# INTEGRATION OF PASSENGER LONG-DISTANCE TRANSPORT AS A WAY FOR ACHIEVING GREATER EFFICIENCY AND REDUCED ENVIRONMENTAL IMPACT

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## ABSTRACT

Long-distance travel on the one hand accounts only for a small share of total trips but on the other hand for a high share of distance travelled, energy consumed and pollutants emitted. Furthermore long-distance travel has experience high growth rate in the past and is expected to continue to grow significantly in the future. From this perspective it is essential for a sound assessment of transport strategies not to neglect long-distance travel. The main objective of the paper is to present the problem of optimization of the passenger long-distance travel from the perspective of economic and environmental aims. In the European Union's transport policy the priority of transport sustainability in evident and the issues of transport integration is going to be crucial. Integration of passenger transport is analysed in the context of intermodality and co-modality. In order to enable seamless door-to-door passenger long-distance trips both traveller behaviour and system needs should be taken into consideration. Then scenarios for future co- and intermodality in long-distance passenger travel are included. The evaluation of these scenarios may reveal either gaps in understanding and/or identify still unsolved problems in the supply of co- and intermodal transport.

*Keywords: intermodality, comodality, transport policy, sustainable transport, transport system efficiency, passenger transport,*

# OBJECTIVE

The main objective of the paper is to present the problem of optimization of the passenger long-distance travel from the perspective of economic and environmental aims. This paper is based on results of **ORIGAMI** project (Optimal Regulation and Infrastructure for Ground, Air and Maritime Interfaces), co-funded by the European Commission within the Seventh Framework Programme. In the European Union's transport policy the priority of transport sustainability in evident and the issues of transport integration is going to be crucial.

The problems of passenger transport integration have appeared already in the White Paper of 2001 (White Paper, 2001), where in the chapter "Transport with a human face" the Commission stated its willingness to encourage measures in favour of intermodality for people and pursue its action on users' rights in all modes of transport. It is included here that in passenger transport, there is considerable scope for improvements to make travelling conditions easier and facilitate modal transfers, which are still highly problematic. The principle of subsidiarity notwithstanding, priority should be given in the short term to at least three fields of action: integrated ticketing, baggage handling and continuity of journeys.

Then, since the review of the transport White Paper (Mid-term review of the transport White Paper, 2006), the EU policy has focused on comodality (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 and in urban areas and congested corridors, but at the same time each transport mode needs to be optimised on its own.

According to the newest White Paper of 2011 (White Paper, 2011), "a Single European Transport Area should ease the movements of citizens and freight, reduce costs and enhance the sustainability of European transport". That means that Europe needs a 'core network' of infrastructure, carrying large and consolidated volumes of freight and passengers traffic with high efficiency and low emissions.

ORIGAMI project starts from the premise that, with the continuing increase in trip length in interregional travel, effective use of the available transport modes as well as the interconnection between trip legs will become increasingly important for a growing proportion of passenger journeys, particularly of those which contribute most to the regional and national economies. The general focus of ORIGAMI is on those long-distance journeys which might benefit from more effective co-operation and/or interconnection between different 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. By reviewing potential solutions and assessing their applicability and usefulness in a range of scenarios for the medium- and long-term future, ORIGAMI makes a substantial contribution towards the estimation of the impact of new policies on promoting co- and intermodality and then on transport efficiency and reducing environmental pressure.

# DATA AND METHODOLOGY

Within this paper integration of passenger transport is analysed in the context of intermodality and co-modality. In order to enable seamless door-to-door passenger long-distance trips both traveller behaviour and system needs should be taken into consideration. In the ORIGAMI project traveller needs are studied through the online survey on trends in long-distance passenger transport by 2030. System needs analysis enables identifying main critical areas, for which the current systems still fail to be fully operational.

Analysis of user and system needs allows to identify best practice examples of solutions as well as their applicability. Then it is possible to assess the impact of different solutions through scenarios developing. The evaluation of these scenarios may reveal either gaps in understanding and/or identify still unsolved problems in the supply of co- and intermodal transport.

In the ORIGAMI project scenarios are defined at European level where the specific evolution of different types of transport segments is studied from multiple dimensions. Different models are used and they enable for the evaluation of relative performance. Scenarios are developed for 2030 and 2050 time horizons and they are 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 EU 2020 strategy.

