TRANSFERABILITY OF BEST PRACTICE EXAMPLES OF TECHNICAL SOLUTIONS TO IMPROVED CO-MODALITY AND INTERMODALITY IN LONG-DISTANCE PASSENGER TRANSPORT

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ABSTRACT

The objective of the paper is to identify co-modal and intermodal opportunities in long-distance passenger transport and to assess possibilities for their transferability in different geographic contexts or different modes. The identification and classification of best practice examples allows for further investigation of gaps and bottlenecks and assessment of the future directions of research in long-distance passenger transport in the context of improving co- and intermodality. The evaluation of transferability provides a decision making tool for different groups of stakeholders, including policy makers and service providers.

This paper disseminates results of research conducted within the ORIGAMI project (Optimal Regulation and Infrastructure for Ground, Air and Maritime Interfaces, project co-funded by the European Commission within the Seventh Framework Programme), http://www.origami-project.eu/.

Keywords: intermodality, co-modality, long-distance passenger transport, transferability

OBJECTIVE

Effective use of available transport modes becomes increasingly important for a growing proportion of long-distance journeys which contribute most to the regional and national economies. Nowadays the topic has particular relevance because of the existing disintegration of international networks and poor interconnectivity between transport modes.

Therefore the objective of the paper is to identify co-modal and intermodal opportunities in long-distance passenger transport and assess possibilities for their transferability in different geographic contexts or different modes.

DATA AND METHODOLOGY

Within ORIGAMI project the deskwork and review of available data sources has been used to collect best practice examples of technical solutions to improved co-modality and intermodality. Additionally the literature review includes suggested solutions which have not yet been realised in practice. Then comparative revision of the examples is prepared. Quantitative and qualitative analysis is applied for the evaluation of best practice examples according to different criteria. Then preliminary evaluations are consulted with the stakeholders at the special seminars organised for this aim within the ORIGAMI. To be included in the web directory, solutions must fulfil the following criteria (Ulied et al, 2011):

1. Solutions need to be relevant, i.e. they need to prove their potential for long-distance transport optimisation beyond comfort improvement to passengers (through intermodality or co-modality).

2. They need to be potentially applicable in other situations (possibility to be generalised); focused on new or upgraded infrastructure, on the improvement of the management of modes, regulation/deregulation of transport, or on new technologies.

3. Stakeholders behind each of the solutions were identified, and whenever possible also contact persons directly participating in the design or implementation of the solution. Identified stakeholders have been involved in the strategic discussion in later stages of the project.

All examples are presented in a consistent format. The review of the solutions is presented at the dedicated website: http://80.33.141.76/origami/. They include: source references (e.g. other research projects, institutions, operators, etc.); relevant website - documents or websites available online and which present the solution; involved stakeholders - list of major stakeholders directly involved in the case; status (to chose between existing, pilot, planned, concept); description - in 10 to 20 lines, briefly present the case and major lessons to be learned; relevance - how the case study contributes improving either intermodality or co-modality in long distance passenger transport.

ORIGAMI project established criteria to assess transferability of solutions. They are based on the former INTERCONNECT 7FP evaluation framework (Bonsall et al, 2011) and on the evaluation criteria proposed by the European Bank of Investment in the Railway Project Appraisal Guidelines (RAILPAG, 2005).

In ORIGAMI, a solution is 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. The transferability evaluation of each solution is done based on six complementary criteria reflecting six (not always conciliated) dimensions in the transport market (Ulied et al, 2013):

1. The user dimension (traveller) - users tend to obtain the benefits of a transport project not included in the cash flows: travel time savings, safety and comfort improvements, reliability. Users being usually poorly organised, they tend to have a very modest influence in decision-making, their interests being mostly defended by the public administrations, local governments, trade unions, and neighbourhood associations. However, foreseeing a substantial benefit from the user point of view will help administrations justifying required expenditure for a project.

2. The operator dimension - competing operators will try to obtain the best deal from any new investment. Operators may have interest in implementing a new solution when it tends to reduce the costs of transport (i.e. optimise the transport system) or when it creates new business opportunities (e.g. increased flows in an airport terminal brought in by a HSR connection, increasing the value of retailer spaces), and will expect new solutions not to bring in additional organisational difficulties (e.g. necessity to reconcile a large number of stakeholders or interests).

3. The government dimension - the tendency of governments to look at their own financial interests should not detract from their ultimate goal, which is to promote the interests of society at large. The ultimate goal should be to obtain a maximum level of social benefit for a minimum level of investment. The distribution of costs and income among different governments and infrastructure owners is politically sensitive and an essential component of the decision-making process. At the same time, any major transport investment should have an impact on the distribution of traffic flows and therefore on the performance of other transport modes, bringing in some cases threatened operators to try to influence the decision making process.

