Air-Rail Inter-modality From Passenger Perspective

Antonia Cokasova
EUROCONTROL Research & Development Center
BP15, 91220 Bretigny, FRANCE
antonia.cokasova@eurocontrol.int

Abstract

Inter-modal transport is not a phenomenon of the latest science. Many passengers are switching between different transport modes for decades, while undertaking one continuous journey, mainly because they have no other choice. So why is air-rail inter-modality becoming a hot issue now? The answer is rather complex and relates to many parties – a substitution for short haul flights that works towards passenger satisfaction and reduces time spent by travel is not only wanted but much needed. Aviation world does not have an infinite capacity to absorb new traffic. A capacity constraint of airspace and airports is becoming visible more than ever before. Only High Speed Train (HST) has a commercial speed that makes it possible to compete with air services on short hauls in terms of journey time.

"Inter-modality from passenger perspective" investigates a basic physical retroaction – how to make inter-modality work towards passenger satisfaction, so passengers can work for us – using High Speed Train instead of short haul flights, thereby releasing ATM and airport capacity. The paper presents preliminary results of the study analyzing key travel attributes that influence passenger's choice when it comes to traveling, Passenger sensitivity to these travel attributes is closely examined for better understanding of transport choice process. Based on the travel variables and passengers' sensitivity to these variables a decision making model is introduced and applied for two significant European origin destination pairs.

The study is focusing on passengers' expectations and needs, putting political and operational issues aside. Passengers in the spotlights is our watch-ward.

1. Introduction

A frustrated air passenger impatiently glancing at the timetable, disappointed by 'flight delayed' notice is not an unusual scene at any airport. How far can the situation evolve, - into few hours of delay? Perhaps even flight cancellation? Has anybody asked a delayed passenger after missing a connection flight, how much is the latest ATM system & technology worth to him?

Passengers are requesting fast, efficient and in many cases, environmentally friendly transport connections. Considering the recent situation in aviation, this requirement is very hard to fulfill, especially because of rising delays and congested airspace and airports.

Travel distances in Europe are shorter. For many significant origin destination pairs, transfer via a hub incurs too great a time penalty [1]. Replacement of direct flights by indirect flights via hub airports has resulted in a reduction in the average size of aircraft, since airlines prefer to run more frequent flights rather than have a more limited schedule using larger aircraft. Unfortunately, not only does this cause congestion on the ground; it also means that far more effort is necessary to control all the aircraft trying to use a limited amount of space [2].

As air traffic is concentrated at hub airports, constraints come up, such as long walking distances and delays [2]. Passengers must wait at the hub airports for the connection flight, mostly longer than it would be necessary, since the flight co-ordination is less efficient and minimum connecting time is higher, especially at main hubs like Paris CDG and London Heathrow. Large airports have longer waiting times than the smaller airports (Frankfurt Main, Amsterdam Schiphol), even though one would expect shorter waiting times given the higher frequencies of services [3].

Passengers would benefit from the fact that it wouldn't be necessary to make a detour via the hub airport implying an extra stop, since HST can operate between cities with secondary airports as well. Most cities' rail stations are located in the city center, while most airports are in the cities' outskirts which gives HST the advantage when comparing city center to city center travel time [4]. It is important to remember that, almost regardless of any other advantages in shifting traffic from air to rail, it is the travel time feature that would determine the scale of any likely shift. In the case of air travel passengers spend at least 3 hours by traveling to the airport, walking and waiting at the airport. Traveling by rail the time spent reduces to 1 hour 10 min. Even if the time spent on train is much longer than the time spent in the air, under a certain distance the total journey time is shorter if the journey is undertaken by rail. The time spent by each transport mode and the average speed of each mode indicates that high-speed trains could replace flights of up to 750 km's.

One might think there is not much to discuss, transport choices are given, distance limits are set, following the logic passengers will choose the fastest transport, - a hasty conclusion build on rationale of time saving. But there is much more to a journey than a simple equation of time, distance and speed. There is baggage to be transferred, tickets to be exchanged, quality of interconnection points, there is passenger comfort and many other factors, becoming crucial when it comes to traveling.