# APPLICABILITY OF BEST PRACTICE EXAMPLES IN THE CONTEXT OF USER AND SYSTEM NEEDS FOR CO- AND INTERMODALITY IN LONG-DISTANCE PASSENGER TRAVEL

Best practice examples of solutions integrating passenger transport can improve efficiency and reduce negative environmental impacts. But this only concerns specific area and specific transport system conditions. Therefore it is important to assess what the applicability of different solution is. Within ORIGAMI project the context for applicability analysis is the assessment of user and system needs. These two concepts, i.e. user needs and system needs, are used in order to identify respectively the long-distance traveller needs (e.g. comfort, reduced travel time, etc) and the long-distance transport system needs (e.g. information, standardisation, technical integration, etc). The final steps are to investigate the areas that are critical in the system needs to fulfil the user needs and to suggest the pre-conditions to address them. This last objective is pursued through the indication of the pre-conditions of the transport system (technical and organisational) and to accommodate at best the most relevant user needs (Enei R et al, 2011).

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

1. The analysis distinguishes three stages as essential components of the intermodal and co-modal transport chain: 1) the first/last mile, 2) the interchanges, 3) the main trip.

Each component deserves a specific analysis since the user and system needs have different characteristics for each stage of the co- and intermodal long-distance transport chain.

2. The analysis considers the entire transport chain (all modes and interchange points) and the individual transport modes involved (i.e. air, rail, road, bus/coach and ferry), in order to differentiate the analysis of user and system needs by specific transport modes.

## First/last mile stage

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

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

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

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

## Interchange stage

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

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

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

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

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

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

## Main trip stage

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

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

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

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

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

## Entire transport chain

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

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

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

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

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 provision of major information to the passengers, etc;

3. The presence of integrated transport infrastructures and networks (rail, road, local public transport) to the interchange point and terminals.

Table 1 summarises the system requirements to reconcile the system needs with the user needs in terms of updated information, integrated ticketing and service quality along the entire multimodal and co-modal long-distance passenger journeys. It can be observed that the informational gaps between user and system needs pointed out for interchanges and main trips stages also hold true for the entire long-distance intermodal trip chain (Enei R et al., 2011).

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

Table 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)<br>• Implementation of Protocols TAP-TSI, ERTMS, ETCS (Rail) | • Ensuring interoperability of applications: chip, payments means, etc (Road)<br>• Implementation of Protocols TAP-TSI, ERTMS, ETCS (Rail) | |
| Regulation<br>• Market openness<br>• 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)<br>• Regulation on enforcement of passenger rights in multimodal journeys |
| Stakeholder co-operation | • Public-Private partnerships (Road)<br>• Co-operation among operators (Rail)<br>• Co-operation among modes (Ferry/Air/Rail) | • Public-Private partnerships (Road)<br>• Co-operation among modes (Ferry/Air/Rail) | |

Source: (Enei R et al., 2011).

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

### Conclusions for applicability

Within ORIGAMI projects plenty of solutions have been identified and their applicability have been assessed taken into consideration user and system needs. Detailed applicability analysis of each practice is available in D6.4. (Ulied A, et al., 2013), as well as in the project website – http://www.origami-project.eu/.

To summarise the discussion, it can be said that few identified gaps found concern real-time information: real-time information at rail stations in ports on ferry departures, real-time information on onward travel at ports, and real-time information on trip status and connections for coaches. On the other end of the spectrum, there are just a few needs for which, at least in principle, there are universal solutions available. These are:

- Hire cars at airports for the last mile;
- Park & Ride facilities for the first mile;
- Demand responsive public transport services;
- Cars with assisted driving facilities to make cars safer; and
- Electric vehicles to make cars cleaner, even though facilities to reload batteries are in some countries still very rare.

The closest candidates for availability for all of Europe are the routeRANK travel planner, although this does not contain information on local public transport in the publicly available version, and the German Reiseauskunft and DB navigator, which both provide rail information for all of Europe, though door-to door information only for Germany (Ulied A et al., 2013).

All other solutions identified are only available for certain countries, regions or even cities, although 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. Here is a role for the European Commission and policy makers 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.

## ORIGAMI SCENARIOS ANALYSIS

There is no doubt that transport is a complex system that is based on the interaction of many components all of which need to evolve together: vehicles, infrastructure, behaviour, management etc. This explains the strong inertia of the system and the need for addressing several problem areas in order to determine a paradigm shift. A central element of the Community Strategic Guidelines on Cohesion 2007-2013 is the assumption that transport infrastructure and accessibility are necessary conditions for economic growth in the Union, having a direct impact on the attractiveness of regions for businesses and people (EC, 2006).

