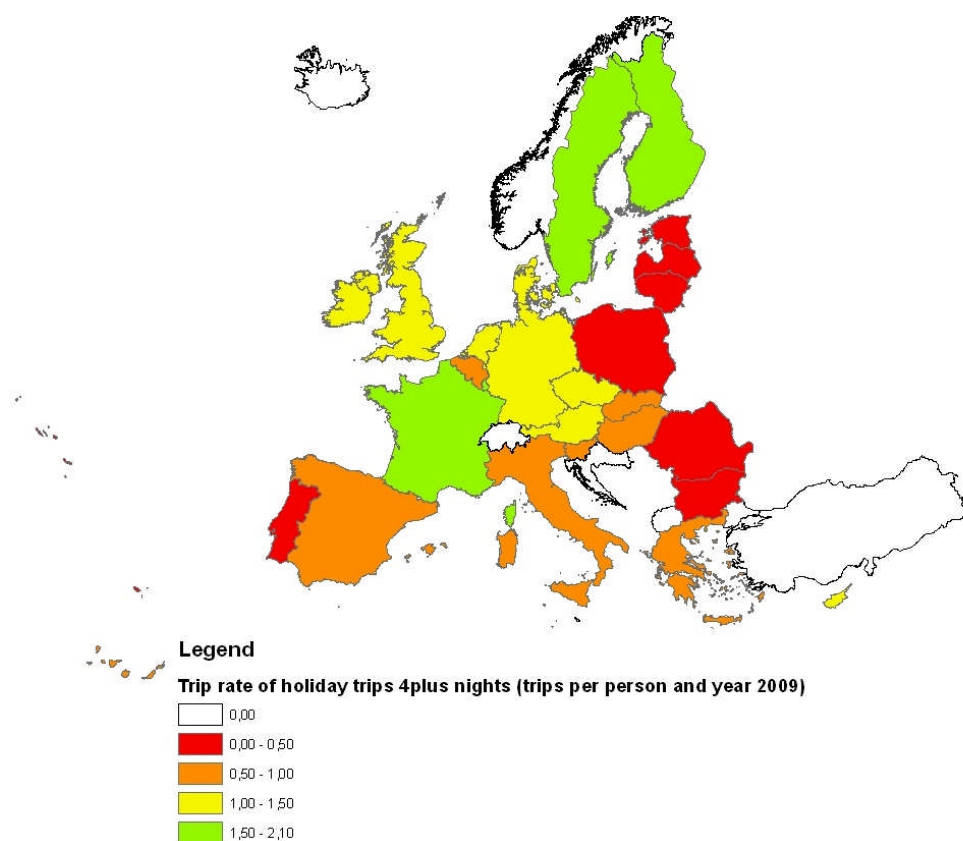
There is no clear trend concerning trip rates by gender. In about two thirds of the countries higher trip rates are reported for the female population while in the rest higher trip rates are reported for the male population. There is also no clear trend concerning holiday trip rates by age group. The hypotheses that holiday trips rates are declining with age could not be supported by the available data. While the age group 65 and over has the lowest trip rate in the majority of the countries there even two countries (Germany and France) where this age group has the highest trip rate.



Source: (Eurostat 2011d), own calculation

Note: No data about trips with at least one overnight stay are available for Portugal

Figure 2-2 Comparison of trip rates with at least one and at least four overnight stays - Eurostat

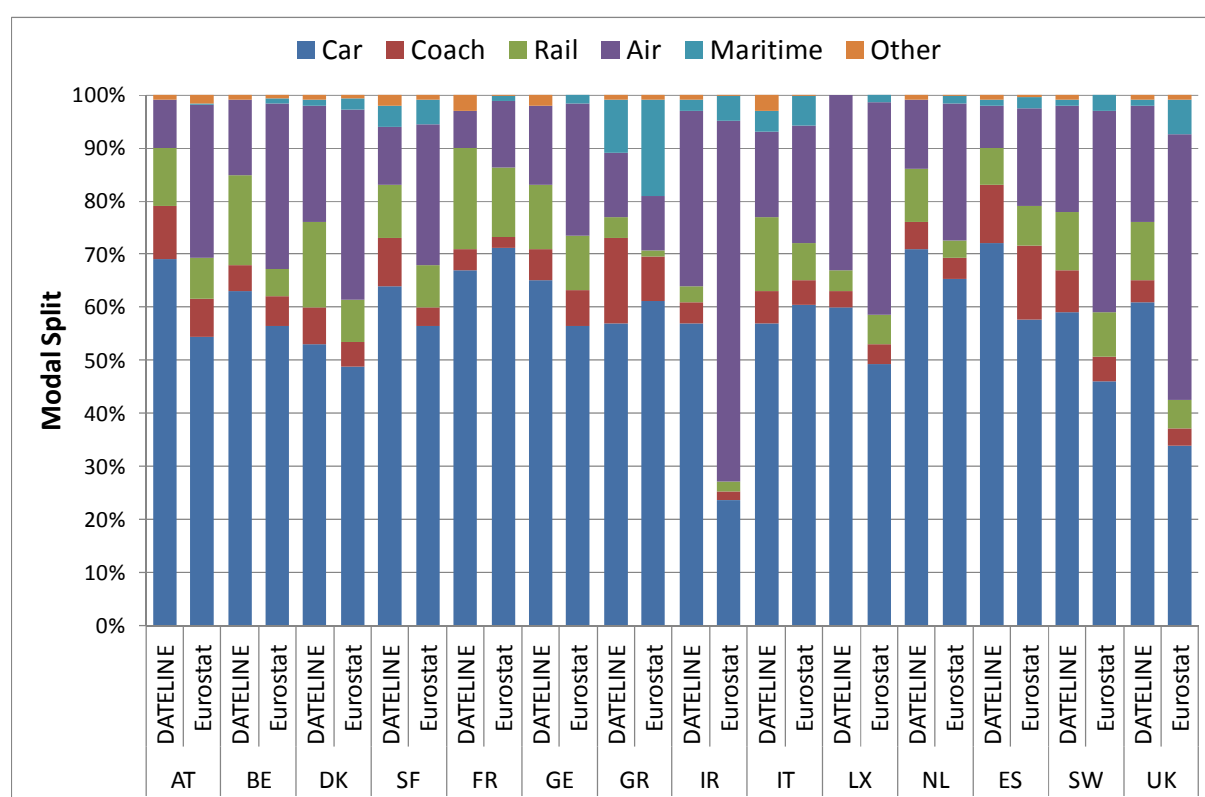


Source: (Eurostat 2011d), own calculation

Figure 2-3 Trip rates with at least four overnight stays - Eurostat

2.4 MODE OF TRANSPORT

Figure 2-4 shows a comparison of the share of modes of transport as reported by DATELINE and Eurostat. The share reported for air travel is with the exception of Greece consistently higher in the Eurostat database than in the DATELINE database. On the other hand the share of the car is generally higher in the DATELINE database than in the Eurostat database. The exceptions are France, Greece and Italy. The most significant outliers are Ireland and the UK with extremely high shares for the mode air due to their geographic separation as islands. For some countries with either a long coastline or situated on an island both data sources report significant shares for the mode maritime. Both data sets show significant differences in the share of rail and bus/coach between the different countries. The share of these two modes depends highly on the supply side. The modes car and air are the dominant long-distance modes in all countries. Depending on the country they account together for 70% to 90% of all long-distance trips. Apart from the variation across countries the modal split shows significant differences between the two samples. It has to be noted that the time when DATELINE was sampled reflects the year 2001, where e.g. Low Cost Carrier air services have just started to become prominent on the continent, while Eurostat reflects observations gathered in 2009.



Source: (KITE 2007) based on DATELINE survey, (Eurostat 2011d), own calculation

Figure 2-4 Comparison of mode of transport DATELINE – Eurostat

For further investigations on mobility and traveller behaviour it is recommended to update and extend the DATELINE survey.

3 TRENDS AFFECTING THE FUTURE OF LONG-DISTANCE TRIPS

3.1 OBJECTIVES

Similar to the activities described in the last chapter, the purpose of this task was twofold: to provide a basis for further research and model development for the wider community and to inform the development of the LUNA modelling and the scenarios for 2050 (see chapter 9).

3.2 TOTAL LONG-DISTANCE TRAVEL DEMAND

A literature review in combination with a qualitative and quantitative data analysis was carried out in order to identify the major drivers of future long-distance travel. Figure 3-1 gives a qualitative overview of the major drivers identified in this process. Obviously population is a major driver of total demand for long-distance holiday travel. The higher the *Population* the higher the *Holiday travel demand* will be (indicated by a plus next to the arrow). Population itself is influenced by the development of total fertility rates, life expectancy and trends of in- and outmigration. The second driver of *Holiday travel demand* is the *Holiday trip rate*, i.e. the number of holiday trips made per person and year. Holiday trip rates are influenced by the disposable income per household, car ownership and the share of population in the different age cohorts. The higher the *Disposable income* and *Car ownership* the higher the *Holiday trip rate* will be. The disposable income is influenced by the development of the economy (*GDP per head* and *Employment*) and costs for basic needs (*Living costs* and *Mobility costs*). As it was shown in chapter 2, there is no clear relationship between the age of population cohorts and holiday trip rates. While in most countries older people have lower holiday trip rates, this trend might reverse when people continue to adopt more active life styles into higher age. Business travel demand is influenced by the number of employees and the business trip rate. The number of employees depends on the development of the economy in general and productivity in particular, travel costs and technology (e.g. teleconferences).

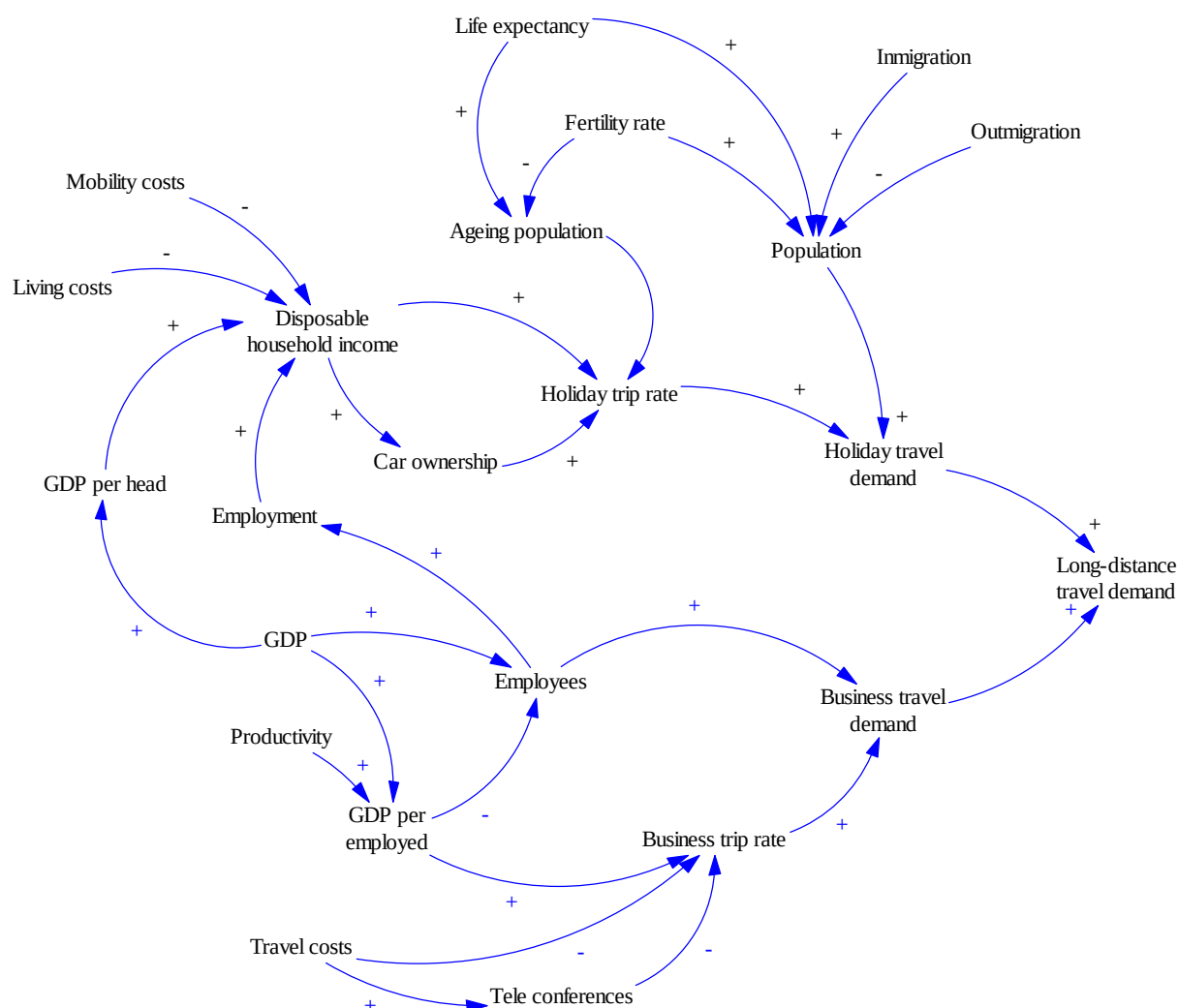


Figure 3-1 Drivers of long-distance travel demand

A trend analysis in Germany comes to the conclusion that the demographic shift (i.e. ageing population) and economic changes (higher unemployment, precarious working conditions instead of full time employment, longer working hours for those with a job, etc.) will result in significant changes in overall tourism demand (Petermann, T., et al. 2006). Petermann assumes that the holiday travel intensity of the German population will remain stable up to 2050. As the German population is predicted to decline this will result in a declining demand for holiday trips. The expected reduction in disposable household incomes will not necessarily reduce the number of holiday trips, but more likely the date and duration of stay.

A long term analysis of the data collected in the British National Travel Surveys identifies for the recent past a decline in the number of number of long-distance trips while average trip distance still continues to rise resulting in a stabilisation of total distance travelled (HS2 2011). Total long-distance travel demand in Great Britain is forecast to increase by about one third up to 2040. There is a clear correlation between household income and long-distance trip making. While the total demand in the lowest income band is about 3 long-distance trips per person and year, people in the highest income band make about 14 long-distance trips.

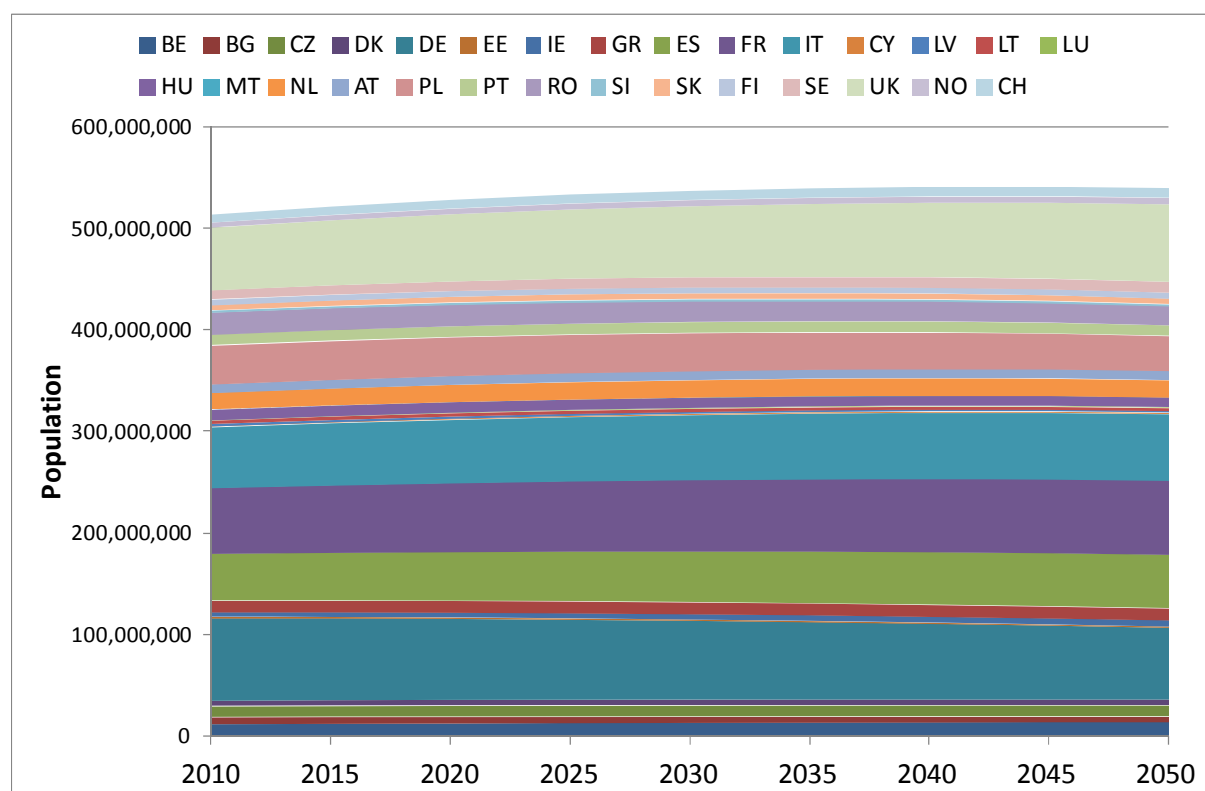
J. Dargay predicts total long-distance travel demand and mode share based on the drivers GDP, population, transport costs (petrol prices, car fuel efficiency, motoring costs, coach fares, rail fares, air fares) and journey times (Dargay, J. 2010). The base case assumes an increase in GDP by 58%, an increase in population by 14%, an increase in per kilometre fuel prices by 4% and motoring costs by 0.5%, an increase in coach fares by 3% and rail fares by 28%, a decrease in air fares by 13% and an increase in journey times road by 7.5% up to 2030. Relative to 2010 total long-distance mileage is predicted to increase by about one third. The report also estimates the effect of the 2008 recession on

future long-distance travel and comes to the conclusion that recession decreases the demand by about 7% up to 2030.

The Independent Transport Commission published a study based on British National Travel Survey Data (ITC 2010). The major conclusions are as follows. Income affects travel demand; as incomes grow or decline so does travel demand. Where people live affects long-distance travel demand; people living in metropolitan areas make fewer long-distance trips, while those in rural areas make most long-distance trips. Cost affects the volume of long-distance travel demand; business travel is less affected, whilst holidays, leisure travel and visiting friends and relatives are more price sensitive. Total demand in 2030 is predicted to grow by 18% to 38% relative to 2005.

Population trends

Relative to 2010 the convergence scenario of the Eurostat population prediction EUROPOP2010 forecasts an increase of the population in the EU27 plus Norway and Switzerland of about 5% by around 2030 (Eurostat 2012). Between 2030 and 2050 total population begins to stabilise (Figure 3-2). The growing population is a driver for an increase in long-distance travel demand. About two third of the countries are predicted to grow while the rest is predicted to decline. Countries with a decline in population between 2010 and 2050 are Bulgaria, Germany, Estonia, Latvia, Lithuania, Hungary, Malta, Poland, Portugal, Romania and Slovakia. With the exception of Germany all these countries' long-distance holiday trip rates are below the European average. Hence the predicted changes in population location caused by fertility, life expectancy and in- and outmigration trends cause increasing trip rates and hence increased long-distance travel demand. Nevertheless the current economic crisis might hamper this trend; for instance in 2010 and 2011 Germany's population increased due to in-migration overcompensating the low fertility rate and death rate.



