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High Speed Railway in Saudi Arabia: Lessons to be learnt from the Spanish experience

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Abstract

With 25 years of experience, Spain has the largest High Speed Railway (HSR) network in Europe. Taking advantage of this experience, a Spanish consortium was awarded a €6.7 billion contract to construct, operate and maintain the second phase of the Haramain HSR line in Saudi Arabia, as well as the supply of trains and their maintenance for a period of 12 years. For the transport and geographic characteristics of Saudi Arabia, the Spanish HSR is a good example to look at. A comparison of the main topics that can influence HSR development and demand is done including geography, economy, institutional and legal framework and transport characteristics. Even though this kind of comparison was difficult due to a different culture and the development of the country some lessons can be learned.

First, the know-how gained by construction firms and the infrastructure manager has helped drive down costs and is the key to overcoming the challenge of HSR under extreme climate circumstances.

Second, although HSR demand mostly relies on the evolution of national income and the transport system competing with train, Train Operating Companies have control over influencing variables (such as commercial speed, prices or frequencies) and therefore must have freedom to adapt their strategy to increase demand and revenues.

Third, there are difficulties to predict demand and although rapid traffic growth can be expected it seems doubtful the Haramain HSR line will reach 60 million users per annum in 12 years.

Finally, due to the high risks involved in the project a greater understanding by the parties of each other's' position is crucial to its success: Saudi Arabia will gain expertise in the development and operation of HSR and will be able to attract international funding in the future, whereas Spanish companies will benefit by improving their technology and the possibility of exporting its know-how to other countries.

Keywords: Country com-parison, high-speed rail, Spain, Saudi Arabia

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1. Introduction

High Speed Rail (HSR) was defined services as being provided on dedicated, new line with the infrastructure capable of operating speeds of 250 kilometres per hour and up to 350 kilometres per hour. Moreover, there are multiple objectives of HSR such as speed, capacity, reliability, prestige, economic development, etc. (Preston, 2014, 2017). On the first of October 1964, Japan started to operate the first HSR line in the world, the Tokaido Shinkansen from Tokyo to Osaka with a distance of 515 kilometres using a standard gauge (1,435 mm). This line was built to enhance capacity to the transport system, which was necessary for the Japanese economy as rail had become the main transport mode of passenger in Japan. Moreover, the Tokaido Shinkansen was designed to operate at a speed of 210 km/h using electric motor units powered at 25 kV ac. By 1977, Italy started the operation of the Direttiissima services in Europe, followed by France at a maximum speed of 260 km/h (TGV, 1981), Germany (ICE, 1988), TGV Atlantique (1989), Spain (AVE, 1992), Belgium (1997), United Kingdom (HS1, 2003), South Korea (KTX, 2004), Taiwan (2007), China (CRH, 2008), and Netherland and Turkey (2009). In 2007, the world highest speed record was achieved in France at 574.8 km/h, while the total HSR lines in the world extends over 37,964 kilometres by 2017, as there are about 14,973 km under construction. Many countries are nowadays developing HSR in the world. For example, China has implemented approximately 23,914 kilometres of new HSR lines, which is more than half of the total HSR lines in the world. Other countries are developing HSR lines: Morocco, Saudi Arabia and the USA (UIC, 2017) are the most remarkable examples. For the transport and geographic characteristics of Saudi Arabia, the Spanish HSR is a good example to look at. Apart from this brief introduction, this paper contains four further sections. The following section offers the evolution of the Spanish HSR. The background for the Saudi Arabia HSR is provided in section 3. Section 4 shows a comparison of the main topics that can influence HSR development and demand: geography, economy, and legal framework and transport characteristics. This is followed by the policy lessons raised from the research, which might be useful for regions attempting to develop HSR. Although the conclusions are based on the comparison done here, these lessons can be applied to any developing region with similar characteristics.

2. Background of the Spanish HSR

Nowadays, Spain has the largest HSR network in Europe accounting for 2,938 km in service in 2017 and expected to reach 4,903 km once the whole network is completed. It is the second largest in the world after China. On 21st of April 1992 the first HSR line, Madrid – Seville entered into service. The very first year of operation 1.3 million travellers used the new line. Thanks to the new lines that entered into service gradually mainly since 2008 and the new pricing scheme prompted by Renfe (State-owned Train Operating Company) in 2013, in 2016 there were almost 60% more passengers travelling on the entire network than in 2012. HSR average commercial speed is 222 km/h, 99% of HSR trains arrive on time. Before the development of the HSR, the commercial speed for the majority of the lines was around 90km/h, so thanks to HSR the commercial speed has been at least doubled on all the lines. In 2016 HSR was used by 35.2 million passengers which represents a rise of 5.3% with respect to 2015 and its occupancy rate was around 80%. HSR has helped to promote regional cohesion by providing higher accessibility improvements to the peripheral cities than to central cities (Monzon, Ortega and Lopez, 2013), to modernise railways in Spain, to foster economic development, and is an environmentally friendly transport mode. Spatial equity was one of the main reasons to promote HSR in Spain. However, HSR has also disadvantages such as the huge investment necessary to build the infrastructure, the high maintenance costs and the low demand in many corridors that makes difficult to justify some investments from a socioeconomic point of view (Betancor and Llobet, 2015; De Rus and Nombela, 2007), although support for investment in HSR cannot rely only on expectations of economic benefits (Givoni, 2006) and must be part of a broad transport

