Executive summary:

The ORIGAMI project was concerned with improvements in long-distance 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.

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. 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.

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.

ORIGAMI comprised nine workpackages. Apart from the horizontal workpackages concerning project management, dissemination and exploitation, the technical ones were: Identification of travel behaviour, identification of needs, technical solutions, cross-fertilisation, scenarios, and conclusions and recommendations.

The key outputs of ORIGAMI are D3.1 Current travel behaviour, future trends and their likely impact, D3.2 Results from survey of behavioural response, D4.1 Review of needs of long-distance travellers, D4.2 Analysis of system requirements for co- and intermodality in long-distance passenger travel, D6.3 and D6.4 Technical solutions for the improvement of co- and intermodality for long-distance travellers – website and summary paper, D7.1 Scenarios for future con- and intermodality in long-distance passenger travel and D2.1 Final technical report.

From the wider view of ORIGAMI and the project's emphasis on decarbonisation of transport, one conclusion that needs to be particularly highlighted 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. The key policy recommendation is to promote transport policies that favour smart transport solutions.

Project context and objectives:

Motivation and general objectives

The ORIGAMI project was concerned with improvements in long-distance 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 be 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);

- 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.

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.

Project results:

Overall strategy of the workplan

ORIGAMI comprised 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.

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

WP1, WP2 and WP9 were 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 provided 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.

All of the six technical workpackages are broken down into two or more tasks, and in the following the main outcomes of each of these tasks are described.

WP3 Identification of travel behaviour

Task 3.1 Current travel behaviour

The aim of the working paper MS4, Completed analysis of current travel behaviour, was to analyse the travel behaviour of long distance trips travelled by EU 27 residents. MS4 reported the methodology developed in this task for collecting data on long distance travel. It provides a concise overview of the current travel behaviour of EU 27 residents at country level and outlines the information available from data sources including Eurostat, national travel surveys (NTS) and other sources such as tourism data. In addition to describing the data sources, MS4 revealed where there is a lack of data and where there are problems in collecting data, and presented key figures of the Eurostat database such as number of trips, trip rates, modal split and showed figures of the travel behaviour. Finally MS4 investigated the impacts of socio-demographic factors on long distance trips using Eurostat's data such as GDP, household size, unemployment rate, level of motorisation, population density, annual leave and public holidays in order to establish trends and similarities between the travel behaviour in different countries.

To achieve the aims of this task ORIGAMI partners provided input from literature of other EU projects (INTERCONNECT, CLOSER, PASHMINA, TRANSvisions). In addition, ORIGAMI partners were asked to fill in a travel behaviour template circulated by TUW. Task partner UG submitted a working paper outlining an overview of data sources on travel behaviour available in the new EU Member States. Apart from the collection of travel behaviour data, TUW created an extensive database of socio-demographic data of the EU 27 Member States.

The work of this task got underway as soon as the project started; nevertheless MS4 was submitted behind schedule (in month 10 rather than month 6). Although TUW made a substantial progress in the data collection process by the end of month 6, the merger of data and keeping the track of the data sources took longer than expected. Furthermore, TUW did more extensive research in the Eurostat database.

The main outcomes of this task was then also reported as part of D3.1.

Task 3.2 Future trends

The aim of D3.1, current travel behaviour, future trends and their likely impact, was to report the results of the work carried out in T3.1 (current travel behaviour) and T3.2 (future trends. The results of this analysis formed the basis for the identification of future drivers of long-distance mobility and the forecast of future long-distance travel demand.

The second part of D3.1, which is the result of T3.2, presents trends influencing future long-distance mobility behaviour. These trends include economic growth, population growth, aging of population, changes in household structures, and increasing access to cars. As the first step, a brief review of existing literature concerning future long-distance travel demand was carried out. The next step was the development of a set of national population cohort models and corresponding household composition models (based on system dynamics). These take the major drivers into account in order to quantify the impacts of likely trends regarding future long-distance transport demand. A description of the resulting model (LUNA - simulating the demand for Long-distance travel Using a Non-OD-matrix based Approach) was provided.

