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PERFORMANCE OF THE HIGH SPEED RAIL IN SPAIN IN THE CONTEXT OF THE NEW REGULATION FRAMEWORK. EVIDENCE FROM THE MADRID-SEVILLE HSR CORRIDOR.

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ABSTRACT

The ambitious planned development of the high-speed rail (HSR) network in Spain requires the implementation of new sector regulations to fully achieve its objectives, namely to make the sector more competitive and to promote a more balanced and efficient transport system. For this purpose, the Spanish administration recently launched the new Rail Sector Act (39/2003), on a national regulatory framework. The planned liberalisation process foresees the end of the monopoly of the Spanish state operator RENFE, opening up passenger transport to new rail operators by 2010.

On a European level, this new regulatory framework comes in line with EU's concerns both on transport service performance and on infrastructure development. On the one hand, European regulations have focused in measures to guarantee quality of service, equal access and effective competition market rules. On the other, the relevance of the development of HSR projects in the Iberian peninsula is proved with their inclusion among the priority projects of the trans-European networks (TEN).

In this context, we investigated the performance of the HSR line Madrid-Seville during its almost twelve years of operation. This case study constitutes a successful experience of the implementation of a transport infrastructure policy, resulting in a modal shift from air transport. We searched for the key factors and driving forces underlying this success, and to which extent the evidence from this case study could be valuable for other planned HSR developments in Spain.

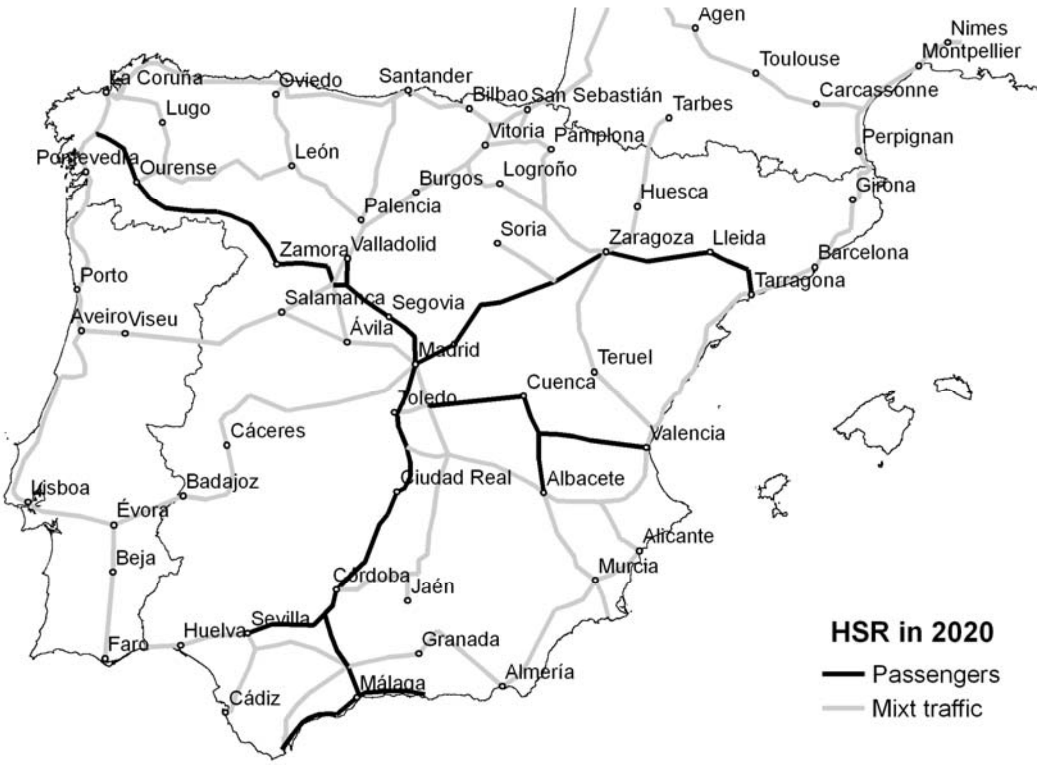
Keywords: High-speed line, policy, Spain, competition

1. INTRODUCTION

The new Rail Sector Act (39/2003), on a national regulatory framework, has been launched recently in Spain. This new regulatory framework is necessary for a harmonization with EU regulations, bringing the opportunity for new rail operators to access the Spanish market. This framework constitutes a challenge for the national rail sector, which needs to adapt its structure to the future changes stemming both from the market liberalisation and the planned ambitious extension of the HSR infrastructure in Spain.