planning. One of the differential characteristics of Spanish HSR is that the average cost per km is cheaper than in other European countries (SDG, 2004) ranking from the initial investment of €5.91 Million/km (1992 prices) of Madrid- Seville to the most expensive of €28.9 Million/km (2012 prices) in Galicia, in the stretch Ourense – Santiago where due to the uneven orography it was necessary to build 31 tunnels, 29.3 km underground, and 38 viaducts, to a total of 20.4 km. The Spanish infrastructure manager, Adif, has also reduced maintenance costs per year and km and efficiency gains are also achieved in the construction of new HSR (Fernandez and Vazquez, 2012). In fact, in the period 2009 – 2017 Adif report a 33% decrease in maintenance costs. Transition areas between bridges and embankments and short rigid structures were found to have the highest deterioration in the Madrid – Seville line (Lopez et al., 2007). Therefore, some changes in the design were required. The reduction of the maximum vertical force exerted by wheels on the track, the reduction of track's vertical stiffness and finally the increment of the minimum radius to 7,000m after the first HS line explain these costs reductions (Lopez and Robuste, 2003).There are therefore economies of experience and economies of scale once the network is being developed that help reduce costs. HSR has been the means of transportation where the Government of Spain has invested the most over the last 25 years with more than €51 Billion. Moreover, after joining the EU in 1986, Spain took advantage of European funds, with around 20% of the investment paid by these funds.

From a technical perspective, the Spanish HSR is broadly regarded as a success, since it helped to improve the service standards and the quality of infrastructure and rolling stock. To have an idea of the know-how and experience gained with the HSR; it is remarkable that in the last decade Spanish construction companies have exported projects for a value of around €10 Billion, including projects in USA, Norway and especially Saudi Arabia.

This first HSR line, Madrid – Seville, linked both cities in 2 hours and 55 minutes compared to the formerly 7 hours required. Seville is the country's fourth largest city and had been elected to host the 1992 Expo World's Fair and through this investment the economy of the south region was expected to be stimulated. The infrastructure also connected the intermediate cities of Ciudad Real, Puertollano and Cordoba. One year later the maximum commercial speed was increased up to 300km/h and the travel time was reduced to less than 2hours and 30 minutes. The effects on the transport system on that corridor were large: the share of the train rose from 14% to more than 43% mainly at the expense of the airplane and by capturing additional users as well.

In 2003, the stretch Madrid – Zaragoza in the line Madrid-Zaragoza - Barcelona was opened at a reduced speed of 200 km/h due to the lack of the European signalling system, known by its acronym ERTMS (European Railway Traffic Management System), and some geotechnical issues in the first years. In 2006 and thanks to the ERTMS, the commercial speed was increased to 250 km/h. Only one year later, in August 2007, there was a new increment to 300 km/h. By the end of that year, two new stretches entered into service: Madrid – Valladolid and the stretch Cordoba – Malaga in the Northwest and South corridor, respectively. The HSR to Barcelona, the second largest city in Spain, was inaugurated in February 2008. Again, the effect on the competition with the airlines was enormous. The HSR increased the market share of trains in that relationship from 12% to 47%, and reduced the share of the airlines to 53%. The year 2012 was the first in which HSR transported more users than air transportation (2.688 Million users vs. 2.573 Million users) on this corridor. This trend was consolidated in the period 2013 – 2016 with HSR market share around 60% and the remaining 40% for airplanes (62.4% of the corridor for the HSR in 2016). The new pricing scheme implemented by Renfe in 2013 helped this consolidation.