Whereas according to the 2011 Transport White Paper, one of the major challenges in the field of transport is to break the system's dependence on oil without sacrificing its efficiency and compromising mobility, in line with the flagship initiative "Resource efficient Europe" set up in the EU 2020 Strategy (EC, 2010a) and the new Energy Efficiency Plan 2011 (EC, 2011a).

Curbing mobility is not an option. The EU and governments need to provide clarity on the future policy frameworks (relying to the greatest extent possible on market based mechanisms) for manufacturers and industry so that they are able to plan investments. The White Paper on Transport 2011 defines a strategy for improving the efficiency of the transport sector that includes the introduction of advanced traffic management systems in all modes; infrastructure investment and the creation of a Single European Transport Area to promote multimodal transport; smart pricing; and efficiency standards for all vehicles across all modes as well as other measures to promote vehicle innovation (White Paper, 2011).

The ORIGAMI project defines prospective scenarios by 2030, 2050 to explore the impact of alternative policies. Policy packages are supply oriented and characterized by different degrees of emphasis on infrastructure investment, infrastructure management, enhanced regulation and more liberalisation. New technologies and upcoming transport solutions identified in the previous stage of the project and discussed in depth with stakeholders are at the basis for the definition of scenarios. They are defined qualitatively based on stakeholder interaction and travel survey analysis and modelled quantitatively with the MOSAIC network-based model (for 2030)[1] and LUNA system dynamics model (for 2050)[2].

The ORIGAMI scenarios are inspired by the scenarios defined by the Impact Assessment report of the transport White Paper, but are adapted to specifically analyse passenger long-distance transport, whereas the White Paper scenarios consider both passenger transport of all ranges and freight transport. The Commission has identified seven transport policy areas in which concrete policy measures could have a key role in stimulating the expected shift of the transport system to another paradigm. These policy areas are: pricing, taxation, research and innovation, efficiency standards and flanking measures, internal market, infrastructure and transport planning (EC, 2011b). In the table 2 the comparison between this two sets of scenarios is given.

[1] The MOSAIC model was developed in the framework of the INTERCONNECT EC 7FP project (2011),and has been refined for ORIGAMI. MOSAIC is a modal choice and assignment module originally programmed to investigate how interconnection facilities and services influence the costs of transport, and therefore, how the upgrading of interconnections in Europe may impact on the European transport system.

[2] The main scope of the LUNA model is to assess long term effects of changes in socio-demography, economy, technology and transport policy. Hence the time horizon of the model is 2050. LUNA is based on the principles of Systems Dynamics and was programmed utilising the System Dynamics software Vensim(r) .

Table 2 – Scenario correspondences between White Paper and ORIGAMI

| Scenario Orientation | ORIGAMI Scenario | White Paper Scenario |
|---|---|---|
| Business as Usual | Baseline | Policy Option 1 (PO1) |
| High public regulation and more infrastructure, including some management | OR1 | Policy Option 2 (PO2) |
| High reliance on technology advances, derived from high regulation on technological EURO standards | OR2 | Policy Option 3 (PO3) |
| Less regulation and more focus on infrastructure management without additional infrastructure | OR3 is a less regulated combination of PO2 and PO3, with high emphasis on management | |
| More infrastructure in an unregulated framework | OR4 is a less regulated combination of PO2 and PO3 with a higher emphasis on infrastructure | |
| Balanced approach | Reference Normative Scenario | Policy Option 4 (PO4) |

Source: (Ulied, A., Biosca, O., Shepherd, S., 2012).

In table 2 correspondences have been set between scenarios of the transport White Paper and ORIGAMI scenarios. Policy Options 2 and 3 of the White Paper have directly inspired ORIGAMI scenarios OR1 and OR2. Additional scenarios OR3 and OR4 are proposed from these basic two in such way that the central area of all these scenarios defines the space where ORIGAMI Reference Normative scenario can be situated, approximately in the same area where the Policy Option 4 of the White Paper would be. An ORIGAMI Baseline has been proposed following similar assumptions to Policy Option 1 from the White Paper, mostly not considering further transport policies than those already in place.