4. The regulator dimension - the regulator is a most important player in the transport system as it is an enabler of a solution being implemented in a certain context or not. A different regulatory framework might make a solution extremely difficult or too expensive to be implemented in a different context (e.g. the Karlsruhe tramtrain has proved to be more difficult to export abroad than expected due to different regulatory frameworks);

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

6. The external dimension or the vision of non-users. Non-users are essentially affected by externalities, notably environmental and social. These are not easy to quantify but can have an important weight in decision-making. Concerns about the external impacts of projects leading to opposition of non-users can make a project unfeasible. Although Environmental Impact Assessment (EIA) procedures should provide enough headway for finding adequate solutions for these impacts in the definition of a project, quite often there are interest groups (in favour or against the project) that will place their position regarding the project firmly in the political arena.

The table 1 synthesises the stated criteria, specifying the dimension / stakeholder each criterion refers to, and some indications on elements to be considered to assess each criterion.

Table 1 - Criteria for transferability (standardisation, generalisation)

	Stakeholder	Criterion	Elements to consider (indicative)
INTEREST	USERS (seamless travel)	Is the solution interesting enough to be useful for other users in a different context?	What are the overall benefits obtained by users from this solution (e.g. decreased travel times and travel costs, increased reliability, comfort, convenience...)
	OPERATORS (system efficiency)	Is the solution attractive enough for other operators to consider?	Does the solution improve overall operation of the system (e.g. decrease operating costs, increase profit opportunities for operator...)? Is it simple enough in terms of organisation?
	GOVERNMENT (social profitability)	Is the solution strategic enough for other governments to consider?	What are the likely benefits for the society in relation to its cost?
FEASIBILITY	REGULATOR (legal framework)	Is the solution acceptable in other regulatory frameworks?	What are the legal constraints constraining the solution? Are there any barriers likely to be insurmountable in a different context?
	TECHNOLOGY (ad hoc approach)	Is the solution applicable in other transport modes or for other technologies?	Is it an ad hoc solution for a specific problem, transport mode or transport technology?
	NON-USERS (externalities)	Is the solution harmless in the territorial dimension?	Is the solution environmentally acceptable? What are the impacts at local or regional scale for not users? (increased noise, pollution, congestion).

Source: Ulied et al, 2013.

Within ORIGAMI research each criterion is rated with a value from 0 to 10, referring low rates to criteria indicating low transferability potential, and high rates pointing towards high transferability rates. The average value of the six proposed criteria will provide an indicative value of the global transferability potential of a specific solution. Results of the evaluation is presented in the subsequent parts of the paper.

TRANSFERABILITY OF FAMILIES OF SOLUTIONS IMPROVING CO-MODALITY AND INTERMODALITY IN LONG-DISTANCE PASSENGER TRANSPORT

In ORIGAMI 13 groups of solutions (called families) have been identified. All of them have been described, compared and then assessed by stakeholders and finally taken into consideration in transferability analysis. The scoring for each solution family has been determined qualitatively based on the outputs of ORIGAMI Stakeholder Seminars and consultations, involving the transport industry, the research community, transport consultants, and civil servants, and complemented by literature review, analysis of specific cases and expert judgment of the ORIGAMI FP7 consortium.

Families of solutions and evaluation of transferability are shortly presented below in table 2 (more information: Ulied et al, 2013). Families of solutions can be divided into 4 major groups:

1. Management: traffic management, ticketing schemes, organisational arrangements.

2. Information and communication technologies (ICTs): travel planners and user information, security and fee collecting procedures.

3. Technology: enhanced vehicle performance, enhanced safety, environmental management, dual mode solutions.

4. Infrastructure: local interconnections, long-distance interconnections, segregation of freight and passenger traffic, mega links: megaprojects.

Table 2 - Transferability of solutions by families (standardisation, generalisation)