2. Distance and time limit

The question arising is up to what distance can high-speed train be considered as an efficient substitution to short haul flights? Most studies talk about distance between 500-800 km's [1][4][5][6][7], very much depending on passengers' sensitivity to different travel factors. But what if we are not familiar with the demand market, we don't know what kind of passengers we are dealing with, neither what are their needs and priorities.

Passengers traveling by air have to consider fixed time blocks, respecting their duration, mostly set by air transport. One of the major disadvantages of air transport to rail is the check-in time, asking the passengers to be at the airport much sooner before the actual flight. In general, it is one hour for economy travelers and about 40 min for business travelers, depending on the amount of luggage as well.

Passenger has to consider the time spent to reach the airport, which is in many cases significantly longer than reaching a train station. Airports are moving further and further from the cities they serve, reflecting that airports are not good neighbors, with noise and pollution being among the problems. But the move brings more problems – notably that of access. Different cities have different public transport and road networks. The time needed to reach an airport can be anywhere between 40 to 120 min in extreme cases (Paris CDG). In the case where road access is being used, this lack of predictability means that passengers generally have to plan for the 'worst-case' often leading to excessive waiting time in the airport prior to departure. On the other hand, for rail transport, a city center with rail station can typically be reached within 30 to 90 min at the most.

Another fixed block to be respected by passengers is the time necessary to unload the baggage after landing, also the time required for passport check & customs, which will never be less than 20 minutes and in some cases, considerably more.

It is interesting to see the duration of "wasted" time at the airport or station. The following graphic shows the total "wasted" time when traveling, although it is not applicable in all cases.

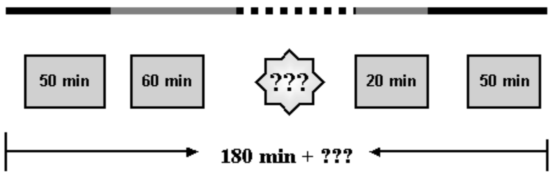

Figure 1. Travel time by air

50 min ... Transport to Airport
60 min ... Time spent at the Airport (check-in, boarding)
??? ... Flight time is variable
20 min ... Awaiting for the baggage, customs + passport check
50 min ... Transport from Airport

The total time "wasted" when traveling by air is at least 3 hours. Considering that 50 minutes for transport to/from the airport is a very optimistic estimation, for the most cases the number is even higher, especially for public transport.

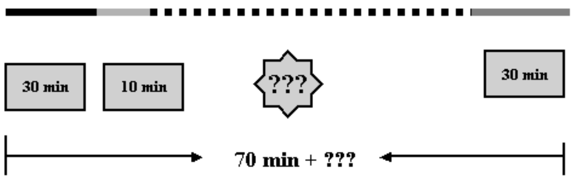

Figure 2. Travel time by rail

30 min ... Transport to Station (town center)
10 min ... Time spent at the Station (check-in, boarding)
??? ... Travel time is variable
30 min ... Transport from Station

The amount of time "wasted" when traveling by rail is about 70 minutes. As already mentioned this estimation can vary depending on many factors, does the passenger have a baggage to check-in, how far is he living from the airport, is the flight domestic or international and so on. Traveling by air the passenger can waste up to 200 min, and by rail transport up to 110 min

	Suburb 40 min	Center 80 min	Distant 120 min
Short Check-in No Baggage 30 + 10 min	80 min	120 min	160 min
Short Check-in Baggage 30 + 20 min	90 min	130 min	170 min
Longer Check-in No Baggage 40 + 10 min	90 min	130 min	170 min
Longer Check-in Baggage 40 + 20 min	100 min	140 min	180 min
Long Check-in No Baggage 60 + 10 min	110 min	150 min	190 min
Long Check-in Baggage 60 +20 min	120 min	160 min	200 min

Figure 3. Air Transport - Check-in and travel time to airport

	Suburb 30 min	Center 60 min	Distant 90 min
Short Check-in 10 min	40 min	70 min	100 min
Long Check-in 20 min	50 min	80 min	110 min

Figure 4. Rail Transport – Check-in and travel time to station

Examples show that HST competes with air services on 300-600 km distance. The breakdown of rail passengers decreases as distance growth.