Exploratory scenarios are defined as policy oriented scenarios by 2030. They were defined considering alternative policy packages directly related to long-distance passenger transport. Four different transport policy packages OR1. OR2. OR3 and OR4 have been defined, each one of them having a relatively higher emphasis on certain set of policy instruments than the others, thus leading towards a different 2030 scenario.

## Definition of scenarios

By 2030, scenarios are discussed in terms of alternative transport supply policy packages characterized by different degrees of emphasis on infrastructure investment / infrastructure management on one side, and on enhanced regulation /more liberalization on the other side (see table 3) [3].

[3] Exploratory scenarios integrate alternative stakeholder views on the future of transport and transport policy. Scenarios were initially inspired by stakeholder contributions in the several activities carried out between 2009 and 2010 by the EC in the process of preparation for the 2011 transport White Paper and were later refined with further inputs by stakeholders in the ORIGAMI expert consultation held during November 2011. more details

Table 3 Focus of ORIGAMI Policy Packages on key policy aims

| | OR1 | OR2 | OR3 | OR4 |
|---|---|---|---|---|
| Focus on infrastructure | High | Low | Low | High |
| Focus on management | Medium | High | High | Low |
| Focus on technology | Low | High | High | Medium |
| Focus on liberalisation | Low | Low | High | High |

Source: (Ulied, A., Biosca, O., Shepherd, S., 2012).

The four ORIGAMI Policy Packages OR1, OR2, OR3 and OR4 can be summarised as follows:

- **OR1. Better public regulation and infrastructure investment, mostly financed by public funds with some regulation** - the OR1 policy package considers a rising level of transport infrastructure investment, especially focused on rail programs aimed to enlarging current HSR network in Europe. A regulation framework is set up to encourage the use of more environmentally friendly modes, and this includes increased road pricing as an extension of Eurovignette to cars, extended air taxation, limited maximum speeds in motorways. Subsidies are dedicated to greener transport services or aiming at territorial cohesion.

- **OR2. Better public regulation, especially on vehicle technological standards and little emphasis on infrastructure** - the OR2 policy package promotes the introduction of cleaner vehicles and more responsible user behaviour. Increased vehicle research and Euro Standard regulations over the private sector bring down vehicle emissions from new vehicles, lowering average emission factors of the vehicle fleet. Favourable taxation and technological developments promote expansion of an alternatively fuelled cars fleet. Train, airplane and ship load factor increases are promoted by environmental regulation; spread of car sharing and car pooling schemes brings more rational use of cars and increased vehicle occupancy.

- **OR3. More liberalization and more emphasis on infrastructure management. Technology applied to improve efficiency of transport infrastructure** - the OR3 policy package aims at intensively increasing performance of existing infrastructure through better management and higher technological implementation. New technologies optimize flows in all modes: ICTs in large urban areas result in less congested road traffic, satellite guidance allows optimal routing; revised airport procedures reduce check-in / security times, ERTMS systems allow for faster operating rail. comfort conditions and services reliance increase the willingness to travel on rail and air.

- **OR4. More liberalization and more investment in efficient infrastructure co-financed by the private sector** - OR4 is focused on further liberalization of the transport market. Reduction of rules and harmonization for all Member States enhances competition within modes and across modes. A substantial reduction of subsidies to infrastructure investment

see: full report on the ORIGAMI Expert Consultation available at the project website: http://www.origami-project.eu/component/content/article/59 .

(public funding) and service operation forces each mode to become more economically self-sufficient, sometimes requiring increases of transport fees in currently more subsidised modes.

The figure 1 shows to what extent each of the policy packages in ORIGAMI relies on different families of solutions to improve co-modal and intermodal passenger transport in Europe.