During the last ten years, there has been an important financial effort in Spain to improve transport infrastructure. Larger investments have been devoted to road, transforming and improving considerably its network. High speed rail (HSR) and metropolitan train received a considerable amount of money being an exception within rail investment. Moreover, the recently launched PEIT -Strategic Plan on Transport and Infrastructure- (Ministry for Development, 2004) includes among its key objectives to extend the HSR network from its 900 to near 10.000 kilometres in 2020 (see Figure 1).

Figure 1 PEIT's planned HSR Network in Spain (2020 horizon)



HSR constitutes an efficient (regular and punctual) high capacity transport mode. Moreover it is a demonstration of a developed top technology that permits vehicles to run at speeds in the range of 200-300 km/h.

However, HSR presents serious environmental, financial and territorial costs (accentuated by the geographical and demographical country peculiarities).

This paper studies the Madrid-Seville high speed railway corridor as an example of a successful implementation of a HSR, resulting in a model shift from air mode. It will investigate issues like the political framework which led to the introduction and development of a high speed railway model in Spain. The study will also inspect the implications at the spatial, sociological and economical level of the election and progress of this high speed railway model. Finally, changes in transport modal shares will be discussed.

In this context, the aim of this paper is to gain insight into the driving factors of this success and, in a first analysis, learn from this experience to face the future changes in the Spanish rail sector.

