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SOME TECHNICAL, FINANCIAL AND ORGANISATIONAL ASPECTS OF HIGH-SPEED TRAINS

Katalin TÁNCZOS and Mohamed ABDELSLAM

Technical University of Budapest
Faculty of Transportation Engineering
Department of Transport Economics
H-1521 Budapest, Hungary

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Abstract

The supply of high-speed train (HST) services which started in number of countries since the early 1980s is still an ambition far from realisation in the near future for many other countries. Provision of high speed trains requires the existing of certain characteristics, including high demand density which is often not granted in the domestic market alone, and consequently certain level of co-ordination and integration among neighbouring countries becomes a pre-condition for the establishment of such services with the resulting problems of operational and technical compatibility. This paper reviews the main aspects of the high-speed trains and presents the main characteristics and the requirement for the expansion of such services.

Keywords: high-speed train, rail transport.

1. Introduction

A great deal of attention has been paid in recent years to the desirability and possibility of high-speed international railways in the European context. With the approach of a united Europe, the opening up of borders between east and west, and also in view of the rapidly growing problems of traffic congestion and environment, this topic is becoming increasingly important.

Reference to high-speed railways in the EU countries is generally taken to refer to traffic over large distances, in excess of about 250 km. Journey distances of this nature are, however, virtually non-existent in the small countries and, in the big countries, it is only on the routes between the big cities and they generate a level of traffic which can justify an intensive transport supply. The interest in high-speed railways has been limited to internal lines in the big countries. The small countries only come into the picture upon the realisation of international high-speed railway links.

At present it is generally recognised that the railways have to be improved drastically on long-distance routes. The improvement strategy should be as follows:

– maintenance and expansion of penetration;
– reduction in waiting times (increase in frequency);
– considerable increase in speed;

– improvement in comfort and service;
– attractive pricing structure.

This market is particularly important, because it is growing strongly in line with increasing prosperity and continuing europeanisation and because it is also commercially interesting for the railways.

It is well known that the railways can only function with heavy traffic. As far as long distances are concerned, this has only been possible between the biggest cities, therefore in the small countries the topic is interesting primarily in terms of international transport.

2. The Possible Market Share of the High-Speed Trains (HST)

If the railways wish to meet the needs of the passenger market in a competitive manner and with an optimum product, this can only be achieved by means of a hierarchical system structure which is subdivided according to range of journey distances (*Table 1*). This system contains the high speed train (HST) on the top of the hierarchical structure. The systems included in the table ought to be, of course, linked with one another, so that it is possible to move easily from one to another.

Table 1. Railway system structure with systems of different scale

Scale	Journey distance range or action radius (km)	Required minimum speed per train (km/h)	Average stopping interval (km)	Transport type
Intercontinental	>800	N/A.	N/A.	Aeroplane
International	250 – 800	150	150	EC/HST*
National	80 – 250	100	50	IC**
Interregional	30 – 80	70	15	IR***
Regional	10 – 30	45	3	R****
Local	3 – 10	30	1	L*****

*EC: Eurocity, HST: High Speed Trains
**IC: Intercity
***IR: Interregional train
****R: Regional train
*****L: Local train

In order to obtain a useful basis for comparing journey speeds (e.g. from actual departure point to destination), the pre- and post-transport times and the waiting time have to be added. Research indicates that the average pre- and post-transport time together is about thirty-five to forty minutes for long-distance travel, with the average waiting time of about one- third of the interval between trains. Research also shows that this interval must be half of the journey time spent in the train.

Some remarks related to the future possibilities of the HST:

– Although high-speed railways have already been in competition with air transport in the distance range between 250 and 800 km, this market will become less interesting for airlines over time, due to both economic considerations and increasing congestion at airports.

– In order to boost the concentration of air travel on longer distances, and particularly on intercontinental traffic, the long-distance railways will have, in turn, to be linked up with the air-transport systems.

– High-speed lines in particular ought to be routed via important airports in order to make possible train–air journeys.

Taking into consideration these facts, interesting market shares could be obtained:

Table 2. Possible train market share at higher speed

Scale	Average distance (km)	Journey time ratio train/car	Modal split train (%)
International	450	0.9	60
Intercity	150	1.2	45
Interregional	50	1.35	30

A major problem of long-distance, high-speed rail systems for small countries is the fact that the stations have to be located in about 150 km distance from each other. More stops might, of course, be tolerated at the end of the lines, where traffic gradually falls off, but the problem then arises that poor traffic levels cannot justify new infrastructure.

