Review Paper
Lessons for Policy Makers in Non-High Speed Rail Countries: A Review

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Abstract:
High speed intercity passenger rail is an inherently strong railway application. It operates over 250 km/hour. For perspective, high-speed represents the ultimate development of preexisting standard gauge infrastructure. Network of high-speed passenger rail lines aimed at reducing accident, reducing traffic congestion, air pollution cutting national dependence on foreign oil and improving rural and urban environments. In implementing such a program, it is essential to identify the factors that might influence decision making and the eventual success of the high-speed rail (HSR) project, as well as foreseeing the obstacles that will have to be overcome. In this paper we review, summarize the most important HSR projects carried out to date around the globe, namely those of France, Germany, Spain, Japan and China. We focus our attention on the main issues involved in the undertaking of HSR projects: their impact on mobility, the environment, the economy and on urban centers. By so doing, we identify lessons for policy makers and managers working on the implementation of HSR projects in Egypt. The conclusion is that there is likely to be a good case for the lessons to benefits in Egypt and developing countries.

Keywords: High-speed rail, transportation between cities, government investment, transport planning, and rail costs

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1. Introduction

Modern European and China interest in high speed trains (HST) begun in a relatively modest way, with the new line in Paris (opened in 1981 (Paris to Lyons), a number of new stretches of high speed line (HSL) in Germany. From these isolated national beginnings, the International Union of Railways (UIC) provision developed the concept of a European Master plan covering the entire continent with new and upgraded HSL. This plan became less a pipedream and more a practical reality as France expanded their plans into whole networks of new lines, and new countries added their own proposals to the list - Britain, Belgium and the Netherlands through the construction of the Channel Tunnel and its associated HSL. Spain, through the Madrid-Seville new line and the proposals to link Madrid and Barcelona to each other and to the rest of the European network. Austria and Switzerland with their ambitious upgrading plans and finally the countries of Eastern Europe following the collapse of communism and the growth of East-West links. In addition, The first Chinese HSR connection was inaugurated in 2008 between Beijing and Tianjin. China has the world's longest HSR network with about 9,676 km of routes in service as of June 2011. In early 2013, there were more than 20,700 kilometers of new HSR lines in operation around the world and about 14,600 kilometers under construction to high speed services [UIC, 2013]. The HSR is a brand new rail technology developed in the 20th century, which consists of a special infrastructure that allows trains running at a speed over 250 km per hour. Previous research of proposal HSR lines in developing countries contemplate three high-speed rail corridors in Egypt, ranging between 200 and 900 km in length, as potential recipients (see Figure 1). Therefore, in these countries, such as Arab countries the design speed of the trains is 120 -160 km/h for passengers [Choueiri, 2010]. Moreover, the average operation speed for the passenger trains is between Ø = 100 - 130 km/h , in a few cases less than 100 km/h [Mohammed A. D, 2007]. From this point, came several questions such as what is the feasibility and opportunities for the creation of proposal HSR in emerging and developing countries, for instance in Egypt (see Figure 1), and what is the extent benefit of the lessons from a comparison of HSL in other countries. The aim of this paper to consider the relevant factors which should be taken into account in such an appraisal, and to review the evidence on the benefits and costs of HST such as it is at the present time. This article will provide interesting and useful lessons from worldwide experiences on policies such as congestion. In this work we review, summarize, the results of studies that have examined the five most prominent cases of HSR implementation: Japan, France, Germany, Spain, and China. These countries have built relatively extensive HST networks to reduce rail travel time between their main cities. By identifying and examining the factors leading to different outcomes in these countries, this article offers valuable lessons learned from the building and operation of HST networks for policy makers, planners, and transportation managers in Egypt. Thus, it will review the evidence on the benefits and costs of HST such as it is at the present time. This article is organized into five sections beyond this introduction. First we list the relevant costs and benefits as we perceive them. Next, we briefly discuss the most relevant issues involved in the building and operating of high-speed rail systems. Then, armed with the guidelines extracted from this discussion, we proceed to review the aforementioned international experiences, which is the core of this article. We are then able to discuss useful lessons for Egypt and developing counties policymakers and planners. Finally, we consider some concluding remarks are recorded before we present our conclusions.

2. The Case for the High-Speed Train: Relevant Issues

By reviewing the cases of European and Japanese HSR networks, it will seek to extract lessons for the Egypt HSR proposal. In the following section, the structure of our review in each case will address: main motivation; network design and functions; economic costs; environmental costs; mobility impacts; and economic and regional effects.

2.1 Main Motivation

The first problem we address are the reasons that led to the creation of an HST network in each of the countries studied. Many of reasons can stimulate the

