IMPROVING INTERNATIONAL ACCESSIBILITY OF EINDHOVEN BY RAIL

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1. INTRODUCTION

European policy is directed at revitalising rail transport. However, development of international passenger rail transport has difficulties to keep pace with the development of international air and car transport. One cause for this development may be the increasing lag behind of international access by rail as compared to road and air transport. On the supply side, factors such as the “availability of infrastructure, travel speed, comfort and transport prices co-determine the transport volumes of the various modes” (EEA 2006: 22). Specifically fast and flexible modes like aircraft, and to some extent high-speed rail, increased their market share due to increasing levels of income, a growth in available infrastructure capacity and stable or decreasing transport prices. A problem for the development of international rail transport is identified by the European Commission to be the poor interconnectivity of national railway networks due to different technical standards and signalling systems (European Commission 2003: 11).

One less documented problem might be deficient international connections by rail to a number of urban agglomerations, even in border regions. Several medium size (border) agglomerations can be identified to lack high quality international rail connections like Nice to Torino (30-40 km/hr), Groningen to Hamburg (40-55 km/hr) and Toulouse to Barcelona (40-60 km/hr). The region of Eindhoven, a city in the south of the Netherlands near the Belgian border is another example. Eindhoven is the central city of an agglomeration with about 400,000 inhabitants. It seeks to become a large international high-tech and knowledge centre. But to facilitate this development high quality international passenger transport connections are considered to be important. Several highways connect Eindhoven to Antwerp in Belgium and to the Ruhrgebiet in Germany. Furthermore the city has developed its regional Airport that now shows high growth in passenger numbers. However, current international rail services to Eindhoven are poor. There are no direct international train services, transfer times are long and on some connections the vehicle speeds are low. The municipality of Eindhoven assigned an investigation to NHTV University of Applied Science Breda and the Technical University Delft, both in The Netherlands, to find cost-effective ways to raise both the service level and the transport volumes.

The analysis starts with analysing the current situation including mapping the level of service on international relations to Eindhoven (Section 2). Next possibilities for improving the services are investigated. In November 2003 a brainstorm session with representatives of administrative and tourist sectors in Eindhoven and rail transport operators has been organised. During

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this meeting two lines of thought were worked out: developing the attraction value of the region and raising international public transport quality. The first line generated 42 ideas that were subsequently reviewed by the delegates. The best rated ideas were ‘lobby to attract a European technology and science institute’, ‘developing the city as base for tourism in the region’, creating a ‘high quality green gateway to the city’ and ‘attraction of more large events’. The second line resulted in 38 ideas, the best being high speed connections to HST stations like Cologne, Antwerp and Liège, better communication on the quality of international public transport, better cooperation between Dutch and Belgium public transport companies and raising (social) safety on stations and in trains.

The first public transport recommendation for the workshop has been worked out quantitatively. Now only long distance rail connections are considered, neglecting regional (bus) transportation. A number of variants for improving international train services are proposed based on the bottlenecks in the current level of service. Five variants regard the services to Germany and four those to Belgium. The variants range from improving train services on the current rail infrastructure (low investments) to introducing high speed train services including building high speed rail infrastructure (high investments). See further section 3. In section 4 the variants are evaluated on passenger volumes and cost-effectiveness.