An international European high-speed railway network will have to meet a high level of speed requirement which will only be feasible on a major, newly constructed network of lines. A limited number of heavy conurbation/core regions will have to form the nodes of this network.

Where necessary, compromise solutions will have to be adopted, in the form of joint use by trains from other scale levels. Lower speeds are also acceptable at the ends of the routes, thus enabling the use of upgraded existing railways and the addition of a small number of extra stops. Finally, it should be emphasised that the high-speed network must be adjusted to or linked up with the overlying air transport network and the underlying express train structure at national (80–250 km) and interregional (30–80 km) scale.

3. Technical, Financial and Organisational Requirements

3.1. Technical Issues

It was determined by a symposium on high-speed trains that a cruising speed of between 150 and 200 km/h requires a maximum speed of between 200 and 300 km/h and a very limited number of stops. Depending upon the distance travelled (generally between 300 and 600 km), the service interval should be between one and two hours. In order to achieve a reasonable level of train occupancy, demand of approximately three million passengers per year has to exist for a particular route, even without taking into account the infrastructure and operating costs.

There is an immediate tendency to traffic fall back upon existing railway lines. As these are often heavily travelled main lines because of their internal and freight role, this will quickly lead to a shortage of capacity, as the high speed of the new international trains has the effect of forcing down capacity. To as great an extent as possible – i.e. if the existing lines can accept high-speed trains after limited adjustments – extra tracks will then have to be constructed alongside the existing ones. This is a favourable solution when crossing open countryside, but not advantageous when crossing urban areas where the train does not stop. In many cases, therefore, it will be necessary to construct entirely new rail links.

Another significant technological characteristic is the number of stops per distance, and the location of the stations. Distances of around 150 km will have to be respected, especially in transit countries. In many cases it is even desirable to increase this distance, which can be achieved where necessary by operating an alternating service (direct alternating with stopping).

The national tendencies have led not only to major technical differences in the classic railway systems, but also to the independent development of new high-speed trains. Not only the enormously high costs of development, the objective of achieving mass production, etc., but also the internationalisation of high-speed railway systems all require the bringing together of programmes of requirements, of development research and of production. The small countries, which generally have insufficient technical potential to meet the scale of their future high-speed networks and rolling stock, could play the role of intermediary, but a greater effort is also required from the EU and the railways themselves.

The internationalisation of the railway industry will eventually lead to compulsory programmes, if the railways do not wish to price themselves out of the transport market.

The situation with regard to safety systems would appear to be more favourable with new generations being introduced, thanks to rapid technical advance. A pan-European train control and safety system is currently being studied. Progress is also being made in other areas: the railways are jointly testing bi-modal vehicles for combined freight transport in the hope of subsequently selecting one for European use. International co-operation is also getting off the ground in the field of computer applications, such as the provision of information to passengers, logistics in general

and the reservation system. Only a combination of efforts on a European scale and the setting aside of national interests will serve the overall European interest, and ultimately the individual interests of the railways.

3.2. Financial Issues

High-speed rail is currently in a favourable position: it is a desired product with a competitive advantage compared to environmentally unfriendly modes of transport by air and road, which are also having to contend with congestion. Available government funds for the expansion of the infrastructure are, however, insufficient and private capital can only be used where the investment is profitable on an individual project basis.

In general the investment costs for the infrastructure are borne by the government. The operating costs and returns for long-distance transport at high speed are considerably better, and it might be expected that at least the infrastructure costs could be borne by this type of transport. There is, of course, a significant relationship between the transport performance and the length of the network: the traffic density of the network can be expressed by the number of passenger-km per km per year.

Other possibilities of the financing issues relate to the pricing structure and also the finance method and the distribution of costs and returns. The solutions have to be fitted to the national framework, too.

3.3. Organisational Aspects

The familiar picture of national (primarily state-run) railways, which take care of infrastructure, rolling stock, sales and production, is gradually making way for other organisational concepts. The separation of the infrastructure and operation has already been done at the majority of the railway companies, at least according to the accounting system. The close links between each area will, of course, require a well organised co-ordination.

4. Conclusions

The paper gave a short overview of the characteristics of the high-speed railway systems. The authors evaluated the trends of the transport modal split and gave a categorisation for the possible market share of the high-speed trains.

The second part of the paper discussed the technical, the financial and the organisational aspects of the future development of the high-speed trains.

The conclusions can be summarised as follows:

– high-speed passenger trains no longer give rise to any real technical problems,
– the development of the HST system in the longer term is an appropriate and realistic decision for the countries joining to the EU as well,
– the co-ordination of the national concepts is an urgent task, to make the necessary steps for the development in time,
– the financing problems must certainly not be underestimated.

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