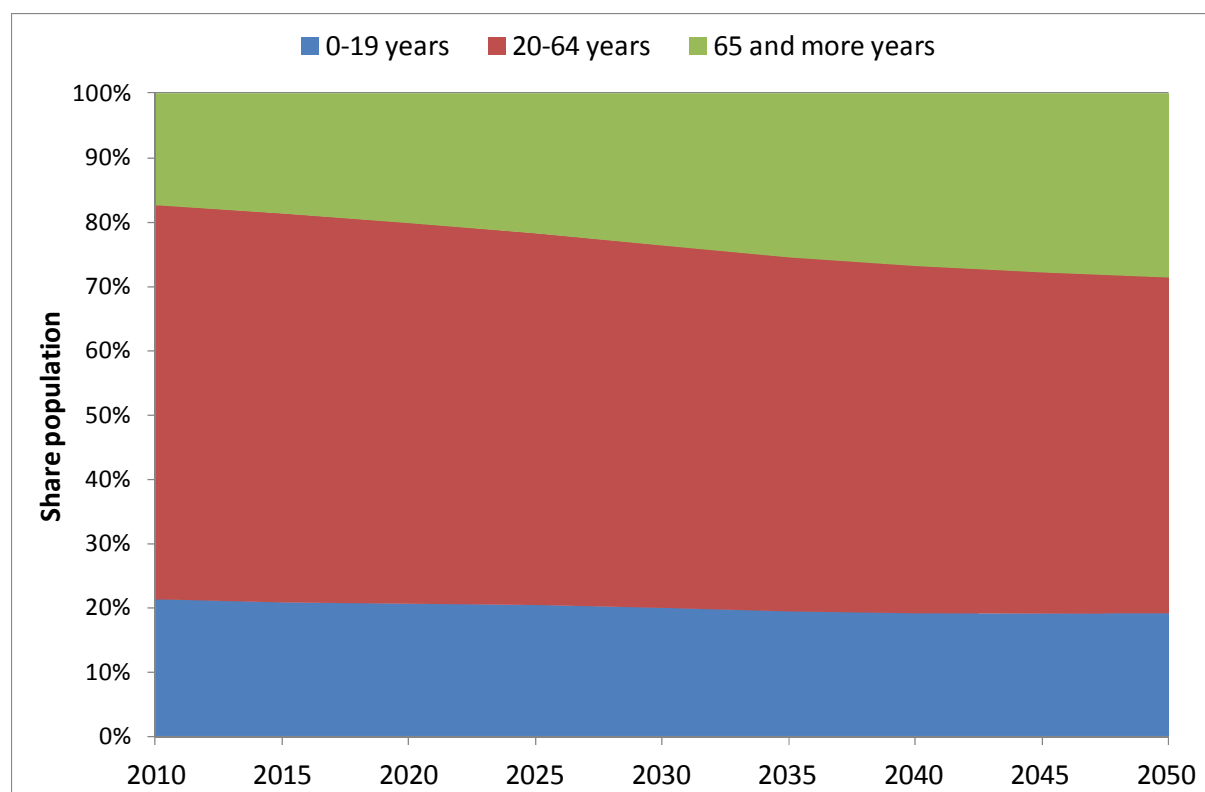
Source: (Eurostat 2012)

Figure 3-2 Eurostat population forecast 2050 by country

Ageing trends

For the next forty years Eurostat predicts a significant ageing of the European population (Eurostat 2012). In the convergence scenario the share of population 65 years and older is increasing from

about 17% in 2010 to about 29% in 2050 (Figure 3-3). The share of population younger than 20 years is predicted to decrease slightly from 21% to 19%. This demographic shift will have an impact on the demand for long-distance travel. Nevertheless as already argued in chapter 2 the impact is hard to predict. Average trip rates in the EU27 plus Norway and Switzerland of the age group 65 years and more are at the moment about 7% lower than in the age group 20-64 years and about 3% lower than in the age group 0-19 years. Nevertheless there are some countries in which the trip rates of the age group 65 years and more are higher than in the other age groups. There is a trend that people stick to a more active life style when ageing than in the past, which means that trip rates of the older age cohorts will increase in the future. Nevertheless the current economic crisis might hamper this trend. While retired people have more time to spend, they might have less money to spend in the future. Furthermore the economic situation might force people to retire later in life.



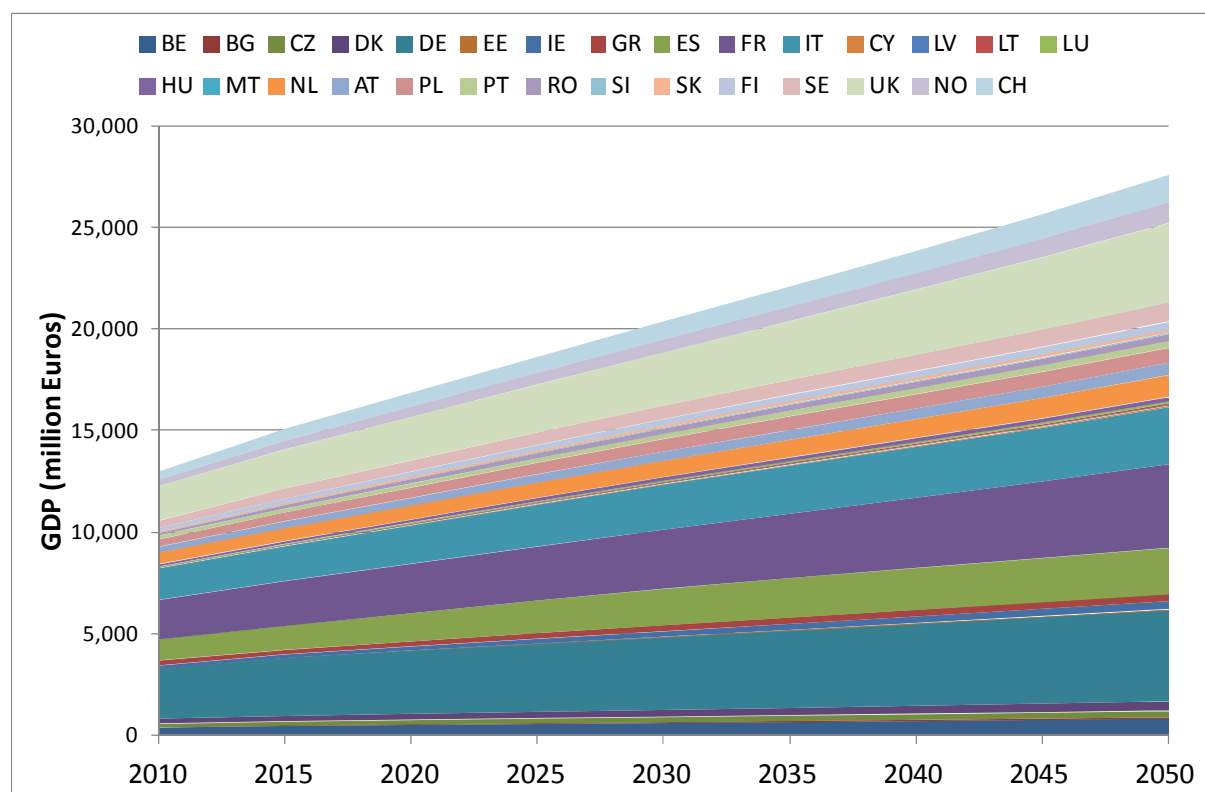
Source: (Eurostat 2012)

Figure 3-3 Share population by age group

GDP and household income trends

For the European Union the 2009 Ageing report of the European Commission assumes a GDP growth rate of about 2.7% per annum for the period 2007-2015 (European Commission 2009). In the later years growth rates are continuously declining to about 1.4% p.a. for 2040-2050. This means that in total GDP is about doubling between 2010 and 2050. In the light of the recent Euro crisis these assumptions might be overoptimistic. By country the growth between 2010 and 2050 ranges from about 60% in Greece to about 240% in Switzerland. Some countries with low holiday trip rates like Estonia, Latvia and Lithuania are predicted to have above average GDP growth rates. Hence it can be expected that long-distance travel demand will increase significantly in these countries.

An analysis of Eurostat data has shown that there is a strong correlation between the development of GDP per capita and income (Eurostat 2011a, 2011b). Although past data have revealed that income is growing at a slower pace than GDP, household incomes are forecast to increase in all countries. This trend will increase long-distance travel demand Europe wide.



Source: (Eurostat 2012), base year adjusted to fit (Eurostat 2011a)

Figure 3-4 ECFIN potential GDP forecast by country

3.3 MODAL CHOICE FOR LONG-DISTANCE TRANSPORT

Mode choice for long-distance trips depends on the availability of the mode and travel time and costs for different parts of a journey in relation to all modes on offer. Car availability is obviously an important driver for total travel demand in general as well as for car use in particular. Car ownership is higher in higher income households resulting in a higher share of long-distance car trips in this group (HS2 2011). For Great Britain (HS2 2011) predicts an increasing share of long-distance rail trips due to investments in high speed rail lines. According to this prediction the share of air trips will increase too, while the share of car trips will decrease.

In the base case (Dargay, J. 2010) assumes the following changes in transport costs from 2005 to 2030: an increase in fuel price per kilometre +4%, motoring costs +0.5%, coach fares +3% and rail fares +28% and a decrease in air fares by -12.5%. Furthermore road journey times increase by 7.5% up to 2030. The result is a significant increase in the share of air travel while the shares of car and coach are decreasing. The share of rail remains constant.

According to (ITC 2010) cost affects mainly the volume of long-distance travel; business travel and commuting are less affected, whilst holidays, leisure travel and visiting friends and relatives are more price sensitive. Travel time affects the demand, notably for car and train. The official demographic and economic forecast and the base case cost assumptions suggest that long-distance-travel demand will increase by 34% overall by year 2030. Car grows by 30%, rail by 35%, coach by 25%, air by 126%

Despite uncertainties about the future development of long-distance travel costs it seems that car and air travel will remain the dominant modes of choice. In some corridors rail can gain substantially due to decreasing travel times through high speed rail.

4 NEW EVIDENCE ON USERS' ATTITUDES TO FUTURE CHOICES FOR LONG-DISTANCE TRAVEL

4.1 OBJECTIVES

The aim of this task was to: (1) provide data on the existing patterns of Long-Distance (LD) travel and (2) to understand the preferences of LD travellers to help determine their likely responses to policy initiatives being considered in the project.

In order to achieve these aims an on-line survey was designed as a tool to collect the data and information on current LD travel patterns and preferences of LD travellers. The survey was challenging, given the number of countries that data was collected from (9 in total), the size of the sample to be collected (close to 6,000 respondents) and the complexity of the data to be collected (a mixture of Revealed Preference³ (RP) and Stated Preference⁴ (SP) data). Despite the challenges involved the data was collected successfully with a rolling programme of surveys that began on 4th May 2012 in the UK and which finished on 2nd July in Poland. The profile of the respondents shows a broadly representative sample across the 9 countries.

The second aim involved detailed analysis of both RP and SP data. A number of analyses were undertaken which examined the various aspects of making a journey such as accessing the main mode of transport, the egress journey, the main journey itself, and the impact of soft factor solutions (such as on-line planners) on overall journeys. These analyses were based around SP experiments but were also complimented by analyses of RP data in the form of trip rate tables and linear regression analysis.

4.2 REVEALED PREFERENCE ANALYSIS

Results on trip rates

The RP analyses of trip rates focused upon the respondents' long distance trip making over the last 12 months and responses to a series of questions covering 3 distance categories (all one way): (1) >1000 km; (2) between 500 km and 1,000 km; (3) and between 100 km and 499 km.

As was expected the vast majority of LD trip making takes place within the lower distance band of 100-499 km, with close to 80% of all LD trips made in the last 12 months. The remaining trips are split nearly equally between the remaining two distance bands with 12% of trips being made in the 500-1,000 km band and 9% in the >1,000 km band. The split across countries has some variation with Austria, France and the Netherlands showing a tendency to travel more frequently over shorter distances.

The mode split for LD trips is as expected, with the car strong for all distance bands but particularly so for the shorter band of 100-499 km where on average three quarters of all trips are accounted for. Air accounts for only a fraction of trips in this band (2%) but is the dominant mode for trips > 1,000 km (41%). Train has a significant presence for all three distance bands with around a 15% share for trips between 100 and 1,000 km, falling to 10% for longer distance trips reflecting air's strong market share. Coach or bus is fairly constant across all of the distance bands at around 7% whilst other (mainly ferry) is too at around 3%.

There is variation across countries which may reflect geography, topography and cultural differences. For example the UK has a consistently higher number of trips undertaken by "other modes" reflecting the strong influence of ferries to engage in LD trips. Likewise train services are much more utilised in mainland Europe where integration between countries is the norm rather than Ireland which does not have the network to support this level of trip making, instead relying on LD coach services and air. Coach services are also particularly strong for Poland which may reflect the cost of competing

³ Revealed preference data concerns data describing actual behaviour, e.g. a trip just recently undertaken.

⁴ Stated preference data concerns data on behavioural intentions and responses to hypothetical choice situations, e.g. a potential trip under certain conditions.

transport modes and strong cultural norm to travel long distances by coach, while for Germany the monopoly of rail services prevented the inauguration of national long-distance bus services⁵.

In terms of purpose split, work related and leisure trips dominate, with the former dominant (52%) for journeys between 100 and 499 km and the former for journeys >499 km (>55%). LD work related trips appear to be much more prevalent within Austria, Germany and Poland (>55%) for trips between 100 and 499 km, whilst education LD trips are prominent for Ireland perhaps reflecting a tendency for study outside of the country.

The average trip rates per respondent with the focus again upon overall distance bands, trip purpose and mode showed that the average respondent makes around 1 return journey a year over 499 km (mainly holidays), with around 9 return journeys for trips between 100 and 499 km (a combination of work and leisure). There is some variation between countries in this regard with Belgium, Germany, Ireland and Poland displaying a tendency to make higher than average trips, with Austria, Switzerland and the UK fewer. A look at the trip rates and journey purpose confirms that leisure dominates trip making at distances greater than 499 km (with average trips rates of 1.47 and 1.29 for distances between 500 km and 1000 km and 1000+ km respectively); with study trips making a significant contribution between 100 & 499 km (with an average trip rate of 1.52) and work trips accounting for around 50% of trips between 100-499 km.

There is some variation between countries, with both Germany and Poland noticeably making more work trips p.a. between 100 and 499 km (10.55 and 11.89) compared with the overall average of 9.19 trips. Study trips within the same distance category show quite strong fluctuations with France, Germany, Ireland and the Netherlands recording average trips rates greater than the overall average of 1.52. This may reflect the size of these countries as in very large (France and Germany) or small (Ireland and the Netherlands); which may result in students travelling long distances within their own country or to educational institutions outside of their own country.

With regard to the transport mode chosen, car dominates trip making between 100 and 499 km, overall accounting for 74% of the number of trips made. Air accounts for the largest number of trips over 1,000 km (41%) but is closely followed by car (39%). Train is well represented in the first distance category (15.2%) and second distance category (15.4%) but falls away in the third (10.1%) reflecting a loss of competitiveness to air in terms of journey time.

Results on factors influencing LD trip rates

Complementing the trip rate analysis were a series of linear regression models that attempt to explain what factors are important in influencing LD trips. The overall picture to emerge is one of LD travel being largely determined by occupation, car access, gender and whether you have children under the age of 16.

The explanatory variables in the general model were largely significant, displayed the correct signs and were largely plausible with a number of the following key findings. Occupation has as strong impact on overall trip making behaviour with those in full time much more inclined to make LD trips, whilst the unemployed, full time home makers and retired are not. This is particularly the case for work as one might expect. Gender also has a strong influence on overall trip making behaviour with men likely to make a significant number of additional trips vis a vis women. This probably reflects the role that men have traditionally assumed (e.g. the main 'bread winner') and the fact that there is still a predisposition for men to have a larger share of senior roles within companies that might lead to additional LD travel all things considered. Households with children aged less than 16 have, all things considered a tendency to do more LD travel than households who do not. This may reflect family visits, family holidays and travel during the school holidays. No access to a car has a significant impact upon overall trip making, but especially so for journeys less than 500 km, reflecting the strength of car for journeys of those types of distances. As trip lengths approach trip distances that are greater than 500 km the influence of car is reduced, with rail and air coming to the fore; whilst for trip distances greater than 1,000 km air is dominant. Coach trips are strongly linked to income with those on lower incomes more likely to travel by this mode. Car trips are strongly influenced by occupation, with those in full time employment making the bulk of the trips, especially for distances less than 500 km. Journey purpose models are strongly correlated to occupation as might be expected with those in

⁵ The monopoly was annulled in 2013.

employment strongly influencing work related trips; those who are in education strongly influencing study trips; and those who are retired, home makers or unemployed strongly influencing other trips.

4.3 STATED PREFERENCE ANALYSIS

A number of SP experiments and analyses were undertaken which examined the various aspects of making a journey such as, accessing the main mode of transport, the egress journey, the main journey itself and the impact of soft factor solutions (such as on-line planners or friendliness of service staff) on overall journeys.

Estimates of soft factor solution valuations

The latter experiment appeared at the end of the survey and respondents were requested to rank a set of ten improvements to their current journey. The improvements consisted of two cost reductions, two fare reductions and 6 soft factor improvements. The ranking exercise was intended to elicit the preference of respondents on particular improvements related to the quality of the journey relative to a set of reductions in travel time and travel cost. The soft-factors included in the ranking exercise were specific for the four possible modes of transport, i.e. rail, coach, air and car.

The values estimated from the soft factor solutions can be found in Table 4-1 and have been estimated across all countries for specific modes (with relevancy applying). The overall picture presented in Table 4-1 is that respondents have displayed high Willingness To Pay (WTP) values for the LD solutions considered in the soft value SP ranging from 312 minutes (additional car park spaces next to coach stations) to 2 hours and 40 minutes (integrated ticketing for air and its access/egress modes). Values higher than 2 for T-ratios indicate that the finding is statistically significant, hence all values in the table indicate very high significance.

Table 4-1 Specific Willingness To Pay values for Long-Distance Solutions

LD Solutions	Rail	Coach	Air	Car
Ticket LPT included	111.84	47.86	159.58	Na
Coordination	104.47	47.41	85.22	Na
Online Journey planner	91.32	33.51	50.97	Na
LPT and taxis next to station	64.66	42.37	Ns	Na
Information LPT ticket service	42.60	42.26	Ns	Na
Luggage drop-off	42.58	Na	Ns	Na
Self-service check-in	31.95	Na	143.02	Na
Passport control	28.79	Na	Ns	Na
Friendly staff	27.11	32.79	Ns	Na
Additional car park space	15.57	11.61	Ns	Na
Wi-Fi	Na	28.69	Na	Is
Level Access	Ns	25.05	Na	Na
Accident reduction 20%	Na	22.12	Na	Ns
Emission reduction 10%	Na	Na	Ns	Is
Emission reduction 20%	Na	Ns	Ns	Is
Emission reduction 40%	Na	Na	Na	Ns
Better rest facilities	Na	Na	Na	Is

Na – not applicable; Ns – not significant; Is – incorrect sign

The question arose why the values are so high and whether they are too high. When the questionnaire was piloted a number of follow up 'depth' interviews were carried out. These showed that LD solutions were consistency placed above reductions in both journey time and journey cost.

When probed further it became apparent that respondents were highly risk averse when it came to LD travel, especially travel to new cities, and especially foreign cities. Respondents valued certainty with respect to how they could make the egress part of their journey, how long it would take, how much would it be and where the mode they would use would be located. For some people it was important for them to ascertain this information before their trip, whilst for others it was important that this information/process was easy to do once they arrived at their destination. Respondents also had similar, if not quite as highly valued (due to greater familiarity), concerns about the access part of their journey, especially if they were travelling to airports and needed to arrive with time to go through check in and security arrangements.

The in-depth interviews therefore provided useful contextual information to set these high values against and highlight that high values for solutions such as public transport co-ordination and positioning of local public transport and taxi ranks next to destination stations/airports will be highly valued by LD travellers. Alternatively some of the solutions, principally the on-line journey planner, will provide actual time savings for people planning trips as the alternative would be a trip to a travel agent or numerous phone calls to different operators who may or may not be in your own country and who may or may not speak your language. Under such circumstances a Willingness To Pay (WTP) of between 34 minutes and 91 minutes for an 'on-line travel planner' may not seem excessively high. Interestingly, emission reductions are not significant which may suggest that respondents are more focused on direct benefits to their own journeys rather than society gains overall.

Estimates of the value of the main mode of travel

The remaining SP experiments were linked together by consideration of the most recent LD journey that the respondent had reported in the questionnaire. The first of these attempted to explain the choices for the main mode of transport, i.e. the first part of the choice experiment. The possible main modes of transport amongst which the respondent could choose here were: car, rail, high speed rail (HSR), plane, and coach. The trip presented to the respondent was characterised by a set of trip characteristics specific to each mode of transport. As such, respondents were requested in the first stated choice experiment to make trade-offs between the: (i) travel costs, (ii) travel time on the main mode of transport, (iii) interchange time, (iv) number of interchanges, and (v) the combined access and egress time. The analysis focussed on deriving the implicit values for changes in these specific trip characteristics. Of key interest was the extent to which respondents are willing to pay for reductions in the different components of travel time and to reduce the number of interchanges during the trip. To derive these implicit values, standard Multinomial Logit (MNL) models were estimated at the European and national level.⁶ The models control for differences in mode choice and willingness to pay across business and non-business journey purposes as a result of variations in the mode specific trip characteristics.⁷ The presented analysis contrasts the Value of Travel Time savings (VoT) across modes, countries, distance bands and journey purposes where possible.