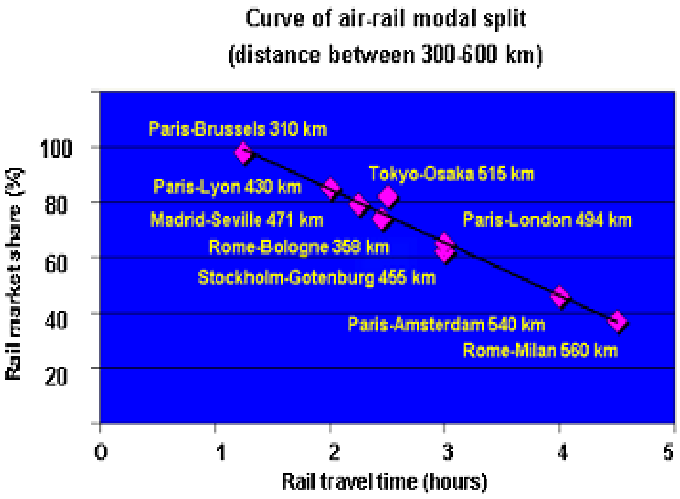

Figure 5. Air/rail modal split [8]

To answer the question about the efficient time/distance substitution we need to set an average plane/train speed.

Aircraft speed = 800 km/hour
Train speed = 270 km/hour
distance 750 km

"Wasted time" + Journey time
= Total time traveled

by air: 180 min + 56 min = 236 min
= 3 hours 56 min
by train: 70 min + 166 min = 236 min

According to simple equation, 56 min of flight time is the upper limit, any flight under this time limit will last longer by plane than by train. If aircraft flying less than 56 min is replaced by train, the total time traveled will be exactly the same. In terms of distance the limit is 750 km's. Any distance traveled under 750 km's has a shorter duration if traveled by train. Although this distance is considered to be a short-haul in the aviation business, in Europe the catchment's area of 750 km's can connect significant origin destination pairs.

3. Passengers' expectations

Even if demand is met and services are provided to all the passengers, service provided does not necessary mean quality service provided. Passengers deserve more attention. Most of the air traffic actors have no exact knowledge of passengers' expectations and needs.

AENA's Barcelona Airport Planning Group has conducted a study based on passenger needs

[9]. The purpose of the study was to understand delay expectations of passengers and their perception of delay. According to interviews undertaken with passengers punctuality is the key substitute. Surprisingly passengers tend to accept delay well if they are informed and updated in advance. Arrival delay is quoted to be 20% more important to the passengers than departure delay. Final results have shown that passengers' expectations are higher than assumed by industry managers.

Even if the HST infrastructure is sufficient in many parts of Europe (there are 3039 km's of high-speed lines in operation, if constructions continue as projected by 2020 there will be up to 10 000 km's of high-speed and upgraded lines in Europe)[8] it is difficult to predict the number of passengers that would prefer rail transport to air transport. Passengers' choice is influenced by many variables. Most of the time there is no indication about passenger choice, there is no simple rule or equation according to which passengers behave when choosing between two transport modes.

The best person to ask before creating a decision making model is a simple passenger, with travel experience, both good and bad. Different passengers have different sensitivity scale to various travel variables. History shows that many times travel attributes are overestimated (railway operators lost capacity because of adding too many dinning coaches, utility of coaches was much smaller than expected) or on the contrary underestimated (unsatisfactory baggage handling and lack of brand identity forced Lufthansa Express to discontinue its service). Findings can be surprising even contradictory, just as many would be surprised to know that the patent for Maglev HST technology writes its history since 1934.