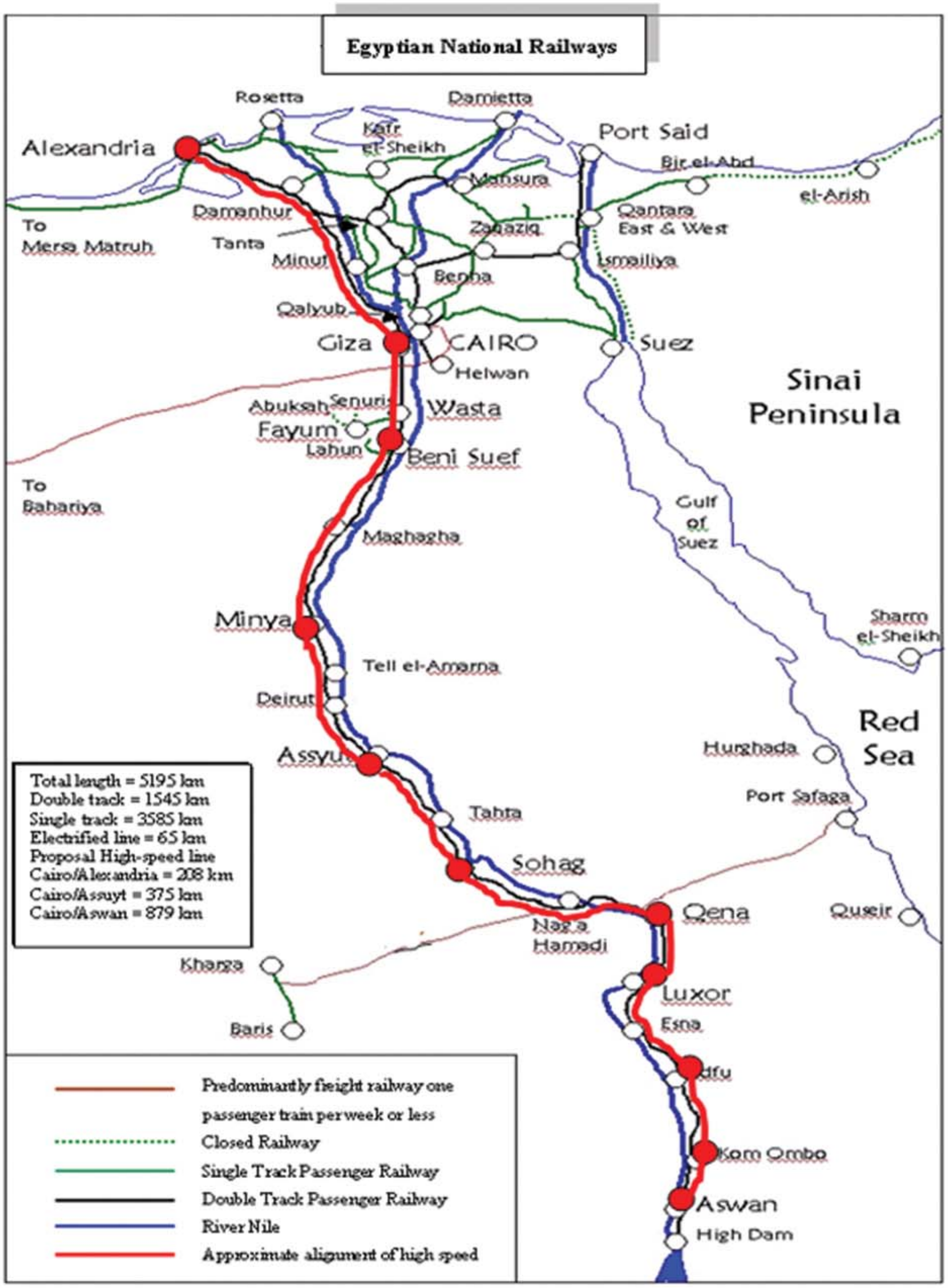

Figure 1. The ENR Network and the Proposal High-Speed Line.

building or upgrading of rail networks to high-speed systems. Among others, congestion is the leading inefficiency factor that can justify capacity investments seeking travel time savings, accidents and boosting productivity. Nevertheless, infrastructure networks become an essential source and means of economic and regional development and this feature may also affect public decisions on route location.

2.2 Structure: Rails, Functions and Geography

Urban structure normally shapes HSR-network needs and their design, as do the functions they seek to achieve, be they of an economic or political nature. For example countries have chosen to construct new

HSR lines exclusively for passengers, while others have promoted a more efficient mobility of freight by upgrading existing infrastructure on a shared track for passengers and freight, even at lower speeds and by incurring higher costs. Politically centralized countries (such as France) have tended to design networks that link the capital to its peripheral centers. By contrast, decentralized countries (such as Germany) have tended to build more territorially balanced networks. A further decision regarding network design is the ability to use conventional lines to reach city centers. By making this choice, construction costs can be reduced, although there is a parallel drop in commercial speeds.

2.3 Economic Costs

HST services offer a punctual, comfortable and rapid mode of transport, and are highly competitive over medium distances (between 160 and 800 km), since by connecting city downtowns they avoid the need to commute from the airport and the inconveniences of traffic congestion. This said, HST links involve huge investment costs, which will vary with network decisions and their functions. Because of these costs –which are designed to create a very high capacity service - high-speed rail generates more economic benefits as the volume of traffic increases [de Rus and Nash, 2007]. Construction costs, together with the associated operating costs, requirement of the social suitability of undertaking HST projects; therefore, cost benefit analyses are necessary. In this review will pay special attention to the way in which network and design decisions affect investment, as well as the circumstances under which this huge fiscal effort is socially profitable. In short, we seek to determine what can be expected from each euro spent on the project.