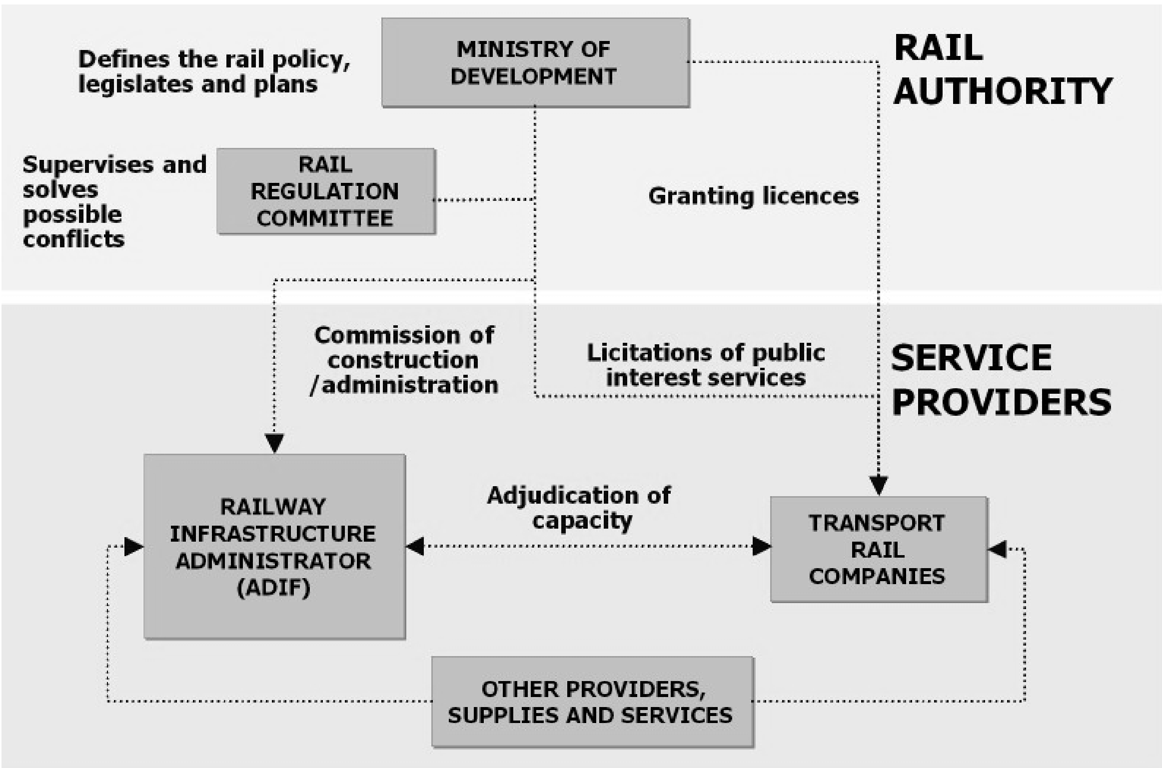
2. THE NEW RAIL SECTOR ACT

The new Rail Sector Act (39/2003) was approved by the Spanish government in line with the European regulations, pretending to make the rail sector competitive and more efficient by opening the market to European operators. The new Act implies a new Spanish model for the rail sector based on basic principles, meaning that the ultimate performance of the high speed network will depend on how well the new rail system functions. The new Act splits administrative activities from infrastructure and it is operative since 17th May onwards (Izquierdo & Vassallo, 2004a). For this purpose, the Spanish State has created the Rail Infrastructure Administration (ADIF) and RENFE Operator.

The Act aims to regulate rail infrastructures (ADIF will administrate them) and services. The new Act will admit new operators gradually, both national and international, first to the freight transport market, leaving passenger transport until the European Union takes the relevant decisions. In the future, RENFE Operator will have to compete with new potential operators. Other basic principles are the institution of a flexible system for granting licenses to operators for the provision of transport services and the establishment of charges to be paid by operators for rail infrastructure use. The structure of the new rail sector model is represented in figure 2.

ADIF, a public corporate body comprising the former RENFE and the current rail infrastructure manager GIF, will preserve and make use of rail infrastructures: management of the lines, traffic control and security. ADIF will also have the competence to build new infrastructures (approximately 75 per cent of the high speed network). RENFE Operator, a newly created public corporate body comprising the old rail transport services units of RENFE, will give services in Spain (freight and passengers) and, exceptionally, will control the management of the HSR Madrid-Seville (Izquierdo & Vassallo, 2004b). The Ministry for Development, which is responsible for the overall organisation and regulation of the railway system, will grant licences and will establish the scale of charges. The Railway Regulatory Committee, a body under the Ministry for Public Works that oversees the proper operation of the system, will act as arbitrator in the event of disputes between the various actors concerned. Finally, the new rail operators, from the public or private sectors, will enter the market providing supplies and services.

Figure 2 New Spanish Rail Model, actors and definition of functions



Among other things, the new Act regulates the authority and functions of the various actors, the sources of economic resources, the requirements that new companies in the rail sector will have to meet, the penalty system and the gradual opening of the market.

3. EVIDENCE FROM HIGH SPEED RAIL IN SPAIN, MADRID-SEVILLE LINE

3.1. Project background

The project to build the high speed train between Madrid as Seville was included in an Infrastructure Plan for the first time in 1987, within the Rail Transport Plan (Guirao-Abad, 2000). Its construction started in 1988 and the line opened in 1992 together with the Universal Exhibition of Seville (EXPO), including Spain into the small group of countries which at that moment had the necessary infrastructure and vehicle technology to allow trains running at speeds higher than 250 km/h. The HSR tends to reinforce the position between to large urban poles of considerable dimensions like Madrid and Seville and strengths the relationship between both cities.

In 1993, the UE proposed the establishment of the European Transport Network (TEN-T), aimed to provide quicker and safety transit of passengers and goods and to improve connections between the EU territory (EC, 2001). The high speed train corridor, Madrid-Seville, fulfilled the requirements and objectives reflected in the proposal for the TEN-T.

This project provides a good example of a successful policy initiative – an infrastructure capacity investment- in terms of encouraging a more balanced transport system. This is the reason why it was included as an example in the EU White Paper "European Transport Policy for 2010: time to decide" (EC, 2001).

The implementation of the HSR faced some barriers to its implementation, mainly derived from the necessary distance between stations. The station's spatial distribution may cause a potential impact in terms of economic development and spatial equity, as one of the main criteria for the selection of the situation of a station was its importance in terms of population and economic activity. High speed rail provides good accessibility to those locations with a HSR station. However, the benefits for the rest of locations of the corridor lacking a train station are difficult to forecast. There is a risk that population and economic activity may transfer to the nearest location with a station, increasing the relative differences –i.e. decreasing cohesion- between regions.