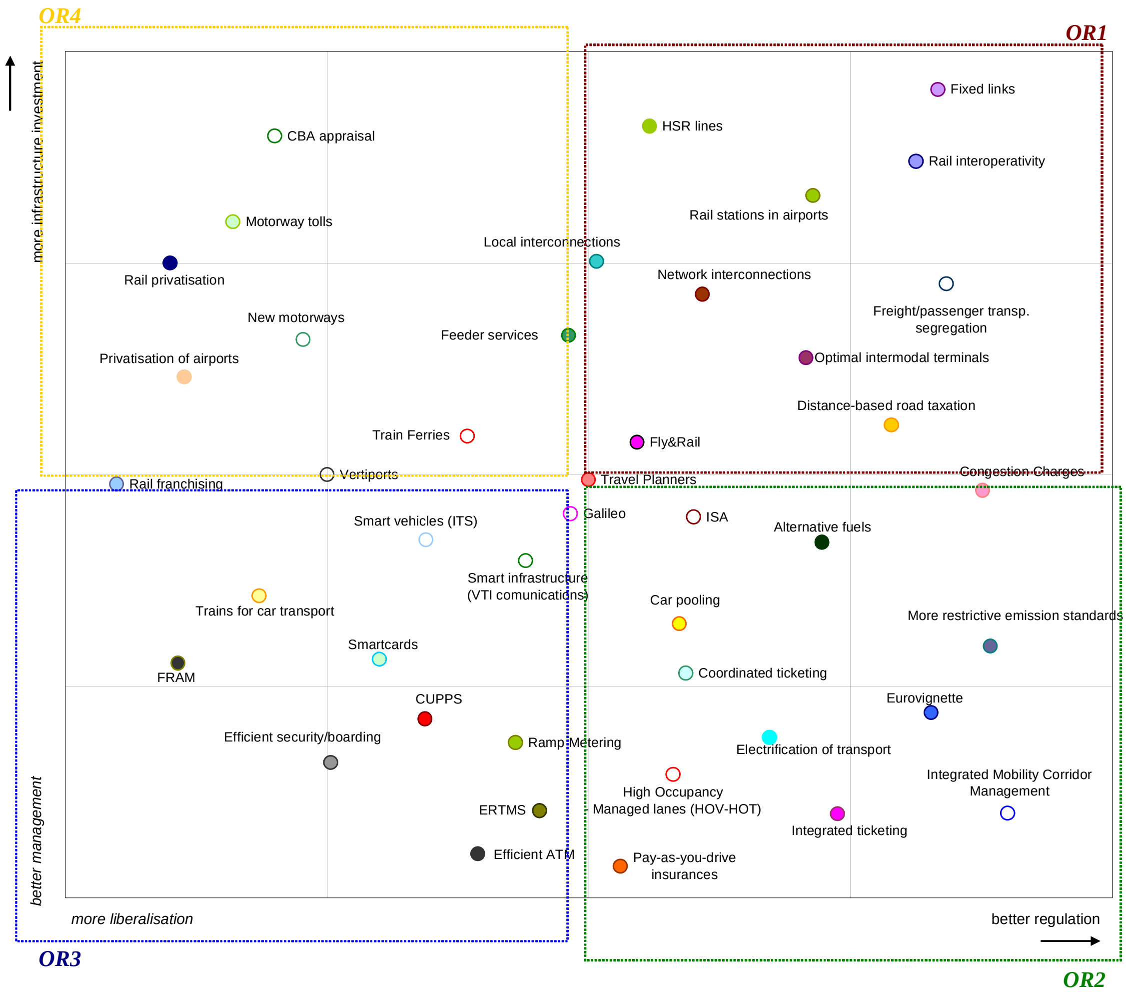


Figure 1 Relative reliance of ORIGAMI policy packages on identified best practice solutions

Source: (Ulied, A., Biosca, O., Shepherd, S., 2012).

Long-term scenarios for 2050 may be defined as the intersection of 2030 alternative transport orientations with selected socio-economic mega-trends on demographics. The 2050 analysis discuss the impact on the transport system of alternative demand patterns derived from societal changes and different socioeconomic megatrends. The Baseline scenario for 2050 represents the future without any additional policy intervention to change current trends. This scenario is the same as Policy Option 1 defined in the White Paper. Scenarios for LUNA can be defined by combination of different assumptions concerning the different socio-demographic, economic and transport sub models. In the project following scenarios for 2050 was built: (1) Baseline, (2) Prospering Europe / Base Transport, (3) Prospering Europe / Normative Transport, (4) Lagging Europe / Base Transport, (5) Lagging Europe / Normative Transport.

The Prospering Europe (PE) scenario is different from the Baseline scenario in that Europe is assumed to prosper with the higher projections of fertility and life expectancy due to increased affluence across the whole EU with the higher growth in GDP being realised. With the general levels of wealth increasing, there is less reason for internal migration.

For the Lagging Europe (LE) scenario, things are generally worse than expected in the base case. Fertility and life expectancy are at the lower end of the projections as is growth in GDP across the EU. The migration and propulsion technologies are assumed to be the same as the base.

## Scenarios results

Below on five graphs some results from scenarios modelling work are presented.