Table 4-2 shows, for the longer distance LD trips (trips >500 km), the value of Combined Access and Egress Time and interchange time is higher than the value of main travel (or in-vehicle) time. The fact that the VoT estimates for interchange time and access and egress time are higher than the VoT for the main modes of transport, can be explained by viewing these as intermediate stages of the journey which are less productive to business travellers and they can result in stressful situations for both leisure and business trips when travellers encounter a new environment and the possibility of missing a connection. Particularly, a longer access and egress time may also increase the probability of missing a flight or a high-speed train. For longer distances, respondents prefer not to have a complicated and long access to their main mode of transport. This is less the case for the shorter distance LD journeys (trips <501 km) where the in-vehicle time has the highest Value of Time estimate. This can be explained by the importance of the car in this distance band, which is associated with no interchange time and low access and egress time. Overall, Table 4-2 clearly shows that the VoT is increasing in distance, which reflects the discomfort of longer journeys and the larger opportunity cost of time spent travelling (Wardman et al. 2012). The largest differences across

⁶ Estimations were conducted in the BIOGEME software package (BIOGEME, 2003).

⁷ The models jointly estimated the choices for the best and worst alternative in each choice task. It is common knowledge that there may be differences in response patterns across these two types of choices (best and worst). For this purpose, an additional scale parameter was estimated allowing for a difference in variance of the error term between the best and worst response format. Observations based on the worst response format always result in a higher variance.

distance bands are observed for the Combined Access and Egress Time and the value of an interchange. The latter can also be explained by a preference for uncomplicated travel schedules in longer distance journeys.

Table 4-2 European Value of Time estimates in euro per hour and per interchange

	Longer Distance			Shorter Distance		
	Non-Business	Business	All purposes	Non-Business	Business	All purposes
VoT across all modes	15.86	25.30	16.75	12.24	20.14	11.93
VoT for Combined Access and Egress Time	27.33	43.57	28.93	8.72	14.35	8.79
Value per interchange	9.52	15.18	10.08	3.85	6.33	3.96
VoT for Interchange Time	10.75	17.14	11.50	8.21	13.52	8.42
Number of observations	34,496			26,382		
Number of respondents	3,242			2,550		

Estimates of the value of access time

Table 4-3 presents mode specific value of access time estimates for the longer distance bands. Here, there are mode specific business VoT estimates up to €171 for drop-off and €131 for the taxi. The choice shares revealed a high tendency for respondents to select the drop-off option. More specifically, a fair share of respondents always select the drop-off irrespective of the presented trade-offs. Some of this is picked up by the mode specific constant, but not all. Similar non-trading issues are present for the other modes of transport. It is therefore not surprising that the mode-specific VoT estimates in the longer distance business segment are of such large magnitude. These values are substantially lower in the non-business segment, where they are respectively €60 and €48. For the shorter distance band mode specific VoT estimates are not supported by the data. This is largely a result of the larger sample size for this segment, which automatically implies more trade-offs to learn about the underlying mode specific value of access estimates.

Table 4-3 European wide value of access time estimates in € per hour

	Longer Distance		Shorter Distance	
	Business	Non-Business	Business	Non-Business
VoT LPT	50.03	20.08		
VoT Taxi	131.45	47.55		
VoT Drop	171.37	59.85		
VoT Drive	106.68	14.88		
VoT all modes	58.89	27.00	58.62	33.22
Number of observations	21,388		17,150	
Number of respondents	3,137		2,478	

For the purpose of consistency, Table 4-3 also reports the value of access time estimates across all access modes. These values are comparable to the overall access and egress time for the longer distance band reported for the main mode SP outlined in Table 4-2. Surprisingly, the access time sensitivities in the shorter distance category (Table 4-3) are higher compared to the main mode SP (Table 4-2) and for non-business trips (Table 4-3) these estimates are even higher than in the longer distance case (Table 4-3).

Overall, the results for the access stated choice experiment suggest that people generally have a specific access mode that they prefer to use. They seem to be stuck in these habits and refuse to

make trade-offs between access time and the associated costs. This affects the analysis substantially, which forces the authors to recommend the use of European wide values of access time, which are more or less in line with the estimates obtained for combined access and egress time from stated choice experiment one. During the design of the survey, an attempt was made to circumvent the non-willingness to trade by adjusting the levels of travel time and travel costs for the presented alternatives, but the scope for this was limited due to the need to keep the levels realistic. Hence, this only had a minor impact on actual behaviour in this part of the survey.

Estimates of the value of egress time

Table 4-4 shows the values of time with regard to the egress mode. Overall, the table makes clear that business people have a higher value of egress time and that the shorter distance value of egress time is also lower. This can be explained by the fact that when arriving at a distant location (i.e. airport or station), people are generally more tired due to the long journey and may want to go to their destination as quick as possible. However, the derived estimates for business trips are associated with large standard errors. Hence, we recommend using the all-purpose specific VoT estimates reported in the Table 4-4.

Compared to the values of egress time obtained from the stated choice experiment on access modes, a lower VoT is obtained here for the shorter distance. The value for the longer distance is very comparable across the two studies. An explanation for the lower VoT for egressing from stations compared to the airport is that people may prefer to take a stroll from the station, or enjoy the local public transport to enjoy the scenery of the city in which they arrive. This is clearly not an option for most airports.

Table 4-4 European level estimates of the value of egress time in € per hour

	Longer Distance			Shorter Distance		
	Business	Non-Business	All purposes	Business	Non-Business	All purposes
VoT	154,19	23,72	31,95	23,35	18,46	19,26
Number of observations	12968			13072		
Number of respondents	3242			2550		

Overall, the results for the access/egress stated choice experiments suggest that people generally have a specific access and egress mode that they prefer to use. They seem to be stuck in these habits and refuse to make trade-offs between access time and the associated costs. The willingness to make these trade-offs is larger when selecting the best egress mode.

5 KEY REQUIREMENTS FOR SEAMLESS LONG-DISTANCE TRAVEL FROM THE PERSPECTIVE OF USERS

5.1 OBJECTIVES

For users, a long-distance intermodal journey can be a complex undertaking involving several transport modes and requiring several interchanges. Therefore, user needs will differ according to the mode combinations used and the number and type of interchange facilities involved in each intermodal journey. Taking this into account, this ORIGAMI task began by considering user needs for long-distance intermodal trips at a generic level (i.e. all modes and interchange points) before looking at user needs at an individual mode level (i.e. air, rail, bus/coach and ferry) to identify any mode-specific user requirements, and also user needs relating to the access/egress intermodal journey stage (i.e. local public transport, walking, cycling). It then reviewed evidence related to how user needs vary according to both personal (i.e. age/mobility-impairment) and situational (i.e. trip purpose) factors.

The main findings of the literature review were then summarised and discussed, highlighting any problems with available data and research gaps, before a final user need classification was presented.

5.2 RESULTS

Based on previous European research which has examined user need requirements for long-distance intermodal journeys (e.g. LINK, KITE and CLOSER), twelve main user needs were identified, related to various *network characteristics*, facilities provided at *interchanges* (transfer points), available *baggage handling facilities*, availability of *tickets and tariffs*, provision of *door-to-door information*, *whole journey cost*, *level of comfort*, *safety and personal security*, *total journey time*, *accessibility issues* and the way intermodal journeys are *promoted*. When considering individual modes that make up long-distance intermodal journeys (i.e. air, rail, coach/bus and ferry) a further four user needs were identified, related to the behaviour of *employees*, the amount of *effort* expended by users when undertaking the journey, *in-vehicle facilities* and *environmental concerns*. A summary of these sixteen factors is provided below in the following.

- **Network characteristics:** Users require transport services that depart and arrive at interchange points of sufficient frequency to meet their needs for each journey; transport services are available that cover an area that allows them to travel to the places they want to go; transport modes are available to allow them to travel to their desired destinations that match their personal mode preferences; available transport services depart/arrive matched to times required by them (convenient); and available transport services run on time.
- **Interchange facilities:** Users require that interchange facilities are designed, managed and equipped to a sufficient standard to allow them to make required connections between different modal stages of their journey as safely (see personal security later), quickly (see journey time) and comfortably (see comfort) as possible. Interchanges also need to be fully accessible for users (i.e. barrier free), which includes use of facilities sited within interchanges including toilets, ticketing machine, shops, cafes etc.
- **Baggage handling facilities:** Users require baggage handling facilities to be provided that are safe, simple to use, and reliable. For some travellers assistance will also be required.
- **Tariffs and ticketing:** Users require tariffs and ticketing systems to be integrated between different modes and individual mode providers, that are both simple to use and understand while providing full passenger rights throughout the journey.
- **Door-to-door information:** Users require that sufficiently detailed high quality information is provided for pre-trip, wayside and on-board journey stages to allow users to efficiently plan their whole journey. For some travellers this information needs to be provided in formats that allow all users to fully use and understand the information provided (e.g. in Braille, talking maps etc.).
- **Cost:** Users require that costs involved in planning and undertaking the journey are affordable, according to individuals' financial means. This includes costs involved to access (first mile) and egress (last mile to desired destinations) transport terminals, as well as the costs involved in each main mode component of the journey.

- **Comfort:** Transport services (vehicles) and facilities (interchange terminals) should be designed and maintained to ensure users are comfortable throughout the whole journey. This includes aspects such as ensuring facilities and vehicles are clean, and providing protection from weather conditions, seating and waiting areas, food and drink facilities, and sanitary installations.
- **Safety:** Users need to feel safe when making long-distance intermodal journeys (i.e. from the risk of accidents).
- **Personal security:** Users need to feel secure when accessing, and using different mode components of the intermodal journey (i.e. from theft, attack, intimidation etc.).
- **Journey time:** Users require the total journey time involved in long-distance intermodal journeys to be as short as possible (i.e. minimal access, waiting, transfer and in-main mode vehicle/vessel time).
- **Accessibility:** Users require transport terminals to be fully accessible by all feeder transport modes, specifically to access modes they wish, but may be restricted (e.g. because of mobility difficulties) to use, as well as the vehicles that they are required to use for the main mode components of the full journey.
- **Promotion of intermodality:** Users need to be aware of intermodal services that are available to them and they need to be marketed in a way that is attractive to them.
- **Employees:** Users require (expect) employees (at interchanges and on-board vehicles/vessels) to be able to assist them (if required), provide the correct information to them, are smartly dressed and courteous.
- **Effort:** Users require that the total effort (physical, cognitive and affective) they need to expend to undertake a journey is reasonable (i.e. is acceptable for them, not uncomfortable for them).
- **In-vehicle facilities:** Users require (expect) various services to be provided, or be available for them (primarily for main mode elements of the journey), including aspects such as catering facilities, communication facilities (wireless access, plug sockets) and entertainment facilities (newspapers, TV/films, games etc.).
- **Environmental concerns:** Users have expectations that transport companies and operators are taking actions to minimise the environmental impact (i.e. using low emission vehicles, fuel etc.).

Many of these broad factors overlap and are interrelated with each other. For example, journey time includes the time required for users to access terminals (and thus related to accessibility), and is also linked to network characteristics and interchange facilities, in that aspects such as speed of transfer and frequency of connecting services will affect the overall journey time. Similarly, comfort is (may) be related to the in-vehicle facilities provided, and effort will be related to the type and amount of transport services available (i.e. accessibility).

The report produced for this task also identified the role of personal (e.g. level of mobility, cognitive ability, age-related etc.) and situational factors (i.e. trip purpose) in determining the relative importance of user needs. Whilst no further specific personal or situational users needs were identified (in addition to those 16 identified above), the relative importance attached to individual user needs was shown to vary for some traveller groups and / or be dependent on their trip purposes. For example, mobility-impaired travellers, depending on their level of mobility-impairment, attached greater importance to user aspects such as accessibility (are transport terminal facilities and main mode vehicles/vessels fully accessible to them), information provision (details of barrier-free routes required for them to make the journey, and this information to be provided in formats they can understand, and use) and whether staff are trained (disability awareness) to fully understand their specific needs.

Similarly, for those on business related trips, aspects such as overall journey time, in-vehicle facilities (e.g. WIFI availability), comfort and reliability issues (likelihood of delays) are more important compared to travellers making the same journeys for leisure purposes, where aspects such as cost and information provision (due to their unfamiliarity of making these journeys).

However, which of these 16 user need aspects are of greatest importance (relative to each other) to users, or how these aspects influence individuals' decisions to undertake long-distance journeys (or not), and which modes to use when making such journeys is not fully clear and needs to be established in future research.

6 CRITICAL AREAS FOR SEAMLESS LONG-DISTANCE TRAVEL FROM A SYSTEM'S PERSPECTIVE

6.1 OBJECTIVES

The analysis of key requirements for seamless long-distance travel took into account the entire trip transport chain. This implied to focus on three stages of the long-distance intermodal transport chain: 1) the first/last mile, 2) the interchanges and 3) the main trips. In doing that, the aim was 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.

6.2 RESULTS

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:

1. Multi-modal information systems and integrated ticketing;
2. 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
3. The provision of major information to the passengers, etc.;
4. The presence of integrated transport infrastructures and networks (rail, road, local public transport) at the interchange points 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.

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. LINK project) 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 (e.g. in the CONDUITS project) 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 6-1 summarises the system requirements 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.

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).

Table 6-1 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)	

7 CO-MODALITY AND INTERMODALITY ON LONG-DISTANCE TRANSPORT: BEST PRACTICE AND SUGGESTED SOLUTIONS

7.1 OBJECTIVES AND ACTIVITIES CARRIED OUT

Workpackage 5 of ORIGAMI is at the core of the project. It has identified potential solutions for the improvement of co-modal and intermodal travel. This comprises solutions that are already examples for best practice in Europe or elsewhere in the world as well as solutions that so far are only in their planning stages or even only just suggestions found in the literature.

The solutions are structured into 13 families. Although the lists of solutions presented are not exhaustive and many additional examples can be identified, the ones presented provide insights in the most relevant alternatives currently existing in Europe, or being considered for the near future. A few unsuccessful cases have also been included to complete the overall picture. All solutions are documented, illustrated and referenced in the Best Practice Library accessible from the ORIGAMI website.

The compilation of best practices and suggested solutions is focused on infrastructure, service management and regulatory strategies applied to improve long-distance intermodal and co-modal transport. The co-modality concept was introduced in the EC 2006 Transport White Paper mid-term revision, referring to the use of different modes on their own and in combination, with the aim to obtain an optimal and sustainable utilisation of resources. Therefore, co-modal solutions do not need to be also intermodal, but intermodal solutions are included into the co-modality approach whenever they are proven to be more efficient and sustainable than unimodal solutions. It is in fact a key objective of the European Common Transport Policy (CTP) to integrate existing transport modes to develop a seamless web of transport chains linking air, road, rail and waterways aimed at promoting overall efficiency of the transport system, reliability and flexibility.

WP6 of ORIGAMI has undertaken further analysis of previously identified solutions:

- The ORIGAMI solutions have been object of an in-depth analysis to compare them against the most relevant problems and requirements of the transport system established in WP4 of ORIGAMI. This analysis is presented in the next chapter of this report.
- The transferability analysis of solutions has also been undertaken by ORIGAMI. It explores to which extent previously identified solutions can be useful in different contexts to solve similar problems, and later on potentially be standardised for a general application. The criteria and the subsequent applicability analysis covers aspects that restrain a solution that has been effective in a given case (engineering, financial, regulatory and legal), to be standardised as a useful solution to all similar cases. Legal aspects, third-party impacts, risk management, and stakeholder interest are also analysed in this context. The key findings of the transferability of solutions are presented in this chapter for each of the solution families.

In addition, WP6 carried out three participatory activities to discuss the potential interest of identified solutions with transport stakeholders (analysis of gaps and bottlenecks, and transferability included). A preliminary consultation was carried out in November 2011 to analyse the likely impact of selected ORIGAMI solutions onto 10 key transport megatrends (activity in collaboration with WP7). Then, one workshop was held in May 2012 and another virtual one in November 2012 bringing together actors that implemented solutions and actors being in position to implement them, in an approach aimed at the transfer of knowledge between different actors. Stakeholders selected included market regulators (public institutions), transport operators and infrastructure owners and managers, members of the scientific community and transport consultants.

All activities related to transport solutions analysed in ORIGAMI are presented in-depth in deliverable D6.4 of ORIGAMI and in the Best Practice Library accessible from the ORIGAMI website.

7.2 INTEREST OF SOLUTIONS

Figure 7-1 shows one example of the total of 167 solutions listed on the website. They are all listed in Table 8-1 in the next chapter. In the following, the families of the solutions are presented one by one.

01.02. Air-rail integration at Frankfurt am Main airport (4.86 out of 5)

Source
 Ulled A, Bielefeldt C, Biosca O, Matthews B, Shires J, Schnell O, Mandel B, Wilmsmeier G, de Stasio C, Raganato P, Bak M, Borkowski, P, Saugstrup S, "Factors Affecting Interconnectivity in Passenger Transport", Deliverable D4.1 of INTERCONNECT, Co-funded by FP7, TRI, Edinburgh Napier University, Edinburgh, October 2010

Frankfurt Airport Website

Relevant websites
 Frankfurt am Main Airport KITE Case Study
 Frankfurt Airport Anreise Parken
 Fraport
http://www.fraport.com/content/fraport-ag/en/products_services/intermodality.html
<http://g.co/maps/4yhy>

Stakeholders
 Fraport AG, DB, Lufthansa

Status
 Existing

Description
 Frankfurt Airport is located 12 kilometres from the city centre of the German city of Frankfurt am Main. It is the largest airport of the country and the third largest in Europe, serving as an important hub for international flights from all around the world. The joint-stock company Fraport AG is the owner and operator of the airport. Airplanes starting from Frankfurt currently approach 265 destinations non-stop.

Relevance for inter- and co-modality
 Improving interconnections between airport and high speed railway network; advance check-in provides added connection security and that, together with the integrated ticket, encourages combined air and rail travel (intermodality). The existence of excellent road connections to/from an airport is a prerequisite for intermodality air <-> car / coach

Contact
 Fraport AG
 Frankfurt Airport Services Worldwide
 60547 Frankfurt am Main
 Germany
<http://www.fraport.de/content/fraport-ag/de/misc/kontakt.html>

Comments (3)
 Primary hub in Europe (Przemyslaw Borkowski)
 Probably the most important air hub in Europe with many interchanges and original solutions developed therefore very promising study objective
 Reply
 Very good example (Mandel)
 A blueprint for many airports and a wide source to learn from. Excellent and furthermore it is expected that a new bus terminal will be added to enhance as well this intermodality.
 Reply

Annotations:

- Solution ID and name
- Potential interest rating (as voted by site visitors)
- Source references
- Relevant websites
- Involved stakeholders
- Status: Existing / Pilot / Planned / Concept
- Solution description
- Relevance for inter and co-modality
- Contact of person involved in development of solution
- Illustrative materials (multimedia)
- Comments by site visitors

Figure 7-1 ORIGAMI examples of best practice web directory (www.origami-project.eu)

In the following, solutions are analysed by type.

Interconnections between long-distance transport networks

14 solutions have been selected by ORIGAMI as examples of initiatives aimed at improving interconnections between different long-distance transport networks (e.g. rail services to airports, connections between railways and ferry lines).

Similarly to local interconnections, enhanced long-distance interconnections have obvious positive impacts on long-distance travellers. In some cases, a proper interconnection may save large amounts of time to passengers on transit, especially when saving users the trip to the closest city to transfer to another long-distance transport network. However, with investments typically large (e.g. 225 million euro for Frankfurt airport's ICE terminal without considering cost of access railway infrastructure; 180 million euro for Düsseldorf Skytrain people mover) and demand for long-distance transits relative low (compared to typical urban public transport ridership figures), these solutions are only cost effective in specific cases, especially if the rail infrastructure exists and just an add-on like a stop, station or short rail link has to be added. In some cases simpler solutions such as shuttle buses may prove to be just as good as more complex and costly solutions.

A majority of stakeholders involved in ORIGAMI workshops declared a need for ad-hoc approaches to undertake long-distance transport network interconnections, mostly in relation to transits, already available infrastructure and possible territorial constraints; a solution which has proved to be efficient in one case may not work in another context. Interconnections may not raise relevant legal issues but may have considerable organisational complexity typically due to a large number of stakeholders typically involved (e.g. central administrations, municipalities, different infrastructure managers and transport operators, civil associations).

According to experts involved in ORIGAMI workshops, a market niche may develop spontaneously in the future for such solutions though it may not be expected to be a very big one.

Access and egress to long-distance transport networks

28 solutions have been selected by ORIGAMI as examples of initiatives aimed at improving access and egress to long-distance transport terminals from cities and metropolitan regions, most of the times via public transport solutions or proper terminal design. Terminals considered include airports, ferry ports, bus and coach stations, and railway stations.

Enhancing the public transport access and egress conditions to airports, rail and ferry terminals has an obvious positive impact on users in terms of travel time savings and increased comfort. When using a car, solutions aimed at increasing traffic flow in congested areas (via management or new infrastructure solutions) result in travel time savings and reduced fuel consumption. On the other side, public administrations responsible for financing investments and service subsidies face very large economic costs and are forced to establish priorities among different transport alternatives, whenever possible with clear and transparent cost-benefit methodologies. Solutions exclusively dedicated to serve long-distance transport terminals, like high speed shuttles to airports, are likely to incur high, sometimes unsustainable, financial costs, while making best use of already existing infrastructure may provide much higher social profitability (e.g. using suburban trains or buses to reach airports). The interest of transport operators to manage such services is usually high as minimum economic profitability for service exploitation is granted through public subsidies.