3.2. Description of the HSR corridor and critical success factors

Madrid-Seville HSR covers a 471 kilometres distance trip, with intermediate stations at Ciudad Real, Puertollano and Córdoba. The HSR circulates at a maximum speed of 300 km/h and a commercial speed of 209 km/h (López-Pita & Robusté, 2003). With the opening of the line, travelling time between Madrid and Seville dropped from 6h30 to 2h15, making time competitive with air mode (EC, 1998).

Table 1 shows the results in demand of the Madrid-Seville corridor split by transport mode. Available data show that the modal split between 1992 and 2003 has changed substantially for the three majority transport modes within the corridor; from 16% to 48% for rail (before and after HSR construction), from 11% to 5% for air and from 73% to 47% for road. The HSR transported 6,088,000 passengers in 2003 giving a market share, rail / air, of 91 / 9 %.

Table 1 Historical passenger data from the Madrid-Seville corridor (millions pkm) by transport mode (modal shares in parentheses)

Year	All modes	Road	Air	Rail
1992	2,654	1931 (73)	299 (11)	425 (16)*
1993	2,373	1124 (47)	151 (6)	1,098 (46)
1994	2,630	1294 (49)	144 (5)	1,192 (45)
1995	2744	1300 (47)	150 (5)	1294 (47)
1996	2874	1362 (47)	163 (6)	1350 (47)
1997	3115	1475 (47)	178 (6)	1461 (47)
1998	3400	1610 (47)	182 (5)	1607 (47)
1999	3780	1791 (47)	203 (5)	1787 (47)
2000	4146	1964 (47)	258 (6)	1924 (46)
2001	4427	2097 (47)	253 (6)	2077 (47)
2002	4542	2152 (47)	210 (5)	2181 (48)
2003	4223	2013 (47)	211(5)	2027 (48)

Source: Road data, Ministry for Development, Statistical bulletin Nº 40.2 -25/02/2005; Air data, AENA Traffic statistics 2002 (Seville-Madrid/Barajas); Rail data, RENFE Annual Report 2004a. * Data corresponding to conventional rail because HSR was fully operative since January 1993

The most important factors underlying Spanish HSR passengers' modal choice, according to RENFE (2004a), are travel time and frequency. The HSR offers an average of 24 services per day and direction, with fares from 67 to 122 € in tourist and business classes, respectively. Competitive journey times, high frequency, convenience and punctuality emerge as the strengths of HSR, areas in which improvements had the greatest marketing significance. According to empirical studies, changes in the intermodal structure of travel times appear as the main explanatory factors of the recent changes in the demand for inter-urban rail (Bel, 1997; Jones & Nichols, 1983, Wardman,2000).

Another important variable driving rail's competitiveness in relation to road and air modes is the operating distance intervals. HSR has more potential in medium distances (400-800 kilometres), (EC, 1998).

Finally, changes in the monetary prices do not play any significant role when studying the inter-regional differences in rail demand changes but it is true that they can have some influence on the changes in aggregate levels of inter-urban rail demand (Bel, 1997).

3.3. HSR key performance indicators

The demand in the Madrid-Seville corridor has increased considerably since the opening of the line due to the high frequency, punctuality and quality commitment by RENFE (2004a). Table 2 shows key performance indicators of the corridor and, coupled with the demand, the supply indicators, in terms of seat-kilometres (skm) and train-kilometres (tkm). Utilization indexes, like the occupation rate, ratio between passenger-kilometres (pkm) and skm, and the number of passengers per train had not varied. The quality commitment since the beginning of the service is the reason why the quality index and punctuality have kept constant in this period.