SOLUTION FAMILY	**CRITERIA FOR TRANSFERABILITY (STANDARDISATION, GENERALISATION)**					
Criterion	**What is the overall magnitude of benefits to users?**	**To what extent benefits to operators outweigh difficulties to implement?**	**How large is the set of benefited users in relation to the cost of the solution?**	**Is the regulatory framework simple enough to allow straightforward implementation of solution in other countries?**	**To what extent can the solution be implemented in other geographic contexts or in other modes?**	**Are there any externalitites or/and side effects linked to the solution affecting third parties other than users?**
Score Range	(1 min - 10 max)	(1 min - 10 max)	(1 small - 10 large)	(1 complex - 10 easy)	(1 purely place-based - 10 general)	(1 negative externalities - 10 positive externalities)
Target Stakeholder	TRAVELLERS	OPERATOR	GOVERNMENT	REGULATOR	TECHNOLOGY	NON-USERS
Issue addressed	Fast, cheap and comfortable travel	Commercial profit	Social profitability	Legal framework	Ad hoc approach	(-) Barrier effect, noise... // (+) friendlier urbanisation
Travel planners and user information	6	7	9	10	9	6
Traffic management	8	7	7	7	7	9
Local interconnections	8	6	6	9	6	9
Enhanced vehicle performance	8	7	7	8	6	8
Enhanced safety	7	7	7	8	7	8
Security & fee collecting procedures	7	7	7	6	9	6
Environmental management	6	6	7	9	7	7
Ticketing schemes	8	5	7	7	7	7
Long-distance interconnections	8	7	5	8	6	7
Organisational arrangements	6	8	7	3	5	7
Segregation of freight & pax traffic	6	6	6	6	7	5
Dual mode solutions	7	6	5	5	5	7
Missing links: megaprojects	6	5	3	5	2	4

Source: Ulied et al, 2013

Interconnections between long-distance transport networks

14 solutions have been selected by ORIGAMI as examples of initiatives aimed at improving interconnections between different long-distance transport networks (e.g. rail services to airports, connections between railways and ferry lines). Similarly to local interconnections, enhanced long-distance interconnections have obvious positive impacts on long-distance travellers. In some cases, a proper interconnection may save large amounts of time to passengers on transit, especially when saving users the trip to the closest city to transfer to another long-distance transport network. However, with investments typically large (e.g. 225 million euro for Frankfurt airport's ICE terminal without considering cost of access railway infrastructure; 180 million euro for Düsseldorf Skytrain people mover) and demand for long-distance transits relative low compared to typical urban public transport ridership figures, these solutions are only cost effective in very specific cases.

Interconnections may not raise relevant legal issues but may have considerable organizational complexity due to a large number of stakeholders typically involved (e.g. central public administration, various municipalities, at least two infrastructure managers, transport operators, user associations). It should be also noticed that improving air/rail interconnections may tend to increase the modal share of the air mode, and consequently, GHG emissions and noise (increased externalities).

Long-distance interconnections have a low level of transferability. According to experts involved in ORIGAMI workshops, a market niche will develop spontaneously in the future for such solutions though it may not be expected to be a very big.

Access and egress to long-distance transport networks

28 solutions have been selected by ORIGAMI as examples of initiatives aimed at improving access and egress to long-distance transport terminals from cities and metropolitan regions, most of the times via public transport solutions or proper terminal design. Terminals considered include airports, ferry ports, bus and coach stations, and railway stations. Enhancing the public transport access and egress conditions to airports, rail and ferry terminals have an obvious positive impact on users in terms of travel time savings and increased comfort. When using a car, solutions aimed at increasing traffic flow in congested areas (via management or new infrastructure solutions) result in travel time savings and reduced fuel consumption. On the other side, public administrations responsible for financing investments and service subsidies face very large economic costs and are forced to establish priorities among different transport alternatives, whenever possible with clear and transparent cost-benefit methodologies. Solutions exclusively dedicated to serve long-distance transport terminals, like high speed shuttles to airports, are likely to incur high, sometimes unsustainable, financial costs, while making best use of already existing

infrastructure provides much higher social profitability (e.g. using suburban trains or buses to reach airports).

Local interconnections may not raise relevant legal issues but as they often need to be built in heavily populated and urbanised areas, they often have a high level of organisational complexity, especially when agreements among multiple stakeholders are needed (city halls, transport operators, user associations). The design of the Barcelona airport interconnections, for instance, was long discussed over the 1990s and 2000s, with a dozen project alternatives proposed and no overall final agreement ever reached. On the other hand, solutions are technically relatively easy to be transferred from one area of Europe to another, but they always have specificities which need to be closely taken into account to obtain a good project. Access and egress public transport to long-distance terminals can also be used by other users than merely long-distance travellers, like metropolitan commuters, increasing the scope and the interest of these solutions. Local interconnections have a high level of transferability.

New transport links: megaprojects

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

While the impact on users is likely to be important in most of the cases, with large travel time savings and increased comfort and convenience, costs are also likely to be important for a relatively limited number of users benefitting. With these hypotheses, social cost benefit ratios are often very low or even negative. Large investments required for mega-projects for instance, often way above 5 or 10 billion euros, make them only possible when a strong political will is able to compensate for all other poor financial performances (e.g. Channel Tunnel or Öresund bridge-tunnel).

The very specific nature of mega-projects makes their transferability difficult. Even when legal obstacles or externalities may not be especially relevant, the specific local approach required by these solutions makes them difficult to be generalised across Europe. The transferability level is lowest for mega-projects.