2. CURRENT SITUATION

2.1. The role of railways in international passenger transport

In Europe the role of the train in international travel is limited. If journeys over 3000 km are excluded, the trains’ market share in international long distance journeys (> 100 km) of residents in the EU-countries is only 7.0% (Dateline project). The train is the fourth largest mode after private car (41.7%), airplane (40.5%), and coach (8.0%). The share of the train depends on travel purpose. It is only 5.6% for long holiday travel (excluding journeys with less than four overnight stays), 8.3% for business travel and 10.5% for other purposes; the latter includes short holidays. The trains’ share is highest on medium distances (200-900 km, as the crow flies). Here the observed shares are between 10% and 12%. At shorter distances (100-200 km) the share is 7%, at longer distances the share decreases continuously at increasing distance. For distances over 1500 km the share is less than 1%. In business travel, the decrease in market share of the train starts already at 300 km. Between 200 and 300 km, business trips have the highest market share of all purpose/distance class combinations: 22%. It is interesting that the train retains a rather constant market share as long distances do not exceed 900 km, despite a rapid increase of the airplane’s market share. The increase of the latter is apparently at the cost of the private car, not the train. The airplane’s share overtakes the trains’ share between 300 and 400 km.

Looking at long distance travel for residents of the different countries, there are large differences in international train use. The market shares range from 0.1% (Greece) to 15% (Switzerland). Other countries with low shares (< 3.5%, half of the EU-average) are Portugal, Spain and Ireland. Other high-share
countries (> 10 %) are France and Belgium. In all countries the trains’ shares in international trips are much smaller than those in domestic trips. For most countries this is also true when the shares are compared per distance class. The only exception is the United Kingdom, were train shares per distance class in international travel are similar to and, at relatively short distances (100-200 km), even higher than those in domestic travel. Interestingly, the domestic and international long distance travel shares are concurrent.

2.2. Travel to and from Eindhoven

Most international long distance trips to and from Eindhoven are made by Eindhoven residents. For trips over one hundred kilometres, 1.1 million international journeys are annually made by residents of the Eindhoven region, as against 0.1 million by Eindhoven visitors. The market share of the train in long distance trips to and from Eindhoven is low. Based on databases of MON (Dutch national travel survey) and international rail statistics, the estimated trains’ share in international trips > 60 km is between 2.5% and 3%. This is half of the share for all Dutch residents in international trips > 100 km (5.4%), which in its turn is below the EU-average (7%). The trains’ share of trips > 60 km to Eindhoven is about 5% for trips crossing the German border and 1.5-2% for trips crossing the Belgian border. The low market share of the train suggests a poor accessibility of Eindhoven by international train, as well as a high potential for expanding demand.

2.3. Current accessibility of Eindhoven by public transport

Figure 2.1 shows the accessibility of Eindhoven by public transport from some selected cities abroad. These cities are selected because they are the most important nearby regional centres (Turnhout, Lommel and Hasselt), the most important transfer nodes for international long distance travel (Duisburg, Cologne, Liege and Brussels) and the most important international destinations (Düsseldorf, Antwerp, Paris, London, also Cologne and Brussels). The figure is based on the timetable of autumn 2003. Except for London and Paris the map is to scale.
Figure 2.1: International accessibility of Eindhoven by public transport (LOM = Lommel, TUR = Turnhout)

Interruption of a line at a city or node indicates the need to make a transfer. The small digits at the transfer sites are the transfer times in minutes (to/from Eindhoven). The large digits at the selected cities indicate average travel speeds in km/h to/from Eindhoven via the fastest routes. The speeds are computed as the station to station travel times divided by the road distances. So they reflect both the speed of the journey when travelling by public transport and a possibly larger detour made by the public transport user compared to the car driver. Thickness of the lines represents frequencies. Most connections are served hourly, some are less frequent (for instance the connection to London), others are more frequent (for instance all connections between Eindhoven and the transfer sites at the border). Train services are represented by continuous lines, bus services by dotted lines.

The figure demonstrates the poor accessibility. There are important bottlenecks regarding travel times and transfer numbers. The average speed to the regional centres is only about 25 km/h, while the speed to the more distant larger cities is between 50 and 70 km/h. Only London and Paris can be reached at a higher speed, but also these speeds, not exceeding 100 km/h, are low for connections that are served by high speed trains on a large part of the route. The low average speeds are due to:

- large detours via the fastest route (Antwerp and behind, Hasselt),
- low vehicle speed (regional connections, connections to the German cities),
- long waiting times at transfer sites.