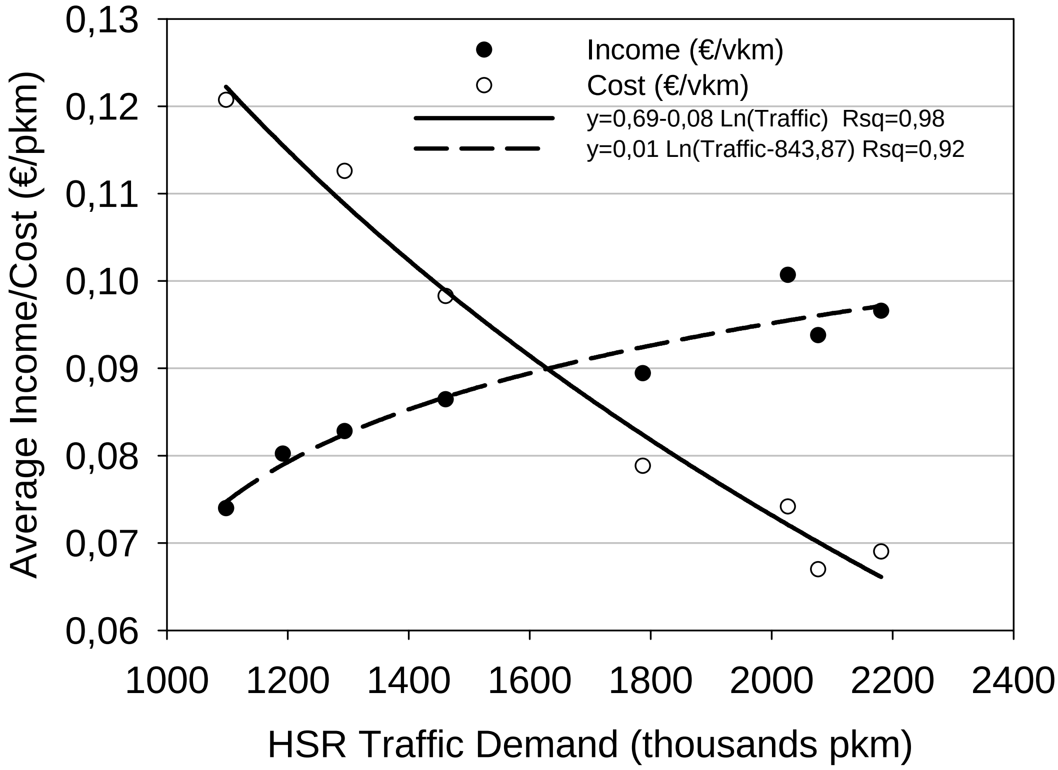
Table 2 HSR Madrid-Seville key performance indicators

Group	Indicatorr	1993	1995	1997	1999	2001	2003	93/03 %
Demand	Traffic (millions pkm)	1098	1294	1461	1787	2077	2027	84,6
Income	Total income (millions €)	81	107	126	160	195	204	151,3
	Average income (€ / pkm)	0,07	0,08	0,09	0,09	0,09	0,10	36,1
Supply	Seats (millions skm)	1682	2049	2331	2763	3239	3193	89,8
	Trains (thousands tkm)	5188	6638	7299	8893	10174	9853	89,9
	Seats / train	324	309	319	311	318	324	0,0
Utilization	Occupation rate (%, pkm / skm)	65	63	63	65	64	63	-2,8
	Income efficiency (€ / tkm)	16	16	17	18	19	21	32,3
	Occupation (passengers / train)	212	195	200	201	204	206	-2,8
Quality	Quality index	9	9	9	9	8	8	-2,4
Punctuality	Punctuality (< 3 minutes)	100	100	99	100	100	100	0,3
Cost	Total cost (millions €)	133	146	144	141	139	150	13,4
	Average cost (€ / pkm)	0,12	0,11	0,10	0,08	0,07	0,07	-38,5

Source: (RENFE,2004a); pkm: passenger-kilometres, skm: seat-kilometres, tkm: train-kilometres, €:Euros at constant prices (1999)

Figure 3 shows the curves obtained when regressing traffic demand of HSR pkm against average income and average costs (expressed in terms of € per pkm), stressing the good working of the corridor. The corridor is economically efficient and its investment is justified specially in cases of congestion of the alternative transport modes (i.e. investment ratio per passenger is higher than in conventional rail lines). From the two curves we found the equilibrium point, where incomes equalled costs; under such circumstances, an amount of traffic of about 1,600 thousand pkm would flow at an operating cost of 0,09 Euros per pkm. Since 1996 onwards the line is economically cost-effective.

Figure 3 Impact of HSR traffic demand on average income and cost



3.4. Environmental imperatives: external cost savings

Regarding to energy consumption and emissions, HSR is an environmentally adapted mode of transport, if compared with road and air. Table 3 compares energy and emission rates of the aforementioned transport modes, highlighting that air and road emission rates are 29 and 5 times higher than rail, respectively.