Dual mode solutions

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

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

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

Enhanced vehicle performance

9 solutions have been selected as examples of initiatives aimed at enhancing the performance of vehicles, i.e. for instance by increasing their speed or making them more reliable. With clear benefits for users (shorter travel times, increased comfort, convenience and safety), not all solutions may be equally interesting to transport operators or public administrations. Investments in some case may be very considerable (e.g. high speed programmes). No major feasibility issues are to be expected for these kinds of solutions. When the approach is on a vehicle basis like for car multiple driving assistants or automatic subways, transferability across Europe is relatively easy, even if technologies may be often mode specific. If the approach is infrastructure intensive, like the high speed rail programs, difficulties may be much higher. Standardisation of technologies is a basic precondition for transferability.

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

Traffic management

19 solutions have been selected as examples of initiatives aimed at better managing traffic flows, either for road, rail, air or ferry. There are many positive impacts of these solutions. For users, proper management of transport infrastructure allows for increased average travel speeds, increased travel reliability, increased safety. For operators, solutions aimed at improving management allow for increasing capacity of existing infrastructure with relatively low investments. For instance, implementing a system of managed lanes in a motorway such as London's and Birmingham's in the UK, including variable speed limits and hard shoulder management, allows better driving conditions with investments being about one third of the cost of enlarging motorways with one additional lane. However, investments required for the implementation of systems allowing for better management of transport infrastructure are not to be underestimated (e.g. ICTs in motorways or ERTMS).

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

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

Organisational arrangements

10 solutions have been selected as examples of initiatives which change the formal organisation of specific transport services aiming at increasing their efficiency. These initiatives may be originated on liberalisation processes such as concessions, franchises, privatisations, de-regulation, or on agreements reached between operators to provide overall better services like in the case of agreements between rail operators and taxis or car sharing providers serving rail stations. The impact on the efficiency of the transport system of public-private partnerships (PPPs), privatisations or liberalisation is uncertain according to most experts having participated in ORIGAMI workshops. Some claim that PPPs should reduce prices for the consumers, bring additional funding resources for transport investment and put less pressure on the public sector. Others claim that PPPs are just a mechanism to postpone the payment of the infrastructure by the public sector with much greater cost in the end, and that it transfers profits to the private sector while keeping risks for the public bodies.

Time is required to acquire enough evidence to draw sensible conclusions on the impact of liberalisation. It is necessary to contrast and compare approaches taken in various EU countries and various initiatives. However, it is clear that no single formula exists that can be applied across modes and territories in Europe. A good regulatory framework to transport sector liberalisation is necessary. For all these reasons, organisational arrangements are given a medium low transferability potential.

Segregation of freight and passenger traffic

4 solutions have been selected as examples of initiatives to segregate passenger and freight transport, or at least decreasing the volume of freight transport in infrastructures shared with general passenger transport. Freeing passenger transport networks from freight traffics can contribute to an overall increase of traffic safety and better traffic flows, especially in most

congested corridors. This family of solutions mostly considers the construction of dedicated roads and railways for freight, but also considers those initiatives aimed at transporting larger quantities of goods using a reduced number of trucks, e.g. the modular truck concept or road trains in Scandinavia. Large investments required for providing dedicated freight motorways or railways can only be socially profitable when transported freight volumes are very important and need to go through very congested transport infrastructure (e.g. to connect largest ports with leading economic regions throughout major metropolitan areas). Benefits of dedicated freight infrastructure are more likely to come from alleviated congestion in the passenger network (few minutes saved by millions of vehicles or passengers) rather than direct benefits for freight transport.

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

Ticketing schemes

10 solutions have been selected as examples of initiatives related to travel tickets or vouchers. The several examples are aimed at increasing the transparency and balance of transport fares across modes and territories, to allow passengers to travel on multiple means of transport using integrated tickets, or making it easier to purchase travel tickets e.g. via smart phone applications or in-vehicle sales booths. Initiatives aimed at providing more comprehensive fare structures on transport are expected to provide highly positive impacts for users. However, solutions like integrated ticketing may have substantial organisational complexity, proportional to the number of different operators involved. Complexity is likely to come from the system used to distribute costs and revenues of integrated systems. The cost of integrated ticketing can be considerable high for the public administrations. General orientations to integrated ticketing schemes and operations may be relatively easy to transfer across modes and territories, but specificities for each case are likely to be very important.

Legal frameworks may be complex and may require adjustment. Overall success of such systems will depend on the capacity to overcome such specificities. Ticketing solutions are granted a medium level of transferability.