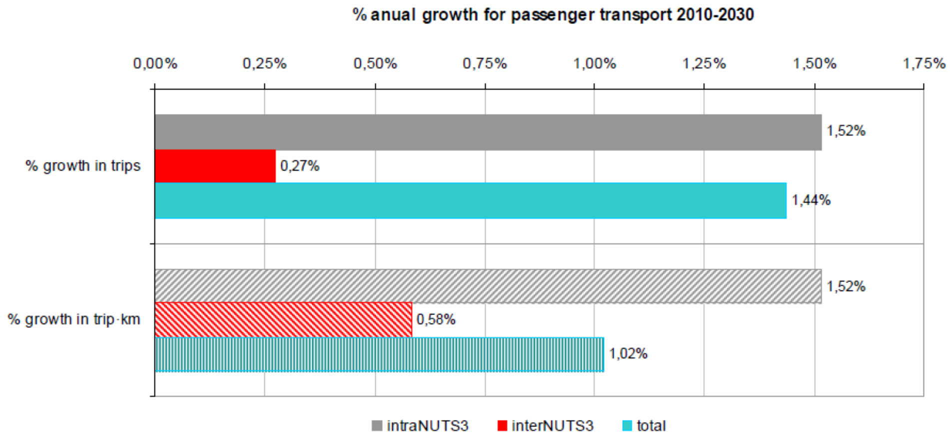


Figure 2 Passenger transport growth in trips and trip km. 2010-2030. All trip purposes included.

Source: (Biosca O., Ulied A., 2012).

For year 2030 annual growth in trip amount is estimated to 1.52% for intra EU trips, 0.27% per inter EU trips and total rate it is about 1.44% per year. Concerning % growth in trip-km total rate is a little lower and amount 1.02% per year.

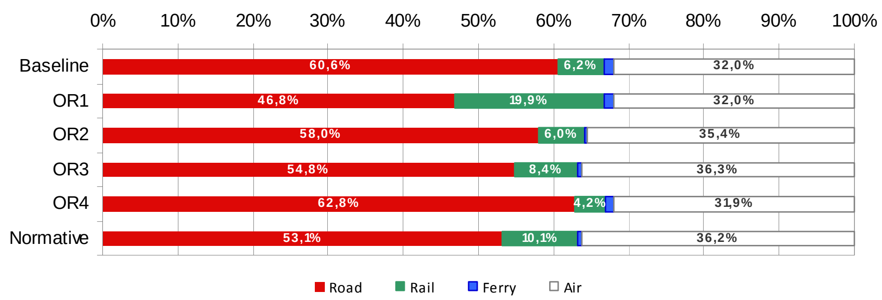


Figure 3 Long-distance modal shares (based on passenger·kilometres). All trip purposes included

Source: (Biosca O., Ulied A., 2012).

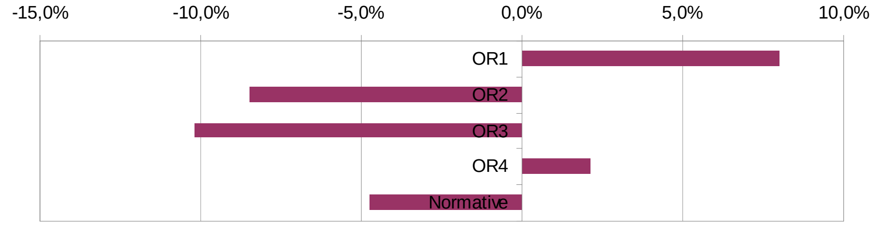


Figure 4 Change in long-distance travel generalised cost in relation to Baseline 2030 (based on euros). All modes and trip purposes included

Source: (Biosca O., Ulied A., 2012)

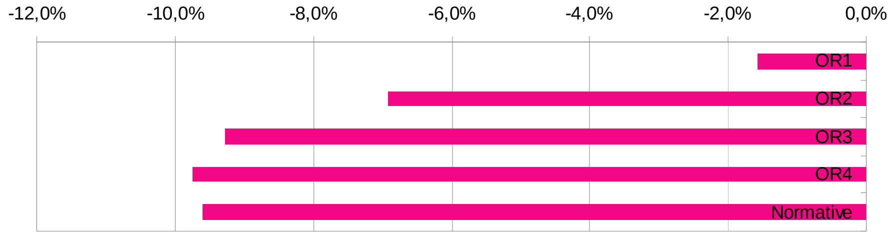


Figure 5 Change in long-distance travel time in relation to Baseline 2030 (based on hours). All modes and trip purposes included