A first baseline scenario regarding economy, population and transport costs was defined. Forecasts for important drivers of future long-distance travel demand were made for this baseline scenario and, where possible, compared with other forecasts. Finally, the LUNA model was used to forecast long-distance travel demand for the baseline scenario in the EU27 countries plus Norway and Switzerland.

Task 3.3 Collection of behavioural response data

The behavioural response data questionnaire was developed and revised by ITS in collaboration with TUW and other ORIGAMI partners.

The choice of countries to be included in the survey was largely language driven with English, French and German identified as the three languages that would be able to provide best coverage across Europe, giving access to the following countries:

(a) UK and Ireland – English;

(b) Germany and Austria – English and German;

(c) Belgium, France, Netherlands and Switzerland - English, French and German.

In addition it was felt that a recent accession country should also be surveyed to help TUW gather more travel data for these types of countries. The obvious choice was Poland given that a Polish partner, Uniwersytet Gdanski (UG), was part of the research consortium and that Poland is the largest recent accession country.

Delivery of the survey was to be via an online panel provided by ITS's market research partner (Research Now). Piloting took place towards the end of February and consisted of two separate rounds of 100 online respondents each in the UK. The process resulted in revisions to the SP values that were to be presented to respondents and journey length. In addition several software and layout issues were discussed with Research Now, as well as sampling quotas and minimum response times.

The first surveys were launched on 4th May 2012 with the UK and Ireland surveys which had been piloted in English earlier. Only one language (English) was offered for this sample and it took two weeks to achieve a national representative sample of around 650 respondents. The exception to this was the UK which obtained a sample of around 900 due to that country's survey being used to pilot the overall survey and test the initial roll out of the main survey leading to more respondents than had been targeted originally.

Whilst the UK and Ireland surveys were live the task of translating the questionnaire into different languages commenced. The German and Austrian surveys went live on 18th May with respondents able to answer either in German or English. Respondents in France, Belgium, Switzerland and the Netherlands were offered the chance to respond in French, German or English. The final survey to be launched was the Polish one, with respondents offered the opportunity to respond in Polish, English or German. The Polish survey closed on 2nd July 2012 and fulfilled milestone MS9.

The next six months saw intensive analysis of the collected data which in total numbered 5,792 respondents split over nine countries, an average of around 644 respondents per country. A number of contrasting data sets had been collected, with several sets of both Revealed Preference & Stated Preference data which required quite different analytical approaches.

The main analysis was split into two major tasks that reflected the data split of RP and SP. With each task a number of sequential analyses were undertaken. For SP this meant the estimation of models for'access','egress','main journey' and'soft factors'. For RP this meant'trip rate' analysis and the estimation of'regression models'. During the analysis there was interaction with other partners to check interpretation of results from different cultural and country specific perspectives and how specific results would feed into other deliverables and the final report. The final results led to Deliverable 3.2 - Results from Survey of Behavioural Response, which was submitted on 21st December 2012.

The key findings can be broadly split between the two types of data analysis, RP and SP. The RP based trip rates found in the survey tell a consistent story with around 80% of all trip making taking place in the distance band between 100 and 499 km. The majority (74%) of these trips are made by car/van/motorcycle, whilst train and coach account for around 15% and 7% (shares that they largely continue to hold at longer distance categories). Air's dominance (41%) starts to emerge when trip distance grows larger than 1,000 km. In terms of purpose split, work related and leisure trips dominate across all the trip distance categories, with leisure in particular dominating at distances greater than 500 km.

The RP based regression models estimated provide useful estimation tools for measuring the influence of certain key socio-economic variables on long-distance (LD) travel behaviour. A number of key messages come through, namely that occupation has a strong impact on overall trip making behaviour, with those in full time much more inclined to make LD trips per se, whilst men are likely to make significantly more trips than women. Households with children aged less than 16, all things considered, exhibit a tendency to do more LD travel than households who do not, around 6 extra trips per year. No access to a car has a significant impact upon overall trip making, but especially so for journeys less than 500 km, whilst coach trips are strongly related to income with those on lower incomes more likely to travel by this mode.