Table 3 Energy and emission rates of the Madrid-Seville corridor break up by transport mode

	2000	2001	2002	2003
HSR				
Traffic (millions pkm)	1924	2077	2181	2027
Energy consumption (GJ)	519572	571176	576852	562464
Green house gases emission (t CO2 eq.)	75722	74134	89534	
Energy Intensity (GJ per 1000 pkm)	0,27	0,28	0,26	0,28
Emission Intensity (k CO2 eq. per 1000 vkm)	39,35	35,69	41,05	
ROAD				
Traffic (millions pkm)	1964	2097	2152	2013
Energy consumption (GJ)	2993743	3179890	3337292	2991421
Green house gases emission (t CO2 eq.)	207259	220146	231043	207098
Energy Intensity (GJ per 1000 pkm)	1,52	1,52	1,55	1,49
Emission Intensity (k CO2 eq. per 1000 pkm)	105,53	104,98	107,36	102,88
AIR				
Traffic (millions pkm)	258	253	210	211
Energy consumption (GJ)	2471992	2214649	1757525	1709149
Green house gases emission (t CO2 eq.)	171138	153322	121675	118326
Energy Intensity (GJ per 1000 pkm)	9,58	8,75	8,37	8,10
Emission Intensity (k CO2 eq. per 1000 pkm)	663,32	606,01	579,40	560,78

Source: RENFE Sustainability report (RENFE,2004b)

The externalities occurred were computed using the costs ratios for Spain included in the recently published INFRAS study (2004). The methodology estimated external costs of 19,38 € / 1000 pkm for HSR, lesser than road and air, 49,35 € / 1000 pkm and 50,37 € / 1000 pkm respectively). External costs included are: accidents, noise, air pollution, climatic change, urban effects, nature and landscape and upstream effects. To quantify the savings provided by the HSR service, it has been assumed that if the HSR had not existed, 70 % of the passengers who have used it would have used the plane, and the remaining 30 % the car. On the basis of this hypothesis, result show that external cost savings of HSR mode versus road and air was 30,68 € / 1000 pkm. According with this estimate, the 2027 millions pkm in 2003, represent a total of 62 millions € saved in terms of external costs, mainly stemming from the reduction in accident rates and the effects on climate change.

Although the environmental issues have been of irrefutable importance in policy making, their significance in the market is less clear. Empirical studies have showed that environmental concerns have not been important for most travellers' modal choice (EC, 1998). Nevertheless, it appears important for the HSR to appreciate their status as an environmentally friendly transport mode, when future concurrent scenarios between modes will appear, by tackling the environmental problems associated with one's one activities (RENFE, 2004b).