Source: (Biosca O., Ulied A., 2012)

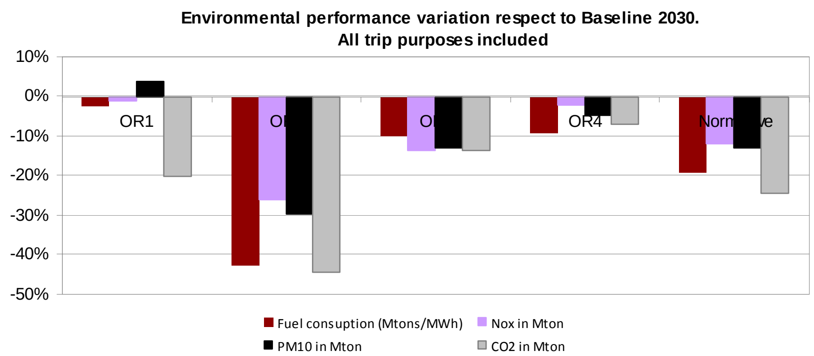


Figure 6 Change in energy consumption and emissions of long-distance travel in relation to Baseline 2030. All modes and trip purposes included

Source: (Biosca O., Ulied A., 2012).
Analysing the results of scenarios for 2030 based on the above graphs we can generalize:

- Scenarios focussed on management (OR2 and OR3) tend to promote more passenger-kilometre reductions;
- OR1 is successful on massively moving people from car to rail at the expense of increasing costs in the transport system;

- Scenarios focussed on management (OR2 and OR3) tend to reduce costs, as they promote higher vehicle load factors;
- All scenarios provide net time savings respect to baseline. OR1 has substantially lower time savings;
- OR2 provides best environmental performance. Normative scenario has relatively good performance at much lower cost.

Taking into consideration the scenarios for 2050 summary of the results is given below and numbers are presented in table 4. Firstly we can see that fertility changes have a greater impact on total population than does the change in life expectancy (by an order of magnitude). However it is also clear that a given percentage change in population does not necessarily imply the same percentage change in emissions. This presumably reflects the fact that increases in fertility increase the proportion of young people who do not travel as much as older people. Of the transport strategies OR1-OR4, OR2 is the only one which reduced emissions by 11.8% in 2050 relative to the base case. This is due mainly to the increase in average occupancy of cars (+25%). The reduction in infrastructure affects the load factors for other modes, but mainly impacts on air, which shifts people to other modes.

Table 4 Prospering Europe and Lagging Europe –Basic indicators

| | Total EU Population 2050 (million) | CO2 Emissions 2050 (million tons/year) | Percentage change in population from base 2050 | Percentage change in $CO_2$ from base 2050 |
|---|---|---|---|---|
| Base | 540.87 | 85.36 | | |
| Prospering Europe : Base Transport | 588.61 | 81.58 | 8.8 | -4.4 |
| Normative Transport | 588.61 | 64.77 | 8.8 | -24.1 |
| Lagging Europe : Base Transport | 507.37 | 77.98 | -6.2 | -8.6 |
| Lagging Europe : Normative Transport | 507.37 | 63.1 | -6.2 | -26.1 |
| Prospering Europe : Base Transport without low emission technology | 588.61 | 95.07 | 8.8 | 11.4 |
| **Transport** | | | | |
| Regulation +High Inf (OR1) | No change | 86.72 | 0 | 1.6 |
| Regulation +Low Inf (OR2) | No change | 75.3 | 0 | -11.8 |
| Liberalisation + Low Inf (OR3) | No change | 85.76 | 0 | 0.5 |
| Liberalisation + High Inf (OR4) | No change | 88.87 | 0 | 4.1 |

Source: (Shepherd, S.P., Biosca, O., Pfaffenbichler, P., 2012), For OR1 the end result is a slight increase in emissions of 1.6%. This is due to a transfer from car to rail and air as car becomes slower and more expensive, while rail is cheaper and quicker and air, despite being more expensive, has reduced access costs. The slight reduction in car related emissions is more than outweighed by increased emissions from air travel.

For OR3 there is a modest increase in emissions of 0.5%. As with OR1 there is a slight reduction in car related emissions which is outweighed by an increase in air related emissions. The impact on other modes is only slight.