2.4 Mobility Impacts

As an HST service enters a given corridor as a new or upgraded transport mode, its performance can attract new passengers, as well as those that had previously been using air, road or traditional rail services. Thus, upgrading rail transportation is expected to affect the airline industry and road usage over medium distances. The European Commission, 1996 provides data on changes in modal shares following the introduction of HST on the Paris- Lyon (France) and Madrid-Seville (Spain) lines. In the first of these (Paris-Lyon), between 1981 and 1984, the modal share of air traffic fell from 31 to 7%, and that of car and bus traffic fell from 29 to 21%, whereas rail traffic rose from 40 to 72%. In the case of the Madrid-Seville line, between 1991 and 1994 the modal share of air traffic fell from 40 to 13%, and that of car and bus from 44 to 36%, while train increased from 16 to 51%. Hence, as modal shares are subject to dramatic changes, this review highlights the ways in which the introduction of an HST line can alter the modal split between two cities.

2.5 Environmental Advantages

As HSR is more environmentally efficient than its natural competitor – the airline industry - making medium-distance transportation more environmental friendly is an obvious rationale for building HST networks. However, the building and operation of HSR systems are also responsible for environmental damage, in terms of land take, noise, visual disruption, air pollution and the increase in the global warming effect because of the high consumption of electric energy.

2.6 Economic and Regional Effects

It can be said the most interesting effects are the economic and regional impacts of HST networks. Does HSR generate new economic activities and promote job creation? Which sectors benefit most from HSR systems? Does HSR increase regional productivity and cohesion? Does HSR affect firm location decisions? On these issues, [Esteban Martín, 1998] claims that cities served by HSTs benefit from improved accessibility, but at the same time there is a downgrading of traditional train services and air services on those lines where a HST alternative exists. While business tourism and conferences benefit from HST services, a reduction in the number of overnight stays cuts tourist expenditure and the consumption of hotel services. Interestingly, while a HST line improves accessibility between the cities connected by the service, it disarticulates the space between these cities- what has been referred to as the tunnel effect [Gutiérrez, 2005]. Hence, HST lines do not seem to increase inter-territorial cohesion, but rather they promote territorial polarization.

3. International Experiences

In this section we apply our simple implementation framework to five key cases of HSR network development in the world : Japan, France, Germany, Spain, and China. Our inquiry is based on a review of the extant literature of these cases, as well as on our own research data. While there have been several studies on each of these cases individually, no study to date has combined analyses across a large number of cases. Unlike studies that examine only one case or, perhaps, compare two, our review allows us to draw general lessons for policy makers, planners and transportation managers to apply that in the Egypt. We have selected these five cases because they are the most thoroughly documented experiences and there is sufficient information to record results and to draw conclusions.

3.1 Japan: 'Shinkansen'

One way to see how well high-speed rail might work in the Egypt and other developing countries is to examine the experiences in other countries. The natural place to start is Japan, the first link in its network, connecting Tokyo to Osaka, came into service in 1964, which opened the world's first high-speed rail line, the 210 km/h Shinkansen (or bullet trains). The main motivation underlying this policy was to promote mobility demand in this corridor due to the rapid economic growth experienced after World War II. Today, the Shinkansen network crosses Honshu Island – the nation's largest island - and serves more than 300 million passengers each year.

The regional structure of Japan, with large metropolitan centers located a few 161 km apart with a high demand for travel, has favored HSR [Givoni, 2006]. The network was given a new, purpose built infrastructure with a different track gauge and specific vehicles designed to offer commercial speeds of 210 km/h, with a current top speed of 300 km/h. Although the service was designed to serve both freight and passengers, the large passenger demand and maintenance needs carried out mainly at night favored a passenger orientation. In addition, its separation from the conventional rail service allowed HSTs to avoid problems derived from these conventional services and its ageing infrastructure.

Table 1. Shinkansen construction costs

Line	Year	Total Cost (nominal $US billion)	kilometer	Cost per km (nominal $US million)
Tokaido	1964	0.92	559	1.65
Sanyo	1975	2.95	626	4.71
Tohoku	1985	11.02	540	20.41
Joetsu	1985	6.69	337	19.90

Source: [Taniguchi, 1999]

Construction costs for the 559 km between Tokyo and Osaka rose to $0.92 billion in 1964, while the Sanyo (626 km), Tohoku (540 km) and Joetsu (337km) lines were considerably more expensive (Table 1). The cost share attributable to infrastructure (cuttings, banks, viaducts, bridges, tunnels) on the Sanyo line (58%) was the highest, according to [Taniguchi, 1992]. Land price, the second most important share, represented a quarter of total costs. Tunnels and bridges built along the route meant costs were high. Indeed, 30% of Japanese lines run through tunnels [Okada, 1994]. Moreover, building links into city centers added both to the complexity of the operations and to overall costs.

Demand forecasts proved to be underestimated. While the number of passengers-km (million) was 11,000 in 1965, in just ten years it had risen to 35,000. Time savings are estimated at 400 million hours per annum. Cities with HST railway stations achieved average rates of 1.6%, while those by passed by the service only increased at a 1% rate [Hirota, 1985]. It was found that HST stations resulted in marginal population impacts, and that these were more marked in cities with an information exchange industry, access to higher education and expressway access [Nakamura and Ueda, 1989]. Employment growth in retail, industrial, construction and wholesaling was 16-34% higher in cities with a HST station [Hirota, 1985] and land value increased by 67%.

