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TOWARDS SEAMLESS PASSENGER TRANSPORT: PERFORMANCE OF INTERMODAL APPROACHES

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ABSTRACT

The growing demand for mobility in general and for air transport in particular puts increasing pressure on today's transportation providers. Supplying sufficient capacity, hence alleviating potential congestion of the entire system, and ensuring seamless and efficient operation of the overall transport system are two of the main challenges for the future. The integration of transport modes along the entire passenger journey can help to streamline the current system and, thus, increase existing capacities as well as passenger comfort level. Today, there are already some approaches in place that interlink different transport modes by providing single ticketing, or specially dedicated interchange platforms. Four such intermodal transport models are assessed within this paper. For this purpose, a set of key performance indicators is developed and applied to evaluate the intermodal transport performance of each concept. Aspects such as journey time and costs as well as baggage through-handling are considered and data for each concept acquired. Based on the evaluation, the AIRail concept is ranked highest since it best meets the criteria of a seamless passenger journey. However, the results show that there is potential for improvement within each investigated concept.

KEYWORDS

Intermodal Passenger Transport; Key Performance Indicators; Benchmarking; Intermodal Approaches; Quantitative Assessment; Performance Assessment.

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1. INTRODUCTION

The air transport system faces great challenges in the future. Capacity shortages within the transport system, for example at airports, complicate the provision of fast door-to-door travel. Passengers complain about time-consuming and inconvenient connections during airport access. In order to enhance and optimize the current transport system, the European Commission, therefore, defined ambitious goals for the air transport system within the Flightpath 2050 document. One of these goals states that 90 per cent of European passengers should be able to complete their door-to-door journey in Europe within four hours (European Commission, 2011). Building on this vision, the Strategic Research and Innovation Agenda (ACARE, 2012) outlines requirements for a seamless intermodal passenger journey in more detail and highlights areas which yield optimization potential towards the four hour door-to-door goal. To this end, the overall passenger journey can be broken down into several process steps, each demonstrating different potential for efficiency improvement.

Passengers access the airport via different transport modes (public transport, private car, taxi etc.). The respective level of connectivity in terms of quantity and quality supplied shapes passenger behaviour and travel times. Furthermore, arrival times differ by passenger type. Leisure passengers, for example, allow more time for airport access and arrive early at the airport since they incorporate potential delays in public transportation or during airport processes in their planning. Business passengers, on the contrary, who are often frequent travellers, are more accustomed to travel related processes and can, hence, anticipate travel process duration more accurately. At Munich Airport, for example, more than 60 per cent of leisure passengers arrive at least 90 minutes prior to departure compared to only about 32 per cent of business travellers. About 35 per cent of the latter arrive 30 to 60 minutes before their flight (Munich Airport, 2010). When investigating overall journey times, the flight time is an important factor to be considered. An analysis of the distribution of the stage length of European flights to the overall travel time shows that about 35 per cent of intra-European flights cover a distance up to 500 kilometres (OAG, 2012) which corresponds to a block time of about 70 minutes. Another 33 per cent of flights take place up to 1000 kilometres and have a respective block time of 105 minutes. In regard to the four hour door-to-door goal and the current distance distribution for intra-European flights, a large share of passengers already spends between 30 per cent and 44 per cent of these four hours in the aircraft.

Since passengers spend a high amount of their overall journey in waiting for or interchange between the different modes of transportation, there is optimization potential in increasing the efficiency of modal interchange and reducing passenger waiting as well as queuing times. This paper introduces an assessment framework with the purpose to better understand how intermodal approaches can improve the passenger journey and to identify gaps impeding the provision of a seamless intermodal journey. For this purpose, a set of key performance indicators is developed (section 2) which are then applied to investigate the performance of four different intermodal concepts already in place (section 3). The results are presented and discussed in section 4.

2. KEY PERFORMANCE INDICATORS AND INTERMODAL APPROACHES BENCHMARKING

The key performance indicators, defined within this section, are based on the SRIA (2012) goals in regard to intermodal performance, a stakeholder analysis concerning respective requirements (Urban et al., 2014) as well as studies in the field of intermodal applications for seamless passenger travel (e.g. ORIGAMI 2013, KITE 2007). Table 1 depicts the set of key performance indicators used for the analysis. Each indicator is assigned to high-level assessment parameters (left column). The data for all metrics, outlined in the third column, is collected for each of the four intermodal approaches.