In December 2010, the connection between Madrid and the third most populous city in Spain, Valencia, entered into service, reducing the travel time by train from 7 hours to 1 hour and 35 minutes. In this origin-destination pair, the modal share of the train grew from 12% to 46%. The share of air and bus transportation went down from 17.4% and 9.2% to 2.6 and 3.1%

respectively. This HSR line also connected small cities such as Cuenca and Albacete to Madrid. In 2011, the speed for Madrid–Barcelona was increased to 310 km/h to become the fastest commercial speed in the network. The same year the stretch Orense – La Coruna in the line to the northwest was opened. In June 2013, the stretch Albacete–Alicante opened, with a length of 165 km. In September 2015 the stretch Valladolid – Leon of 166 km came into service. This stretch was designed to operate at a maximum speed of 350 km/h but the ERTMS system is still being installed and tested, so this branch has used ALFA signalling system in 2016 and its actual maximum speed is 200 km/h. Finally, in 2016 the stretch Olmedo (Valladolid) – Zamora (in the HSR to Galicia) was opened.

Due to the concerns about lack of demand and low occupancy rates, in February 2013, Renfe implemented a new pricing scheme which reduced ticket prices by at least 11%, and introduced flexibility in their purchase in order to boost the usage of HSR. This pricing scheme is similar to the Yield Management technique used in airplanes, which sets the price depending on the hour of the day, the category of the user (i.e. first class or tourist), the demand expected, and how far in advance the booking is made. The year after the introduction of the new pricing scheme, the revenue was increased by 6.7% and the average occupancy rate of HS trains rose from 66% to 74.3%, so it met the initial objective of boosting the demand and increasing travellers by train. The economic growth since 2013 and frozen prices by Renfe boosted this tendency, this occupancy rate has been hugely improved and is above 80% in 2016. Despite the small increase of 1% tickets price in 2017 according to Renfe demand is growing at 4.5% on average in the first half of 2017. The effect on corridors with high demand and competing with airplanes was more remarkable than on corridors with low demand (Ortega et al., 2016). Madrid – Barcelona and Madrid – Seville corridors have almost reached their capacity (i.e. occupancy rates above 90%) and more trains will be necessary in the upcoming years to cope with demand expectations. These new trains are supposed to enter into service by 2019.

The last milestone reached by the Spanish HSR was by late 2016 when Renfe officially awarded Talgo Company to modernize and extend its fleet. The main objective of the bid is to adapt Renfe to the upcoming liberalisation in 2020 and at the same time keep the reduction of prices aimed at gaining market share. The bid was composed of two parts, economic and technical, and four companies made their bids: Talgo and CAF from Spain, Siemens from Germany, and finally, Alstom from France. Talgo won the competition with 94.6 points (29.6 points in the technical and 65 in the economic) with the Avril train. The high capacity of the Avril (521 seats) implies at least a 30% increase in the offer of seats per train compared to the existing trains. The actual maximum capacity is 407 passengers and corresponds to the trains that entered into service in 2007, whereas the first HS trains from the nineties can carry up to 321. The composition of 5 seats per row in the tourist class is similar to the already existing composition in many airplanes and makes this increase possible. The greater capacity and lower cost and consumption will allow Renfe further reduce ticket price.

3. Background of Saudi Arabia HSR

The Haramain High Speed Rail (HHSR), also known as the Western Railway, is the Middle East's first HSR line linking two Muslim holy cities, Makkah and Madinah, in Saudi Arabia with a total distance of 453 km. The majority of this distance corresponds to the main link between cities, whilst there is a branch of just 3.75 km connecting to King Abdulaziz International Airport (KKIA) in Jeddah. The line will also pass through Jeddah and King Abdullah Economic City (KAEC) in Rabigh and connect with the national network in Jeddah. This HSR double track line will be electrified with a maximum operation speed of 300 km/h, and will reduce the journey time to 2 hours and 30 minutes (less than 30 minutes from Makkah to Jeddah, and about two hours from Jeddah to Madinah). The main motivation to develop HHSR line was to address the transportation needs of a growing number of seasonal pilgrims to Makkah, performers of Umrah

and the people of the city. The estimated demand is quite high, with 60 million passengers per year (Arabnews, 2017). The city of Makkah attracts about 2.5 million pilgrims during period of Hajj every year as well as more than 2 million of Umrah performers during the month of Ramadan and seasonal holidays and a heavy passenger traffic during Fridays. Due to the safety and comfortable transport, the HHSR is seen by the Saudi Arabian government as the best option for the pilgrims, and it will help reduce traffic congestion and accidents on the roads linking Makkah and Madinah. The design and construction of this project will help it to withstand heavy traffic conditions and tough climate, while the track, rolling stock and stations will be designed to handle the temperature change up to 50°C. Due to this environmental conditions, slab track was chosen as the best option for this country, unlike Spain where due to the lower initial investment requirements, ballast track is largely installed (i.e. only in a few special sections such as tunnels or bridges slab track is installed). Partial operations on the HHSR line would begin in December 2017 whilst the service full opening will be in March 2018.