No matter how sophisticated the system can get, it will hardly reach the desired success if not serving the passengers. Having sound knowledge of passenger feedback is the first step towards well-organized and satisfactory inter-modal connection and interchange node with efficient baggage handling logistics and integrated ticketing, a foundation for successful air-rail inter-modality.

3.1 Passengers' sensitivity – fix parameters

Variables influencing transport choice could be grouped into three main categories.

Time – time is more important to traveler than distance. Passengers' sensitivity to this factor varies mainly according to the purpose of the travel and importance of the travel. Business travelers tend to be more sensitive to time than economy travelers. In terms of time there are two main parts not to be neglected - time traveled to the airport or rail station and time spent at the airport or station before the actual journey. All these factors are very important to passengers and could be decisive in case of transport choice.

Expenses – money still talks. No need to mention that most passengers still look for the least expensive flight ticket, than try to adjust their need prior to price. The target group at this time are leisure travelers. Business travelers are rather ignorant to this variable, although the latest figures show that business travelers, especially the individual business travelers (from a small company or working for himself/herself) are becoming extremely cost sensitive on very short haul flights and switching to low cost carriers. To calculate total expenses spent on the journey we should also consider expenses for the transport to/from the airport or station.

Attractiveness and quality – is a variable gaining significantly more attention, especially in Western European countries and US. We need to mention few detailed examples, such as passenger comfort, punctuality, influence from other transport mode, frequency, attractiveness of arrival and departure time and dependency of transport mode from weather conditions. Variables describing passenger comfort can add up to a never-ending list of attributes. Among the most important are catering services, luggage handling, possibility to work on-board using lap-top or talking on cellular phone, advantages from mile acquisition, possibility to order taxi from board, magazines and different kinds of entertainment. Travelers seek quality transport more then ever before. Quality standard set by air transport is relatively high, however rail transport has bigger potential to reach the same level of comfort due to its many advantages.

Looking for the breakdown between air/rail mode there are many variables and differences to be taken into account. One of the main difference is the purpose of the travel. As mentioned before passengers have different preferences when traveling business or leisure. Preferences vary when traveling in the morning or late night.

The passenger market share of each mode depends on the passengers' sensitivity to different travel attributes, such as cost (journey cost, cost to and from the airport/station), time (journey time, time to and from the airport/station, walking/waiting time) and attractiveness (frequency, competition, on-board services). These attributes, and especially passengers' sensitivity to them, will be investigated closely.

3.2 Questionnaire

A questionnaire was undertaken in order to study the sensitivity of passengers to eight different travel factors (ticket price, price to/from airport/station, travel time, time to/from airport/station, walking/waiting time, frequency, competition, on-board services). Around 50 participants who answered the questionnaire were from EUROCONTROL ERC, 20 international students and 30 French citizens, different age and sex. The questionnaire was undertaken in May and June 2002. Participants were asked to assign an importance to each travel attribute, while traveling both way - economy and leisure. On a 10-point scale the results were the following. The higher the number the more sensitive passengers are to a certain factor.

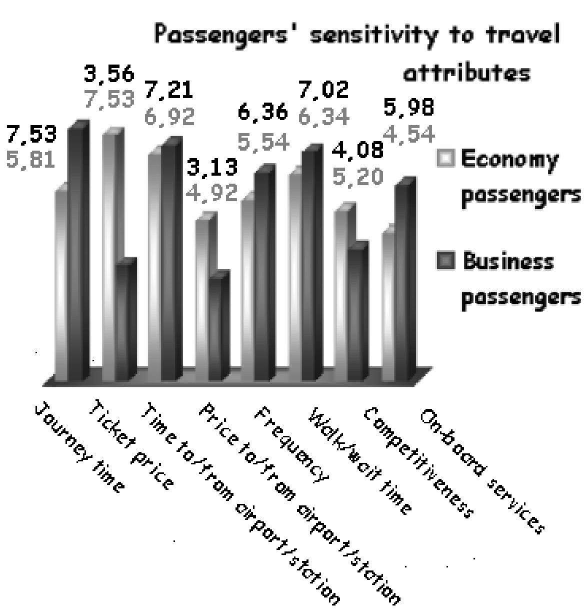

Figure 6. Passengers' sensitivity to travel attributes
Antonia Cokasova – May/June 2002