Studies of the economic impact of HSR show that services was the most favored economic sector in Japan. Service industries became highly concentrated in the cities of Tokyo and Osaka, resulting in the centralization of this sector in the country's major nodes. Indicative of this trend is the fall in employment in Nagayo, a city located between Osaka and Tokyo, following the inauguration of the HST line. According to this fall was estimated at around 30% from 1955 to

1970 [Plaud, 1977]. For the same period, the increase in employment in Osaka, Kyoto and Kobe was 35%. Tourism also showed significant growth rising from 15 to 25% between 1964 and 1975. In the case of the retail industry, Tokyo would appear to be the dominant force following the opening of the HST service.

3.2 France: 'Train à Grande Vitesse' (TGV)

The level of congestion on the rail link joining Paris and Lyon – the gateway to south-east France - led to the introduction of an HSR service in France with the building of a new, separate network. The line was named "Paris Sud-Est" and was constructed between 1975 and 1983. The total number of rail passengers increased following its inauguration, rising from 12.5 million in 1980 to 22.9 million in 1992 – 18.9 million of whom were TGV passengers according to [Vickerman, 1997].

Its success led to the promotion of an investment plan that provided the funds to construct connections from Paris to Le Mans [1989], Tours [1990] and Calais [1993]. The Rhone-Alpes [1994] and the Mediterranée [2001] were the next corridors to be served. Today, France's HST network comprises 1550 km of line. Indeed, France decided only to create a new, separate network along congested links, and to use conventional services along less crowded connections and for accessing big cities when construction and expropriation costs were likely to be exorbitant. As a result, and in contrast to Japan, France has a mixed HST infrastructure system. In fact, the current share of specific HST lines over total network is just 37%, serving more than 100 million travelers. However, even with this system, commercial speeds fluctuate between 240 and 320 km/h, but are lower on the conventional network (210 km/h). All in all, HST has meant an 80% increase in speed on average.

An interesting policy implemented at the regional level involves the development and improvement of the regional rail services that serve the nodes with HST railway stations so that benefits can be spread more widely and overall accessibility be enhanced. This strategy has resulted in an even greater increase in HST network traffic than was predicted - in the cases of St. Etienne, Marseille and Annecy the traffic volume was twice that expected by 1984 [Vickerman, 1997]. The cities of Mâcon, Le Creusot, Montceau and Montchanin illustrate the failure of this strategy [Martí Hennenberg, 2000]. In Montchanin the HST link has attracted just four firms, creating 150 new jobs.

The French TGV lines were financed primarily according to their profitability, with an expected 12% minimum financial and social rate of return. This has been surpassed on several lines [Vickerman, 1997]. For example, the Sud-Est link is estimated to have provided a 15% financial rate of return, but a 30% return in social terms. It had already been amortized by 1993, just 12 years after coming into service. However, the other lines have provided lower rates of return.

Table 2. TGV Infrastructure Costs

Line	Year beginning operation	kilometer	Cost per km $US million
Paris- Lyon	1981	425	4.35
TGV Méditerranée	2001	250	11.80

Source: [Campos and de Rus, 2009]

In fact, the most important node is the one that benefits most from HST [Arduin, 1991]. The Paris-Rhône-Alps route illustrates this point, as flight and train journeys to Paris increased by 144%, while journeys in the inverse direction only experienced a 54% increase due to the HST connection. This means that round trips originating in Paris increased much less than round trips originating at the other end of the city-to-city connection. Although a compatible network allowed the HST network to be extended, the region surrounding Paris has been the one to enjoy the largest increase in its HST supply mainly due to the spatial concentration of population.

Finally, as in Japan, HSR has promoted the centralization of economic service activities in big nodes and favored intra-organizational business trips. Such trips originating in Paris are up 21%, while those with Paris as their destination are up 156% [Rodríguez, et al.2005]. By contrast, the impact on industrial activities has been largely irrelevant.

The impact of HSR on business location decisions within the service sector also seems negligible. Mannone [1995, 1997] designed a survey to review how the HST was viewed by firms established in Dijon, the capital of the French region of Bourgogne, between

1981 and 1994. One third declared that HST was a factor they considered in their decision, but only 4 firms from a total of 663 claimed it was a key determinant in their choice of location. Similar results were obtained in Valence and Avignon. Consequently, it is consistently found that the HSR has neither accelerated industrial concentration nor promoted administrative or economic decentralization from Paris [Martí, 2000].

3.3 Germany: "Neubaustrecken"

The German InterCity Express (ICE) arrived a decade after the French TGV (1991). There are several reasons for this delay. Besides the obvious problems of constructing an HSR system in the country's mountainous terrain, it proved considerably more complicated to obtain the necessary legal and political approval for building to start [Dunn and Perl, 1994]. Furthermore, the rationale underpinning the HST network was somewhat different in Germany. Given the west-east orientation of the rail network constructed before WWII and the current north-south patterns of industrial cooperation, Germany sought to reform the network so as to facilitate freight transportation from the northern ports to the southern industrial territories. For this reason, the first two new lines were those linking Hannover and Würzburg and Mannheim and Stuttgart, respectively. The main goal was to solve congestion problems in certain corridors and to improve north-south freight traffic. Following the country's political reunification the need to connect east and west became an additional priority, which explains why the Hannover- Berlin and Nuremberg-Leipzig corridors were the next links to be constructed [Gutierrez, 2005]. Thus, there are considerable differences between the German strategy and the models adopted by Japan and France. Instead of building new exclusive high-speed lines, Germany chose to operate a system that would serve freight traffic too [Dunn and Perl, 1994]. The result has been much higher upgrading costs and, arguably, operating costs but the industrial centers served have enjoyed greater benefits [Haynes, 1997]. Therefore, in most instances Germany did not build a separate HST rail network, but rather upgraded existing lines. This means the network is shared by high-speed and more conventional passenger trains together with freight trains and the country has renounced higher commercial speeds (with a maximum of >240-260 km/h). Nevertheless, the HST system still offers commercial speed gains of around 60%.