With regard to the SP data, there were a number of key findings. First of all, respondents place a high value on 'soft improvements' ranging from 12 minutes (additional car park spaces next to coach stations) to 2 hours and 40 minutes (integrated ticketing for air and its access/egress modes). These high values are a result of the key characteristics of LD journeys, namely the length of the journey, the unfamilarity of the journey and the journey purpose. They also reflect very real practical time and cost savings from the soft improvements that carry a high value, e.g. time savings when checking in at airports or when using online planners (compared to obtaining information from travel agents etc). Other improvements are valued because of the assurance they bring to the LD traveller, especially when arriving in an unfamiliar place, particularly a foreign country, i.e. integrated LPT and main mode tickets. WTP values tend to be lowest for coach, reflecting income and cost differences between coach and other modes.

The questionnaires, the data file code plan and the cleaned survey data for model estimation are still being installed for download ITS's website: http://www.its.leeds.ac.uk/projects/ORIGAMI as part of the exploitation activity WP 9.2 while this Final Report is being prepared. Once the installation is complete, a link on the main ORIGAMI website will lead to the downloads.

WP4 Identification of needs

Task 4.1 Traveller needs

The aim of T4.1 (traveller needs) was to identify user needs for long-distance intermodal journeys. This was achieved via a comprehensive and systematic literature review of previous EU project findings and academic journals. The initial stage of the task, led by TRI, was the identification of key words (e.g. seamless travel, long distance travel etc.) which were then used to search suitable online search facilities (e.g. Science Direct, CORDIS database) as well as Edinburgh Napier University's online library resources. This literature search led to the identification of a range of EU and National reports, and academic journal articles. This information was then synthesised and summarised leading to the production of D. 4.1, Review of Needs of Long-Distance Travellers.

The key findings of the deliverable were as follows. Based on previous European research which has examined user needs for long-distance intermodal journeys (e.g. LINK; KITE; CLOSER), eleven main user needs were identified, related to various network characteristics, facilities provided at interchanges (transfer points), available baggage handling facilities, provision of door-to-door information, whole journey cost, level of comfort, safety and personal security, total journey time, accessibility issues, and the way in which 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. Whether these additional four mode specific aspects apply to all long-distance intermodal journeys, as well as which of these 15 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.

Task 4.2 System needs

D4.2, analysis of system requirements for Co- and intermodality in long-distance passenger travel, has been prepared based on the working paper MS3, First overview of system needs. Under the coordination of ISIS (road transport) the partners reviewed for each transport mode the analysis of the key system needs. Objectives of the analysis were a) the identification of the physical elements of the intermodal trips, whereby the long-distance intermodal and co-modal passenger trips have been classified on the basis of the links, interchanges and basic technological components involved; b) the first outline of the system needs, in which the main specifications of the requirements to ensure seamless trips have been identified; and c) the analysis of the pre-conditions and the framework conditions for a full and efficient implementation of the system requirements.

The basis of the task assignment for T4.2 was on the one hand the working paper MS3, and on the other the deliverable D4.1 on the analysis of user needs, with which the D4.2 has provided the necessary comparison. The final steps and main objectives of D4.2 were 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.

WP5 Technical solutions

Task 5.1 Best practice examples and Task 5.2 suggested solutions

During the first months of the ORIGAMI project research it was initiated to find best practice examples as well as solutions suggested in the literature for improved intermodal and co-modal long-distance passenger transport.

A website section in the ORIGAMI site was created to present all examples (see http://www.ORIGAMI-project.eu/bp-examples-website online). The website offered during the development of the project the possibility for users to rate their interest in each case and to provide comments. A total of 166 examples have been gathered in total, the website being updated whenever new cases appeared to be sufficiently relevant.

The website has been a reference element for participatory activities in the ORIGAMI project, including the online Expert Consultation on key transport trends (November 2011) and the two stakeholder seminars (May 2012 and November 2012). Results of all participatory activities, along with survey questionnaires when available, are documented in the website as well.