Travel planners and user information

21 solutions have been selected as examples of initiatives aimed at increasing the quantity and quality of information provided to travellers, allowing them to do most adequate route choices when travelling. Information may be related to a single mode (e.g. rail schedules, terminal orientation) or to multiple modes (e.g. multimodal travel planners). Solutions allowing for multi-modal trip planning and ticket purchasing in Europe can have an important role in optimising passenger routes in the future. Providing real-time trip information in smart phones or car navigating systems that will change the suggested route in case of road

congestion or delayed public transport promotes increasingly accurate decision making in transport. As users are better informed about alternative route choices, they can optimise their trip itineraries saving time and money. Transport operators also benefit from this solution as they are able to easily sell tickets and facilitate user information using less human resources (employees), and can also make a profit from publicity appearing in the travel planner applications. The market is already spontaneously promoting these solutions without regulation or public support required. The social benefit of such solutions at EU level may seem rather marginal, but as costs are also low, the social profitability of these initiatives is likely to be positive.

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

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

Enhanced security and fee collecting procedures

14 solutions have been selected as examples of initiatives aimed at preventing the generation of cues in bottlenecks of the transport network generated by the need to undertake specific formalities such as security checks or transport fare payment. Most of the examples are aimed at making faster the security and check-in procedures at airports, the road toll payment, or the purchasing of public transport tickets.

For users, these solutions tend to improve service quality, provide travel time savings, increase transport comfort, and transport reliability. Most of the time, operators aim at keeping the system working efficiently to attract more users and save operating costs: for instance, increasingly automatic motorway tolls to prevent congestion and increase road demand; reducing delays caused by formalities at airports can make medium distance flights more competitive respect to rail. In other occasions, it may be the interest of the operator to keep passengers as long as possible within the transport system, e.g. to increase profit of retailing spaces at airports or to increase revenues from car parking. Public administrations are likely to seek transport solutions as efficient as possible. Solutions considered can easy be implemented all over Europe, and may also be easy to be transferred across different modes: security procedures from the air mode are starting to be applied to access high speed services at rail stations, and cue management at road tolls is comparatively similar to airport cue management at security controls, or cue management at urban traffic lights.

However, there may be legal obstacles in relation to privacy issues depending on the technologies used, like in the case cell phone tracking via blue tooth IDs. Transferability is estimated medium-high for these kinds of solutions.

Environmental management

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

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

No major legal obstacles may be expected. Intensive land occupation and visual intrusion may be some determinant drawbacks. Because of not having major technical obstacles or insurmountable social barriers to wide-spread application, and having a relatively high public sector interest, transferability is determined medium-high. However scores may differ widely from one solution to another.

Enhanced safety

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

Not all solutions may be equally interesting to transport operators despite benefits for users. However, public administrations are likely to be supportive of such solutions. Transferability across Europe is more likely to be easy when the approach is on a vehicle basis (e.g. eCall) than on infrastructure. Standardisation of technologies is a basic precondition for transferability. Transferability is to be expected high for those solutions with a market interest and providing high traveller benefits.

General assessment of transferability

Taking into consideration ORIGAMI transferability criteria the ranking of families can be provided (fig. 1) from the highest transferability level for travel planners and user information to missing links – megaproject representing the lowest transferability. It's also worthy noticed that in general technology and management types of solutions are quite easier to transfer than infrastructure and even management types of solutions.