For OR4 there is an increase in emissions across all modes of transport resulting from investments in infrastructure, resulting in an overall increase of 4.1%.

The normative reference scenario lies somewhere between the base case and OR2 and results in reductions in car and air related emissions with small increases from rail and coach, the overall reduction being some 6.6%.

The improved propulsion technology scenarios or low emission technologies give the largest overall reductions in emissions with a 14.5% and 26.4% reduction for the low and very low emission scenarios respectively. The majority of these reductions come from the air and car sectors, which have significant increases in efficiency or emissions per km as described above. In particular the air sector had a 30% reduction in emissions per km in 2050 compared to the base case in the very low emissions scenario, while for car the reduction was 25% compared to the base by 2050.

# IMPLICATIONS FOR RESEARCH

Results of the study provide policy recommendations at the international (e.g. the EU), national and regional levels. Long-distance seamless intermodal and co-modal trips imply that the existing transport services must work together and have to be synchronised.

Additionally future research needs are identified considering gaps and bottlenecks in the current transport supply (solutions improving integration) as well as future requirements for long-distance travel resulting from technological and demographic changes.

In order to provide the most reliable forecasts of transport in the long-distance journey for taking actions to improve co- and intermodality, it is necessary to provide reliable and complete data on the different travel components. One of the ORIGAMI project task is to assess the future directions of research in long-distance passenger transport in the context of improving co- and intermodality. The knowledge for assessing the future research needs is based on the analysis conducted within the whole project. They has been divided into five areas: (1) Statistics, (2) Solutions identification, (3) Applicability of solutions, (4) Behavioural response, (5) Future trends (scenarios / modelling). Research gaps can be translated into following researchable questions presented in table 5.

Table 5 Research gaps and needs identified in the ORIGAMI project

| Research area | Research problem |
|---|---|
| Statistics | • Improvement of statistics for distance travelled by passengers by using innovative measures and technologies in observation and data collection,<br>• Better knowledge of user needs and preferences in various types of long-distance trips and for long vs short distance journeys,<br>• Centrally collected and automatically updating data on the number of annual ferry crossings and ferry passengers for all European sea,<br>• 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. |
| Solutions identification | • Technology driven solutions which are most likely to improve future transport.<br>• Wider introduction of less technology intensive modes into transport system.<br>• Methods for optimisation of existing networks and services.<br>• Enforcement of the shift towards more sustainable transport (e.g taxation or reduction of private car capacity measures).<br>• Alternative fuels to reduce negative transport impacts without need to significantly change user behaviours.<br>• Optimisation through coordination of modes and provision of co-operative framework among stakeholders. |
| Applicability of solutions | • Identification, measuring and assessment of wide benefits for travellers/users.<br>• Assessment methods of relationship between extent of benefits to operators and difficulties to implement individual solution.<br>• Measuring the set of benefited users in relation to the cost of the solution.<br>• Creation of a proper regulatory framework to implement an individual solution<br>• Identification, measuring and assessment of any externalities or/and side effects linked to the solution affecting third parties.<br>• Assessment to what extent can the solution be implemented in other geographic contexts or in other modes |
| Behavioural response | • Harmonization of definitions and categorisations concerning trip rates<br>• Assessment of relationship between e-modes and transport demand<br>• Analysis the travel patterns of aging/retired people in EU countries |
| Future trends (scenarios / modelling) | • Improvement in measurement of transport trends and efficiency<br>• Better coordination of actions by different stakeholders<br>• Higher involvement of slower modes in transport system functioning<br>• Role of soft transport factors in future transport system<br>• Development of optimal business models for transport enterprises |

Source: (Bak M, Borkowski P, Pawlowska B, 2013)

# CONCLUSIONS

Long-distance travel on the one hand accounts only for a small share of total trips but on the other hand for a high share of distance travelled, energy consumed and pollutants emitted. Furthermore long-distance travel has experience high growth rate in the past and is expected to continue to grow significantly in the future. From this perspective it is essential for a sound assessment of transport strategies not to neglect long-distance travel. The scope for European influence on passenger co- and intermodality at the European and national levels is determined by the sorts of measures that the EU can realistically impose.

Significant attention in future research programmes adjusted to improve co- and intermodality in long-distance passenger transport 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. There is a powerful argument that a major impact of co- and intermodality can only be achieved by a strong combination of many of the solutions summarised in D6.4. (Ulied A., et al., 2013), as well as in the project website – http://www.origami-project.eu/.

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