According to the questionnaire passengers flying for leisure travel are most sensitive to ticket price and the least sensitive to on-board services. Business travelers are the most sensitive to journey time and the least sensitive to price to and from airport or station. This questionnaire covers a very specific group of people, there is a high geographical sensitivity. It would be interesting to see the results if the participants were from different working environment and from different part of the world (Eastern Europe or US). The results would most likely vary in Germany, since the population is very time sensitive, much more than in France. Since participants were mostly from France, when implementing passengers' sensitivity in the demand distribution model, it was better to consider origin destination pairs relating to a French destination, - Paris.

4. Demand distribution model

4.1 Travel factors - variable parameters

After the parameters influencing passenger transport choice were specified, it was necessary to describe the parameters and assign a value to each of them, in order to implement them into the demand model. The model consist of fix and variable parameters. Fix parameters were introduced above as passengers' sensitivity to travel attributes.

Value - all the factors used in demand model vary on 10-point scale in order to allow the same importance to each factor. Variable factors considered for the demand distribution model are the following:

- *Journey Cost*

Flight cost (AIR) – it is difficult to consider the cost in money value, we need to have a common attribute suitable for different short haul flights. The classification used in the IATA APT Rules (Air Passenger Tariff) offers ticket categories, according to which different ticket types could be graded. Since we are only interested in short haul flights, mostly provided by medium size aircraft with no first class seats, 7 different ticket classification are available (including low cost fare). In the model the ticket classification has a value on a 10-point scale, starting Low cost fare with the value 2.5 going up to Business Class Premium air fare with value 9,5.

J - Business Class Premium	*9,5*
C - Business Class	*9,0*
D - Business Class Discounted	*8,5*
W - Economy/Coach Premium	*6,0*
S - Economy/Coach	*5,5*
BHKLMNQTVX - Economy/Coach Discounted	*5,0*

The number of passengers choosing low cost carriers is rising all over Europe, It is important to add the 7th ticket classification. The ticket price is in most of the cases comparable with train fares.

Low cost fare *2,5*

There is a value jump between economy and business fares, since the prices of the business tickets are often almost the double of economy, both for air and rail mode.

Journey cost (RAIL) – the variety of the ticket types is smaller than in air transport. Although some railway companies are setting their fares using methods akin to the airlines' yield management policy; for example Thalys has already 7 ticket classes. To cover most of the railways we consider only the major classes, since not all railways practice the same pricing policy as Thalys.

Business Class 1 / Class 1	*5,0*
Business Class Discounted	*4,5*
Economy Class / Class 2	*2,5*
Economy Class / Discounted Student Fare	*2,0*

- *Cost to/from airport/station*

the factor depends on the location of the airport or station (distance from the departure point of the passenger) and on the means of transport (public transportation/own car/taxi). The best comparison is made by converting the cost to EURO per km. There is no differentiation between air or rail travelers.
This variable is also between 1 and 10. The cost should not exceed 5 Euro/km.

Price	Value	Price	Value
0.5 Euro/km	1	3 Euro /km	6
1 Euro/km	2	3.5 Euro/km	7
1.5 Euro/km	3	4 Euro/km	8
2 Euro/km	4	4.5 Euro/km	9
2.5 Euro/km	5	5 Euro/km	10

- *Time*

All the factors concerning travel time (flight time, time to/from airport/station, and walking/waiting time) are applied in hours.