Local interconnections may not raise relevant legal issues but, as they often need to be built in heavily populated and urbanised areas, they often have a high level of organisational complexity, especially when agreements among multiple stakeholders are needed (city halls, transport operators, user associations). On the other hand, solutions are technically relatively easy to be transferred from one area of Europe to another, but they always have specificities which need to be closely taken into account to obtain a good project. Access and egress public transport to long-distance terminals can sometimes also be used by other users than merely long-distance travellers, like metropolitan commuters, increasing the scope and the interest of these solutions.

New transport links: megaprojects

9 solutions have been selected by ORIGAMI as examples of initiatives aimed at addressing missing links. Only examples relevant at a European scale are included. Consequently, most of the solutions discussed in this chapter fall in the category of the so called megaprojects: tunnels or bridges overcoming major natural obstacles like large mountain ranges or ocean straights. These very unique and particular projects are usually worth over €5 billion or even €10 billion.

While the impact on users is likely to be important in most of the cases, with large travel time savings and increased comfort and convenience, costs are by definition very important for an often relatively limited number of users benefitting. With these hypotheses, social cost benefit ratios are most of the times very low. Large investments required for mega-projects for instance make them only possible when a strong political will is able to compensate for poor financial performances of the transport project itself (e.g. Channel Tunnel or Öresund bridge-tunnel).

The very specific nature of mega-projects makes their transferability difficult, especially because of the very specific local approach required by these solutions.

Dual mode solutions

5 solutions have been selected by ORIGAMI as examples of initiatives aimed at designing hybrid vehicles that can use the classic infrastructure of different transport modes without requiring travellers to tranship from one mode to another. These solutions are typically cars and buses able to run on train tracks, tramways able to run on railways and trains able to run on tramway networks, or even trains able to transfer to ferries.

Dual mode transport solutions may only be socially cost effective when required investments are relatively low, like in the Karlsruhe tram train case, but unlike many of the other tram train experiences in Europe. Train ferries face increasing financial problems and also car train services are cut back as passengers move to other modes such as low-cost aviation.

The very specific nature of dual mode transport solutions makes their transferability difficult. Even when legal obstacles or externalities may not be especially relevant, the place based approach required by these solutions makes them difficult to be generalised across Europe.

Enhanced vehicle performance

9 solutions have been selected as examples of initiatives aimed at enhancing the performance of vehicles, i.e. for instance by increasing their speed or making them more reliable.

With clear benefits for users (shorter travel times, increased comfort, convenience and safety), not all solutions may be equally interesting to transport operators or public administrations. Investments may in some case be very considerable (e.g. high speed programmes).

No major feasibility issues are to be expected for these kinds of solutions. When the approach is on a vehicle basis like for car multiple driving assistants or automatic subways, transferability across Europe is relatively easy, even if technologies may be often mode specific. If the approach is infrastructure intensive, like the high speed rail programs, difficulties may be much higher. Standardisation of technologies is a basic precondition for transferability. Legal issues need to be resolved for the introduction of automatically driven cars.

Transferability is to be expected high for those solutions with a market interest and providing high traveller benefits. These solutions will mostly be developed by the private sector.

Traffic management

19 solutions have been selected as examples of initiatives aimed at better managing traffic flows, either for road, rail, air or ferry.

There are many positive impacts of these solutions. For users, proper management of transport infrastructure allows for increased average travel speeds, increased travel reliability, increased safety.

For operators, solutions aimed at improving management allow for increasing capacity of existing infrastructure with relatively low investments. For instance, implementing a system of managed lanes in a motorway such as London's and Birmingham's in the UK, including variable speed limits and hard shoulder management, allows better driving conditions with investments being about one third of the cost of enlarging motorways with one additional lane. However, investments required for the implementation of systems allowing for better management of transport infrastructure are not to be underestimated (e.g. ICTs in motorways or ERTMS).

Despite the fact that some adjustments in the legal framework might be necessary for the implementation of certain management solutions (e.g. hard shoulder driving, variable speed limits), these legal adjustments should not be insurmountable. Although ICT technologies applied to traffic management are relatively mode-based, making it difficult to transfer them across modes, they can be exported relatively easily from one region to another, all across Europe. Implementation of such solutions is only expected to be cost efficient in areas with important traffic congestion, like in metropolitan motorways and railways, European airport hubs and a very limited number of long-distance rail lines across Europe. Externalities are likely to decrease with improved management. For the road mode, a reduction in congestion results in a decrease in the number of accidents, emissions and noise, with particularly positive impacts for communities living close to large transport corridors, like metropolitan motorways. Improved management strategies for the air space, like point to point routing (FRAM) and optimisation of airplane landing procedures (REACT) have shown that fuel savings are also possible through management in the air mode (SEASAR).

Traffic management solutions have the highest level of transferability. Spontaneous implementation by transport operators is relatively likely according to experts. There are already several examples of such practice in Europe

Organisational arrangements

10 solutions have been selected as examples of initiatives which change the formal organisation of specific transport services aiming at increasing their efficiency. These initiatives may be based on liberalisation processes such as concessions, franchises, privatisations, de-regulation, or on agreements reached between operators to provide overall better services like in the case of agreements between rail operators and taxis or car sharing providers serving rail stations.

The impact on the efficiency of the transport system of public-private partnerships (PPPs), privatisations or liberalisation is uncertain according to most experts having participated in ORIGAMI workshops. Some claim that PPPs should reduce prices for the consumers, bring additional funding resources for transport investment and put less pressure on the public sector. Others claim that PPPs are just a mechanism to postpone the payment of the infrastructure by the public sector with much greater cost in the end, and that it transfers profits to the private sector while keeping risks for the public bodies.

Time is required to acquire enough evidence to draw sensible conclusions on the impact of liberalisation. It is necessary to contrast and compare approaches taken in various EU countries and various initiatives. However, it is clear that no single formula exists that can be applied across modes and territories in Europe. A good regulatory framework to transport sector liberalisation is necessary.

Segregation of freight and passenger traffic

4 solutions have been selected as examples of initiatives to segregate passenger and freight transport, or at least decreasing the volume of freight transport in infrastructures shared with general passenger transport. Freeing passenger transport networks from freight traffics can contribute to an overall increase of traffic safety and better traffic flows, especially in the most congested corridors. This family of solutions mostly considers the construction of dedicated roads and railways for freight, but also initiatives aimed at transporting larger quantities of goods using a reduced number of trucks, e.g. the modular truck concept or road trains in Scandinavia.

Large investments required for providing dedicated freight motorways or railways can only be socially profitable when transported freight volumes are very important and need to go through very congested transport infrastructure (e.g. to connect largest ports with leading economic regions throughout major metropolitan areas). Benefits of dedicated freight infrastructure are more likely to come from alleviated

congestion in the passenger network (few minutes saved by millions of vehicles or passengers) rather than direct benefits for freight transport.

The very specific nature of these solutions makes their transferability relatively difficult. Even when legal obstacles or externalities may not be especially relevant, the specific local approach required by most of these solutions makes them difficult to be generalised for other modes or areas of Europe.

Ticketing schemes

10 solutions have been selected as examples of initiatives related to travel tickets or vouchers. The examples are aimed at increasing the transparency and balance of transport fares across modes and territories, to allow passengers to travel on multiple means of transport using integrated tickets, or making it easier to purchase travel tickets e.g. via smartphone applications or in-vehicle sales booths.

Initiatives aimed at providing more comprehensive fare structures on transport are expected to provide highly positive impacts for users. However, solutions like integrated ticketing may have substantial organisational complexity, proportional to the number of different operators involved. Complexity is likely to come from the system used to distribute costs and revenues of integrated systems. The cost of integrated ticketing can be considerably high for the public administrations.

General principles of integrated ticketing schemes and operations may be relatively easy to transfer across modes and territories, but specificities for each case are likely to be very important. Legal frameworks may be complex and may require adjustment. Overall success of such systems will depend on the capacity to overcome such specificities.

Travel planners and user information

21 solutions have been selected as examples of initiatives aimed at increasing the quantity and quality of information provided to travellers, allowing them to make the most adequate route choices when travelling. Information may be related to a single mode (e.g. rail schedules, terminal orientation) or to multiple modes (e.g. multimodal travel planners).

Solutions allowing for multi-modal trip planning and ticket purchasing in Europe can have an important role in optimising passenger routes in the future. Providing real-time trip information in smart phones or car navigating systems that will change the suggested route in case of road congestion or delayed public transport promotes increasingly accurate decision making in transport. As users are better informed about alternative route choices, they can optimise their trip itineraries saving time and money. Transport operators also benefit from this solution as they are able to easily sell tickets and facilitate user information using less human resources (employees), and can also make a profit from publicity appearing in the travel planner applications. The market is already spontaneously promoting these solutions without regulation or public support required. The social benefit of such solutions at EU level may seem rather marginal, but as costs are also low, the social profitability of these initiatives is likely to be positive.

New ITS protocols for trip planning (like EU-spirit) allow for the distributed computation of alternative cross-border journeys. Different networks of existing local and regional journey planners are used for computing segments of the journey corresponding to specific regions or modes. This makes the technical side of this solution simpler to implement. Additionally, the inclusion of environmental indicators such as CO₂ emissions in travel planners, like in routeRank, might promote more responsible behaviour by travellers, decreasing the level of externalities of transport. This technology can be applied for different modes and different regions of Europe, or for all modes and all Europe simultaneously in an integrated approach.

Considering relatively high interest for travellers, operators and public authorities, and being easy to implement, travel planners and passenger information have the highest level of transferability.

Enhanced security and fee collecting procedures

14 solutions have been selected as examples of initiatives aimed at preventing the generation of queues in bottlenecks of the transport network generated by the need to undertake specific formalities such as security checks or transport fare payment. Most of the examples are aimed at making the

security and check-in procedures at airports, the road toll payment, or the purchasing of public transport tickets faster.

For users, these solutions tend to improve service quality, provide travel time savings, increase transport comfort, and transport reliability. Most of the time, operators aim at keeping the system working efficiently to attract more users and save operating costs: for instance, increasingly automatic motorway tolls to prevent congestion and increase road demand; reducing delays caused by formalities at airports can make medium distance flights more competitive to rail. In other occasions, it may be the interest of the operator to keep passengers as long as possible within the transport system, e.g. to increase profit of retailing spaces at airports or to increase revenues from car parking. Public administrations are likely to seek transport solutions that are as efficient as possible.

Solutions considered can easily be implemented all over Europe, and may also be easy to transfer across different modes: security procedures from the air mode are starting to be applied to access high speed services at rail stations, and queue management at road tolls is comparatively similar to airport queue management at security controls, or queue management at urban traffic lights. However, there may be legal obstacles in relation to privacy issues depending on the technologies used, like in the case cell phone tracking via blue tooth IDs.

Environmental management

13 solutions have been selected as examples of initiatives aimed at making transport more environmentally friendly and less dependent on fossil fuels. Although these solutions do not have a direct impact on the travel experience, like reduced travel times or travel costs for users, they are a major issue for the transport system as a whole towards meeting the sustainability targets established in the EU2020 strategy (by 2020, 20% GHG emissions reduction; 20% energy consumption from RES; 20% energy efficiency increase) and in the 2011 EC Transport White Paper (60% GHG emissions reduction in 2050).

Environmental solutions, such as in-situ energy generation to power transport infrastructures such as rail or the electrification of motorways are most attractive for public administrations concerned with energy dependency and environmental conservation. Some initiatives developed by the public sector are only aimed at generating the initial necessary conditions (seeds) for the private sector to take over later on. However, there are many alternatives available and some of these are of higher value than others. Some solutions might not prove to be sufficiently cost-effective.

Technologies are easy to be transferred across Europe and across modes. Environmental returns may be positive. No major legal obstacles may be expected. Intensive land occupation and visual intrusion may be some determinant drawbacks.

Because of not having major technical obstacles or social barriers to wide-spread application, and having a relatively high public sector interest, transferability is deemed to be medium-high. However, this may differ widely from one specific solution to another.

Enhanced safety

6 solutions have been selected as examples of initiatives aimed at making transport safer. Although also these solutions do not have a direct impact on the travel experience, like reduced travel times or travel costs for users, they are a major issue for the transport system as a whole towards meeting the safety targets established in the 2011 EC Transport White Paper (transport fatalities close to zero level by 2050)

Not all solutions may be equally interesting to transport operators despite benefits for users. However, public administrations are likely to be supportive of such solutions. Transferability across Europe is more likely to be easy when the approach is on a vehicle basis (e.g. eCall) than on infrastructure.

Standardisation of technologies is a basic precondition for transferability. Transferability is to be expected high for those solutions with a market interest and providing high traveller benefits.

8 CO-MODALITY AND SEAMLESS DOOR-TO-DOOR TRAVEL: GAPS AND BOTTLENECKS?

8.1 OBJECTIVES AND SCOPE

The Description of Work of ORIGAMI says that this part of the work will bring together the two sets of solutions found for both existing best practice and suggested solutions, as outlined in the last chapter of this report, and categorise them into one common framework. The solutions would then be systematically compared against the user and system requirements established in chapters 5 and 6 of this report.

In accordance with this, the initial idea for this work had been to look at both user needs and system needs at the same time, so that they would form a matrix in which the fields would then be filled in with solutions that meet a particular pair of user and system needs. However, the way in which the systems requirements were developed meant that the system needs are now defined on the background of the user needs and the two are no longer independent entities. Therefore the originally designed matrix has now become a simple table in which the system needs form the rows and the different types of solutions have become the columns.

8.2 THE TABLE OF NEEDS AND SOLUTIONS

Table 8-1 brings the needs and solutions together, but this current summary report of the ORIGAMI project cannot discuss them in any detail. An extensive description and discussion of the needs and solutions can be found in the milestone report MS11 *Finalised Analysis of Gaps and Bottlenecks*, published on the ORIGAMI website.

It needs to be noted that ORIGAMI is well aware that the listed examples in Table 8-1 are in no way exhaustive. In some cases they were chosen because they stand out from other similar solutions for a particular aspect. In other cases, an arbitrary example has been chosen from a possible multitude of options just to illustrate the issues involved. In other cases again, there are so many good practice cases around, such as for instance level access to PT vehicles, that there is no need for any illustrative example.

The numbers given in brackets behind each solution refer to the code that the solution has been given in the web directory <http://80.33.141.76/origami/>.

Table 8-1 Needs and solutions

Mode	System needs	Best practice example			Suggested solution		
		Fulfils need in key aspects	Meets need in parts of the world	Meets need partially	Fulfils need in key aspects	Meets need in parts of the world	Meets need partially
Pre-trip stage							
All public transport	On-line information on routes and timetables		10.10 Poznan planner 10.11 Edinburgh Bustracker				
	On-line real-time information on delays and cancellations		10.3 Reiseauskunft 10.11 Edinburgh Bustracker 10.17 VBB Fahrinfo 10.18 DB Navigator				
	On-line travel information for combined public transport modes		10.7 START 10.9 Flyrail	10.13 routeRANK			
	On-line door-to-door travel information for public transport usage		10.2 In-time 10.3 Reiseauskunft 10.4 Resrobot 10.8 Transport Direct 10.17 VBB Fahrinfo 10.18 DB Navigator			10.7 START	
	Fully integrated on-line public transport ticket		10.5 Rejseplanen 10.9 Flyrail ⁸	9.4 SailRail 9.5 Dutchflyer 9.8 Pomerania for tourists 9.9 Rail&Fly 10.1 SBB City-Zuschlag			
	Ticket not requiring a printer		11.7 SMS ticket in Wroclaw 11.9 DB mobile ticket 11.10 Lufthansa app				

⁸ Not listed under ticketing.

Mode	System needs	Best practice example			Suggested solution		
		Fulfils need in key aspects	Meets need in parts of the world	Meets need partially	Fulfils need in key aspects	Meets need in parts of the world	Meets need partially
			11.11 Oystercard 11.13 m-ticket 11.14 Walrus card				
All transport modes	On-line comparative travel information with all realistic mode combinations incl. car usage and flights		10.4 Resrobot 10.8 Transport Direct	10.2 In-time 10.6 Ecopassenger 10.13 routeRANK			
	On-line comparative information on CO2 emissions for different mode combinations			10.3 Reiseauskunft 10.5 Rejseplanen 10.6 Ecopassenger 10.8 Transport Direct 10.13 routeRANK			
First/last mile							
Car	Efficient road connections		1.2 Frankfurt airport Motorway control systems as for the main trip stage.				
	Effective urban traffic management		6.13 Singapore ERP	Many UTC systems exist. 6.4 London congestion charge 6.5 Stockholm congestion charge		6.1 NL flexible road charging	
	Pre-bookable parking space		9.10 O2 Arena				
	Availability of a car for the last mile	Hire cars are available at all airports. Park & Ride facilities exist in many locations.	2.12 ÖBB Vorteils card 2.13 Mobilpunkt Bremen			7.7 Mobilfalt	
Bus, tram, metro	Safe and comfortable stops		Many examples exist.				
	Accessible metro stops		Many examples exist in the newer stations.			13.6 Barcelona	

Mode	System needs	Best practice example			Suggested solution		
		Fulfils need in key aspects	Meets need in parts of the world	Meets need partially	Fulfils need in key aspects	Meets need in parts of the world	Meets need partially
	Dedicated bus lanes		There are many examples of fixed bus lanes, both segregated and within the general road space. There are also many examples for lanes that are only reserved during peak hours. 6.19 Reversible bus lane Madrid				
	Bus and tram priority at junctions		All UTC programs contain bus priority options, and there is also a series of smaller individual control algorithms.				
	Public transport links to ports		2.19 Helsingborg 2.24 Piraeus				
	Optimising public transport operation	Demand responsive services exist in many variations in many parts of Europe	7.9 Use of taxis in Austria 7.10 Use of taxis in Limburg				
Rail	Rail links to ports and airports		1.1 Schiphol 1.2 Frankfurt airport 1.3 Charles de Gaulle 1.4 Zürich Airport 1.13 Port of Dagebüll 1.14 Port of Turku 2.5 Copenhagen airport 2.9 Hong Kong airport 2.19 Port of Helsingborg	1.5 Düsseldorf airport 1.7 Lyon airport 1.8 Vienna airport 1.12 Port of Ancona 2.1 Stockholm Arlanda 2.2 Oslo Gardermoen 2.3 Shanghai Maglev 2.6 Cracow airport		1.6 Barcelona airport 2.4 Gdansk airport links	
Ferries	Fast and frequent connections to airports		1.10 Kansai Kobe ferry 1.11 Amsterdam	2.11 Vancouver airport 2.20 Lisbon rail stations			

Mode	System needs	Best practice example			Suggested solution		
		Fulfils need in key aspects	Meets need in parts of the world	Meets need partially	Fulfils need in key aspects	Meets need in parts of the world	Meets need partially
	and rail stations		2.8 Marco Polo airport 2.9 Hong Kong airport 2.10 Logan airport Boston				
	Safe and comfortable stops		Many examples exist				
All public transport	Real-time information on current mode		10.11 Edinburgh Bustracker				
	Real-time information on main mode		1.8 Vienna CAT				
Interchange							
Coach stations	Safe and comfortable waiting areas for passengers		2.27 Edinburgh 2.22 Madrid				
	Central coach parks		2.28 Southport coach park				
	Waiting facilities for tourist coach drivers		2.28 Southport coach park				
Rail stations	Pleasant station layout		2.25 Prague 2.16 Berlin				
	Accessibility for mobility impaired passengers		This is the general standard in larger bigger railway stations				
	Real-time information on connecting trains		This is the general standard.				
	Real-time information on ferry departures at port stations						
	Real-time information on plane departures at airport stations		1.2 Frankfurt airport				
	Real-time information about local public transport		10.20 Göttingen main station 10.21 Birmingham				

Mode	System needs	Best practice example			Suggested solution		
		Fulfils need in key aspects	Meets need in parts of the world	Meets need partially	Fulfils need in key aspects	Meets need in parts of the world	Meets need partially
			International rail station				
Ports	Real-time information on onward travel						
Airports	Real-time information on onward travel		Various examples, see 10.12 Real Time information on trains or buses in the arrival section of an airport				
	Short waiting times at security		11.1 Automated controls 11.4 CUPSS		11.2 Checkpoints of the future		
All interchanges	Making interchange unnecessary		4.5 Toyota bus-train 4.6 TramTrain		5.3 Vertiports		
	Roll-on / roll-off service		Many examples for car ferries exist. 4.1 Cars on trains 4.2 Puttgarden - Rodby train ferry 4.3 Train ferries in Italy 4.4 Train ferries in China				
	Short distances within the terminal		2.16 Berlin Central Rail Station				
	Easy navigation	There are now several indoor navigation systems that allow downloading floor plans for a large interchange where finding the way may be difficult.					
	Orientation guide for the visually impaired		2.16 Berlin Central Station				
	Level access to PT vehicles		Many examples exist.				