Table 1: Indicator set for the analysis of seamless intermodal transport

High-level assessment parameters	Key performance indicators (KPI)	Metrics
Joint booking and ticketing	– Booking of entire journey via a single platform or contact point	– Yes/no
	– Availability of single ticketing	– Yes/no
	– Availability of different ticket types, e.g. digital, print	– Score
Liability issues	– Availability of single contact point for information and complaints	– (0) no, (1) partly, (2) yes
	– Availability of delay compensation	– Ticket price/ delay of journey time
	– Responsibility across transport chain	– (0) mode-specific, (1) partly bundling of modes, (2) single point

Predictability of passenger journey	– Information about expected delays – Provision of faster alternative routes – Information about baggage location – Information about additional transport-related services and products	– (0) no, (1) mode-specific inform., (2) single information platform – Same as above – Same as above – Same as above
Integrated journey planning	– Planning tool including all available journeys – Comparison of price and time for available alternatives – Planning via different devices/distribution channels	– (0) mode-specific, (1) partly bundling of modes, (2) single point – (0) no comparison, (1) only for one variable (2) for both variables – Available channels/ possible channels
Journey time and costs	– Price of different alternatives considered in the analysis – Travel time along the journey – Number of interchanges along the journey – Interchange time between journeys	– Price (in €) – Minutes – Number of interchanges – Minutes
Quality of physical platform for interchange between modes	– Number of level changes between modes – Wayfinding aids between modes – Distance between physical infrastructure of different transport modes	– Number of level changes – (0) none, (1) mode-specific, (2) integrated wayfinding – Metres
Baggage through-handling	– Luggage transfer without passenger involvement – Cost of baggage through handling – Number of alternatives available for baggage handling	– (0) passenger responsibility, (1) rail station/ car parking/ bus stop, (2) city station, (3) door to aircraft handling – Price (in €) – Score

Based on the data collected, the approaches are ranked on a scale from 0 to 4 for each metric. The best performing approach(es) receive(s) a value of 4 and the worst performing approach(es) receive(s) a value of 1.

Table 2: Example benchmarking of KPI "Price of different alternatives"

Intermodal approach	Price of different alternatives considered in the analysis (in €)	Ranking
AIRail	50	3
SkyFerry	60	2
Bus&Fly	70	1
CarSharing	40	4

In the example in Table 2, which concerns the ticket price of different alternatives (exemplary values), the CarSharing alternative has the lowest price with 40 Euros and the Bus&Fly alternative has the highest price with 70 Euros. Therefore, these approaches receive the scores 4 and 1, respectively. For some of the intermodal approaches no data is available for certain key performance indicators. In this case, a value of 0 is assigned and the specific metric is not further considered in the evaluation. Subsequently, the scores for all metrics are merged in an overall assessment.

3. SELECTED INTERMODAL APPROACHES AND AIRPORTS

Four currently operated approaches are selected for application and validation of the key performance indicators. These concepts include air transport and another different transport mode. Moreover, they provide first indications on the current status of implemented intermodal transport solutions. Table 3 summarizes the considered approaches and respective characteristics which will be evaluated in the following section. Each approach has been structured according to pre-defined characteristics such as involved operators or the ticketing process to ensure the comparability in the subsequent assessment. In the following paragraphs, a short overview for each approach is provided.