All connections need at least one, most two or more transfers. The only service factor that has a good quality is the frequency. Hourly service on most connections is high for international standards.

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As explained before, the study concentrates on longer distances. Therefore, regional travel has been left out of consideration in the remaining part of this paper.

2.4. Sensitivity of train demand to service level and price

To find efficient ways to ameliorate the international train services, one should notice not only the current bottlenecks but also the travellers’ assessment of the bottlenecks and other service factors. Van Goeverden (2006) mentions four factors that are likely to have a large influence on international train patronage:

- Number of transfers: One additional transfer on all connections between two cities decreases patronage by 30-60%.
- Generalised cost ratio between train and car: The generalised cost is the weighed sum of travel cost and travel time. When the ratio increases by 10%, demand falls by 10-40%.
- Obligatory seat reservation: Introduction of obligatory seat reservation may decrease train patronage in two ways. Travellers dislike making reservations and therefore decide not to travel by train (active choice from the traveller’s viewpoint), or train companies refuse to admit travellers to preferred trains because these trains are already fully booked (passive choice). The passive choice implies that the effect of introducing obligatory seat reservation on patronage depends on capacity shortages. For the Thalys services between Amsterdam and Paris, where seat reservation is obligatory while capacity is insufficient in high-demand periods, on relations where regular trains were fully replaced by Thalys services a loss of 25-40% of former travellers has been observed. Introduction of obligatory seat reservation could be the main explaining factor, though also other factors play a role (like higher fares).
- Train ‘status’: There is evidence that high speed trains or special luxury train services attract more passengers, apart from the speed effect. These services might be considered as a serious alternative for plane or car by persons who do not have conventional train services in their mind. Analyzing the results of Thalys introduction (Ettema et al., 1998), replacing regular services by high status services is likely to increase train demand by some tens of percents (van Goeverden, 2006).

The conclusion is that there is a strong relation between service level/price and patronage in international train travel. Removing the main bottlenecks for travelling to Eindhoven may have substantial effects on train patronage. The accessibility might be improved by reducing the need to make transfers, increasing average speed, refraining from obligatory seat reservation and adding high status train services.

3. VARIANTS FOR IMPROVED ACCESSIBILITY

Five variants have been developed for improved services to Germany, four for services to Belgium. The main improvements are providing direct connections
between the larger cities and upgrading rail lines for a maximum speed of 200 km/h. In German variants that include through services to Duisburg and behind, a new rail link in Viersen is assumed in order to avoid the need of reversing the train at Viersen station. The Belgian variants exclude the rather unimportant relations to Liege and behind. Starting point for the Belgian variants is operation of the high speed railway line between (Rotterdam-) Breda and Antwerp that will be opened in the near future. High-speed services are either operated by ICE-trains that require no seat reservation and HSA-trains for which obligatory seat reservation is assumed.

Table 3.1 gives an overview of the proposed variants.

Table 3.1: Variants for improved accessibility

<table>
<thead>
<tr>
<th>variant</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>to/from Germany</strong></td>
<td></td>
</tr>
<tr>
<td>G2</td>
<td>Extend the hourly intercity service The Hague-Eindhoven-Venlo alternately to Cologne and Duisburg-Dortmund. The service to Dortmund replaces current services between Duisburg and Dortmund. Add one daily service The Hague-Eindhoven-Düsseldorf v.v.</td>
</tr>
<tr>
<td>G3</td>
<td>Variant G2 including a two hourly ICE-service The Hague-Eindhoven-Cologne-Frankfurt. This service replaces current ICE-services between Cologne and Frankfurt.</td>
</tr>
<tr>
<td>G4</td>
<td>Variant G1 including a two hourly ICE-service Brussels-Eindhoven-Duisburg-Berlin, replacing between Duisburg and Berlin half of the (hourly) ICE-services Cologne-Duisburg-Berlin.</td>
</tr>
<tr>
<td>G5</td>
<td>Variant G2 including both ICE-services from variants G3 and G4.</td>
</tr>
<tr>
<td><strong>to/from Belgium</strong></td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td>Status quo, including an hourly HSA-service between Breda and Brussels.</td>
</tr>
<tr>
<td>B2</td>
<td>Variant B1 including an extension of the Brussels-Breda service to Eindhoven every two hours.</td>
</tr>
<tr>
<td>B3</td>
<td>Variant B2 including upgrading of the track between Breda and Eindhoven.</td>
</tr>
<tr>
<td>B4</td>
<td>Like variant B3, but replacing HSA-service between Brussels and Eindhoven (with obligatory seat reservation) with ICE-service Brussels-Eindhoven-Berlin (without obligatory seat reservation). This variant corresponds to the German variants G4 and G5.</td>
</tr>
</tbody>
</table>