4. CURRENT SITUATION AND FUTURE AIMS

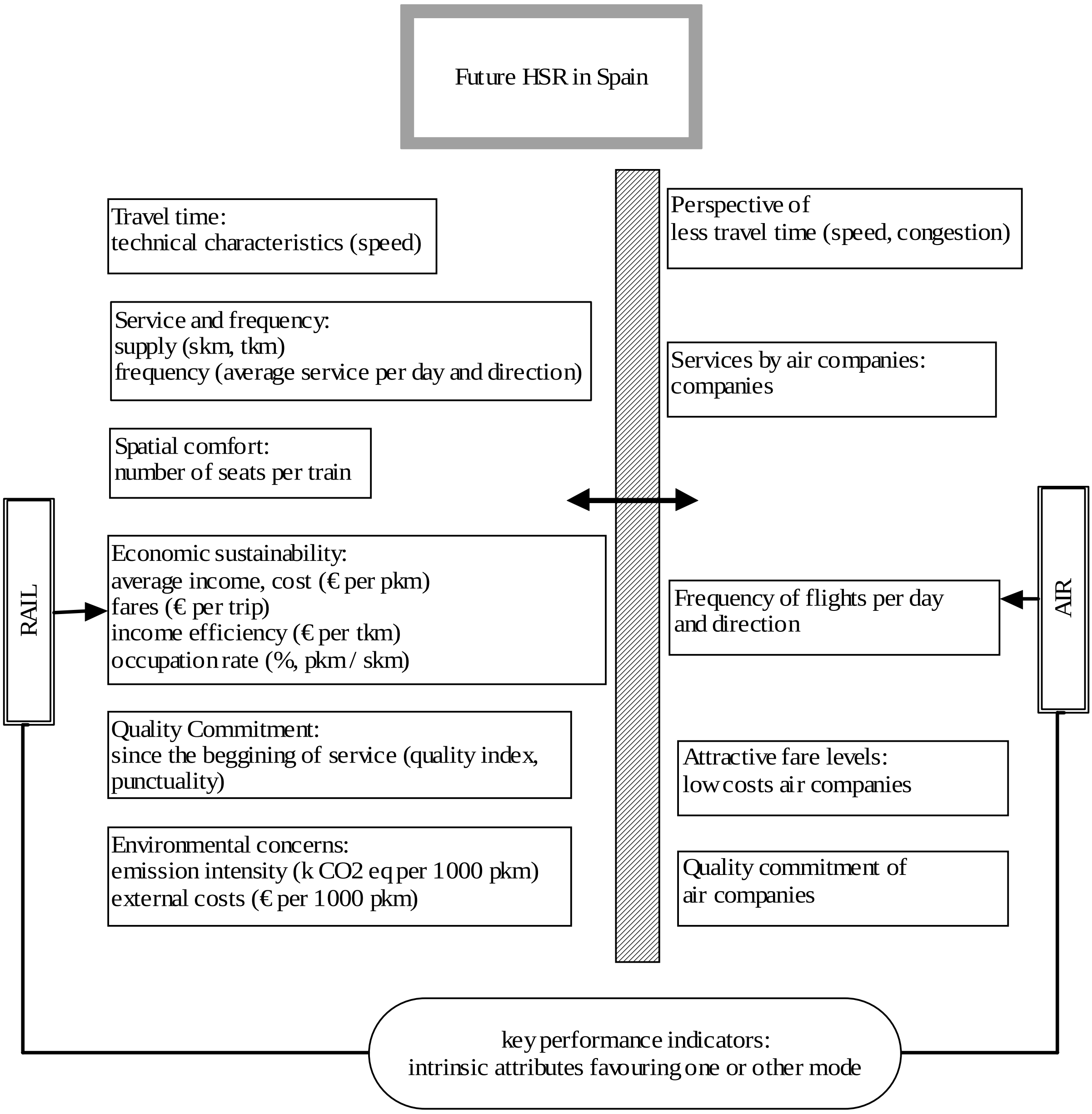
Future developments of new rail lines, like the HSR Madrid-Barcelona (already operative between Madrid and Lerida), are foreseen to be built following the commercial success achieved with the HSR Madrid-Seville. The recently launched PEIT includes the rail infrastructure network planned by 2020. This ambitious Plan needs of new and accurate demand studies which, having a closer look to the air flows, could predict the expected demand of the new lines.

Taking Madrid-Barcelona as an representative example of a corridor with competition from road an air modes, air traffic between both cities has more than doubled in ten years (1991-2001) at an average annual accumulative growth rate of 8,5 %. However, the quality of services has not improved in parallel, showing that flights delayed by over 15 minutes were almost 50%. The length of the HSR line Madrid-Barcelona, 625 km, fits in the range of distances in which HSR has the higher market potential, suggesting that the new line could have a similar result as the Madrid-Seville. According to recent studies, the HSR would achieve a market share of 38-50 % with respect to all modes of transport depending of the operative travelling time (López-Pita & Robusté, 2003).

In general terms, an increasing demand followed by an alternative quality of railway service could warrant the success of the line. In this case, HSR is really attractive to air passengers, particularly regarding travel time but also high quality service.

Figure 4 summarizes different competence situations between rail and air transport modes with relation to new HSR lines. In particular, it stresses the situation where the existence of a very high quality air service, including a quality commitment (return of air fares) and attractive fare levels (potential low costs air companies), could jeopardize the good development of new rail lines. On the contrary, technical characteristics of the new lines, such as higher speeds, together with a quality commitment from the very beginning of the opening of new line would favour them.

Figure 4 Competence between High Speed Rail new lines and Air services



Recently approved transport policy documents and regulations in Spain, along with EU transport policy, support the development of quality HSR services. In particular, on the one hand the new rail Act encourages the sector to be more competitive by opening the market to new operators. On the other, the PEIT includes rail infrastructure development among its top priorities, as a measure to improve the efficiency of the transport system, encouraging the shift to rail from road and air modes. Moreover, increasing environmental concerns, driven by international commitments such as the Kyoto Protocol, will make this transport mode even more attractive when compared to air and road, in particular when trying to reduce green house emissions responsible for climate change.