- *Competitiveness*

This corresponds to the influence in the decision making process from different types of plane/train or other mode of transport. In a two-hour slot how many other planes/trains leave from the same airport or station with the same destination? The highest number of planes/trains departing from the same station we considered was 10. If there is one train/plane leaving in 2 hour slot from the same station/airport the value in the demand model is one, if there are 5 trains/planes the value is 5.

- *Frequency*

The value represents the number of planes/trains departing from the same airport/station with the same destination in a 24-hour period. To prevent overestimation it is essential to normalize the final number so as to remain on a 10-point scale. The highest frequency we have considered was 20 planes/trains in a 24-hour period. Each factor will be divided by 2.

- *On-board services*

This factor is a group of services such as catering services, luggage handling, possibility to work on-board using lap-top or talking on cellular phone, advantages from mile acquisition, possibility to order taxi from board, magazines and different kinds of entertainment. The factor has a value from 0 to 10, according to the services provided. There are 10 different classes of air and rail tickets all together, in this case it's easy to assign a value from 1 to 10.

4.2 Seat ratio

The difference in number of economy and business seats must not be overlooked when comparing the breakdown. Most of the aircraft flying on short-haul distances that could be replaced by HST services carry on-board 93% of economy and only 7% business passengers. This seat ratio is an average number of examined aircraft types:

A 320	**12 Business/138 Economy**
A 319	**8 Business/116 Economy**
B 737-300	**8 Business/118 Economy**
B737-600	**8 Business/102 Economy**
B737-700	**8 Business/118 Economy**
B 737-500	**8 Business/102 Economy**

The situation is different for trains. HST carry 60% economy and as much as 40% business passengers.

Since the difference between plane and train is significant, the seat ratio was taken into consideration in the demand model.

4.3 Demand equation

Once the travel factors and passengers' sensitivity were observed, the transport demand model or utility, was completed. The demand model of a certain transport mode has the following form: C is a total cost, T is total time and S is attractiveness and quality.

$$D = C + T + S$$

The first two factors, cost and time, have negative values, the smaller the value the better for the passenger. The total cost can be described as a sum of journey cost from departure “i” to destination “a” (C_{ia}) multiplied by passengers' sensitivity to journey cost (θ), and cost to/from airport/station (O_{ia}) multiplied by passengers' sensitivity to cost to/from airport or station (ε).

$$C = - [\theta C_{ia} + \varepsilon O_{ia}]$$

The total time is described as the sum of journey time (T_{ia}) multiplied by passengers' sensitivity to journey time (α), time to/from airport/station (A_{ia}) multiplied by passengers' sensitivity to time to/from airport or station (γ), and walking/waiting time (W_{ia}) multiplied by walk/wait time sensitivity (δ). Factors have negative value for the same reason as described before.

$$T = - [\alpha T_{ia} + \gamma A_{ia} + \delta W_{ia}]$$

Attractiveness and quality is the sum of frequency (H_{ia}) multiplied by passengers' sensitivity to frequency (β), competitiveness (P_{ia}) multiplied by passengers' sensitivity to competitiveness (λ), and on-board services (S_{ia}) multiplied by passengers' sensitivity to on-board services (μ). Attractiveness is the only attribute with a positive value, since the higher the quality the better from the passenger point of view.

$$S = \beta H_{ia} + \lambda P_{ia} + \mu S_{ia}$$

After comparing each factor separately the result shows a percentage of passengers choosing the examined transport mode. The form of equation is such that the model will always forecast passenger distribution between 0% and 100%.

4.5 Practical examples

Once all the variables are introduced, they can be applied to practical examples and real situations. As mentioned before it is better to choose a flight from Paris, since the examined group of people were mostly French.

Paris – London

According to airport statistics, this was the 2nd busiest route in Europe in the last few years, supporting 2,92 million passengers each year [10]. Passenger numbers changed following the introduction of the new Eurostar high-speed train passing through Channel Tunnel. It is one of the few OD pairs where HST and air can simultaneously be considered as viable travel options.