The service quality of the rather simple variants G2 and B2 is demonstrated in Figure 3.1. The figure shows also the transfer times and average speeds in the most sweeping variants G5 and B4 (between brackets). Just like in Figure 2.1 the small digits indicate transfer times and the large digits average speed (based on road distances).
Comparing Figure 3.1 to Figure 2.1 demonstrates that service quality will increase substantially. The need to make transfers will be removed or reduced largely, and the average speeds will become much higher. Compared to the current situation, the speed increase is on average 50% in the variants without high speed services (G2+B2), and even 90% in the variants with high speed services (G5+B4).

The improved accessibility of Eindhoven is also shown by the improvement of travel time ratios (see Figure 3.2). The figure shows also that the largest improvements are reached by the variants (B2/G2), while adding more expensive high speed rail infrastructure (B4/G5) does so to a lesser extent.
4. ASSESSMENT OF THE VARIANTS

4.1. Demand

The impacts on demand are estimated by using a travel demand model for international train travel that is developed by van Goeverden (1986). A brief description in English is given by van Goeverden (2006). The model estimates number of train travellers between two zones, located in different countries, as a function of service levels of train and car and population and attraction of the two zones. The service levels are defined by travel time and travel cost, that for the train also by transfer numbers. The results are corrected for services with obligatory seat reservation by reducing the estimated demand by 15%, and for services with high-status trains by increasing demand by 30%. Only effects on international train demand are predicted; effects on domestic demand are neglected, though these may be substantial, in particular in Germany.

Table 4.1 presents for the German variants the predicted numbers of travellers from Eindhoven to the German border (all border crossings), as well as the passenger numbers that pass the border at Venlo by express trains. In 2003, when only local trains operated between Venlo and Germany, the number includes only the actual passengers that are expected to have travelled by express trains if express train services were provided. These are the passengers that would benefit from the proposed improvements. The figures regarding travellers from Eindhoven to the German border indicate the impact of the improved accessibility of Eindhoven. The figures regarding all travellers passing the Venlo border by express trains indicate the
full impact of the improved train services to Germany. The region that benefits from the improvements is much larger than the Eindhoven area. It includes most of the southern Netherlands as well as large cities like Rotterdam and The Hague.

Table 4.1: Predicted number of travellers by train to Germany (one direction)

<table>
<thead>
<tr>
<th></th>
<th>2003</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>G1</td>
<td>G2</td>
</tr>
<tr>
<td>Eindhoven-German border</td>
<td>28,800</td>
<td>70,200</td>
</tr>
<tr>
<td>Express trains Venlo border crossing*)</td>
<td>154,000</td>
<td>382,000</td>
</tr>
</tbody>
</table>

*) In 2003 potential express train users.

The higher numbers in 2010 include a small volume effect due to population increases of Eindhoven and other cities. Besides, the number of train passengers crossing the border at Venlo includes about 40,000 persons that would have chosen another Dutch-German train border crossing (mainly the crossing at Emmerich) if the improvements should not be realized. Additionally, the through ICE-service Brussels-Eindhoven-Germany in the variants G4 and G5 attracts some 100,000 passengers travelling from Belgium to Germany, about half of them might otherwise have used the Belgian-German crossing at Welkenraedt.