Table 3: Overview of selected intermodal approaches
Source: Urban et al. 2014

Approaches / *Characteristics*	**AIRail**	**SkyPier Ferry Transfer**	**Bus&Fly**	**CarSharing**
Modes involved	air, rail	air, sea (boat)	air, road (bus)	air, road (car)
Operator(s)	Deutsche Lufthansa, Deutsche Bahn, Fraport	Hong Kong Int. Airport, various airlines, ferry operator	Iberia, Alsa, Avanza	DriveNow, Car2Go, Munich Airport
Price incl. air fare	train trip included: one ticket, one price	separate price for ferry and flight	bus trip included: one ticket, one price	separate price for car sharing service and flight
Ticketing process	integrated ticketing and booking available	separate tickets, flight ticket mandatory for ferry	integrated ticketing and booking available	car sharing offer independent from flight ticket
Baggage handling	no through-handling available; check-in at airport	upstream check-in possible at selected ports for selected airlines	no through-handling available; check-in at airport	no through-handling available; check-in at airport
Physical inter-change platform	AIRail Terminal incl. check-in and baggage drop-off	Dedicated SkyPier at Hong Kong Int. Airport	Check-in and baggage drop-off at Iberia Terminal (T4) at Madrid (MAD)	Dedicated parking space between two airport terminals
Connection frequencies	2-13 connections per day (depending on route)	ferry shuttle every 1-1.5 hrs each day, not coordinated with flight plan	2-4 connections per day (depending on route)	individual scheduling dependent on car availability

The AIRail approach represents a potential solution for a smooth intermodal cooperation along the transport modes rail and air. It is based upon the cooperation between Deutsche Bahn, Fraport and Deutsche Lufthansa. Fraport provides the infrastructure at Frankfurt International Airport connecting the train platform with the airport gate. Deutsche Lufthansa purchases entire carriages on trains of Deutsche Bahn. One key characteristic of the approach is the integrated ticketing and booking option which allows passengers to travel with only one ticket. Furthermore, train connections to and from the airport are treated like actual flights in the schedule of Lufthansa and intermodal connections are guaranteed. Thus, the passenger has only one focal point providing journey-related information and being responsible for cancellation or delay issues.

Air and maritime transport means are combined within the SkyFerry approach at Hong Kong International Airport. SkyFerry offers a connection from several ports in the Pearl River Delta to the airport via small boat ferries. A baggage service is offered at selected ports. The ferry shuttles operate with high frequencies but independent from flight schedules. However, the passengers need a separate ticket for the ferry transport which is exclusively sold to passengers holding a valid flight ticket.

An approach, which links road and air transport, is operated by Iberia in cooperation with the two bus companies ALSA and Avanza. Similar to the AIRail approach, Bus&Fly includes a selected set of cities and locations in the geographical area surrounding Madrid airport and provides bus connections aligned with the Iberia flight schedule. The approach enables integrated ticketing and booking for the entire journey as well as the provision of delay management and guaranteed connections.

Another type of intermodal airport connection is offered by the two car sharing providers DriveNow and Car2Go in cooperation with Munich Airport. Passengers can book cars in advance, use the reserved car for the individual travel to the airport and then park the car in a dedicated parking space for car sharing vehicles close to the terminal. The car sharing service differs from public transport in terms of individuality. The passenger can book his journey at any time and is not restricted by the schedule of public transport. The passenger has to manage the journey to the airport independently and the service requires separate payment and ticketing.

4. ASSESSMENT RESULTS

This section discusses the results from the quantitative assessment of the performance of the four selected intermodal transport approaches in detail, applying the key performance indicator set outlined in Table 1. The combination of the findings for each indicator yields a high-level comparison in terms of intermodal performance as shown in Figure 1.