5. CONCLUSIONS

The HSR Madrid-Seville constitutes a successful example of a policy initiative resulting in a modal shift from air to rail mode. The main factors driving this success have been competitive travel time and high frequencies, along with other factors such as punctuality, competitive fares and convenience. The economic results justified the high cost associated to the HSR line and the reduction and/or delay in other investments (improvement of existing rail network).

This success had important environmental implications. We showed estimates of the external costs savings of the HSR Madrid-Seville, comparing them to the costs of alternative transport modes. According with the results, HSR presents better environmental results than the alternative transport modes. On top of the external costs savings, emission and energy rates showed explicit benefits of using HSR.

The HSR completely transformed the transport system, modifying the share between different modes of transport and shifting passengers away from air. In traffic demand terms, HSR had 91% of the market share with respect to the airplane and 48% with respect all modes (air and road). The consequence of all these modifications will be a more sustainable balance of long distance trip distribution between road, rail and air transport. In this case, the huge investment in this HSR resulted in a modal shift in which rail was the main beneficiary.

The experience learned from this line provides valuable information for the current regulatory and infrastructure planning national context. The new national legal framework, defined by the recently launched Rail sector Act, and the ambitious extension of the HSR network included in the –also recent- PEIT, brings the challenge to ensure the adequate market conditions to guarantee the success of the new lines.

Finally we concluded our study by discussing future scenarios between with relation to the construction of the planned HSR lines in Spain. We highlighted the existence of adequate intrinsic characteristics HSR, such as high quality services, which would justify future developments of new lines in a context of a more sustainable transport and mobility system.

References

Bel,G., 1997. Changes in travel time across modes and its impact on the demand for inter-urban rail travel. Transport Res. -E (Logistics and Transp Rev.) 33, 43-52.

European Commission, D.G.T., 1998. Interaction between High-Speed Rail and Air Passenger Transport - Cost 318 - Final Report of the Action. COST 318, 324 pp. Brussels, European Commission Directorate General Transport. Transport Research.

European Commission, 2001. White Paper – European Transport Policy for 2010: Time to Decide. Office for Official Publications of the European Communities. Luxembourg.

Guirao-Abad,B., 2000. El cálculo del tráfico inducido como herramienta en la planificación de las infraestructuras de transporte. Aplicación de la puesta en servicio de las nuevas líneas ferroviarias de alta velocidad en España. 312 pp. UPM.

INFRAS, 2004. Hadbuch Emissionsfaktoren des Straßenverkehrs, Version 2.1. INFRAS AG –IWW Karlsruhe. Bern/Zurich.

Izquierdo,R., Vassallo,M., 2004a. El nuevo modelo ferroviario español. In: Izquierdo,R. (Ed.)., Nuevos sistemas de gestión y financiación de infraestructuras de transporte. Colegio de Ingenieros de Caminos, Canales y Puertos, Madrid, pp. 559-610.

Izquierdo,R., Vassallo,M., 2004b. La Ley del sector Ferroviario: un nuevo marco normativo del ferrocarril. In: Izquierdo,R. (Ed.)., Nuevos sistemas de gestión y financiación de infraestructuras de transporte. Colegio de Ingenieros de Caminos, Canales y Puertos, Madrid, pp. 541-558.

Jones,I.S., Nichols,A.J., 1983. The demand for inter-city rail travel in the United Kingdom. Journal of Transport Economics & Policy 17, 133-153.

López-Pita,A., Robusté,F., 2003. The Madrid-Barcelona high-speed line. Proceedings of the Institution of Civil Engineers-Transport 156, 3-8.

Ministerio de Fomento, 2004. Plan Estratégico de Infraestructuras de Transporte. Documento Propuesta. Secretaría de Estado de Infraestructuras y Planificación. Madrid.

RENFE, 2004a. Annual report. Dirección de Comunicación Corporativa y Relaciones Externas. Madrid.

RENFE, 2004b. Sustainability report. Alta velocidad Renfe. Gabinete de Calidad y Medio Ambiente. Madrid.

Wardman, M., 2000. Rail network accessibility and the demand for inter-urban rail travel. Transport Reviews 20, 1, 3-24.