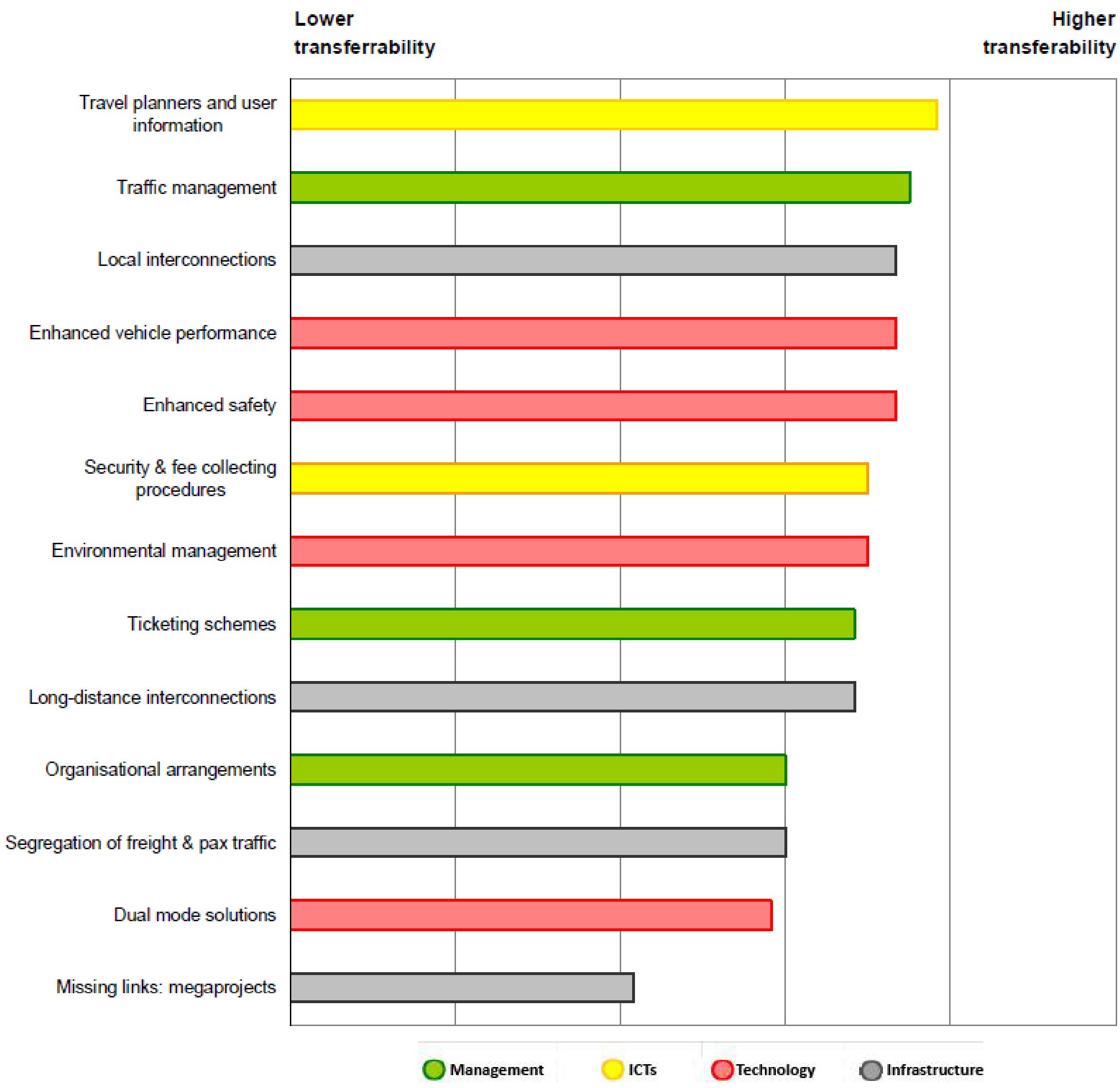

Figure 1 - General results of transferability evaluation of ORIGAMI families of solutions
Source: Ulied et al, 2013.

IMPLICATIONS FOR RESEARCH AND IMPLEMENTATION

The identification and classification of best practice examples allows for further investigation of gaps and bottlenecks and assessment of the future directions of research in long-distance passenger transport in the context of improving co- and intermodality. The evaluation of transferability provides a decision making tool for different groups of stakeholders, including policy makers and service providers. Both implementation and transferability of different solutions is conditioned on the several factors:

1. Availability of information, data for transport trends modelling, consistency of information and its precision.

2. Existence of gaps and bottlenecks preventing use of identified solutions.

3. Non-applicability of solutions due to the limited interest or lack of transferability potential.

From the above data gap has a prohibitive influence due its limiting impact on decision making process. Analysis of practical applications of proposed solutions in different European but also international settings shows that there is a significant data gap concerning the distance travelled by passengers. Without this information it is impossible to calculate trip length distributions and other aspects necessary to model intermodality. This shortcoming could be alleviated by innovative measures and technologies useful in the observation and data collection of passenger distance travelled which is achievable through satellite navigation systems, mobile phone technologies or simpler systems of electronic counting on board of vehicles. Another gap exists in regard to the knowledge base of user (passengers) needs requirements in various types of long-distance trips (business, tourism, education, other). This could be of course forecasted but first basic data should be collected depicting current situation. Currently this type of data is available only for selected locations which are often specific and therefore not transferable to other setups. Solution applicability in particular settings could be perceived from the perspective of transport systems and from the perspective of transport user. From neither side lack of data could be considered as single factor preventing its introduction into the transport system, but it makes prediction of future trends impossible. This in turn reinforces resistance against new technical solutions which are often perceived as expensive toys.

Uncertainty for decision makers results from lack of clear picture regarding user needs in the field of ICT’s. While in general users accept and welcome ICTs it is not clear which of them are most needed and most useful. As often the case with new technology which is main element of all ICT’s, its potential is not fully understood at first. Similarly usefulness of different solutions might change when the perspective changes from long to short distance travel. The company which was mainly local (e.g. city transport providers) while extending its operations to the region might face the problems of non-acceptance of some improvements. The relative importance of ICTs in different modes and in regard to different trip purpose (business vs. commuter, vs. leisure) is also not currently known.