The following example is a simple travel model from Paris to London by air created to simulate our decision making model. There is a mix of economy passengers (73%, see seat ratio chapter) with economy/coach tickets and business travelers (7%) with business tickets. Economy passengers are taking the train to the airport with the average cost of 1 Euro/km, business travelers are taking a taxi, costing 2 Euro/km. The flight time is 72 min and there are two trains leaving from the same airport in a 2-hour slot with the same destination. The time to get to and from the airport is 54 minutes. All of the travelers have to walk and wait at least 1 hour at the airport. Business travelers have much better pre-boarding and on-board services than economy. The frequency of aircraft is once every 2 hours.

For rail we also have a mix of economy and business passengers (60% economy and 40% business, see seat ratio chapter) with corresponding tickets. The other attributes remain the same, except for the travel time, which is 3 hours and the time to/from A/P or station, also the walk/wait time, which is 18 min for each.

<u>*Traveling by AIR:*</u>

	Economy	Business
C - Flight cost	5,5	8,5
O - Cost to/from A/P-S	1,0	2,0
T - Flight time	1,2	1,2
H - Frequency	2,0	2,0
A - Time to/from A/P-S	0,9	0,9
W - Walk/wait time	1,0	1,0
P - Competitiveness	2,0	2,0
S - On-board services	4,0	8,0

<u>*Traveling by RAIL:*</u>

	Economy	Business
C - Flight cost	2,5	5,0
O - Cost to/from A/P-S	1,0	2,0
T - Flight time	3,0	3,0
H - Frequency	4,0	4,0
A - Time to/from A/P-S	0,3	0,3
W - Walk/wait time	0,3	0,3
P - Competitiveness	1,0	1,0
S - On-board services	3,0	6,0

<u>Passenger Sensitivity</u>:

	Economy	Business
(θ) - Flight cost	7.53	3.56
(ε) - Cost to/from A/P	4.92	3.13
(α) - Flight time	5.81	7.73
(β) - Frequency	5.54	6.36
(γ) - Time to/from A/P	6.92	7.21
(δ) - Walk/wait time	6.34	7.02
(λ) - Competitiveness	5.20	4.08
(μ) - On-board services	4.54	5.98

Implementing the values above into the demand equation the percentage of passengers choosing air transport is 43% and passengers prefer rail add up to 57%. This breakdown changes when any factor input changes.

Paris – Brussels

This was one of the busiest air routes prior to the introduction of the Thalys. Recently, high-speed train has replaced all the flights, since passengers had realized the time saving. Under the terms of agreement, Air France replaced its flights with chartered Thalys coaches between Brussels-Midi and Roissy-Charles De Gaulle and showed willingness to go in this direction rather than trying to compete directly. But it was also feasible because of the rail link being at CDG. Without this, it might not have happened.

In order to compare the air and rail breakdown we suppose that there are still flights between Paris and Brussels without a stopover. The flight time is 50 min, and the train journey takes 1h20. For ease of comparison, all the other attributes (walk/wait time, cost to/from airport/station, etc.) remain the same. The demand equation results in 34% for air transport and 66% for rail transport. In reality, it is impossible to measure, since as already mentioned the high-speed train is the only transport option.

According to these results, aviation should capture 34% of the passenger traffic. We can conclude that even if there is 34% of air share, it is not enough to keep the air market alive, since airlines stopped operating on this route. Of course reasons could have been various.

Other destinations

It is interesting to compare the value for breakdown between the European most constrained routes. According the CAA airport statistics and ICAO data, the routes supporting the largest traffic in passenger km's for last few years were the following.

1 London-Dublin	11 London-Munich
2 London-Paris	12 London-Geneva
3 London-Amsterdam	13 Copenhagen-Oslo
4 London-Frankfurt	14 Paris-Milan
5 London-Zurich	15 Paris-Madrid
6 London-Rome	16London-Dusseldorf
7 London-Milan	17 Paris-Frankfurt
8 London-Madrid	18London-Stockholm
9 London-Copenhagen	19 Copenhagen-Stock
10 Paris-Rome	20 Paris-Amsterdam

Out of the 20 busiest routes in Europe, 9 are above 1000 km, 3 routes are between 800-900 km and 8 are less then 800 km. In theory high-speed train can replace 40% of the 20 busiest routes. For less time sensitive passengers the percentage rises to 55%.