The average increase in the market share achieved by the introduction of the HST was 11%, while the average net revenue per train-km of the ICE service was 1.7 times higher than the average for its other long distance services [Ellwanger and Wilckens, 1993]. However, from the financial perspective, building delays and Germany's topography resulted in higher than expected construction cost overruns, as well as operating deficits and increasing debt burdens, which increased the financial pressures to reform the system. [Dunn and Perl, 1994]. As a consequence, the German lines have been much more expensive than the French lines, a situation that can be attributed to the more challenging nature of the terrain, its urban structure and various political and legal obstacles. Furthermore the network only serves around 67 million passengers a year. For this reason, the utility of continuing investment in HSR is being questioned, since it is seen as an expensive solution that might not provide the environmental gains that could be achieved with a more restrictive approach to road transport [Whitelegg, 1993; Vickerman, 1997].

Operational deficits are due in large part to the widespread nature of the German population and the small average size of German cities. The urban structure of Germany lacks France's monocentric focus and so for many years the country's intercity rail system had been based on a complex, interlinking network of services with interchanges that provided regular hourly or two-hourly connections between most major German towns and cities, and more frequent services on certain key lines [Vickerman 1997]. This means there are few corridors providing sufficient demand. Compared to the 9 million annual passengers using the HST link between Koln and Frankfurt, the Paris- Lyon link can boast 20 million passengers and the Tokyo-Osaka link 130 million; i.e., more than 10 times the Koln-Frankfurt figure. Likewise, low population densities lead to higher accessibility needs, which usually result in high regional transportation costs and shorter distances between stations, which in turn negatively affect commercial speed.

Table 3. Construction costs of the first HST lines in Germany (US$ Million)

Line	Cost per km $US million
Hanover- Würzburg	23.11
Mannheim---Stuttgart	22.92

Source: [European Commission, 1996]

3.4 Spain: 'Alta Velocidad Española' (AVE)

The first Spanish HST link, the AVE, was inaugurated in 1992 between the capital Madrid and Seville on the eve of the Universal Expo'92 held in this southern Spanish city. The train covers the 515 km between the cities in just 2 hours 15 minutes (direct service). By choosing Seville, Spain has been the only country not to start its HST in the most congested corridors of the country or to connect its most populated cities, although the conventional link south was arguably somewhat congested. A number of studies point to a political rationale, underlying a strategy aimed at promoting economic development in the country's poorer regions and at favoring cohesion. Thus, territorial equity was the main reason for the choice of this line, which represented a high social cost to the economic system [Sala-i-Martin, 1997].

Spain decided to construct a separate HST network, as had been done earlier in Japan and France, although in these two countries conventional railway lines are also compatible. Moreover, Spain opted to buy in rail technology rather than developing its own [Vickerman, 1997], which is another distinguishing feature from the projects implemented in the other countries studied. In spite of good occupancy rates, infrastructure utilization of this line is under capacity given its length and relative isolation, but particularly because of the small population being served [Martí-Henneberg, 2000]. The HST has had, however, a marked impact on mobility patterns. Before the introduction of the AVE in 1992, the combined number of rail and air passengers traveling between Madrid and Seville stood at around 800,000 each year. According to [Menendez, 1998], just three years later, in 1995, HST recorded 1.4 million passenger journeys, while the numbers of those flying fell to 300,000. No effects have been reported for the interurban bus service, which has continued to carry around 200,000 annual passengers in that period.

Indeed, commercial speed gains in Spain are over 100% with the AVE capable of a maximum speed of 350 km/h. In terms of its economic impact, [Martí-Henneberg 2000] confirms that investment has not been guided by attempts to increase economic dynamism around AVE railway stations. Neither has it led to new firms establishing themselves within their vicinity. Yet, the image of cities with AVE stations has been enhanced and firms already established in these locations have benefited from this new transport infrastructure. It has also been argued that sizeable land value and population increases have resulted from AVE construction. However, [Albalate and Bel 2008] report that Ciudad Real and Puertollano, two cities served since 1992 by AVE, did not experience higher rates of population growth than other cities in the region between 1991 and 2001.In fact, all investment (amounting to 82.96 billion euros) in the country's strategic plan (PEIT) is to be devoted to HSR until 2020 [Bel, 2007], when 9982 km of the AVE network are expected to be in service. These plans are rooted in the desire to build a rapid connection between all the provincial capitals in the country and the political capital, Madrid, as formulated by former Prime Minister José María Aznar on 25 April 2000. Thus, the rationale for extending the network in Spain is to fulfill the political aim of centralizing rail connections.