Different set of problems results from gaps in existing co- and intermodality improvements or are created by bottlenecks resulting from features of particular setups in which solutions were developed making them non-transferable to different conditions. There are for instance physical barriers in introduction of ICTs. Major barrier could be deficiency of existing infrastructure. Especially interchanges might not be at the sufficient quality to enable innovative measures. Interoperability of different services is often very limited making impossible provision of information for long distance travellers, the presence of harmonised schedules of all modes available, common ticketing, etc. Significant problems are caused by lack of standardisation. It is widely acknowledged that standardisation and interoperability requirements, including international level, will help to avoid technological fragmentation and enable businesses to fully benefit from the entire transport market, and to create worldwide market opportunities. The lack of common solutions hampers transferability of certain solutions to different markets. It shows through the absence of business models incorporating intermodal solutions, intermodal co-operation and business plans. Yet another issue is a gap between research and practice. There are certain theoretically researched solutions and yet there are no real life applications. This gap cannot be bridged by research only, real life tests of proposed applications have to be conducted in order to determine their actual usefulness. Another barrier to transferability of solutions is that at least in part they could be seen as enforcements going against free market principle. This applies especially to those ideas which while improving intermodality institute environment protection tools like taxation or fiscal policies to promote greener travel options.

Current practice and research allows for addressing the problem of gaps in the area of solutions applicability. Those could be distinguished taking into consideration stakeholders acceptability and enabling role of adequate technology. Different stakeholders groups have varied interests in improving intermodality and interoperability of transport systems. Transport user are those who might potentially benefit most as they tend to obtain the benefits of a transport project not included in the cash flows: travel time savings, safety and comfort improvements, reliability. The problem is that user groups seldom could vocalize their needs and demands as to the quality and modernity of transport system. In this situation user's interests should be mostly defended by the public administrations, local governments, trade unions, and neighbourhood associations. Yet there is a contradictory tendency of governments to look at their own financial interests. Ideally this should not detract from their ultimate goal, which is to promote the interests of society at large. But there is always a problem of justification of required expenditure for a project. For those reasons it is regulator who often becomes most important player in the transport system as it is an enabler of a solution being implemented in a certain context or not. A different regulatory framework might make a solution extremely difficult or too expensive to be implemented in a different context. From the operator point of view it is a matter of acquiring competitive advantage. Competing operators will try to obtain the best deal from any new investment. Operators may have interest in implementing a new solution when it tends to reduce the costs of transport or when it creates new business opportunities and will expect new solutions not to bring in additional organisational difficulties. But if there are no immediate and certain benefits operators will be rather reluctant to introduce new solutions. Especially those which require radical change of conduct, new procedures or which are simply expensive will most likely be rejected. Non-users are essentially affected by externalities, notably environmental and social. These are not easy to quantify but can have an important weight in decision-making.

The technological dimension is another crucial issue for generalisation of a certain solution. Ad hoc solutions are hard to transfer onto contexts different than those where originally planned, regardless of their technical virtuosity. Even when some solutions are of easy application onto diverse geographic contexts, they might still prove to be specifically mode-based. There are multiple possible technology based solutions which are either being currently researched or prototypes are under tests like: people movers, urban electric cars, dual mode technologies (e.g. electric cars on monorails or new kinds of electric bicycles), ultra compact electric vehicles, autonomous vehicle technologies, use of wind to propel vehicles, PRT systems to link air, rail and road and sea. The problem with those modern technologies is that they require modern transport and supporting infrastructure which is usually found only in big urbanized centres. Alternative to the technology is to concentrate on opposite – less technically advanced solutions which are already very well known but have been until recently virtually neglected. This could take form of supporting slow modes (walking and cycling); widening bike rental facilities in big cities, yet again those tools address mostly city inhabitants needs neglecting rural areas.

Taking all above into consideration the limits for inter and co-modality solutions could be summarised as in Table 3.

Table 3 - Barriers for inter and co-modality solutions development

Stakeholder	Major identified problems
Users / Travellers	Lack of full realisation of possible benefits Unspecified user needs Difficult measurement of benefits for the users
Operators	Benefits to operators delayed Difficult to measure benefits Necessity to change conduct
Government	High expenditure Cost-benefits unclear
Regulators	Optimisation of required regulatory framework needed while regulation will deal often with “new territory” – innovative solutions which impacts are not known.
Technology	Lack of technical infrastructure Non-transferability of solutions Lack of technical capacity
Non-users	Externalities, mainly environmental impacts.

Source: Own elaboration.