The initial part of the website was also available as the paper milestone MS6, delivered in November 2011. To achieve the milestone as required by the DoW a working paper was prepared and circulated, although the web directory remained live and publicly accessible. The analysis of transport solutions, based on the identified best practices, stakeholder input, transferability analysis and analysis of gaps and bottlenecks, was further developed in later activities of the project in WP6. As a result of all these activities, the website became D6.3 Technical Solutions for the Improvement of Co- and Intermodality for Long-Distance Travellers – 'Website', a rich source of material, and a site intended to remain active at least five years beyond the project life, available for general public consultation.

The solutions part of the ORGIAMI website had by the closed of the project received 96,738 hits, on average 583 hits per solution.

Task 5.3: Gaps and bottlenecks

For this task it was initially intended to consider 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, allowing for an analysis of 'gaps'. However, the way in which T4.2 developed meant that the system needs were defined in the context of the user needs and so system needs and user needs were no longer independent entities.

The analysis was then based on the solutions identified in tasks T5.1 and T5.2 and on input from the system needs task, and in particular from the system needs and 'critical areas' table in D4.2.

At the core of MS10 is a table of needs and solutions. This contains the various identified needs in the left column and then the solutions found either under the top heading of best practice (as per T5.1) or suggested solution (as per T5.2). Each of these two groups is then further broken down into 'fulfils needs in key aspects', 'meets need in part of the world' and 'meets need partially'. The first output was MS10 that was ready as scheduled by the end of month 13. This was followed by further refinements, in part based on written feed-back by stakeholders following the workshop in Barcelona, that then led to MS11 and finally MS14. For MS11 also a version has been produced that is published on the ORIGAMI website.

It was found that the coverage of needs with solution is rather uneven, with some needs being well addressed and others much less so. However, the only needs for which no solution were found were of minor relevance and, moreover, they could be addressed with existing technologies.

Most solutions identified are only available for certain countries, regions or even cities, but a roll-out to other sites is in most cases technically perfectly feasible. 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. MS11 suggests that here is a role for the European Commission to help further the development of these standards and providing a central point, for instance through EUROSTAT, where key data could be stored and be made available to all.

Overall, it was somewhat unexpected that there were no system needs identified by ORIGAMI in the first place for which a solution is not already available or technically feasible or at least under development somewhere. The key conclusion was that engineers in Europe and worldwide have addressed the user needs of long-distance travellers in a multitude of ways, all that is needed is that these solutions are rolled out throughout Europe.

WP6 Cross-fertilisation

Task 6.1 Applicability analysis

Mcrit elaborated an initial set of criteria to explore the potential of ORIGAMI solutions to be transferred into contexts different than those in which they were originally conceived; in other words, the possibility for the application of certain solutions to be generalised into different geographic contexts or even different modes. The selected criteria are based on the INTERCONNECT evaluation framework (TRI et al. 2011) and on the evaluation criteria proposed by the European Bank of Investment in the Railway Project Appraisal Guidelines (RailPAG, EIB 2005) synthesised by the stakeholder-effects matrices (SE).

In ORIGAMI, a solution was considered to have a high generalisation and transferability potential when it may have a manifested interest for a wide range of stakeholders (users, operators, government), and when conditions are such that there are no feasibility barriers to its transferability.

An initial evaluation of all best practice examples gathered in MS6 was done using the proposed criteria, and was presented in MS10. This milestone was shown and disseminated to stakeholders in the Barcelona workshop in May 2012. Feed-back was received from a number of them over the following weeks, and incorporated in the analysis. Analysis was extended to all newly incorporated transport solutions, after the delivery of MS6.

The 2nd stakeholder seminar (organised in Task 6.2) was designed to further discuss the potential interest and generalisation of key transport solutions, and transport solution families. This second stakeholder seminar was organised in an electronic format and based on a 10 questions survey, which illustrated examples of upcoming transport solutions – technology, management, infrastructure, regulation - (see Task 6.2 description for further details). The qualitative and quantitative input by almost 200 participating stakeholders was key for drawing conclusions on the transferability of ORIGAMI transport solutions.