Table 4 shows the building costs for the most recently constructed AVE lines in Spain. Although the Madrid-Barcelona line has the lowest cost per km, construction of the first stretch between Madrid and Lleida (435 km), which started in 1996, was not completed until 2004 and the AVE did not reach Barcelona until February 2008. As no information is available for separate stretches on the Madrid-Barcelona line, we are only able to give total investment figures. Thus, the 12-year investment on the Madrid-Barcelona link ($US 10,600 million) is lower than that for the Córdoba-Málaga and Madrid-Valladolid projects, which were completed relatively quickly between 2004 and 2007.

Table 4. Construction costs of the most recently inaugurated Spanish AVE lines

Lines	Length km	Construction costs (nominal terms ($US million)	Cost per km ($US million)
Madrid-Valladolid	180	6.307	35
Córdoba-Málaga	155	3.808	65
Madrid-Barcelona	621	10.624	18

Source: Authors' own calculations based on information from the Spanish Ministry of Transportation.

As regards the environmental impact of the AVE, we are able to evaluate its CO2 emissions with respect to those produced by conventional trains. Data presented by [García Alvarez, 2007] on distances, emissions and passenger capacity means we can compare CO2 emissions per passenger-km on three Spanish HST lines and their corresponding conventional rail services.

3.5 China: 'China Railways High Speed (CRH)'

China, the world's most populous nation, has joined other countries in the development of high-speed rail and will soon become the country with the most kilometer of high-speed rail tracks. With an existing conventional rail network of 91000 km reaching its operating capacity due to an expansive growth in the last decade, the Chinese government has sought the opportunity to expand and upgrade the network with a very ambitious plan that is to be completed by 2020.

China planned passenger-dedicated HSR network consists of four north-south HSR corridors and four east-west HSR corridors, with a total of 16,000 km of dedicated high-speed rail lines connecting all of China's major cities by 2020 [Xinhua News Agency, 2008], the country will have more high-speed rail track kilometer than the total length all of the high-speed tracks in the world [Kang, 2010]. A total investment of $118 billion USD will be invested by 2012 [Zhao, 2010].

The average operating speed for the Chinese high-speed lines is 260 km/h with a maximum speed of 350 km/h. The 1318 km corridor runs in a north-south direction connecting these two cities in 5 hours, provides a 64% travel time reduction and is expected that its annual ridership exceeds 160 million passengers. As with other developments of high-speed rail in China there has been active participation of the private sector in the financing of the line through private pension funds, insurance and investment companies. High expectations and confidence exists amongst the investors that the system will generate enough revenue to repay loans and costs [Chen, 2009].

Construction of dedicated high-speed passenger lines is proceeding in several new corridors simultaneously. The Guangzhou-Wuhan-Zhengzhou-Beijing line (2,100 km) is being built in four sections. The construction of the southern section, Guangzhou-Wuhan (1,068 km), started in June 2005 and, as noted in Section 1, opened in early 2010 at a cost equivalent to about $17 billion USD; the trains on this section have a top speed of 394 km/h. Non-stop trains on this line travel at an average commercial speed of 350 km/h, significantly faster than in Japan and France. The remaining three sections of Beijing- Guangzhou, between Beijing and Wuhan (1,100 km), are scheduled for commissioning in 2012. Other dedicated high-speed passenger lines the Beijing-Shanghai line, where construction began in early 2008 and opened in 2011. It is estimated that as many as 110,000 to 120,000 workers are engaged in building the line, which will cost an estimated $ 33 billion USD. The terminal-to-terminal time will be reduced from ten to about five hours [Ten Huang, 2011].

Table 5. Construction costs of HST lines in China (US$ Million)

Main lines	HST Lines km	Construction costs (US million)	Cost per km ($US million)
Wuhan – Guangzhou	1068	17,000	15.92
Beijing-Shanghai	1318	33,000	25.04

Source: [Ali, 2012]

4. Lessons from Worldwide Experience

This journey across countries and continents to examine the different HSR experiences provides some important lessons that should not be ignored when considering future extensions of HSR, in the Egypt and elsewhere. Based on the case studies reported above, we are now in a position to highlight a number of useful lessons for those proposal HSR project in Egypt. This should ensure that it achieves its maximum potential and avoids the most frequent obstacles.

4.1 Motivation

HSR projects seem to make most sense when they seek to solve capacity restrictions, lightening congestion in certain corridors, and when facilitating industrial connections by enhancing accessibility for freight transportation. The linking up with other corridors to promote regional equity or to foster regional development only seems to result in the economic failure of the project.

4.2 Structure: Design and Functions

Perhaps the first major decision to be taken is whether to run a joint passenger/freight network. Some countries have chosen to build high-speed lines exclusively for passenger services; others have chosen to share the upgraded tracks with freight transport even though this means renouncing higher speeds and accepting higher costs so as to promote industrial connections. As few economic impacts are directly attributable to passenger HSR, it seems reasonable to not allow freight transportation, especially in Egypt where a much lower share of freight is transported by rail than is the case in Europe, Japan and China.A other lesson to be learnt from network design concerns decisions regarding which routes to implement. Routes have to be established between the most highly populated centers so as to ensure satisfactory occupancy rates and to guarantee that the service can break even, particularly in light of high construction and operation costs. This is the case in France, where HST lines are centered on Paris to reflect the country's strong political, economic and demographic centralization. Given the centralized regional structure of the Egypt, with its the same mega-regions, a more centralized network connecting these hubs would seem to make better sense. A further point to bear in mind is the fact that European, Japanese and China downtown areas are Less dense than their Egypt counterparts. For this reason, the Egypt HSR project will reap the benefits of one of the main comparative advantages of HSR, namely city center connection.. Finally, it should be pointed out that HSR stations located outside the downtown district and without adequate multimodal connections are usually unsuccessful.