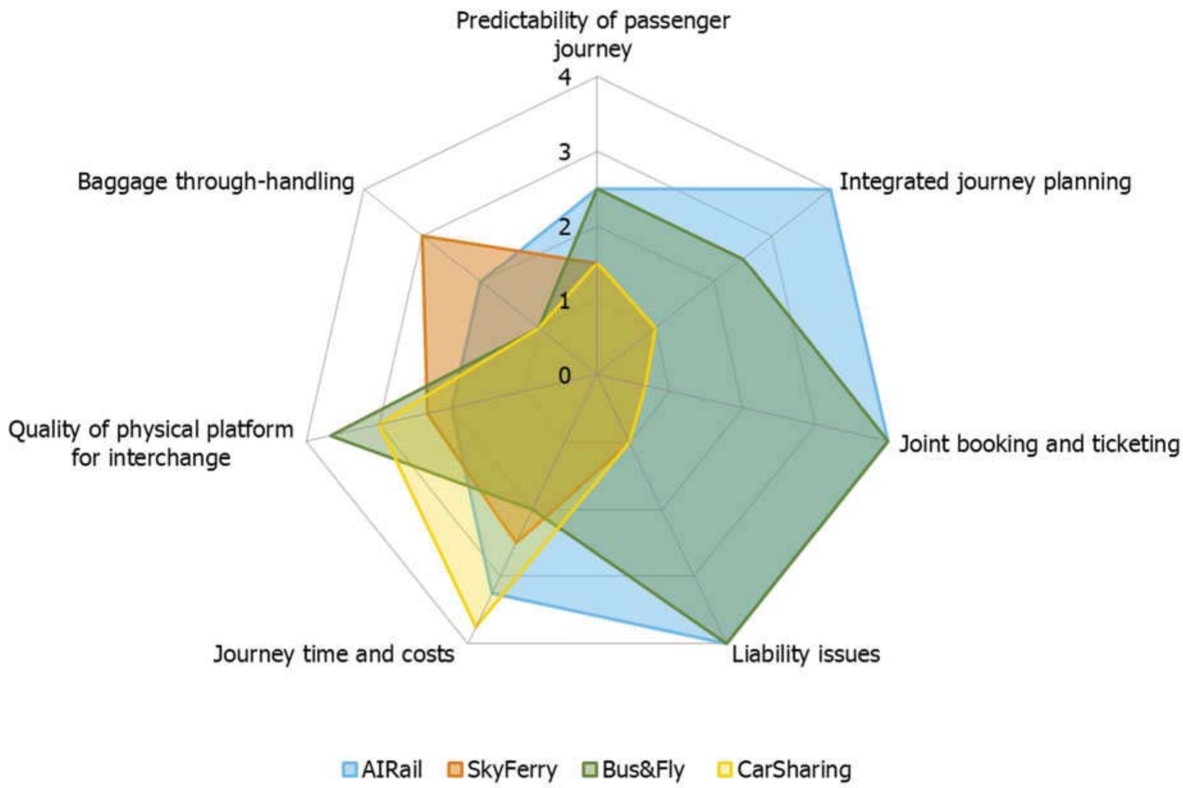

Figure 1: Assessment results for intermodal approaches

The results show that the AIRail approach is the best performing intermodal approach out of the four selected ones with an overall ranking of 67 per cent of the maximum attainable score of 100 per cent, i.e. the concept achieved 62 points out of a maximum of 92 points. However, each of the approaches has different strengths and weaknesses (see Figure 1). In the category "baggage through-handling" AIRail receives a lower score than the SkyFerry approach and in the category "quality of physical platform for interchange" the AIRail approach performs worst. This is due to long walking distances and a high number of required level changes between the rail stop and airport terminal. The Bus&Fly approach receives an overall score of 61 per cent, the SkyFerry 41 per cent and the CarSharing 40 per cent out of potential total points. On a more detailed level, the parameter "quality of physical platform for interchange between modes", for example, is made up of three different key performance indicators (Figure 2):

- The number of level changes a passenger has to conduct to change between modes
- The availability of wayfinding aids across modes

- The distance between the physical infrastructures of involved transport modes.

For each aspect, data is collected and the approaches are rated accordingly (as described in section 2). Regarding the number of level changes, the Bus&Fly approach performs best, and receives a score of 4, since the bus arrives on the same level as the flight departure area. The AIRail approach performs worst since passengers have to overcome the highest amount of level changes, as outlined above. Furthermore, within all approaches there are mode-specific wayfinding aids and no uniformity across transport modes. Overall, the best performing approach in terms of "quality of the physical interchange platform between modes" is the Bus&Fly approach.