Taking into account these notes still a huge increase in traveller numbers remains. In terms of the trains’ market share, the numbers increase from 5% in 2003 to 12% in G1 and 25% in G5. The market shares in the most sweeping variants exceed the European average in international travel by far; however, the assumed service level in these variants is also much higher than the average.

Table 4.2 shows similar figures for travellers to Belgium. The ‘HST Breda-Belgium’ figures are the expected passenger numbers passing the Belgium border by the high speed trains that run from Breda to Antwerp and Brussels. Passengers of other high speed trains using the same border crossing (from Amsterdam to Brussels and Paris) are not included. In 2003, when there was no high speed service between Breda and Belgium, the numbers indicate the actual passengers that crossed the Belgian border and would have travelled with the high speed trains Breda-Belgium if these had been in operation.

Table 4.2: Predicted number of travellers by train to Belgium (one direction)

<table>
<thead>
<tr>
<th></th>
<th>2003</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B1</td>
<td>B2</td>
</tr>
<tr>
<td>Eindhoven-Belgian border</td>
<td>24,400</td>
<td>43,600</td>
</tr>
<tr>
<td>HST Breda-Belgium*)</td>
<td>167,000</td>
<td>268,000</td>
</tr>
</tbody>
</table>

*) In 2003 potential HST users.
The figure regarding all HST-passengers between Breda and Belgium in B4 includes the 100,000 persons travelling by ICE from Belgium to Germany mentioned before.

If regional travel (≤ 60 km) is excluded, the trains’ market share from Eindhoven to Belgium and further south increases from less than 2% in 2003 to 3% in B1 and 6% in B4. This is from very low to normal.

When assessing these figures one should realise that the model is likely to overestimate the effects when many train connections improve at the same time. The model is a direct demand model that estimates the effects on a certain city-city relation ceteris paribus. One of the factors underlying the passenger growth on the relation is change of destination by train travellers. However, when train connections on other relations also are improved, the destination choice effect will be smaller or even absent, leading to a smaller growth on the relation concerned. We have no evidence to what extent the numbers presented in Table 4.1 and Table 4.2 are overestimated. As indicated before, at the same time the growth of domestic demand due to the improvements has been neglected. Therefore we confidently used these numbers for the financial evaluation in the next section.

4.2. Financial evaluation

The financial evaluation of the variants is based on marginal costs and returns. These are the additional costs for offering the improved services, and the returns of additional train passengers. Returns of passengers that otherwise also would have travelled by train, either via the same route or via another route, are excluded. This is also true for possible effects on costs for train operation via other routes.

In calculating the marginal values for the German variants, these variants are compared to the situation in 2003. In the case of Belgium, the variants B2 to B4 are compared to variant B1. The latter is chosen as the reference because the high speed connection between Breda and Belgium will be in operation in the near future anyway. The definition of the reference variant B1 is based on the initial plans and deviates to one point from the most recent plans: the initially hourly train service between Breda and Belgium is reduced to a two hourly service, running from The Hague via Breda to Brussels. Assuming the latest plans could have produced different values for the marginal costs and returns.

There are two cost components: capital costs (costs related to the railway infrastructure) and operating costs (costs related to train operation).

The capital costs concern the costs of building a new rail link in Viersen and upgrading several rail sections to 200 km/h. The assumed costs of building the rail link in Viersen are €100 million. This amount is based on the observed costs of two recently built comparable rail links in the Netherlands (Gooiboog and Hemboog; the costs were published at www.prorail.nl). Upgrading one km double track railway is assumed to cost €35 million. This amount is based on the cost assessment of a similar upgrading of the railway line Utrecht-Zevenaar (CPB, 2000). In converting the investments to annual amounts, it is assumed that a) the new infrastructure will be operated for 100 years, b) the
discount rate is 4%, and c) the annual maintenance costs are 3% of the investment costs (Rijkswaterstaat, 1996).