CONCLUSIONS

The relevance of particular groups of problems leads to definition of major future research needs. Primary delimiter is actual interest of stakeholders. Practical implementation of improved co- and intermodality solutions requires cooperation of different stakeholders. This are after all stakeholder decisions which make particular innovation viable or not. Within ORIGAMI project certain barriers have been researched which pose a threat to improving intermodal or co-modal measures. As a result certain prerequisites were identified in areas of data collection, impacts and applicability.

The first area provides necessary information to operators on user needs and determines economic validity of the given tools. Impacts address possible consequences of various ICT solutions. Those are mostly not known at present and could be only vaguely envisaged. Further clarification of potential non-direct effects on business, users and transport system need to be clarified. Third area deals with preconditions for implementation. Within ORIGAMI stakeholders were asked to indicate their stance on major issues envisaged in each of those three areas. Summary of their interest is presented in table 4.

Table 4 - Prioritisation of important factors in co- and intermodal solutions implementation

Problem area	Core criteria	Additional criteria (1-hig, 2 – medium, 3 – low)		
	Interest for stakeholders	Costs of research	Funding opportunities	Feasibility
Improvement of statistics for distance travelled by passengers by using innovative measures and technologies in observation and data collection	low	1	2	2
Better information on relative importance of user needs for long vs. short distance journeys	low	2	2	3
Better knowledge of user needs and preferences in various types of long-distance trips (business, tourism, education, other)	low	1	2	2
Evidence related to the relevance of some user needs for some individual transport modes (e.g. ferries, metro/underground systems)	low	2	2	3
Centrally collected and automatically updated data on the number of annual ferry crossings and ferry passengers for all European sea crossings (or even better month by month data)	low	2	2	3
Common framework for intermodal data collection (including development of ITS-ICT applications improving data collection) and implementation of integrated platforms that allow data to be shared	moderate	1	2	3

between different types of ITS or technological applications implemented within the same geographical area				
Technology driven solutions which are most likely to improve future transport	high	1	3	1-3
Introduction of less technology intensive modes	moderate	3	2	3
Methods for optimisation of existing services	high	3	2	3
Enforcement of the shift towards more sustainable transport	moderate	3	2	1
Alternative fuels to reduce negative transport impacts without need to significantly change user behaviours	low	1	1	1
Optimisation through coordination of modes and provision of co-operative framework among stakeholders	low	2	2	2
Identification, measuring and assessment of wide benefits for travellers/users.	high	1	1	1
Assessment methods of relationship between extent of benefits to operators and difficulties to implement individual solution.	moderate	2	3	3
Measuring the set of benefited users in relation to the cost of the solution.	high	3	2	1
Creation of a proper regulatory framework to implement an individual solution	moderate	3	3	3
Identification, measuring and assessment of any externalities or/and side effects linked to the solution affecting third parties.	low	2	3	2
Assessment to what extent can the solution be implemented in other geographic contexts or in other modes	moderate	2	2	2

Source: Bak et al, 2013.

The stakeholder consultation clearly shows where major interest of those concerned with co- and intermodality improvement lies. Firstly they point at technology driven solutions as primary moving force behind improvement of future transport, at the same time they prefer less technology intensive solutions. ICT's are considered as having significant value added as they are perceived as optimisers of entire existing network and not only segmented solution by themselves. There is a high awareness of need to address environmental issues with enforcement of the shift towards more sustainable transport introduction of alternative fuels. But this in turn is handicapped by lack of major technical breakthrough in regard to alternative fuels. Secondly an importance of cooperation among different stakeholders is stressed but yet again this is countered by shown reluctance of transport service providers who like to protect their independence. Organisational improvements in transport based on optimisation of existing services also score highly as they are considered by stakeholders as cheap efficiency optimizers. The enforcement measures are likely to face significant social resistance resulting in rather low feasibility while introduction of less technology intensive modes seems attractive but its real potential remains unknown. It is doubtful if slow modes like cycling could replace mass transit systems.

From the practical standpoint important issue is real cost and benefit of any solution. The question how to identify, measure and assess wider economic benefits of improvements remains open. Difficulties are known or at least predictable but benefits are only envisaged. As most solutions utilize new technologies their true impacts are unknown. Besides not only scale of potential benefits is undetected but also who will be beneficiary is not fully clear. The aim of ICTs is to improve user situation, but operators must also benefit if they are to willingly participate in this scheme. Than the question of externalities affecting third parties has to be brought into open.

Finally there are implementation concerns with one question outstanding – whether the solutions developed in one environment are easily transferable to different settings? Research into all those open questions will allow for co- and intermodal improvements in transport system to become common and to spread. Preliminary research shows great potential in them for society as a whole and for individual entities involved in transport markets. But also have a potential to activate wider economic benefits.

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