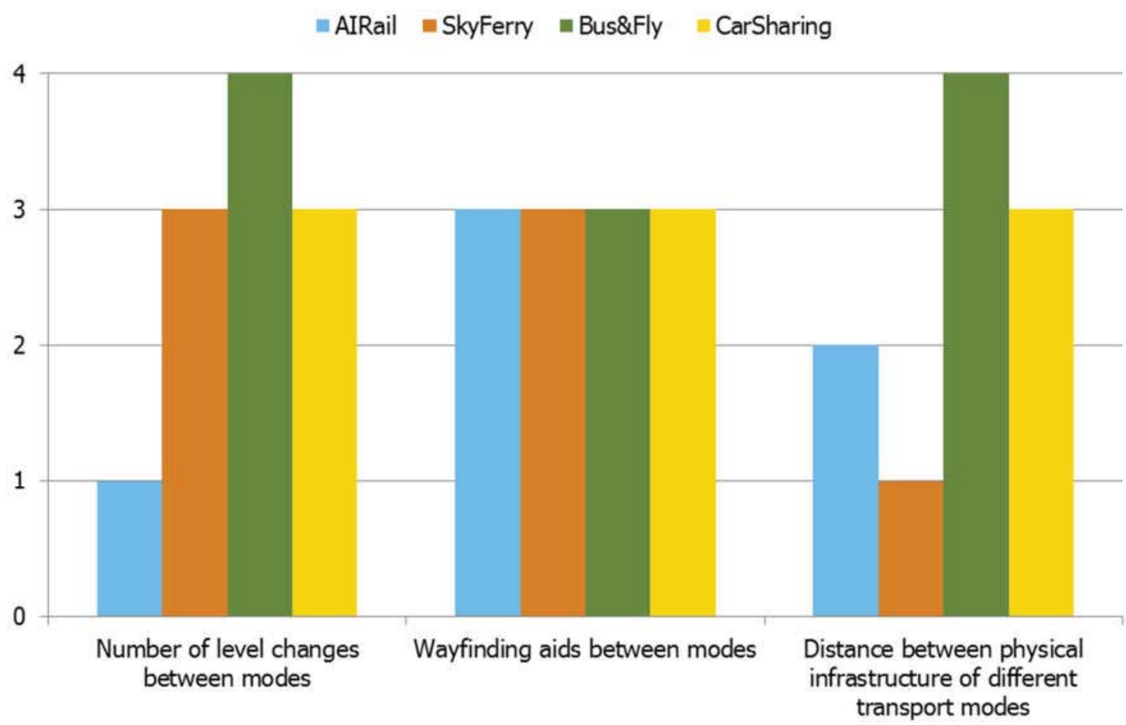

Figure 2: Benchmarking results "Quality of physical platform"

Figure 3 addresses the high-level parameter "journey time and costs" and includes the key performance indicators:

- Price of different alternatives considered in the analysis
- Travel time along the journey
- Interchange time between journeys.

The total costs consist of the actual price, i.e. the flight price and costs for public transportation, and travel time. Travel time is made up of the actual time in a vehicle as well as the time allocated for the interchange and waiting times between different transport modes. In order to obtain values in the same measuring unit, the travel time values are monetized using the general value of travel time for passengers, published by Eurocontrol (2013), with an average of EUR 27 for both leisure and business travellers. These travel time related costs are added to the ticket price for each journey (Figure 3). The actual ticket price has been extracted for a specific short-haul connection from each of the airports, i.e. the cheapest ticket on a specific day (November 10, 2014) has been selected.