4.3 Economic Costs

The development of an HSR network entails huge construction and operation costs. The key decision at the outset, as discussed above, concerns the complementarity of carrying passengers and freight. Complementarity with freight transport increases costs, since the track gradients have to be more carefully controlled. However, making freight carriage compatible with that of passengers can boost industrial productivity and increase connectivity between industrial areas and airports, ports, and logistic areas. Investment in HSR is difficult to justify when the expected first-year demand is below 8–10 million passengers for a line of 504 km, a distance at which HSR's competitive advantage over road and air transport is clear [de Rus and Nombela , 2007]. The economic rationale for new HSR infrastructure depends heavily then on the expected volume of demand. Thus, building an HST line should only be considered in the case of links with high demand expectations for rail travel, i.e., routes connecting densely populated metropolitan areas, with severe problems of road congestion, and a deficient air connection. This economic framework hinders the use of public-private partnerships (PPPs) in HSR projects.

4.4 Mobility Impacts

HSR provides significant travel time savings when compared to conventional rail services, but similar door-to-door timings are reported for air transportation on routes of around 644 km. However, HSR provides a highly reliable service with average delays of just two minutes and it can offer considerable advantages in terms of comfort, the fact that passengers can use their electronic devices while in transit and are subject to less rigorous security restrictions and controls. Its comparative advantage would seem to lie on routes that range from between 160 to 800 km. Over shorter distances, HSR finds it difficult to compete with road transportation, while over longer distances air transportation takes the upper hand.The modal distribution of traffic has been affected by the introduction of HSR in all the cases studied, having the greatest impact on the airline industry in France and Spain. As Table 5 highlights, immediately following the inauguration of the HST service, the share held by air transport fell significantly in both countries. Similarly, road transportation has suffered from competition from HST, albeit to a lesser extent. Surprisingly, the impact on the modal shares of the Paris-Lyon and Madrid-Seville lines were very similar according to the European Commission [1996]. Recent data on the traffic between Barcelona and Madrid, the main air corridor in the Spanish airline market (and indeed in the entire world market, with almost five million passengers per year in 2007), show that after a year of HST service a third of air traffic has switched to rail.

Table 6. Modal share change before and after the introduction of the first HST corridor.

Mode	Paris-Lyon (1981-1984) 425 km	Madrid-Seville (1991-1994) 470 km
Airports	-24	-27
Rail	+32	+35
Road	-8	-8
Total	37	35

As the result in the Egypt case can be show in the Figure 2 as the following. The induced demand model is based on a relationship between existing models demand (dependent variable) to existing models travel times and costs. The covariates include socioeconomic variables related to population and employment in the zones connected by the proposal HSR services. This model was calibrated by mean of a before study carried on travel in the proposed new lines in Egypt, when the new HSR services was proposed. The application of the models system to hypothetical transportation scenarios has shown the following Table:

Table 7. Elasticity ranges in fares price and time for proposal corridor in Egypt

Elasticity HSR to other transport Model		Cairo/Alexandria		Cairo/Luxor-Aswan	
		Cost	Time	Cost	Time
Proposal HSR	Air	-2.1	-2.23	-1.28	0.85
	Car	4.74	-1.68	6.0	-2.03
	Conventional Rail	3.02	-2.23	5.26	-2.85

The model will be applied to predict the impacts on national passenger volumes, of the new proposal HSR services and operators. Different scenarios will be tested for different macroeconomic assumptions and marketing strategies of the main passenger transportation competitors on the long distance.

4.5 Environmental Advantages

There has yet to be a detailed, systematic evaluation of the impact of an expanding HST network on the reduction in CO_2 emissions at either an aggregate or country level. However, information is available on the environmental effects of HSTs, particularly as regards their energy consumption. According to estimates conducted by [van Essen et al 2003], energy consumed per MJ/seat km by air transport is 240% higher than that attributable to HSTs. However, the energy consumed by HSTs is 12.8% higher than a petrol-driven car when traveling on the motorway, 55.9% higher than a diesel-driven car on the motorway, and 140.9% higher than an intercity train. [van Wee, van den Brink and Nijland, 2003]. In the most favorable analysis for HSTs –conducted by [García Álvarez, 2007] for Spain, HSTs and conventional trains were reported as producing similar emissions on two of the lines analyzed, while the conventional train was much more efficient on the remaining line.

4.6 Economic and Regional Impacts

It is consistently reported that HSR does not generate any new activities nor does it attract new firms and investment, but rather it helps to consolidate and promote on-going processes as well as to facilitate intra-organizational journeys for those firms and institutions for whom mobility is essential.