Inter-modality with rail will produce significant capacity gains by transforming competition between rail and air into complementary between the two modes, with high-speed train connections between cities. We can no longer think of maintaining air links to destinations for where there is a competitive high-speed rail alternative. In this way, capacity could be transferred to routes where no high-speed rail services exist. More efficient, more rational use of airports will not obviate the need for increase in capacity. The fact is that new airport projects are few in number (Lisbon, Berlin, Paris).

5. Conclusion

Preliminary results obtained seem to open a new spectrum of questions. As mentioned before it would be interesting to see a different mix of participants as well as a different questionnaire asking passengers to rank their priorities instead of assigning an importance to each attribute. At the moment more attention is given to true air-rail co-operation (plane-train, train-plane) rather than surveying each mode separately, following the door-to-door transport scheme. Up-to-date results slightly vary from preliminary results, mainly because the average speed of both transport modes was overestimated in the beginning. Study continues on the decision making model, also the parameters influencing decision making are observed in a more detailed way. Another questionnaire is foreseen, at this time focusing on passengers passing through inter-modal terminals (Paris CDG, Frankfurt Main, Oslo Gardemoen, Lyon Satolas, Zurich Airport, Brussels International). Passengers given the choice to travel both modes will be our main source of information. Another survey is planned, examining passengers at travel agencies in order to gain a better knowledge of passengers' trade off between various travel factors. Having passengers feedback and sound knowledge of their expectations will help to identify the reduction in air transport demand.

The era of transport rivalry must become a thing of the past. If mobility is to be safeguarded in the long term, the modes will have to work together. In the long term, intelligent division of labor is indispensable, each mode covering that part of the transport chain for which it is best suited.

Reference

[1] Widmer, J.P. & Axhausen, K.W. (2001) Institute fur Verkehrsplanung, Transporttechnik, Strassenund Eisenbahnbau. *Do rail stations at airports allow a better distribution of passenger demand among airports?* (Presentation paper), ETH Zurich, January 2001, Washington D.C.

[2] European Transport Policy 2001, *Controlling the growth in air transport*

[3] Rietveld, P. & Brons, M. (2001). *Quality of hub-and-spoke networks; the effects of timetable co-ordination on waiting time and rescheduling time*. Journal of Air Transport Management 7 (2001), p. 241-249

[4] Givoni, M. (2001). *Airline and railway co-operation, a new approach to intermodality – a research perspective*. April 2001, University College of London, London

[5] Moore, P. (2001). *High speed rail as a solution to airport congestion*. Sierra Club – Loma Prieta Transportation Committee, California

[6] European Commission - European Co-operation in the field of Scientific and Technical Research (1996). *Cost 308. Interaction between High Speed and Air passenger Transport.* April 1996, Brussels

[7] Ellwanger, G. (2002). Successes for high speed rail. Rail international. UIC, September 2002, Brussels

[8] All about HS, *Definition of High Speed Train* (2002), http://www.uic.asso.fr

[9] AENA (2002). Analyses of Passengers Delays at Barcelona Airport, October 2002

[10] Fresneau, X. (2000). Generic services on capacity constrained routes, Final thesis, University of Westminster, London

Keywords

Inter-modality, air-rail, high-speed train, air transport demand reduction, passenger sensitivity, demand distribution model, transport modal split, travel attributes, fix and variable parameters, questionnaire.

Biographies

Antonia Cokasova is a PhD student in The Innovative Research Business Area at the EUROCONTROL Experimental Center. She holds a Master Degree in Civil Aviation Engineering from University of Transport in Zilina (Slovakia).