Mode	System needs	Best practice example			Suggested solution		
		Fulfils need in key aspects	Meets need in parts of the world	Meets need partially	Fulfils need in key aspects	Meets need in parts of the world	Meets need partially
	Convenient luggage services		1.2 Frankfurt airport ⁹ 1.8 Vienna airport 2.15 SBB 11.11 Door-to-door luggage service				
Main trip stage							
Car	Effective motorway management		6.7 Lane control 6.14 Hard shoulder running 6.15 HOV lanes 6.16 Coordinated ramp metering	6.7 French dynamic speed limits	8.3 SARTRE	5.8 simTD / V2I comms 6.1 NL flexible road charging	
	Safety	13.1 Assisted driving				5.8 simTD / V2V comms 13.4 V2V communication	13.2 Intelligent speed adaptation 13.3 Pay as you speed
	Real-time in-car navigation		6.6 Satnavs				
Coach	Comfortable vehicles		Many examples exist.				
	Real-time information on trip status and connections					10.15 Postbus	
Rail	Construction of High Speed Rail systems		5.1 Maglev Tokyo-Osaka 5.7 HSR in Europe			5.2 HSR network Spain	
	Departures and arrivals on time		6.9 ITS for Smarter Railways	6.8 ERTMS			
	Minimisation of overcrowding		6.9 ITS for Smarter Railways				
	Comfortable carriages		Many examples available.				
	Real-time information		10.14 ÖBB Railjet				

⁹ The entry in the web directory does not mention that arriving train passenger can check their luggage in straight in the train station.

Mode	System needs	Best practice example			Suggested solution		
		Fulfils need in key aspects	Meets need in parts of the world	Meets need partially	Fulfils need in key aspects	Meets need in parts of the world	Meets need partially
	on train status and connections		10.18 DB Navigator				
Road and Rail	Direct connections		3.1 Øresund bridge 3.2 Great Belt 3.3 Channel tunnel			3.4 Saint Gotthard tunnel 3.5 Brenner Base tunnel 3.6 Fehmarn Belt 3.7 Lyon – Turin tunnel 3.8 Pyrenees tunnel 3.9 Gibraltar Strait tunnel 3.10 Gedser-Rostock bridge	
Air	Efficient air traffic management to keep departures and landings on time			7.3 Privatisation of UK airports		6.12 EMMA 6.17 NextGen 7.2 SESAR 13.5 UPLINK	7.4 Privatisation of Spanish airports
	Efficient use of air space		6.11 FRAM				
	Real-time information on connecting flights		10.19 IFE use				
All modes	Clean engines	12.1 Electrification of Road Transport	12.10 Wind power for trains 12.12 List of Austrian electric charging stations	12.4 Autogas 12.11 Biofuel	12.5 Fuel cells and hydrogen		12.3 TEGs in cars 12.6 Clean sky 12.7 Electrical aviation 12.8 REACT-CR 12.9 Biofuels on commercial flights
All trip stages							
All public transport modes	Integrated planning		6.18 Primeline Coventry 7.5 Merseyrail 7.6 Edinburgh Airport Transport Forum 9.1 Integrated rail in Wroclaw				
	Well trained staff		2.1 Arlanda Express				

9 SCENARIOS OF CO- AND INTERMODALITY IN LONG-DISTANCE PASSENGER TRANSPORT OF THE FUTURE

9.1 OBJECTIVES

ORIGAMI developed medium and long-term scenarios through modelling, forecasting and analysing factors influencing transport and travel behaviour.

- MOSAIC was applied for the 2030 horizon. The model was developed in the INTERCONNECT project. It is an integrated modal split and traffic assignment model and focuses on infrastructure, unimodal, intermodal and transport policy scenarios. MOSAIC only models travel within Europe, but in that all long-distance trips.
- The LUNA model was applied for the 2050 horizon. The model has been developed in the ORIGAMI project. It is a System Dynamics model and focuses on socio-demographic, economic and transport policy scenarios. It models also intercontinental trips, but only trips within at least one overnight stay.

The scenarios were conceived to support the discussion about the level to which the passenger long-distance transport sector can contribute to the objectives set by the 2011 transport White Paper and the EU2020 strategy.

Therefore, the ORIGAMI scenarios are based on those presented by the Impact Assessment report of the transport White Paper, but adapted to specifically analyse passenger long-distance transport, whereas the White Paper scenarios consider passenger transport of all ranges as well as freight transport.

Since the 2006 mid-term review of the transport White Paper, the EU policy has focussed on co-modality (i.e. the efficient use of modes on their own and in combination, that will result in an optimal and sustainable utilisation of resources). Shifts to more environmentally friendly modes are needed, especially on long-distance journeys and in urban areas and congested corridors, but at the same time each transport mode needs to be optimised on its own.

9.2 DEVELOPMENT OF THE SCENARIOS

The main objective of this part of the work in ORIGAMI is the definition of scenarios at European level where the specific evolution of different types of transport segments is studied for multiple dimensions. Task 7.1 provided specifically the framework for the scenarios by defining the dimensions that they would have and the most relevant aspects that would be taken into account. Task 7.2 modelled and implemented the scenarios. Task 7.3 evaluated their relative performance.

Scenarios were developed for 2030 and 2050 time horizons and cover the main issues analysed in ORIGAMI.

Four Explorative scenarios for Europe in 2030 were defined, with qualitative narratives and quantitative characterisation. These scenarios are inspired from those proposed in the Impact Assessment report of the 2011 transport White Paper, but focussing only on long-distance passenger transport.

Explorative scenarios considered alternative visions to promote co-modality through more or less strict market regulations, at national and European level, by applying alternative planning and public investment strategies, and public-private partnerships. These scenarios investigated the impact of four different strategies without imposing explicit a priori constraints (e.g. CO₂ targets). They tried to cover all possible futures, so hypotheses for these four scenarios were alternative, but always realistic.

The four scenarios are linked to four alternative policy packages operating on the supply side of the transport system. Each policy package contains diverse policy actions linked to all transport modes which work together towards a specific transport option. Each scenario tests how demand responds to alternative hypotheses of infrastructure availability and transport management, mostly in terms of

variations in the cost of transport, modal shares, or the levels of emissions released in the atmosphere.

The four Exploratory policy packages are as follows:

- OR1. Better public regulation and infrastructure investment, mostly financed by public funds with some regulation.
- OR2. Better public regulation, especially on vehicle technological standards and little emphasis on infrastructure.
- OR3. More liberalisation and more emphasis on infrastructure management. Technology applied to improve efficiency of transport infrastructure.
- OR4. More liberalisation and more investment in efficient infrastructure co-financed by the private sector.

A Normative scenario has been defined by incorporating transport, energy and environment targets currently in place in the EU, mostly by the White Paper and the EU2020 strategy. The task of ORIGAMI has been to identify the combination of alternative policies required to achieve these predefined goals.

Scenarios are contrasted to a Baseline. This Baseline scenario is defined as a future without further policy implementation, a continuation of current socioeconomic trends as forecast in EU strategy documents (Energy & Transport outlook 2030, Ageing report) and no additional transport policies applied besides those already in place.

Scenarios for 2050 compare a Prospering Europe (PE) and a Lagging Europe (LE), where trends in demographics and economic growth assumptions are varied, against a Baseline that continues current trends (Business As Usual, or BAU). A variant of the 2030 Normative scenario was then tested within these three alternative base scenarios.

The transport dimension of scenarios focuses on the co-modal optimisation of transport system for seamless travelling (which includes all intermodality options as well). For 2030, the analysis was based on a network analysis model (MOSAIC) and focused on the economic and environmental costs of European passenger travel resulting from different management criteria (e.g. more or less strict market regulations, legal / technological speeds of different modes, costs of interconnection...) and availability of infrastructure (alternative definitions of TEN-T). For 2050, the analysis has been carried out at a more strategic level using the new system dynamics model (LUNA) developed in the context of the ORIGAMI project.

9.3 RESULTS FOR SCENARIOS 2030

The main findings from the scenarios 2030, as modelled by MOSAIC, are as follows:

- Total mobility measured in passenger kilometres changes slightly across different future scenarios, with some stronger local variations.
- Road will remain the main mode for passenger transport in Europe, but some degree of modal shift can be achieved depending on the policies applied. A trade off between road and rail can be achieved by policy actions. Rail has the highest growth potential, multiplying by 3 its share on scenario OR1 (see Figure 9-1).

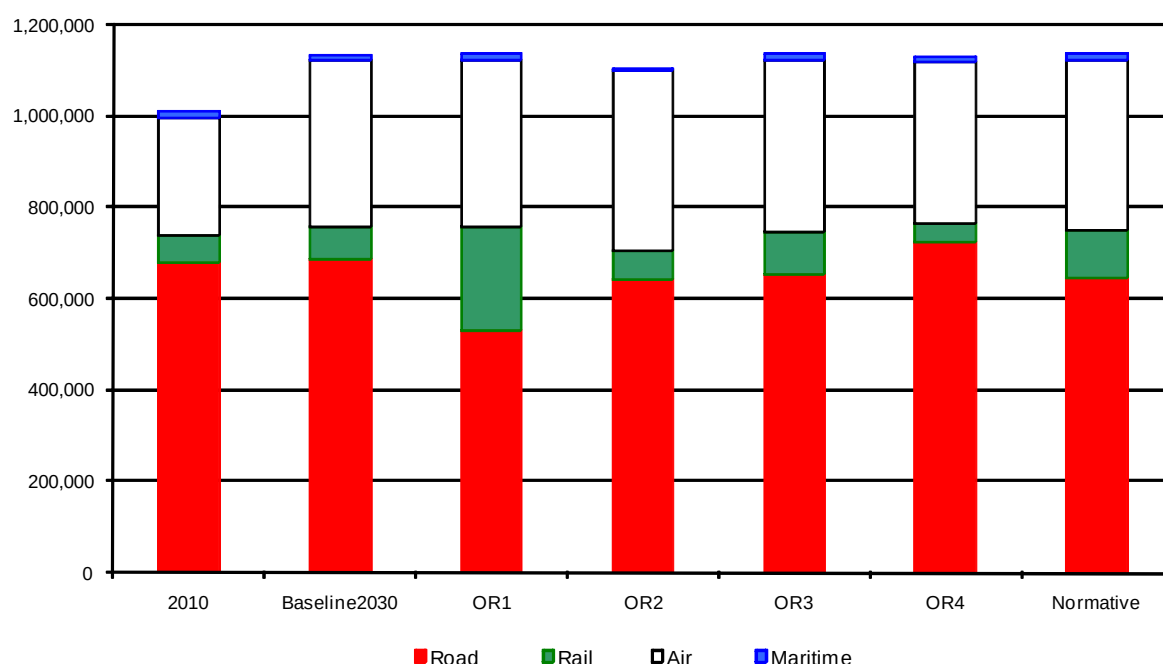


Figure 9-1 Distribution of network usage by passenger kilometres

- The most effective policy for lowering the number of cars on the roads is to increase the average vehicle occupation rather than forcing modal shift when alternative modes are not competitive enough.
- New routing options appear when new infrastructure is developed. For new rail this usually causes trips to get a little shorter in distance to get to the rail station, although in some cases the distance can become longer when rail is used as part of an intermodal chain; but even then trips generally become shorter in total travel time.
- Global travelling time tends to decrease in all the scenarios as changes in transport costs and infrastructure lead to better routes. However, the most effective measure to improve it is increasing the speed on the road as in scenario OR4.
- In most scenarios with a higher share of rail, trips tend to be more multimodal, mixing rail with road but also with air on the same trip. Mobility becomes more complex with lots of interchanges between modes. However in scenario OR4, the increase of rail does not result in an increase of multimodality, as the growth of air trips and the high increase in road speed compensates it.
- On the other hand, in some cases scenarios with a higher share of air mode tend to be more unimodal with long-distance flights, making mobility simpler (access/egress to airports from a very close location is not considered another mode), although scenarios OR4 and the Baseline are exceptions, as here the air trips are not so long, and road as a feeder mode becomes relatively more relevant.
- Fuel efficiency improves in all scenarios, but the most effective policy is the technological one. In scenario OR2, the vehicles are forced to consume less, resulting in a reduction of up to 40% compared to the Baseline.
- CO2 emissions also decrease in all the scenarios, with the technological scenario again being the one with the highest reduction. The Normative scenario achieves the White Paper target of reducing emissions by 20% by 2030 (Figure 9-2). Especially remarkable in OR2 is the reduction of emissions of the air mode by nearly 50% from 2010 to 2030 and for road by about two thirds

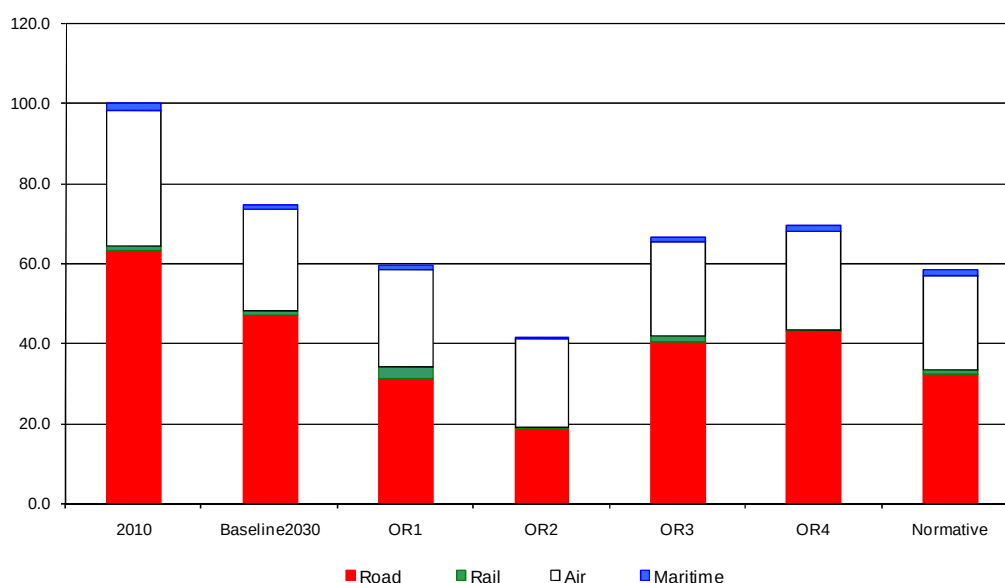


Figure 9-2 Distribution of greenhouse gas emissions in million tons / a

- Accessibility measured as the accessible population weighted by the time of reaching this population tends to improve when new infrastructure appears, allowing for better transport chains. However, the pricing policy in some scenarios causes transport to get more expensive, thus lowering the accessibility in certain regions.

9.4 RESULTS FOR SCENARIOS 2050

The main findings from the scenarios 2050, as modelled by LUNA, are:

- Car ownership will be rising in the future, but least in a Prospering Europe scenario due to a combination of population growth, an increase in older population, rising household sizes and a decrease in GDP per person. The Normative Transport Policy curbs car ownership to a limited extent.
- The total number of cars will also rise, but here the population growth is the key factor, so that the number of cars rises highest in a Prospering and least in a Lagging Europe.
- The number of passenger kilometres grows in all scenarios from 2010 to 2050, by up to 52% in PE, mainly due to the increase in the number of trips and to a lesser extent due to a lengthening of air trips, and with the policy also rail trips. (Figure 9-3). The number of trips is not affected by the application of the Transport Policy.

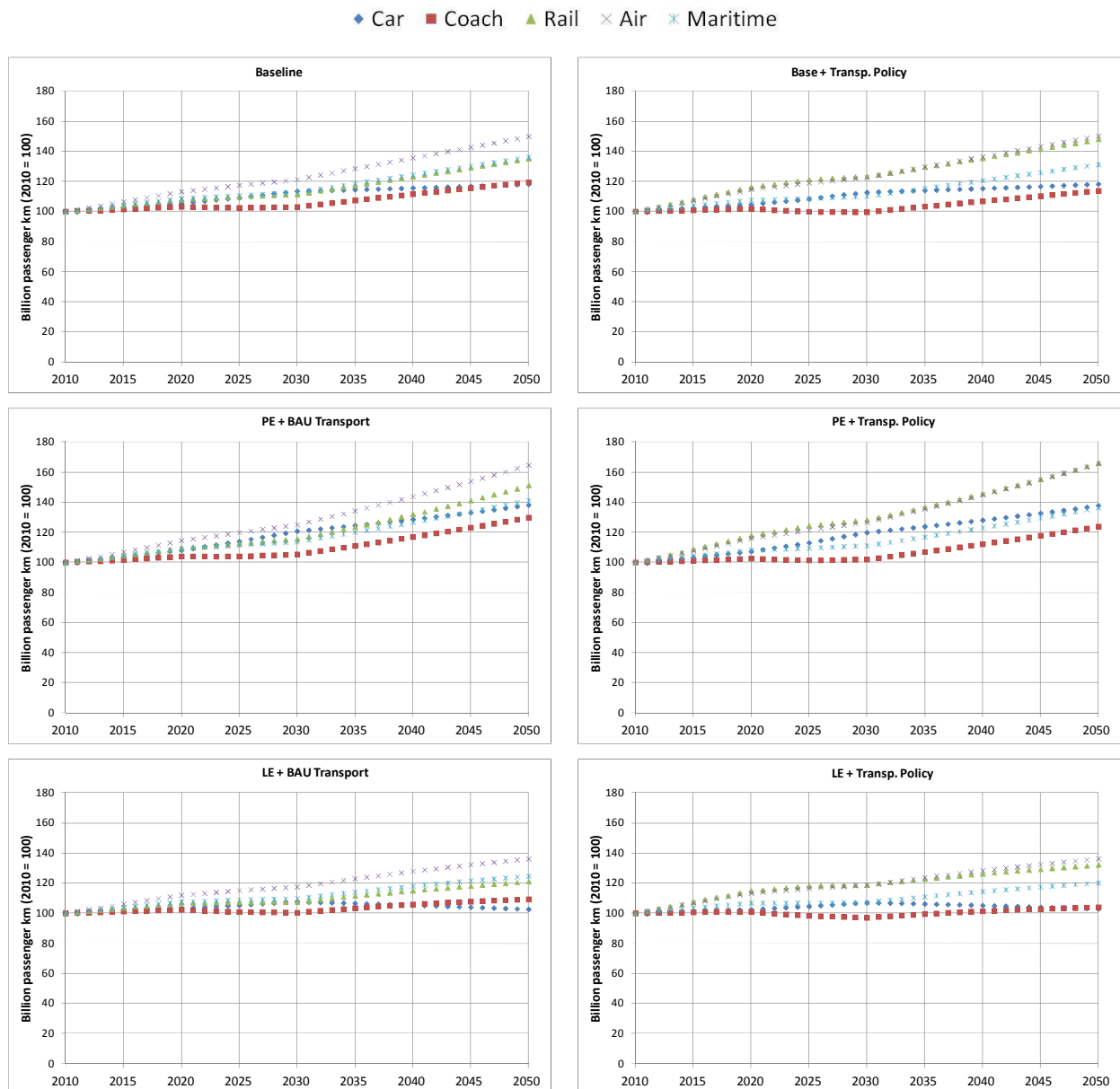


Figure 9-3 Change in network usage by passengers

- The strongest growth in passenger mileage comes in all scenarios from the growth in air travel, while growth in car travel depends much more on the socio-demographic and economic development. Neither is much affected by the Transport Policy, but the Policy does lead to an increase in rail travel, in the combination of the Policy with the assumptions of a Prospering Europe by up to 66%. Coach and maritime travel are both expected to grow continuously, slightly less with than without the Policy, but in terms of overall pax km, they will still remain less important than the other modes.
- The development of vehicle kilometres is, unsurprisingly, dominated by the car whose mileage is in 2010 27 times that of all collective modes together, and this relationship does not change much until 2050 in the Baseline scenario. But it is susceptible to both the socio-demographic and economic development and the assumptions about car occupancy in the Policy, and therefore its growth ranges from -6% in LE with the Policy to 39% in PE without the Policy. The fastest growth of all modes with 21% in LE to 41% in PE is that in the air travel mileage and the Policy only reduces that by less than 5% in all cases, while at the same time increasing the use of rail.