In fact, for regions and cities whose economic conditions compare unfavorably with those

of their neighbors, a connection to the HST line may even result in economic activities being drained away

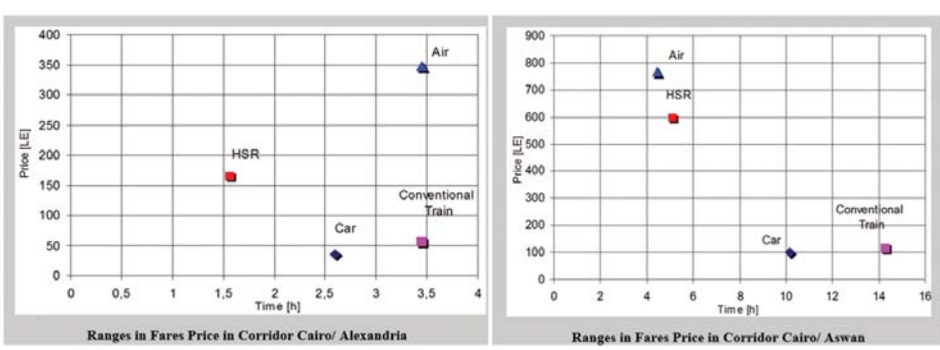

Figure 2. Ranges in fares price and time for proposal corridor in Egypt.

and an overall negative impact [Givoni, 2006; Van den Berg and Pol 1998; Thompson 1995]. Medium size cities may well be the ones to suffer most from the economic attraction of the more dynamic, bigger cities. Indeed, [Haynes, 1997] points out that growth is sometimes at the expense of other centers of concentration. Several reports describe the centralization of activities in big nodes, especially in the services sector.

Besides business journeys, tourism is the first sector to show an immediate effect following the inauguration of an HST line. Indeed, the number of tourists in cities linked to the network tends to increase thanks to this alternative mode of transport. However, the number of overnight stays falls due to easier same day travel, which also has a marked impact on business trips. Therefore, HSR impacts on the tourist industry by promoting the number of leisure travelers to connected cities but at the same time it reduces the number of nights spent in hotels. Finally, the reports reviewed also show that HSTs had only marginal impacts on population and housing growth.

5. Preconditions for New HSR and Positive Effects in Egypt and other Developing Countries

It can be observed that, there are no experiences or projects in most developing countries (as case study in Egypt), thereby, according to the international experience, what are the main preconditions or success factors for reasonably getting started on a high-speed rail project?

The first condition is that depends on the terrain and geography and the speed of trains and other factors, etc, but it can be seen from international experience that between 25 % and 60 % of the costs of high-speed tracks would in any case be required to build conventional railways with 160 km/h speeds. Where, project appraisal should then focus on the incremental benefits of high speed operation versus the additional costs to achieve this goal.

Secondly the promising indicator of economic potential feasibility is a corridor of a high population density within large cities and high volume of demand with enough economic value to repay the high cost involved in the providing and maintaining the line. It is not only that the number of passengers must be large; however, a high willingness to pay for the new facility is required**.** **The third precondition** is a high-speed rail service that can deliver competitive advantage over airlines in our example for journeys of up to about four hours or 700 km, particularly between city pairs where airports are located far from city centers. For short journeys, say up to 100 kilometers, then private car transport is likely to be the main competitor, offering door-to-door travel not requiring a connecting trip to a high-speed train station. One suitable type of corridor is that which connects large cities such as in Egypt range from 200-900 km apart (Cairo-Alexandra, 208 km; Cairo-Asyut, 375 km; Cairo-Luxor, 671 km). But another promising situation is a longer corridor that has a very large number of urban centers located on the line (eg: Cairo- Aswan, 879 km). On these corridors high-speed rail has the ability to serve multiple cities in Egypt in one line.

6. Conclusion

In this paper, we have highlighted the main questions that policy makers must consider when designing HSR networks to reduce traffic congestion, cut dependence on foreign oil and improve the environment. A number of obvious lessons can be drawn from the five cases we review here. First, the project design must take into consideration the specific characteristics of the urban patterns and economic structure of the country, including its traffic patterns, because of the overriding importance of a country's mobility characteristics. Second, cost considerations are of central relevance when making choices concerning HSR projects and their implementation. The fixed costs of HSR investment are huge, and cost overruns notoriously high. In addition, political factors (on the supply as well as on the demand side) can contribute to further increase costs. Therefore, the potential demand for HSR services must be particularly high in order to make investment in HSR socially profitable. This means its main targets must be those corridors linking densely populated metropolitan areas, suffering severe road congestion problems, and deficient air links. These constraints also hinder the use of PPPs and governments must be prepared to intervene in constructing their HSR networks.

This analysis of the appraisal of, and market for, HSR shows that HSR provides travel time benefits for trips of at least 150-200 km and up to 800km; and that the appraisal are greatest for journeys of 200-600 km. Our analysis shows that the market conditions for HSR to be successful are met in Japan and France more than the other case study countries, and in this context it is perhaps not surprising that these countries have invested more in HSR than the others. The population densities in Egypt is more conducive to HSR development than in the other countries, and the distribution of population centres along corridors in Egypt is conducive to high speed development.

The present paper was based on a review of the main HSR experiences around the world. Future research should seek to draw on recent developments in Egypt transportation planning, which provides an increasing number of project analyses, including those already underway in Alexandria to Aswan via Cairo. Additionally, new lessons should be learned by comparing the proposal HSR planning process and the context in which it is being undertaken (political system, mobility patterns, energy policy, fiscal constraints) with the experiences and contexts of other countries around the globe.

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