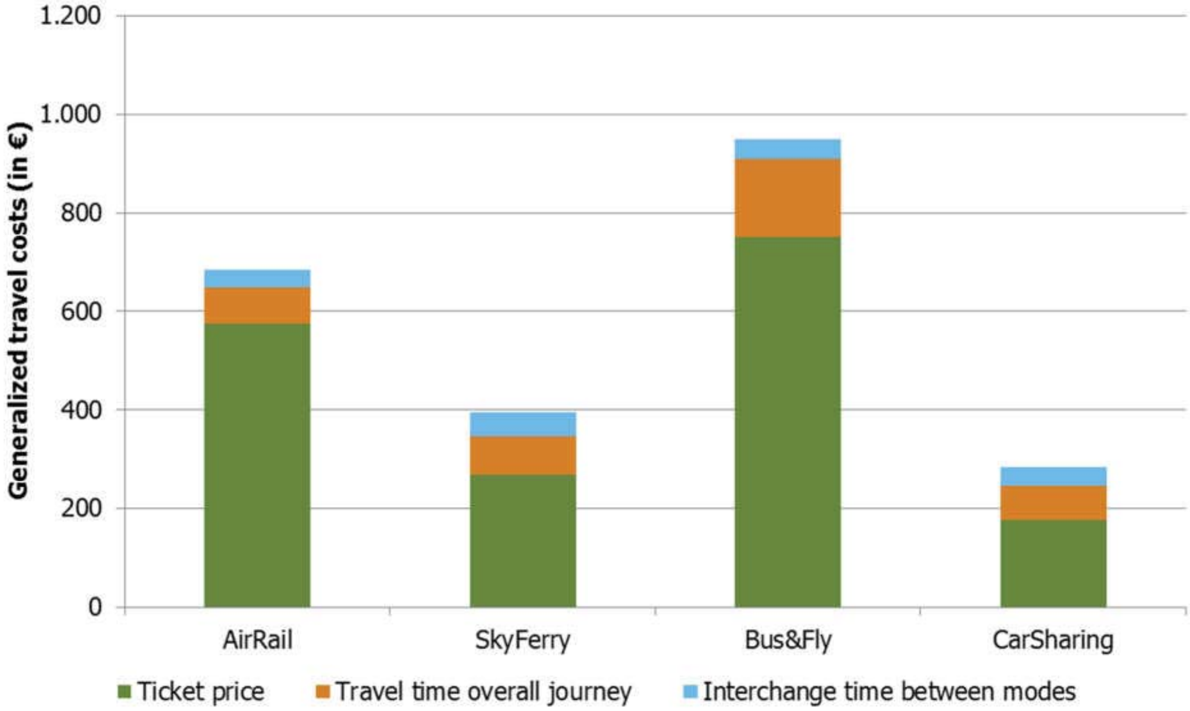

Figure 3: Generalized travel costs for intermodal approaches (short-haul) (reference day: Nov 10, 2014)

For the European intermodal approaches, London Heathrow (LHR) has been selected as short-haul destination, resulting in the routes Madrid Airport (MAD) – LHR (Bus&Fly), Frankfurt Airport (FRA) – LHR (AIRail) and Munich Airport (MUC) – LHR (CarSharing). For Hong Kong Airport, Manila has been selected as short-haul destination since it provides an equivalent to the short-haul routes in Europe. Taking the average generalized travel costs for each approach, the CarSharing approach performs best in this category, and the Bus&Fly offer is the most expensive one, both in regard to ticket price (one-way) and to overall travel time.

5. CONCLUSION AND FUTURE WORK

The paper introduced a quantitative assessment approach including key performance indicators with respective metrics to measure the intermodal performance of four different intermodal concepts currently in place. The AIRail concept yields the best performance, followed by the Bus&Fly and SkyFerry concepts. The CarSharing approach revealed most drawbacks in regard to intermodal performance and, therefore, ranks last. This assessment approach and results yield a feasible guidance for decision makers in regard to identifying intermodal improvement potential as well as enablers that contribute to the realization of a four hour door-to-door journey for passengers.

These include the establishment of a common platform for data transfer and exchange which requires the involvement of stakeholders from other industries than the transport sector, e.g. providers of data exchange platforms that deliver respective capabilities across all involved transport modes. Data exchange is a necessary prerequisite for passenger comfort, e.g. real-time information provision and ability to react to schedule changes during the journey, as well as for an improved communication among different transport mode operators. Incentives have to be designed for stakeholders, both from the transport industry and other sectors contributing additional expertise, to engage in new approaches. This includes a detailed analysis of the cost and revenue allocation scheme as well as liability aspects across interest groups. If responsibilities and benefits are not clearly defined certain stakeholders will not engage in intermodal solutions. Therefore, it is recommended to conduct a detailed analysis of different stakeholder business models, the regional focus and market segment addressed by their operation, and the passenger groups which are targeted at. A regional train company, for example, might not be interested in investing in infrastructure, technological services and facilities to ensure smooth and hassle-free interchanges between rail and air since its business focus is on a particular region and the respective origin and destination transport. A detailed market analysis also facilitates the establishment of harmonized intermodal framework conditions and a feasible incentive structure for different providers. Other important areas are the improvement of the quality of interchange between transport modes for passengers. This includes the provision of real-time and accurate information along the entire journey, optimization of schedules to reduce passenger waiting times including suggestions for schedule alignment in case of delays as well as the provision of a physical connection platform.

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