- The time spent on long-distance travel per person per year increases from 16.8 hours in 2010 to 21.0 hours in LE, 21.9 in the Baseline and 22.4 in PE, but the Transport Policy reduces this in all three again by one hour, mainly due to less time spent on air travel.
- User expenditure increases from €248 per person per year in 2010 to €410 to €440, depending on the scenario. The main factors are a doubling of the cost of car travel and a 60% increase in the cost of air travel, but differences between scenarios with or without Transport Policy are with a maximum of €25 per person per year between the lowest and highest value too small to make a factual difference for the users. Differences in user expenditure between richer and poorer countries increase, however, from €1,200 in 2010 to €1,900 in 2050.
- In all scenarios there is an initial decline in fuel consumption but then it is rising again and, except for LE with the Transport Policy, ends up in 2050 well above 2010 levels. This is largely driven by the large increase in air fuels, and the decrease in car consumption through the increase in car occupancy, while the impact of any changes in the other three modes is totally marginal.
- Greenhouse Gas emissions decrease with the Transport Policy in place by between 22% and 28% and without the Policy decline even much less. This is all well below the EU's GHG reduction target for 2050 of 60 %, and even a much more stringent Transport Policy than the one chosen in these scenarios could not possibly lead to results that come anywhere near that. Only a step change in propulsion technology would have any chance of producing a result that is approaching the EU target. (Figure 9-4).

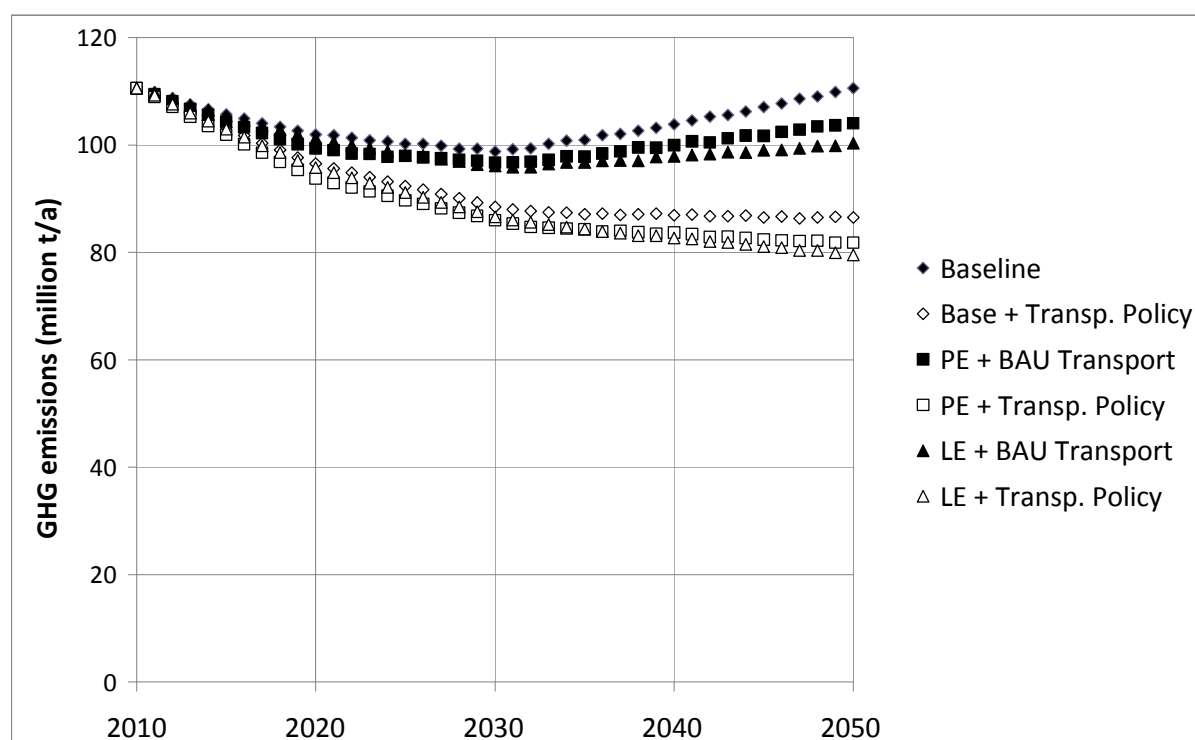


Figure 9-4 Development of Greenhouse Gas emissions in the six scenarios

- The biggest absolute and relative decrease in particulate emissions in the three BAU scenarios from 2010 to 2050 comes from rail, based on the assumptions made about the electrification of rail. However, the biggest absolute decrease overall comes from the Transport Policy, and therein for the cars due to the change in the car fleet: the reduction in particulates for cars in the Baseline scenarios in 2050 from BAU to With Policy is significantly higher than the particulates for the entire rail sector contributed in 2010.
- The indicator for social welfare available from LUNA is the holiday trip rate per country and age group. The number of holiday trips per year increases in all scenarios, though more in PE than in LE. The trip rate for young people is catching up with that of the middle-aged, but people of 65+ years fall further back as their level of car ownership does not increase at the same pace as their

longevity. There are stark differences between holiday trips in different parts of Europe with that of Central Europe being – and remaining in the future – twice that of Eastern Europe, and Western Europe being another 10% ahead, even though there are strong differences within each of these three groups, in particular a very strong north/south divide. Moreover, the disparities between social welfare in the different European countries, as measured by the holiday trip rate, increase over time.

10 THE NEED FOR FURTHER RESEARCH TO ADVANCE CO-AND INTERMODAL LONG-DISTANCE PASSENGER TRANSPORT

10.1 INTRODUCTION AND OBJECTIVES

This chapter summarises the research conducted in task 8.1 to assessing future research needs reflecting ORIGAMI results. The conclusions are based on ORIGAMI reports (deliverables and milestones) as well as on opinions of the stakeholders derived from two workshops.

This is the only section of this current report that is not a summary of work carried out and conclusions from related deliverables that could be found on the ORIGAMI website, but instead stands alone in reporting the ORIGAMI findings.

Taking into consideration ORIGAMI objectives and workpackages it was decided to assess the research needs in five areas:

- Statistics;
- Solutions identification;
- Applicability of solutions;
- Behavioural response;
- Future trends (scenarios / modelling).

For the identification of research needs both gaps applicable to the problems related to the ongoing research as well as gaps applicable to the possible future directions of research were considered.

10.2 METHODOLOGY

The methodological framework for the future research needs assessment consists of following steps:

- To identify gaps in current research and future research requirements;
- To translate gaps into researchable questions;
- To define criteria for prioritising research needs;
- To prioritise research areas (stakeholders and ORIGAMI experts' perspective).

ORIGAMI reports taken into consideration are:

- Deliverable 4.2 Analysis of System Requirements for Co- and Intermodality in Long-Distance Passenger Travel;
- Deliverable 4.1 User Needs;
- Deliverable 3.1 Current Travel Behaviour, Future Trends and their Likely Impact;
- Deliverable 3.2 Results from Survey of Behavioural Response / MS 12;
- Deliverable 6.4 Technical Solutions for the Improvement of Co- and Intermodality for Long-Distance Travellers - (MS10/MS14);
- Deliverable 7.1 Scenarios for Future Co- and Intermodality in Long-Distance Passenger Travel;
- MS11 and MS14 Analysis of Gaps and Bottlenecks.

Additionally also some results of other projects dealing with similar problems have been reviewed:

- KITE Deliverable D10 - General methodological framework;
- KITE Deliverable D17 - Recommendations for a standardisation of intermodal information and ticketing services;
- NICHES Research and policy recommendations;
- Conclusions of the HERMES project.

There are two approaches for prioritisation: core and additional. Since ORIGAMI is a stakeholder oriented project the core criterion is the interest for stakeholders which is assessed on the base of opinions derived from the workshops, especially answers to the questions regarding future research needs included in ORIGAMI Stakeholder eSeminar on Key Transport Solutions to Change European Mobility.

Rating scale of interest for stakeholders:

- High – high interest for stakeholders (opinion on the base of two ORIGAMI stakeholders workshops);
- Moderate – moderate interest for stakeholders (opinion on the base of two ORIGAMI stakeholders workshops);
- Low – low interest for stakeholders (opinion on the base of two ORIGAMI stakeholders workshops).

Additional criteria taken into consideration are:

- Cost of research;
- Funding opportunities;
- Feasibility.

Rating scales for additional criteria are:

Cost of research:

- 1 – relatively high cost of research;
- 2 – relatively moderate cost of research;
- 3 – relatively low cost of research.

Funding opportunities

- 1 – low priority for institutions offering funding opportunities, strong barriers preventing funding;
- 2 – some potential funds available but with limited access;
- 3 – high priority for many institutions offering funding opportunities, relatively easy access to funds.

Feasibility

- 1 – research representing low possibility to successful completion and implementation research;
- 2 – research representing moderate possibility to successful completion and implementation;
- 3 – representing high possibility to successful completion and implementation.

10.3 AREAS OF RESEARCH NEEDS BASED ON ORIGAMI RESEARCH

10.3.1 Statistics

Identification of current and future research gaps

ORIGAMI Deliverable D3.1 Current Travel Behaviour, Future Trends and Their Likely Impact

- Data concerning the distance travelled by passengers. Without this information it is impossible to calculate trip length distributions and other aspects of problem of intermodality.

Future: Innovative measures and technologies useful in the observation and data collection of passenger distance travelled should be sought after. Data sources already existing in electronic form to be collected and sampled in an automatic way have to be explored. All trips to, from, within and across Europe by all modes and trip purposes have to be considered. Obstacles have to be identified and solutions to be recommended.

- Gap in the knowledge base of user (passengers) needs requirements in various types of long-distance trips (business, tourism, education, other).

Future: Forecasting of the qualitative and quantitative evolution of long-distance travel and their influence on the passengers needs and preferences. Panel data as well as monitoring of transport are of high use.

Deliverable 4.2 Analysis of System Requirements for Co- and Intermodality in Long-Distance Passenger Travel)

- Lack of standardisation. It is widely acknowledged that standardisation and interoperability requirements, including international level, will help to avoid technological fragmentation and enable European businesses to fully benefit from the entire European transport market, and to create worldwide market opportunities. The lack of common framework can hamper intermodal data collection. The latter applies as well for the different interpretation of regulations across Member States where data is widely published in a detailed granulation by some Member States (e.g. UK, DE, SE) while others qualify the same data as “trade secret” and delay fragmented publication (e.g. PL, FI, GR) although these data are on sale at commercial data provider.

Future: Development of ITS-ICT applications improving data collection along the intermodal chain, e.g. smart card collecting data on changes among transport modes in a single trip. A harmonisation of data privacy across the Member States need to be accomplished and timely automatic data delivery has to be established.

Deliverable 4.1 User Needs

- Whilst the deliverable identified the key user needs for long-distance intermodal journeys, at present it is unclear what is the relative importance of each (in relation to one another) of the 15 key user needs identified.
- Similarly, the relative importance of each user need for long vs. short distance journeys is unclear.
- It is also not fully clear how the importance of these key user needs vary across the different user groups and trip purposes.
- Evidence related to the relevance attached to certain user needs for some individual transport modes (e.g. ferries, metro/underground systems) is missing or unclear.

Research gaps identified:

The variation of user needs across Member States, modes, trip purposes and trip lengths need to be investigated. Samples of significant size need to be drawn and modelling has to be applied establishing scientific proof before taking policy action.

Deliverable D7.1 Scenarios

- From all the transport modes and forms discussed in ORIGAMI the distinctive unavailability of data on ferries shows up. Consequently there is a need to centrally collect data on the number of annual ferry crossings and ferry passengers for all European sea crossings, or even better month by month data. The same shortage of data holds for bus/coach transport, where appropriate reporting regulations have to be established.

Future: The research should be in the form of a project that creates ways of collecting and automatically updating this data.

Research gaps identified by stakeholders:

The implementation of integrated platforms, in other words telematics frameworks that allow data to be shared between different types of ITS or technological applications implemented within the same geographical area.

Potential options tracking trips anonymised and aggregated on a regional base electronically by using e.g. toll collect, 10% ticket sample, and mobile phone data. An extension of this task for intermodal trips would be recommended as well.

Prioritising research needs

Research gaps can be translated into following researchable issues:

- Improvement of statistics for distance travelled by passengers by using innovative measures and technologies in observation and data collection;
- Better information on relative importance of user needs for long vs. short distance journeys;
- Better knowledge of user needs and preferences in various types of long-distance trips (business, tourism, education, other) by mode and across Member States;
- Evidence related to the relevance of some user needs for some individual transport modes (e.g. ferries, bus/coach, metro/underground systems);
- Timely, centrally collected and automatically updated data on bus/coach transport and the number of annual ferry crossings and ferry passengers for all European sea crossings (or even better month by month data);
- Common framework for intermodal data collection (including development of ITS-ICT applications improving data collection) and implementation of integrated platforms that allow data to be shared between different types of ITS or technological applications implemented within the same geographical area.
- Analysis and suggestion to harmonise European and national regulations for data collection and data privacy.
- Identification of possibilities for automatic electronic data collection. Search for opportunities tracking trips anonymised and aggregated on a regional base electronically by using e.g. toll collect, 10% ticket sample, and mobile phone data.

Table 10-1 Prioritisation of research needs - statistics

Research needs	Core criteria	Additional criteria		
	Interest for stakeholders	Costs of research	Funding opportunities	Feasibility
Improvement of statistics for distance travelled by passengers by using innovative measures and technologies in observation and data collection	low	1	2	2
Better information on relative importance of user needs for long vs. short distance journeys	low	2	2	3
Better knowledge of user needs and preferences in various types of long-distance trips (business, tourism, education, other) by mode and across Member States	low	1	2	2
Evidence related to the relevance of some user needs for some individual transport modes (e.g. ferries, bus/coach, metro/underground systems)	low	2	2	3
Timely, centrally collected and automatically updated data on bus/coach transport and the number of annual ferry	low	2	2	3

crossings and ferry passengers for all European sea crossings (or even better month by month data)				
Common framework for intermodal data collection (including development of ITS-ICT applications improving data collection) and implementation of integrated platforms that allow data to be shared between different types of ITS or technological applications implemented within the same geographical area	moderate	1	2	3
Analysis and suggestion to harmonise European and national regulations for data collection and data privacy	moderate	3	1	2
Identification of possibilities for automatic electronic data collection. Search for opportunities tracking trips anonymised and aggregated on a regional base electronically by using e.g. toll collect, 10% ticket sample, and mobile phone data	high	2	1	1-3 (depending on the source of information and mode concerned)

Research needs can be perceived from the perspective of transport systems and from the perspective of transport user. The most important research need concerns common framework for complex intermodal data collection. Such a research would be costly but on the other hand it represents high possibility to successful completion.

Additionally also statistical gaps within some individual transport modes (e.g. ferry crossings and ferry passengers, bus/coach transport) and specific user needs and preferences across EU Member States in individual types of long-distance trips differentiated by mode and trip purpose are a permanent area of research. Of great interest and important are automatic data collection possibilities ensuring data privacy while matching the scientific and transport industry needs. All the data sets have to be consolidated as well and in parallel the European and national regulations on data collection have to be made transparent and harmonised.

10.3.2 Solutions Identification

Identification of current and future research gaps

This section deals with non existence of solutions. The objective here is to look at certain theoretical solutions envisaged for which there is no application at all or there is no widespread real life application or there is only a pilot/prototype.

ORIGAMI Deliverable 4.2 Analysis of System Requirements for Co- and Intermodality in Long-Distance Passenger Travel

- Required: 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, and the enforcement of passenger rights.
- Research in new infrastructure design (solutions) is needed.
- Data concerning the distance travelled by passengers. Without this information it is impossible to calculate trip length distributions and other aspects of problem of intermodality.

Future: Future research gaps have been identified in terms of updated information, integrated ticketing and service quality along the entire multimodal and long-distance intermodal trip chain.

Future: Research on the provision of the co-operative framework among stakeholders (including public private partnerships in future settings) is required.

ORIGAMI Deliverable 4.1 User Needs

- Further research is needed to fully understand the relationship between key user needs identified, in terms of their relative importance across Member States, according to the different user groups' trip purposes and transport mode combinations identified in the report.

ORIGAMI MS11 and MS 14 Analysis of Gaps and Bottlenecks

- Technology progress is fast in the domain of transport. The impact of upcoming technologies can be large in making a more efficient, environmentally and economically sustainable transport system. There is an evident difficulty in maintaining a fully updated solutions database, especially after the closure of the project.

Future: Maintenance of an updated good practise database.

Deliverable D7.1 Scenarios

- Since car ownership and usage will be rising in the future and even stronger growth in transport measured in passenger kilometres will come from the growth in air traffic, there is a need for further research for identification of solutions providing new and sustainable fuel and propulsion technologies.

Future: Already existing solutions must be introduced into the market supported by regulations and incentives.

- Given that electrification of road transport for long-distance traffic, at least with current battery technology, is not a feasible proposition, development of sustainable fuels and / or entirely new propulsion technologies for cars and aircraft is needed, in particular from the perspective of the objective of GHG emissions which will not be lowering substantially enough with currently available technologies according to scenarios results.

KITE Deliverable D10 - General methodological framework and Deliverable D17 - Recommendations for a standardisation of intermodal information and ticketing services

- Gap between research and practice is large and can certainly not be bridged by research alone. In addition many vested (though legitimate) interests exist in the various guidelines for economic appraisal in different countries. In order to propose guidelines at EU level, the existing differences in guidelines required a careful mediation and uncovering of underlying assumptions and preferences. Therefore, a process approach is required rather than a linear sequence of development tasks.
- Similarly, the relative importance of each user need for long vs. short distance journeys is unclear. It is also not fully clear how the importance of the key user needs vary according to different user groups and trip purposes.
- Evidence related to the relevance attached to certain user needs for some individual transport modes (e.g. ferries, bus/coach, metro/underground systems) is missing or unclear.

Future: The greatest lack is the absence of intermodal co-operation and business plans. To foster this process the creation of whitepapers for interoperation according to management plans for traffic incidents on roads may be a valid way. Also propaganda on regional, national and European level for more intermodal operations can improve this situation.

Future: Analysis of supplementary new interesting case-studies (especially innovative) of intermodal passenger good practice and their economic and social evaluation.

Research gaps identified by stakeholders:

There are multiple possible technology based solutions proposed by stakeholders. Most of them are currently either being researched or prototypes are under tests. Among those often mentioned are: people movers, urban electric cars (often mentioned together with additional benefit of shared use), dual mode technologies (e.g. electric cars on monorails or new kinds of electric bicycles). Along those lines there are proposals for ultra compact electric vehicles, autonomous vehicle technologies, use of wind to propel vehicles. PRT systems to link air, rail and road and sea to some extent with podcars as an intermodal link in some situations. Most of new technologies rely on better electric power distribution and storage thus except for direct research into transport technologies further research in basic sciences of physics and chemistry is needed.

Alternative to the technology is to concentrate on opposite – less technically advanced solutions which are already very well known but have been until recently virtually neglected. This could take the form of supporting slow modes (walking and cycling); widening bike rental facilities in big cities.

Organisational solutions offered by stakeholders include: pedestrianisation, clean city logistics, development of e-communication and e-commerce, area wide parking place charge, relocation of public service functions to rail nodes. Most of those solutions demand a political decision to be made and could be seen as enforcement going against free market principle. From the organisational side also better integration of modes thanks to more advanced ICTs (all – mode travel planners, coordination of services and payments) is considered as key to meeting the mobility goal.

Another path is optimisation of existing modes by new mobility services instead of heavy remodelling of transport landscape. Examples include: transport on demand, integrated mobility through ICT – widespread use of mobile phone technology in combination with information and payment services, better use of existing infrastructure (e.g. promoting bus lanes etc.), advanced car sharing schemes.

Enforcement measures are also considered – especially taxation or fiscal policies to promote greener travel options. Taxes applied individually according to the carbon dioxide emissions registered by personal chips (this like any other individual tracking devices will likely not be acceptable due to the danger of extreme control of society by authorities unless there is a clear way to anonymise data on regional level). Other options include: harmonisation of taxation among modes across borders. Deregulation of rail services combined with a harmonisation of technical regulations and a real independent track management. Reduction of EC subsidies for production to avoid unnecessary freight transport.

In relation to fuels and propulsion, in the survey stakeholders were only asked about the electrification of motorways and railways, and that did not find very many favours. No specific question was included about affordable and sustainable new fuels and / or new propulsion technologies that do not depend on fossil fuels. However, the need for those was not only clearly expressed by stakeholders during the ORIGAMI final conference, but, in the light of global warming, is also a much more widely held view.

Prioritising research needs

Research gaps can be translated into researchable issues about:

- Technology driven solutions which are most likely to improve future transport;
- New affordable and sustainable fuels and / or propulsion technologies;
- Wider introduction of less technology intensive modes into transport system;
- Methods for optimisation of existing networks and services;
- Enforcement of the shift towards more sustainable transport (e.g. taxation or reduction of private car capacity measures);
- Alternative fuels to reduce negative transport impacts without need to significantly change user behaviours;
- Optimisation through coordination of modes and provision of co-operative framework among stakeholders.