The main outputs from T6.1 have been reported in deliverables D6.3 (web) and D6.4 (report), due near the end of the project (delivered by the end of 2012).

The most transferable solutions were found to be Travel Planners, mostly due to relatively high interest for travellers, operators and public authorities, and being easier to bring forward than other solutions; followed by Traffic Management solutions, for which spontaneous implementation by transport operators is relatively likely according to ORIGAMI stakeholders; Local Interconnections between long-distance transport networks and urban centres, Enhanced Vehicle Performance, and Enhanced Vehicle Safety solutions, were also found to have high transferability potential.

At other end of the line, solutions which seemed more difficult to be transferred to other modes or regions in Europe were as follows: Mega-Projects, mostly because of being complex tailored solutions for specific contexts, both in terms of design, technical solutions and political arrangements; Dual-Mode solutions, for being highly driven by local pre-conditions; Freight and Passenger Traffic Segregation, for their higher interest in local and metropolitan logistics (e.g. urban bypasses, access/egress to ports) than for long-distance transport (except in very busy corridors like in the Betuwe line); and Organisational Arrangements of different sorts, mostly because of being highly dependent of existing stakeholders and their previous cooperation history records.

Task 6.2 Stakeholder consultation

The first stakeholder workshop was held on May 4th 2012 in Barcelona. It was aimed at discussing upcoming solutions with the potential to enhance passenger transport in Europe, emerging transport policy and technology trends, and future transport scenarios. Transport operators and managers, transport associations, European institutions, and transport consultants and researchers were invited to participate in this one-day workshop. The workshop was organised in collaboration with the GlobalCat network, an official program by the Catalan regional administration organising a series high level forward looking conferences and debates in the domains of economy, society, transport, energy, environment, and governance. Almost 100 stakeholders participated, with 20 interventions on selected upcoming transport solutions integrated in 5 different round tables. The workshop is documented in the ORIGAMI project website (see http://www.ORIGAMI-project.eu/component/content/article/72 online), where presentations are available for downloading, as well as in D6.1 – First Stakeholder Seminar.

The second stakeholder workshop was developed electronically during November and December 2012. The workshop was based on 10 questions presenting ten transport solutions (infrastructure, management, regulation or technology based), and participants provided their expertise assessing the potential interest of these solutions, and to what extent these solutions were likely to be spontaneously developed by the market alone, or required of further support. Stakeholders were allowed to provide qualitative opinions and remarks on each of the questions. After the development of this activity, stakeholders were sent a report of conclusions, and were allowed to submit further reactions to be incorporated in the report. Almost 180 stakeholders participated in this activity. The workshop is documented in the ORIGAMI project website as well as in D6.2 – Second Stakeholder Seminar (see http://80.33.141.76/ORIGAMI/index.php?option=com_content&view=article&id=458&Itemid=88 online). The results of this second workshop fed directly into the analysis of ORIGAMI transport solutions in D6.3 and D6.4, especially on the analysis of transferability, as well as in the analysis of transport scenarios in WP7.

WP7 Scenarios

Task 7.1 Scenario building and Task 7.2 Forecasting

Tasks 7.1 and 7.2 are closely interlinked, since the development of the scenarios and the models to provide the forecasts was an iterative process, and it is often not possible to say where one ended and the other one began. Hence the development of both tasks is reported here together.

During the first year of ORIGAMI, a qualitative and quantitative framework for scenarios in 2030 and 2050 time horizons was created to allow for a common understanding of scenarios within the consortium. Four exploratory scenarios for Europe were eventually defined with qualitative narratives and quantitative characterisation, inspired by those proposed in the Impact Assessment Report of the 2011 Transport White Paper, but adjusted in ORIGAMI to specifically deal with long-distance passenger transport.

The expert work of ORIGAMI in designing the 2030 scenarios was complemented with inputs from experts in the European transport sector to make sure that the most relevant factors influencing the transport market in the next decades had been considered. To achieve this, a web-based expert consultation had been conducted in November 2011 among a number of academic experts, industry stakeholders, civil servants and transport consultants to help define the ORIGAMI scenarios and to check their relevance and convenience after first draft versions. The survey had been scheduled to tie in with the transport White Paper (March 2011) and TEN-T guidelines (October 2011).