The assumed operating costs are €0.026 per seat km for conventional express trains and €0.023 for high speed trains that stop each 50 km. These figures are based on calculations by the ‘Box of building blocks for transport systems’, a model that simulates transport systems (Egeter et al., 1995).

The marginal returns are estimated assuming that additional passengers travel on an average 200 km (400 km for the Belgian-German passengers) and pay €0.10 and €0.12 per km for conventional and high speed services respectively.

Table 4.3 gives an overview of the costs and returns in each of the defined variants, except for the reference variant B1.

<table>
<thead>
<tr>
<th>Variant</th>
<th>Capital (million Euro)</th>
<th>Operation (Euro)</th>
<th>Returns (million Euro)</th>
<th>Benefit-cost ratio overall</th>
<th>Benefit-cost ratio operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>0</td>
<td>10.8</td>
<td>7.5</td>
<td>70%</td>
<td>70%</td>
</tr>
<tr>
<td>G2</td>
<td>7.1</td>
<td>8.8</td>
<td>12.1</td>
<td>76%</td>
<td>137%</td>
</tr>
<tr>
<td>G3</td>
<td>354</td>
<td>23.4</td>
<td>19.7</td>
<td>5%</td>
<td>84%</td>
</tr>
<tr>
<td>G4</td>
<td>275</td>
<td>16.6</td>
<td>18.1</td>
<td>6%</td>
<td>109%</td>
</tr>
<tr>
<td>G5</td>
<td>441</td>
<td>29.2</td>
<td>26.6</td>
<td>6%</td>
<td>91%</td>
</tr>
<tr>
<td>B2</td>
<td>0</td>
<td>3.1</td>
<td>2.5</td>
<td>81%</td>
<td>81%</td>
</tr>
<tr>
<td>B3</td>
<td>144</td>
<td>3.1</td>
<td>2.8</td>
<td>2%</td>
<td>91%</td>
</tr>
<tr>
<td>B4</td>
<td>144</td>
<td>3.1</td>
<td>7.3</td>
<td>5%</td>
<td>235%</td>
</tr>
</tbody>
</table>

Table 4.3 shows that variants with high capital investments have a low overall cost recovery. The variants with small or absent capital investments have a much better overall financial performance, though the benefit-cost ratios never come to 100%. Looking only at the operating costs, all variants have a high cost recovery or even yield profits. It is interesting, that even if the capital costs are ignored, the high-investment variants perform not significantly better than the low-investment variants.

The variant pair G2+B2 has the best overall performance. If it will be decided to upgrade railway links to 200 km/h anyway, the variant pair G4+B4 is the best choice.

5. CONCLUSIONS

International rail connections in Europe sometimes are poor. This is, among others, true for the connections to the city of Eindhoven. Though Eindhoven is located near the border, it has no direct international train connections. The international accessibility of Eindhoven can be improved significantly in a rather simple way. Extension of the express trains now ending in Venlo alternately to Cologne and Duisburg-Dortmund as well as extension of some of the intended HSA-trains Brussels-Breda to Eindhoven will produce a large increase in demand and a decrease of the operating deficits. However, the overall deficits (including capital costs) will increase slightly. Upgrading rail
tracks to Eindhoven to higher speed is not cost effective. Though it will induce a large additional demand increase, the additional returns are far below the high capital costs.

A more general conclusion may be that more attention might be needed for the quality of international rail services connecting medium sized urban agglomerations to other agglomerations. For these connections, and supposing the planned high speed rail network will be completed, large and (almost) cost effective improvements may be reached without investing in expensive infrastructure all the way up to these agglomerations. The main impediments for increased speed and quality seem the lack of direct cross-border connections with high grade stock.

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