Table 10-2 Prioritisation of research needs – solutions identification

Research needs	Core criteria	Additional criteria		
	Interest for stakeholders	Costs of research	Funding opportunities	Feasibility
Technology driven solutions which are most likely to improve future transport	high	1	3	1-3(depending on particular technology)
Affordable and sustainable fuels and / or propulsion technologies	high	1	3	2
Introduction of less technology intensive modes	moderate	3	2	3
Methods for optimisation of existing services	high	3	2	3
Enforcement of the shift towards more sustainable transport	moderate	3	2	1
Optimisation through coordination of modes and provision of co-operative framework among stakeholders	low	2	2	2

The relevance of particular groups of problems leads to definition of major future research needs. Primary delimiter is actual interest of stakeholders. This criterion combined with many financing opportunities makes technology driven solutions likely winner notwithstanding their high cost of research and sometimes difficult introduction into transport system. This last feature is heavily dependent on the particular features of a given design.

Organisational improvements in transport based on optimisation of existing services also score highly as they are considered by stakeholders as cheap efficiency optimisers. The enforcement measures are likely to face significant social resistance resulting in rather low feasibility while introduction of less technology intensive modes seems attractive but its real potential remains unknown. It is doubtful how far slow modes like cycling could replace mass transit systems.

Coordination of actions by different players on the transport market although considered productive is not especially attractive to transport service providers who like to protect their independence. Alternative fuels still wait for scientific breakthrough which will make them feasible in both technical and financial ways.

10.3.3 Solutions Applicability

Identification of current and future research gaps

Current and future research gaps in the area of solutions applicability could be recognised based on the criteria of transferability identified in WP5 / MS11.

Research gaps can be distinguished taking into consideration the category of stakeholders and technology.

Users usually tend to obtain the benefits of a transport project not included in the cash flows: travel time savings, safety and comfort improvements, reliability. Users' interests being mostly defended by the public administrations, local governments, trade unions, and neighbourhood associations.

However, foreseeing a substantial benefit from the user point of view will help administrations justifying required expenditure for a project.

Competing operators will try to obtain the best deal from any new investment. Operators may have interest in implementing a new solution when it tends to reduce the costs of transport or when it creates new business opportunities and will expect new solutions not to bring in additional organisational difficulties.

The tendency of governments to look at their own financial interests should not detract from their ultimate goal, which is to promote the interests of society at large. The ultimate goal should be to obtain a maximum level of social benefit for a minimum level of investment.

The regulator is a most important player in the transport system as it is an enabler of a solution being implemented in a certain context or not. A different regulatory framework might make a solution extremely difficult or too expensive to be implemented in a different context.

Non-users are essentially affected by externalities, notably environmental and social. These are not easy to quantify but can have an important weight in decision-making.

The technological dimension is another crucial issue for generalisation of a certain solution. Ad hoc solutions are hard to transfer onto contexts different than those where originally planned, losing interest with each new specificity that makes them unique, regardless of their technical virtuosity. Even when some solutions are of easy application onto diverse geographic contexts, they might still prove to be specifically mode-based. Most interest lies on those solutions which can be generalised onto other geographic contexts and be transferable onto other modes.

Taking all of the above into consideration the following research gaps can be identified:

- TRAVELLERS/USERS – main gaps are connected with:
 1. Classification of benefits.
 2. Measuring benefits for the users.
 3. Benefits assessment using CBA benchmark from user perspective.
- OPERATORS – main gaps are related to:
 1. Measuring benefits for the operators.
 2. Benefits assessment using CBA benchmark from operator perspective.
- GOVERNMENT – main gaps are connected with benefits assessment using CBA benchmark.
- REGULATOR – main gaps are related to optimisation of required regulatory framework,
- NON-USERS - research gaps are connecting with: externalities assessment,
- TECHNOLOGY - gaps are suspected to assessment of the technical transferability.

Future: Difficulties to measuring benefits for the users and operators, especially where impacts cannot be directly measured in the relatively more objective terms of travel/transport time or travel/transport cost savings, but are related to increased traveller information, comfort, convenience, impact on local communities. More research on the impact of soft-factors would be interesting.

Research gaps identified by stakeholders:

There is need for the discussion to take into account the costs of the various implied solutions, the timescale, the full environmental costs and benefits and any equity implications. The EU can help by increasing awareness of the various solutions and encouraging a wide-ranging debate across Europe.

Assessment methodology of transportation variants offering innovative solutions based on full transportation cost calculation including external costs.

Prioritising research needs

Research gaps can be translated into following researchable questions:

- How to identify, measure and assess wide benefits for travellers/users?
- To what extent do benefits to operators outweigh difficulties to implement individual solution?
- How large is the set of benefitting users in relation to the cost of the solution?
- Is a solution being implemented in a certain context or not?
- Are there any externalities or/and side effects linked to the solution affecting third parties other than users?
- To what extent can the solution be implemented in other geographic contexts or in other modes?

Table 10-3 Prioritisation of research needs - solutions applicability

Research needs	Core criteria	Additional criteria		
	Interest for stakeholders	Costs of research	Funding opportunities	Feasibility
Identification, measuring and assessment of wide benefits for travellers/users.	high	1	1	1
Assessment methods of relationship between extent of benefits to operators and difficulties to implement individual solution.	moderate	2	3	3
Measuring the set of benefited users in relation to the cost of the solution.	high	3	2	1
Creation of a proper regulatory framework to implement an individual solution	moderate	3	3	3
Identification, measuring and assessment of any externalities or/and side effects linked to the solution affecting third parties.	low	2	3	2
Assessment to what extent can the solution be implemented in other geographic contexts or in other modes	moderate	2	2	2

Research needs in this area should be focused on the improvement of methodology to assess the wide benefits for a wide range of stakeholders (users, operators, government and the society as whole). Also identification, measuring and assessment of any externalities linked to the solution especially affecting third parties is a very important issue which till now is not taken in a proper way into consideration in conducted research.

Creating opportunities for a fair comparison of costs and benefits will enable to implement the solution in more efficient and cheaper way. So the future research should undertake measuring the benefits for users in relation to the cost of the solution. It is worth to highlight the universality of solutions in the context of the application in a different location, as well as other transport modes.

Another important issue in this area is the creation of a proper regulatory framework to implement an individual solution. It will make it possible that the solution will be introduced easier and cheaper.

10.3.4 Behavioural Response

Identification of current and future research gaps

Current and future research gaps in this area can be recognised based on *MS 12 Draft results from survey* and *Deliverable 3.2 Results from Survey of Behavioural Response*.

- Lack of statistically robust trip rates (by mode, distance band and purpose) for all EU countries using the same definitions and categorisations.
- No information about the "do not travel" option (required to enable analysis of the extent to which improvements in transport services or infrastructure would generate additional trips rather than simply divert from other modes. Similarly required to establish whether increases in price or deteriorations in level of service would lead to the suppression of trips rather than their diversion to other modes.

Future: Exploration of this topic would require information about use of e-modes as well as trip-chaining and might be achieved via detailed questions about existing activities (done with/without travelling) or via a stated response survey.

- Missing particular focus on the travel patterns of aging/retired people in EU countries.

Research gaps identified by stakeholders:

There is need to include policies and measures to reduce overall transport needs, such as virtual conferencing, teleworking, delivery services, etc.

Taxation or fiscal policies to promote greener travel options and to reduce the need to travel - virtual meetings.

Prioritising research needs

Research gaps can be translated into following researchable issues:

- Harmonisation of definitions and categorisations concerning trip rates;
- Assessment of relationship between e-modes and transport demand;
- Analysis the travel patterns of aging/retired people in EU countries.

Table 10-4 Prioritisation of research needs - behavioural response

Research needs	Core criteria	Additional criteria		
	Interest for stakeholders	Costs of research	Funding opportunities	Feasibility
Harmonisation of definitions and categorisations concerning trip rates	high	2	1	1
Assessment of relationship between e-modes and transport demand	moderate	3	1	2
Analysis the travel patterns of aging/retired people in EU countries	high	2	2	3

Social acceptance is a very important element for the implementation of different types of solutions. The future research aims to harmonisation of definitions will lead to improvement in assessment methodology.

Further and wider research is also needed on the interaction between transport demand and e-mode. These relationships are recognised but not detailed.

10.3.5 Future Trends

Identification of current and future research gaps

ORIGAMI Deliverable 7.1 Scenarios for Future Co- and Intermodality in Long-Distance Passenger Travel

- Trip OD matrixes used in ORIGAMI were the only TRANS-TOOLS matrixes available at the time of constructing OR scenarios. They correspond to the 2005 and 2030 time horizons, and were obtained from the DGMOVE TEN-CONNECT2 study (2009) aimed at defining the TEN-T Core Network. These matrixes were based on pre-crisis assumptions. As 2010 pax-km in Europe are relatively similar to 2005's (+2,5% inc), ORIGAMI has used 2005 OD matrix as a relatively good proxy to today's baseline situation. 2030 matrix may overestimate traffics to some extent (6% to 10%). Even though the available matrixes are good to compare scenarios among them and discuss the impact of alternative transport policy packages onto a certain transport demand scenario, an updated OD matrix taking into consideration the crisis would allow for better overall discussion.

Future: New OD matrixes for Europe based on the ETIS+ project are available in 2013 and a regular update of this information would secure a validated observed platform for testing transport policy options and changes on the socioeconomic and sociodemographic dimension. Other sources like the Reference Scenarios of the European Commission are based on models under development like HighTool and TransTools, which are based on the ETIS data as well, consider more recent effects like the ongoing crisis in Europe.

- The impact of soft factors on the European transport system (e.g. Likely impact of travel planners, ticketing integration...) has only been possible in ORIGAMI through assumptions in the models at an aggregated level based on the results ORIGAMI SP and RP surveys. Further knowledge on the impact of these kinds of solutions would improve the overall exercise.

Future: Further research on the field of potential impact of soft factors on the transport system.

NICHES Research and policy recommendations

- Lack of well defined optimal business models.

Future: Need of technical-organisational patterns (benchmarks) for commonly held long haul intermodal travel, according to what is the main means of travel:

a) rail (facilities for the traveller in the case of the need to change train (connecting) and reliable support for start and end station)

b) by plane (reliable and flexible synchronization schedules in the relationships between large airports, pickups and passenger transportation from the city to the airport, by the air carrier or the carrier cooperating, full service for luggage),

c) marine boat (attractive and convenient for the passenger's landfall during the voyage, pickups and passenger transportation to the terminal port of the marine carrier or carrier cooperating, full service for luggage),

d) by bus or coach (the frequency and conditions stops relaxing, pickups and transportation to the start and end station by bus carrier or carrier cooperating, full service for luggage "door-to-door".

HERMES Project

- The interdependences between "hard infrastructure measures" impact and "soft measures" impact like improving the lighting in stations, optimising the visual orientation or the provision of elevators are not researched.
- How to better coordinate different stakeholders is not addressed well.

Future: With future role of slow modes - they have to be investigated in depth especially on the attractiveness of local and regional terminals enhancement by the provision of adequate access and egress offers for non-motorized passengers.

- Early stages of infrastructure planning needs to integrate with requirements of operators - current research does not address how to do this efficiently.

Future: Resulting from stakeholder's consultation;

a) research into possibilities of introducing a central (external) body to coordinate all agents of the system in the planning and/or management of transport nodes;

b) ways to integrate topic of intermodality with urban planning issues and decision making process

c) need for development of business model to provide a better chain of intermodal transport services;

d) extension of stakeholder consultations beyond public decision makers, transport operators or terminal operators.

CLOSER Project

Intermodality indicators are poor in regard to capturing environmental and greening of transport aspects. There are few good indicators focusing on both environmental and long/short distance interfaces.

Future: Research into changing legal background for operation of transport modes.

Future: Research into categorisation of intermodal terminals.

Future: Researching new transport indicators allowing for measurement of interconnectivity which have to be adjusted due to emergence of new transport schemes. The indicators should be tested on a group of in depth case studies covering long-distance and short-distance freight and passenger transport networks to validate our findings. The case studies should also be tested against the outlined EC policy goals in the latest White Paper (Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system).

Research gaps identified by stakeholders:

- The interdependency between new ways of life and mobility needs to be investigated. More and more people have two jobs, work partially at home, live in single households and are facing globalisation at the job. What are the resulting needs and what effects does this cause to the existing transport system?
- The spread in income will be reflected in mid-term on the mobility pattern of the society. There is no information about the expected effects and mobility needs.
- Younger generation switch values (e.g. from car ownership to car sharing, travelling is out as it is environmentally outdated) so that any trend forecasts will be biased and in consequence transport policy decisions will address the wrong necessities.
- Direct, indirect and catalytic effects of transport on the economy have not been explored in detail to optimise transport policy and infrastructure investments.
- Identification of long term effects of the global warming on the mobility, e.g. the Southern Member States will travel to the North while the northern Member States just use local facilities.

Prioritising research needs

Research gaps can be translated into following researchable problems:

- Better coordination of actions by different stakeholders;
- Improvement in measurement of transport trends and efficiency;
- Higher involvement of slower modes in transport system;
- Role of soft transport factors in future transport system;

- Development of optimal business models for transport enterprises.
- Investigation of the interdependence between transport and economy;
- Investigation of effects caused by new societal developments, behaviour, and way of life on the transport system;
- Long-term scenarios of various kinds.

Table 10-5 Prioritisation of research needs – Future trends

Research needs	Core criteria	Additional criteria		
	Interest for stakeholders	Costs of research	Funding opportunities	Feasibility
Improvement in measurement of transport trends and efficiency	moderate	3	1	2
Better coordination of actions by different stakeholders	moderate	2	2	2
Higher involvement of slower modes in transport system functioning	low	3	2	3
Role of soft transport factors in future transport system	high	3	2	3
Development of optimal business models for transport enterprises	moderate	1	2	2
Investigation of the interdependence between transport and economy	moderate	3	1	2-3 (not every interdependence can be scientifically proven)
Investigation of effects caused by new societal developments, behaviour, and way of life on the transport system	moderate	3	1	2-3 (not every relationship can be scientifically proven)
Long-term scenarios of various kinds	high	2	1	3

Significant attention in future research programmes should be given to establishing relations between soft (e.g. information, communication) and hard (e.g. infrastructure) transport components. The key to more efficient future transport seems to be a wider use of soft measures on traditional infrastructure. It is certainly more cost effective than replacing old infrastructure with new and easy to introduce from technical point of view.

The research projects often recognise important missing pieces in the knowledge of the workings of transport systems necessary for transport improvements which are not obvious from the market entities point of view and cannot be captured by transport practitioners. This is the case of better transport measurement instruments often indicated by academic world which are very important in long term planning and transport policy formulation. Research on them seems to be feasible and rather cheap and could improve political decision making on transport. From the business point of view development of optimal business models which can capture future trends and changes in transport needs and services seems to be a challenge. This task although very feasible could also be very costly.

The investigation of interdependencies between societal changes, economy and mobility respectively transport needs and the identification of effects upon the transport infrastructure is a challenge to be

faced. There are rarely data and models available although both are essential to cover the aspects about the future design of the transport system, necessary regulations and transport policy actions. Apart from changes in the transport system the change in user behaviour and needs have to be captured and evaluated.

11 FINAL CONCLUSIONS AND RECOMMENDATIONS

11.1 CONCLUSIONS

Information needs

There is a shortage of data on long-distance trips, in particular on trips that do not involve an overnight stay, which means in particular on a large part of trips made for business purposes. Furthermore, the data sources that are available provide contradictory data, differ in sample size and survey methods and do not cover all Member States. Therefore, a large-scale and consistent collection of data on long-distance travel across the EU will be a precondition for more reliable forecasting and better informed decision making for the future transport system.

What can be said with certainty is that the car is the dominant mode for trips up to 500 km, rail and air become more prominent in trip longer than 500 but shorter than 1000 km, while air is absolutely dominant for trips longer than that. For long-distance holiday trips overall car and air combined account for 70% to 90% of all such trips depending on the country. There is a very high variation in the share of rail and bus/coach between the different countries; the share of these two modes depends highly on the available offer.

It is also clear that there are big differences in the trip patterns between European countries, with, for instance, residents of the Nordic and Central European countries making more holiday long-distance trips than residents of Southern and Eastern European countries. There is no clear trend concerning trip rates by gender, in some countries the female population makes more holiday trips in others less than the male population. Similarly, while in the majority of the countries older people make less holiday trips than younger people, there are also countries where they make more holiday trips.

The major drivers of future long-distance travel demand are population, demographic shifts, employment, GDP, household income, car ownership and travel costs and travel times. Most forecasts for these drivers point into the direction of a continuing increase in long-distance travel demand. Based on current trends it appears likely that air and car will hold their dominant position, with rail gaining more significant shares in corridors with high speed rail infrastructure.

Many expect that the demographic shift towards and ageing population will lead to more trips by this group due to longer and healthier lives and, as already indicated above, in some countries they already travel more than the rest of the population. However, people may have to work longer in the future and have less money when they are retired, so the catching up in trip rates with the younger generation might not take place.

More generally it appears that many forecasts on the future of travel demand may have to be revised downward, since in the light of the current Euro crisis, some of the forecasts seem overoptimistic.

Traveller and system needs

Based on the review of previous European research and academic research, twelve main user needs were identified, related to various *network characteristics*, facilities provided at *interchanges* (transfer points), available *baggage handling facilities*, availability of *tickets and tariffs*, provision of *door-to-door information*, *whole journey cost*, *level of comfort*, *safety and personal security*, *total journey time*, *accessibility issues* and the way intermodal journeys are *promoted*.

When considering individual modes that make up long-distance intermodal journeys (i.e. air, rail, coach/bus and ferry) a further four user needs were identified, related to the behaviour of *employees*, the amount of *effort* expended by users when undertaking the journey, *in-vehicle facilities* and *environmental concerns*.

The survey carried out within ORIGAMI found that travellers place a high value on “soft” improvements that in some way or other reduce the level of uncertainty associated with making a long distance trip and the cognitive burden of organising and taking such a trip, particularly a trip that may involve a number of different modes or different segments by the same mode (e.g. interchange). This value is magnified further if the trip being taken is to an unfamiliar place, particularly a foreign country where

the language and travel conventions may differ from home. So for example, having an integrated public transport ticket that negates the need to purchase an egress ticket from your point of entry into a foreign country (e.g. an airport or train station) will be strongly valued. There are, in addition, often very real practical time and cost savings associated with “soft” improvements. For example being able to check in online for air travel saves a considerable amount of time waiting at check in desk queues, whilst the ability to plan your long distance journey using an online planner saves a trip to the travel agent or train station information desk.

The valuations of “soft” improvements will also vary according to a number of other factors. The length of distance is important with a desire for “soft” improvements much larger for long than for short journeys. The choice of mode will sometime reflect inherent income and costs differences with coach travellers tending to have the lowest valuations of “soft factors” compared with rail and air passengers. Interestingly car users either did not engage with the “soft” improvement survey or dismissed the improvements offered to them (better rest facilities, emission reductions and Wifi) as not important or not realistic. Returning the focus to public transport it is clear that “soft” improvements have an important role to play in delivering seamless long-distance travel and help persuade travellers that such a concept is achievable.

The key requirements for seamless long-distance travel from the system perspective can be identified in two broad categories: the information needs and the corresponding system requirements that can be identified as follows:

1. Informational system needs, i.e. extensive data such as traffic flows, time tables, weather, accidents, incidents, which is dynamically linked to events and flows to calculate updated travel times; information on connections, next interchanges on routes, timetables. The data should be available timely at a central place online and free of cost, and should be stored to allow for transport monitoring in the long run.
2. Technological system requirements, in order to provide platforms for on-line application development, standardisation in data formats and communication, and interoperability protocols, enabling the implementation of co-operative vehicle-to-vehicle, vehicle-to-infrastructure and, more than anything, infrastructure-to-infrastructure systems. The EC has a key role to play in enabling and encouraging the development of standards and protocols that physically allow a widely available and free of cost data exchange across Europe.

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 precondition to realise the above system and informational needs. Operators are often very reluctant to share data for a variety of commercial reasons, and the European Commission should try to find ways to incentivise operators to make their data available to others who could improve services for travellers, but also enable a better overall management of the transport system.

ORIGAMI solutions

A total of 167 solutions were identified under ORIGAMI as having a potential to improve long-distance transport for passengers. Solutions were fully documented in an on-line public web directory, in a systematic structure. Solutions were classified according to 13 different solution families, each of them acting in a specific segment of the transport chain to improve overall efficiency of the European transport system.