The exploratory scenarios for 2030 were linked to four policy packages (as defined in MS5) operating on the supply side of the transport system. Each policy package contained diverse policy actions (infrastructure, management, regulation and technology) linked to all transport modes which worked together towards specific transport options. The 2030 scenarios relied on the transport solutions identified and explored in WP5, and later discussed with stakeholders in WP6. A normative scenario was implemented to seek an optimum policy combination to obtain the best approach to targets currently in force in the EU (EU2020 strategy, transport white paper, GHG targets). While the demand side for 2030 was kept constant (compatible with TransTools project matrices) allowing for ceteris paribus analysis of transport policy effects, the mode specific developments and interactions have been forecasted and analysed on the intermodal network level based on NUTS 3.

The scenarios for 2050 do not only include transport policy packages but also different socio-demographic and economic trends. Due to the dynamic nature of the model LUNA it is necessary / possible to define different values for each scenario variable for each year up to 2050. Up to 2030 the transport policy elements were defined in line with the scenarios for 2030. Trends were extrapolated for the period 2030 to 2050. The socio-demographic and economic scenarios are defined by the following six elements: total fertility, life expectancy at birth, in and out migration, employment and GDP. The baseline assumptions are consistent with the EUROPOP2010 convergence scenario and the ECFIN ageing report (Eurostat 2012, (European Commission 2009). The other scenarios are defined in line with (Lanzieri 2006). The propulsion technology scenarios are defined in line with the scenarios of the EU project GHG-TransPoRD (Fiorello et. al. 2012). The approach considers changes in mobility and mode choice on NUTS 1 level reflecting a scenario defined by transport policy actions, technological developments and socio demographic as well as socio economic developments.

The modelling work developed in two strands with Mcrit developing MOSAIC further for the scenarios for 2030 and TUW/ITS developing the LUNA model to reflect the 2050 scenarios. The models were adapted to be able to represent the scenarios and transport policy packages. In the case of LUNA this meant including new structures within the model to account for changes in fertility, mortality and car ownership due to changes in GDP assumptions as well as changes in fleet emissions. Initial modelling results were discussed in consortium meetings which led to refinements in both the development of the models and the scenarios. A set of sensitivity tests completed the development of the LUNA model and informed the subsequent analysis of the scenarios. Evaluation indicators were added to both models and final sets of model runs (see comment under task 7.3) were carried out to inform the evaluation task 7.3.

Task 7.3 Scenario evaluation

A first version of the evaluation framework has been prepared and this was circulated in advance of the Rome consortium meeting in Period 1. In period 2, this was refined further following discussions with Mcrit, ITS and TUW as the model development in Task 7.2 evolved and it became clearer which parameters the models would be able to deliver and which ones not.

In the next step, detailed templates for the graphs and tables to be produced by the two models were then developed by TRI and, again in discussion with Mcrit, ITS and TUW, refined. These were largely different for the 2030 and 2050 scenarios, reflecting the differences in the focus of both the MOSAIC and LUNA model and the differences in the key parameters used for the 2030 and 2050 scenarios.

When what was at the time thought to be final version of the scenarios and models had been established, Mcrit and TUW produced the requested graphs and figures along with some key comments in bullet points. TRI then tried to interpret these but, especially for the 2050 results based on the newly developed LUNA model, implausible results and contradictions between results for different scenarios and / or different parameters were found, which then led to further final refinements of the LUNA model. When the final sets of graphs and figures were available, TRI wrote up the interpretation of the results obtained and produced D7.1.

The two sets of scenarios for 2030 and 2050 start in many aspects from different premises, most notably that the 2050 scenarios only contain trips with at least one overnight stay and also include intercontinental trips, and it was therefore not straightforward to compare them and come to common conclusions. One key difference is that it is one of the core findings in the 2030 scenarios 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 important conclusions can be drawn from the 2050 scenarios only, with the main one being that socio-demographic and economic changes 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 just a marked 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.