ORIGAMI solutions have been discussed in a series of participatory activities with transport stakeholders (transport industry, research community, policy makers and public servants, and transport consultants). It was found that the solutions with highest EU interest, according to these experts, were road pricing, airport interconnections, ICTs for smarter road management, just-in-time travel planners, energy related solutions and collaborative mobility solutions. Widespread smart road pricing showed the largest discrepancy between its interest and its likely implementation, indicating that much more work needs to be done before any wider roll-out will occur. Currently all practical steps into that direction have been undertaken by individual Member States, but it is obvious how strong and widespread public resistance against that is, and hence how few local and national

politicians are willing tackle this is. There is a role for the Commission to identify ways of overcoming this resistance, not through legislation but through persuasive arguments and monetary incentives, thereby helping Member States towards wider implementation.

As already pointed out in an earlier in the main part of the report, few of the user and system needs identified by ORIGAMI in WP4 have no solution already available or at least under development somewhere in Europe. The few identified gaps found concern real-time information related to ports and these may even already exist somewhere unbeknown to the project team, and in any case they could be easily realised with technology already in use for other existing real-time information. Engineers in Europe and worldwide have addressed the user needs of long-distance travellers in a multitude of ways, what is needed is that these solutions are rolled out throughout Europe.

The main obstacle to further developing and implementing solutions that reach across borders is the lack of common standards for data bases and data exchange. As already mentioned in a slightly different context, here is a role for the European Commission to help further the development of these standards and provide a central point, for instance through Eurostat, where key data could be stored and be made available to all.

Furthermore, ORIGAMI solutions identified in WP5 have been assessed in relation to their potential generalisation across modes and territories all over Europe. To do this assessment, a set of six criteria was defined reflecting six (not always conciliated) dimensions in the transport market. A solution is considered to have a high generalisation and transferability potential when it may have a manifest interest for a wide range of stakeholders (users, operators, government), and when conditions are such that there are not feasibility barriers to its transferability (regulatory, technical, externalities). Criteria were based on INTERCONNECT FP7 Evaluation Framework and on the EIB's RailPAG Evaluation Criteria.

Starting from a transferability discussion at a family level, particular performance is also proposed for each individual solution identified in WP5. Performance under each of the transferability criteria were qualitatively determined based on discussions with the stakeholder community, literature review and expert judgment by the ORIGAMI FP7 consortium. The ORIGAMI solution families were ranked as follows, in relation to their degree of transferability, from highest to lowest.

- *Travel planners and passenger information* solutions; considering relatively high interest for travellers, operators and public authorities, and being easy to implement, these solutions have the highest transferability level.
- *Traffic management solutions*; spontaneous implementation by transport operators is relatively likely according to experts, and there are already many examples of such practice in Europe. Although ICT technologies applied to traffic management are relatively mode-based, making it difficult to transfer them across modes, they can be exported relatively easily from one region to another, all across Europe.
- *Access and egress to long-distance transport networks (local Interconnections)* solutions; the large economic costs for these investments become increasingly justified when solutions address the needs of users other than merely long-distance travellers, like metropolitan commuters or airport staff.
- *Enhanced vehicle performance solutions*; with clear benefits for users not all solutions may be equally interesting to transport operators or public administrations. No major feasibility issues are to be expected. They are easier to generalise when the approach is based on vehicle upgrading than when infrastructure intensive.
- *Enhanced vehicle safety* solutions; not all solutions may be equally interesting to transport operators despite benefits for users. However, public administrations are likely to be supportive of such solutions.
- *Security & fee collecting procedures* solutions; although solutions may be technically easy to be implemented across Europe, and even transferred across modes, there may be legal obstacles in relation to privacy issues depending on the technologies used.

- *Environmental management solutions*; because of not having major technical obstacles to widespread application, and having a relatively high public sector interest, transferability is determined medium-high. Scores may differ widely from one solution to another, as social acceptability.
- *Ticketing schemes solutions*; specificities for each case of integrated ticketing are likely to be very important. They are ranked here relatively low, although passenger interest in them is extremely high, as pointed out earlier, because legal frameworks may be very complex, especially in the light of passenger rights for intermodal tickets and the necessary guarantees in case of delays. Overall success of integrated intermodal ticketing systems will depend on the determination and capacity to overcome these problems. For regional schemes this can be done by regional and national governments, but for Europe-wide schemes, the Commission should play an enabling role.
- *Interconnections between long-distance transport networks*; with typically large investments associated and relative low demand figures compared to other transport investments, these solutions are only cost effective in specific cases. Analysis of the most suitable technologies to provide such interconnections becomes necessary in each case.
- *Organisational arrangements*; time is required to acquire enough evidence to draw sensible conclusions on the impact of liberalisation. It is clear that no single formula exists that can be applied across modes and territories in Europe. A good regulatory framework to transport sector liberalisation is necessary according to transport stakeholders.
- *Segregation of freight and passenger traffics solutions*; even when legal obstacles or externalities may not be especially relevant, the specific local approach required by most of these solutions makes them difficult to be generalised for other modes or areas of Europe.
- *Dual-mode transport solutions*; even when legal obstacles or externalities may not be especially relevant, the place based approach required by these solutions makes them difficult to be generalised across Europe.
- *Missing links: mega-projects*; due to their magnitude, each megaproject becomes an ad-hoc solution to a specific problem. Mega-projects have to be driven by a strong political will able to compensate for generally poor financial performances.

Scenarios

The two sets of scenarios for 2030 and 2050 start in many aspects from different premises, and it is therefore not straightforward to compare them and come to common conclusions. They are using different types of models and another key difference is that the 2030 scenarios are dealing with any travel between NUTS3 zones (or where no NUTS structure is available similar, if often somewhat larger, regions) within Europe plus Turkey, while the 2050 scenarios only look at travel that involves at least one overnight stay and, furthermore, also includes intercontinental journeys. One key resulting difference is that one of the core findings in the 2030 scenarios is that road is, and will remain, the dominant mode for long-distance travel in Europe, while the 2050 scenarios already start with air journeys entailing the largest share of passenger kilometres in Europe in 2010, and air even enlarging its lead in every scenario for 2050. Nevertheless the two sets of scenarios come to some common findings:

- The most effective way to decrease the number of cars, or at least the growth in the number of cars, is to increase vehicle occupancy with policy incentives.
- Investment in rail, in particular in High Speed Rail, and policies to reduce the cost of rail travel can significantly increase rail usage.
- Air travel will rise in all scenarios well above 2010 levels with the lowest assumption for 2030 being +36% to the highest of +66% by 2050 for a Prospering Europe.
- Both sets of scenarios foresee a decrease in fuel consumption for the nearer future, but in the 2050 scenarios consumption is rising again in later years, largely driven by the increase in air travel, and in most scenarios end up well above 2010 level. The most important factors in limiting fuel consumption are the assumptions for future propulsion technology.

Some further general conclusions can be drawn from the 2050 scenarios only, with the main one being that socio-demographic and economic changes can significantly influence the future of

transport. The difference between a Prospering and Lagging Europe, based even on very reasonable rather than extreme assumptions, can be more than 400 million trips per year. This equates to more than 200 billion passenger kilometres per year, or a difference of more than 25%. In contrast, the Transport Policy applied in these scenarios has a significant influence on mode choice, but very little on total mileage travelled.

One recommendation deriving specifically from the 2030 scenarios, as well as from the stakeholder consultation, is for the Commission to support policies that favour smart solutions over heavy infrastructure.

What can be regarded as the key message from both sets of scenarios concerns the Greenhouse Gas emissions. They decrease in all scenarios, but while the Normative Transport Policy for the 2030 scenarios manages to meet the EU target of reducing GHG emission by 20% by 2030, the 2050 scenarios are much less optimistic and, even in the best case, only reduce emissions by 28% by 2050, far away from the EU target of a 60% reduction by that year. This also reflects the outcome of the SP survey, where emissions are a topic of minor interest for the travellers. As for fuel consumption, the key factor is the future of propulsion technologies, but the assumptions made for 2050, that were assumed to be realistic, are still clearly not sufficient, and a real step change in technology is necessary to make transport and mobility sustainable in the future.

Further research needs

The table below concludes on particular research areas identified and assessed in ORIGAMI. It includes both interest of stakeholders and the assessment of additional criteria.

- **Statistics.** The general low interest of stakeholders is met by low to average additional criteria scores. One area where the interest of stakeholders is at least moderate is a common framework of intermodal data collection and implementation of integrated platforms that allow data to be shared between different types of ITS or technological applications implemented within the same geographical area. But given its low score on additional criteria this is neither a low cost nor easily financed action. The big exception is the area of automatic electronic data collection, in particular for tracking trips, which met with high stakeholder interest, but where the feasibility depends on the source of information and the mode concerned.
- More interest was expressed by stakeholders with regard to **solution identification**. Both the technology driven solutions topic and methods for optimisation of existing practice seem to be key issues for them. Especially, affordable and sustainable fuels and propulsion technologies have to be highlighted as needing to be further researched and developed. The introduction of less technology intensive solutions meets with moderate interest and only few obstacles (high measure on additional criteria), while enforcement of modal shift seems to be moderately interesting to stakeholders but has limited practical applicability (average score on additional criteria). Better coordination of services meets low interest by stakeholders and has a medium score on additional criteria.
- In the field of **solutions applicability** the highest interest solutions (measurement of wider economic benefits and the relationship between costs of solution and benefits to users) are unfortunately considered as being difficult to introduce (low to average score on additional criteria). The solutions with moderate stakeholder interest (improved assessment methods of relationship between extent of benefits to operators and difficulties to implement individual solution and creation of a proper regulatory framework to implement an individual solution) are much easier to implement (high score on additional criteria).
- In the field of **behavioural response** additional research into analysis of the travel patterns of ageing/retired people in EU countries seems to be both interesting to stakeholders and relatively easy to conduct. Two other proposed measures, namely harmonisation of definitions and categorisations concerning trip rates and assessment of relationship between e-modes and transport demand, score moderately on both stakeholder interest and additional criteria measures.

Table 11-1 Research needs identified and assessed in ORIGAMI

Research needs		Level of interest		
		High	Moderate	Low
Statistics	Improvement of statistics for distance travelled by passengers with innovative technologies in observation and data collection			
	Better information on relative importance of user needs for long vs. short distance journeys			
	Better knowledge of user needs and preferences in various types of long-distance trips (business, tourism, education, other)			
	Evidence related to the relevance of some user needs for some individual transport modes			
	Centrally collected and automatically updated data bus/coach transport and European sea crossings			
	Common framework for intermodal data collection and implementation of integrated platforms			
	Analysis and suggestion to harmonise European and national regulations for data collection and privacy			
	Identification of possibilities for automatic electronic data collection			
Solutions identification	Technology driven solutions which are most likely to improve future transport			
	Affordable and sustainable fuels and / or propulsion technologies			
	Introduction of less technology intensive modes			
	Methods for optimisation of existing services			
	Enforcement of the shift towards more sustainable transport			
	Optimisation through coordination of modes and provision of co-operative framework among stakeholders			
Solutions applicability	Identification, measuring and assessment of wide benefits for travellers/users			
	Assessment methods of relationship between extent of benefits to operators and difficulties to implement individual solution			
	Measuring the set of benefited users in relation to the cost of the solution			
	Creation of a proper regulatory framework for individual solutions			
	Identification, measuring and assessment of any externalities or/and side effects linked to the solution affecting third parties			
	Assessment to what extent can the solution be implemented in other geographic contexts or in other modes			
Behavioural response	Harmonisation of definitions and categorisations concerning trip rates			
	Assessment of relationship between e-modes and transport demand			
	Analysis of the travel patterns of ageing/retired people in EU countries			
Future trends	Improvement in measurement of transport trends and efficiency			
	Better coordination of actions by different stakeholders			
	Higher involvement of slower modes in transport system functioning			
	Role of soft transport factors in the future transport system			
	Development of optimal business models for transport enterprises			
	Interdependence between transport and the economy			
	Effects of societal changes on the transport system			
	Long-term scenarios			

Legend:

	score: 0 – 3
	score: 4 – 6
	score: 7 – 9

- In the field of **future scenarios and modelling** the most important area of research from the stakeholders' point of view is the role of soft factors in transport systems. At the same time this topic scores highly on additional criteria. Research needs are also high on long-term scenarios of various kinds. The other research area scoring very well on additional criteria – role of slow modes – is not considered important by stakeholders. Other possible research areas like improvement in measurement of transport trends, better coordination of actions by different stakeholders, development of optimal business models for transport enterprises, investigation of interdependence between transport and the economy, and effects on the transport system through societal developments attract medium interest and score in mid ranges on additional criteria.

From the wider view of ORIGAMI and the project's emphasis on decarbonisation of transport the topic that needs to be particularly highlighted from all of those above is the need for affordable and sustainable new fuel and / or propulsion technologies. Electrification is, at least with current battery technology, not an option for long-distance transport and biofuels cannot be produced sustainably on a significant scale. The scenarios developed in ORIGAMI conclude that air travel will continue to rise strongly, but also car rises further in most scenarios. Hence new technologies to reduce, or even eliminate altogether, carbon emissions from cars as well as airplanes are essential if the Europe wants to achieve its emission targets.

11.2 POLICY RECOMMENDATION: EUROPEAN POLICIES IN FAVOUR OF SMART TRANSPORT SOLUTIONS

These policy recommendations result from the following research activities:

- Analysis of the European Transport White Paper and the policy assessment studies carried out;
- ORIGAMI scenario analysis;
- ORIGAMI online surveys with experts;
- ORIGAMI workshops and conference with stakeholders in Barcelona and Brussels.

These activities clearly demonstrated:

- There is an increasing complexity of the European transport system, at all geographic scales, for all transport modes, and a growing necessity to implement smart solutions that favour the efficiency of the system as integrated network.
- There is a very large number of smart transport solutions already in operation (or in an advanced pilot demonstration phase) across Europe, in most of the cases developed by the European transport industry. The analysis of these solutions revealed their potential transferability.
- At the same time, the inertias of the transport system, the market fragmentation into national and sectorial regulations, make it more difficult to implement smart solutions in Europe than in other Continents.

Therefore, there is a strong need for European policy intervention in this field, not only supporting research and development of new solutions, but also supporting the actual implementation of already existing solutions - not just technological, but also organisational, financial and legal - with incentives.

Smart solutions being studied in ORIGAMI cover all the dimensions of the transport system:

- Long-distance users needs, for different trip purposes;
- Market regulatory frames;
- Optimised service management;
- Vehicle technologies;
- Maintenance and exploitation of vehicles and infrastructure;
- Infrastructure capacity planning and financing.

The European Transport White Paper already emphasised transport innovation in all these dimensions as one of the key strategies to improve the European transport system. In the aftermath of the present economic crisis, when it is likely that public resources devoted to infrastructure extensions are going to be scarce, there is an even stronger need to reinforce policies aiming to remove barriers for the implementation of already existing smart solutions.

From these broad conclusions, more specific policy recommendations can be presented to favour the right implementation of already existing smart transport solutions. In most of the following cases there is nowadays a lack of a clear regulatory environment, and sometimes of insufficient market incentives:

- Enhancing real time interaction between transport carriers and passengers. Information should be encouraged both ways: from carriers to inform users of actual travel conditions as well as from users to inform carriers of their actual needs. Privacy of users should, however, be protected.
- Implementing online pricing systems, particularly on roads, as well as integrated fees for public transport, for a better service management. Getting prices right is a fundamental incentive for a more conscious transport user behaviour. Based on technologies for lorry tolling systems, satellite or other ICT solutions it is possible to track vehicles and charge as a function of the vehicle, the road and the moment in time, as well as the number of vehicle occupants.
- Promoting new and smarter vehicles, and online information exchanges between vehicles and between vehicles and infrastructure. Smart vehicles not only have the potential to reduce GHG emissions, but they can increase road safety substantially. Smart vehicles can be monitored all the time enable intelligent traffic management in dedicated infrastructure or areas (e.g. traffic calming zones in inner cities). New hybrid modes with great potential (e.g. car sharing, electrified motorways...) are emerging as individual transport modes that are collectively managed.
- More integrated intermodal exploitation is feasible if carriers are able to exchange real time information concerning not just the timing of the services, and unexpected events, but, more important, the actual needs of their travellers, and optimise services accordingly. The management of large infrastructure terminals, such as airports and ports, or railway stations, could be dynamically optimised favouring intermodal travellers.
- Favouring public-private infrastructure management. It will be increasingly common in Europe that public and private institutions cooperate to manage and finance new transport infrastructure, and also existing ones. The need for transparent and efficient management requires a precise accountability and allocation of costs and benefits among partner institutions, and therefore the need for a smart institutional management requires for the use of accurate information systems. Also contractual agreements should be monitored. Applying public ex-ante and ex-post evaluation with comparable criteria across transport investments will become essential in this context.
- Emphasising synergies with urban and regional development and transport infrastructure investments is a necessary condition for good planning in the mid- and long-term. Smart transport solutions allow for a time-based management, beyond the space-based management of transport in zones or areas with different restrictions or permits. The negative impact of transport activities, especially private cars and trucks, in terms of noise, pollution, visual intrusion and space occupancy is likely to be reduced, favouring more imaginative spatial planning solutions in urban and metropolitan areas.
- Finally, the ability to monitor transport and travellers' behaviour makes it indispensable to collect and store data and surveys, as policy decision making relies upon independent analyses and research based on free available data.

REFERENCES

<http://www.closer-project.eu/>

Dargay, J. (2010) *The Prospects for Longer Distance Domestic Coach, Rail, Air and Car Travel in Britain*, Institute for Transport Studies, University of Leeds; Report to the Independent Transport Commission, Leeds, UK.

DATELINE Consortium (2003) *Deliverable 7 - Data Analysis and Macro Results*, Tis.pt + UNEW, München

DATELINE Consortium (2004) *Design and Application of a Travel Survey for European Long-Distance Trips Based on an International Network of Expertise (DATELINE)*, Travel Survey Metadata Series, 7, Institute for Transport Planning and Systems (IVT), ETH Zürich, Zürich.

Department for Transport (2011) National Travel Survey 2006/2009, <http://www2.dft.gov.uk/pgr/statistics/datatablespublications/nts/>

European Commission (2009) *The 2009 Ageing Report: economic and budgetary projections for the EU-27 Member States (2008-2060) - Joint Report prepared by the European Commission (DG ECFIN) and the Economic Policy Committee (AWG)*

Eurostat (2011a) GDP per capita - Annual Data, http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

Eurostat (2011b) *Mean and median income by household type (Source: SILC) [ilc_di04]*, Eurostat, http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.

Eurostat (2011c) Tourism demand : domestic and outbound tourism (excluding day-trips), http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database, Accessed: 23/08/2012.

Eurostat (2011d) Tourism demand : domestic and outbound tourism (excluding day-trips), http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

Eurostat (2012) *EUROPOP2010 - Convergence scenario, national level, 1st January population by sex and 5-year age groups*, Eurostat, the statistical office of the European Union, http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.

HS2 (2011) *Demand for Long Distance Travel*, <http://www.hs2.org.uk/assets/x/77832>.

infas Institut für angewandte Sozialwissenschaft GmbH (2010) *Mobilität in Deutschland 2008 - Kurzbericht*, http://www.mobilitaet-in-deutschland.de/pdf/MiD2008_Abschlussbericht_1.pdf

ITC (2010) *Long Distance Travel in Britain - Prospects in a Time of Uncertainty*, Independent Transport Commission (ITC), Oxford, UK. www.independenttransportcommission.org.uk.

KITE (2007) *Existence and Comparability of Data Sources*, Deliverable D3

Ministère de l'Ecologie du Développement durable des Transports et du Logement (2010) National Transport Survey (ENTD), Evolution des volumes et caractéristiques des voyages à longue distance, http://www.setra.equipement.gouv.fr/IMG/pdf/Fiche_Mobilite_no2.pdf

Ministerio de Fomento (2007) *Encuesta de movilidad de las personas residentes en España (Movilia 2006/2007)*,

http://www.fomento.gob.es/MFOM/LANG_CASTELLANO/ESTADISTICAS_Y_PUBLICACIONES/INFORMACION_ESTADISTICA/Movilidad/Movilia2006_2007/

Ministry of Transport and Communications Finland, Finnra and The Finnish Rail Administration and WSP LT Consultants Ltd (2006) *The Finnish National Travel Survey 2004-05*, Helsinki.

<http://www.niches-transport.org/>

Petermann, T., Revermann, C. and Scherz, C. (2006) *Zukunftstrends im Tourismus*, Berlin.

Swedish Institute for Transport and Communications Analysis (SIKA) (2007) RES 2005 – 2006 The National Travel Survey, www.sika-institute.se

LINK (2010) LINK New Member States Report, The European Forum on Intermodal Passenger Travel

CONDUITS (2011) Coordination Of Network Descriptors for Urban Intelligent Transport Systems Del. 2.3 "Define R&D needs for ITS implementations in cities"

Ulied A, Biosca O, Català R, Franco N, Larrea E, Rodrigo R, "Metamodels for the analysis of interconnectivity" Deliverable D5.2 of INTERCONNECT, Co-funded by FP7. TRI, Edinburgh Napier University, Edinburgh, May 2011