WP8 Conclusions and recommendations

Task 8.1 Future research needs

The evaluation of future research needs was based mainly on results of ORIGAMI, therefore Task 8.1 has started in the middle of the second year of the project. The basis for the evaluation was the following ORIGAMI reports:

- 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 / MS12;

- 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 some other reports of research projects have been taken into consideration (especially KITE, NICHES and HERMES).

On the basis of the above mentioned projects results gaps in current and future research have been identified. This assessment has been conducted in five areas: statistics, solutions identification, applicability of solutions, behavioural response and future trends (scenarios / modelling).

Then identified needs and gaps have been presented as researchable questions. The final task was the prioritisation of research needs. As ORIGAMI is 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. Then also on the base of experts' opinion additional criteria have been used to assess cost of research, funding opportunities and feasibility. Final results are presented in MS16 as well as the synthesis is part of the ORIGAMI final report.

Identification of research needs is always a subjective and challenging task. Advantages of the analysis conducted in ORIGAMI result from the specific identification and verification method implemented. Firstly gaps as well as current and future research requirements have been identified by ORIGAMI research team on the base of ORIGAMI and other project reports. But then the process of prioritising research needs has been conducted through consultations with stakeholders involved in ORIGAMI. Then the final picture is not only a theoretical result of deskwork conducted by researchers but also practical verification of these identified gaps by a relatively large group of stakeholders closely connected and interested in the project results.

Summarising the key results very briefly, for statistics the most important research need concerns common framework for complex intermodal data collection. For solutions identification technology driven solutions, especially new propulsion technologies as well as organisational improvements in transport based on optimisation of existing services are scored highly. In the case of solutions applicability research needs 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 the researches. Taking behavioural response into account, future research should aim at harmonisation of definitions which lead to improvements in assessment methodology and the interaction between transport demand and e-mode. Finally for future trends, 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.

Task 8.2 Conclusions and recommendations

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 wide-spread 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

- 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.

- 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.

Policy Recommendation: European Polocies 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.

Potential impact:

Impact

The main impact of the ORIGAMI project stems from five distinct areas: the data collected on future travel behaviour, the directory of best practice and suggested solutions, the scenarios for the years 2030 and 2050, the identification of future research needs, and the general conclusions and recommendations.

The data collected in the large scale survey carried out as part of ORIGAMI provides and understanding of the preferences of long-distance travellers to help determine their likely responses to policy initiatives being considered. It provides a ranking exercise as well as Willingness-To-Pay values for various soft factors, which will help practitioners decide on the best options for any investment decision, as well as providing researchers and modellers with important variables.

The directory of best practice and suggested solutions, which is available on the ORIGAMI website and contains 166 examples, is a reservoir of knowledge that will provide food for thought for any researcher or, more important, any practitioner in search of ideas on how to address specific problems in intermodal travel or to optimise the co-modal transport system. Furthermore, the accompanying analysis of gaps and bottlenecks allows starting from the analysis of the particular problem and needs and finding from there the corresponding solutions.

The scenarios are of most value to decision makers concerned with future transport policy. They demonstrate the impact of both future developments in the European population (migration, ageing etc.) and different investment decision on the performance of the European transport system. Above all, they show that only a step change in propulsion technology can bring Europe anywhere near its Green House Gas emission targets for the year 2050.

The identification of research needs should help shape the European as well as national research agendas in a range of areas related to transport. The final report D2.1 lists which research is needed from point of view of travellers, operators, governments, regulators and non-users, the latter with regard to externalities, and prioritises them with regard to stakeholder interest, cost of research, funding opportunities and feasibility.

Finally, the general conclusions and policy recommendations are relevant in different ways for all stakeholders concerned with the objective of optimising co- and intermodal long-distance passenger transport.

Dissemination

D9.1, the Project Website, at http://www.ORIGAMI-project.eu has been live since March 2011 and been maintained and updated throughout the project by TRI. The website will be further kept live for the foreseeable future. Also partners' websites contain links to the ORIGAMI project. The ITS newsletter to alumni and partners contains details of the final ORIGAMI conference and a link to the conference presentations.

Furthermore, conference presentations have been made at the ETC conference in October 2012 in Glasgow, at the 13th IATBR conference in

Toronto, at the Xth European Transport Congress in Budapest in November 2012 and at the HKSTS in Hong Kong in December 2012. Six separate articles have been published in the Scientific journal of the University of Gdansk, Transport Economic and Logistics, and another one in the newsletter of the Spanish motorway concessionary Abertis. A paper has been published in Transport Geography by ELSEVIER. ORIGAMI was also presented at two SYNAPTIC Roundtables in January and April 2013 in Brussels. More general dissemination took place at various conferences where TRI had a stand with the ORIGAMI leaflet.

Semi-public presentations at aviation meetings with airports and the German airport association have been undertaken by MKm presenting ORIGAMI project results. Especially the soft factor analysis (WP3.3) and the forecasts (WP7) have been of interest. While the first result package showed potential for the airports to improve their services, the second was of great discussion concerning the transport policy effects on the aviation sector and the large impact of socio-demographic and socio economic developments on air transport mobility. The latter fired the discussion concerning specific products to be offered to the increasing share of'silver' travellers (age 65 plus).

The survey undertaken and the corresponding model analysis were disseminated to another European project named HIGHTOOL. This project will develop within the next three years an European model enabling decision makers to scan effects of policy activities under consideration of general changes of transport determinants in a fast way before other tools will do in deep analysis of the pre-selected transport policy action.

Plans for further dissemination of the project results exist beyond the lifetime of the project, including two papers to be given at the WCTR conference in Rio de Janeiro in July 2013, one at the TRB conference in Washington, and one at the national conference at the Politechnika Slaska, Katowice Poland in September 2013. Journal papers are in preparation for submission to either Transportation or Transport Policy, and one for Transportmetrica B. TUW provide an ORIGAMI-LUNA download section at the institute's webpage (see http://www.ivv.tuwien.ac.at/forschung/projekte/international-projects/ORIGAMI-luna.html online). They intend to exploit and disseminate LUNA widely, and for instance plan to produce a joint MARS/LUNA folder which they will distribute at future events. Also the ORIGAMI website will be maintained for the foreseeable future.

The resources used for this task is different from the budget with some partners carrying out more dissemination activities than other (ITS and UG) and other partners less (TRI, MKm and TUW), which was due to the opportunities found, or not found, to disseminate the project results.

Exploitation

There are a number of products arising from the ORIGAMI project which are exploited as follows:

Survey data and models from Task 3.3 – the survey data and resulting models represent a key source of primary data for long distance travel in the Europe. Other researchers will be able to access the survey and raw data plus the model analysis at ITS's website: http://www.its.leeds.ac.uk/projects/ORIGAMI

LUNA – The System Dynamics based long-distance travel demand model LUNA (Simulating the demand for Long-distance travel Using a Non-OD-matrix based Approach). A published version of the model with all scenarios available plus short user guide is available to download at the Technical University of Vienna's website and on the ORIGAMI website.

http://www.ivv.tuwien.ac.at/forschung/projekte/international-projects/ORIGAMI-luna.html

MOSAIC, along with the improvements done during the ORIGAMI project, is currently being applied in the COMPASS FP7 project, as well as in the ESPON ET2050 project (program derived from Interreg). In these projects, the model is being further improved and refined to meet new specific requirements derived from them, and for the use in future applications.

The ORIGAMI project has created a web directory of best practice examples and suggested solutions on optimising long-distance passenger transport by enhancing intermodality and co-modality. Over 160 examples are described and these may be searched by category and rating making this a valuable resource for any transport planning department. See http://80.33.141.76/ORIGAMI/

The address of the project public website, if applicable as well as relevant contact details.

Furthermore, project logo, diagrams or photographs illustrating and promoting the work of the project (including videos, etc…), as well as the list of all beneficiaries with the corresponding contact names can be submitted without any restriction.

List of websites:

http://www.ORIGAMI-project.eu