The Saudi Railway Organization (SRO) is responsible for the HHSR project with allocated a budget of over €12 billion of public investment in terms of its completion. The project of dunes, sands and strong winds involves in two phases, with Phase 1 that was awarded in 2009 and divided into two packages. The first package in phase 1 was awarded to Chinese-French consortium for €1.48[1] billion which includes the civil works of the track such as construction of viaducts, bridges, subways, tunnels, shafts, retaining walls, and embankments). The second package was awarded to Saudi Bin Laden and Saudi Oger, which consists the construction of the five stations- Jeddah central and KAIA in Jeddah (€631.8 million), Makkah central in Makkah (€692.5 million), King Abdullah Economic City in Rabigh (€381.2 million), and Knowledge Economic City in Madinah (€336.8 million). Moreover, the design contracts for the stations was awarded to the FosterHappold Joint Venture (FHJV) in 2009 for €30.9 million, which have adopted for designing a modularised approach with aesthetically iconic designs and taking into account Islamic architectural traditions. Moreover, all stations will have a separate distinctive design and same planning strategy as well as different arrival and departure zones will be provided, while the public areas of stations will be environmentally controlled along with the platforms to provide comfort. On the other hand, Phase 2 of the project has been awarded to the Spanish consortium "Al-shoula Group" in 2011 for €6.7 billion, which includes Adif, Copasa, Imathia, Consultrans, Ineco, Cobra, Indra, Dimetronic, Inabensa, OHL, Talgo, Renfe, and the Saudi companies Al-Shoula and Al-Rosan. It consists of the remaining infrastructure and related tasks that were not included in the first phase such as the study of the market, assembly and supply of railway track, and installations of electrification, communications, signalling, power, etc. It also includes the supply and maintenance of rolling stock, and the operation and maintenance of the line for a period of 12 years. Talgo will supply 35 trains with a capacity of 500 passengers for each train, while there is a possibility of requesting additional trains due to demand. Moreover, this phase 2 is divided to two parts; the first part involves the construction of the superstructure (i.e. track, catenary and signalling systems), the supply of rolling stock and the commissioning of the line which will take about 4 years and 3 months. The second part relates to the operation of the line and the maintenance of rolling stock for 12 years, while Renfe and Adif will operate the trains and manage the line.

Finally, some dynamic tests are being developed in a satisfactory way, in extreme environmental conditions, with very high temperatures close to 50°C and with the presence of desert sand, proving the good response of the trains in such conditions. The maximum speed of operation of 300 kilometres per hour was reached in July 2017. This test are being carried out in 370 kilometres of the line, 80% of the route.

1 *Convert rate used in the paper 1€=1.22$*

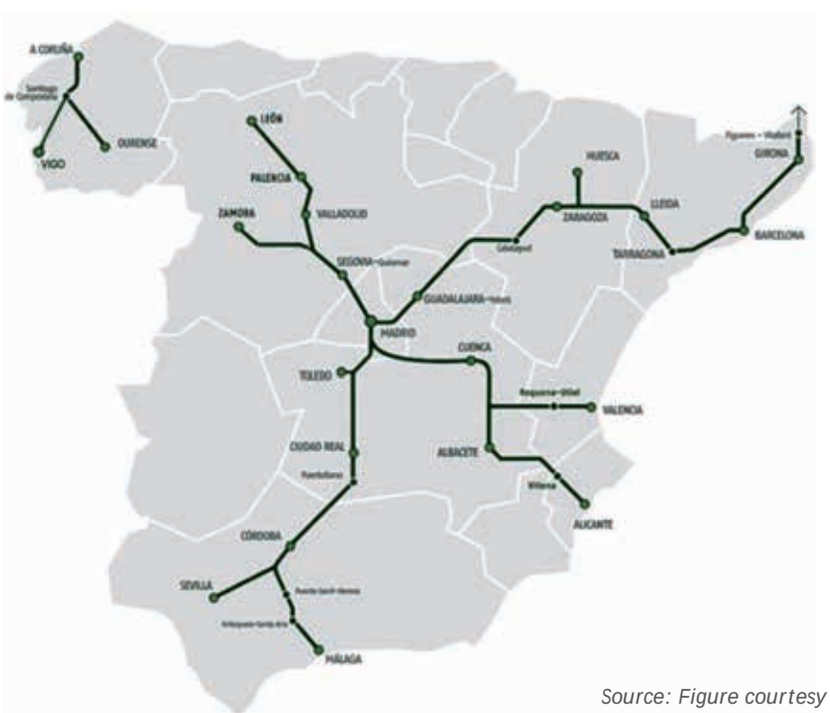
4. A comparison between countries: geography, economy, legal framework and transport

This section is split into four subsections. The first one offers a comparison between the two countries in terms of the geography and distances between main cities. The second one replicates the same comparison but for the economy of both countries. The third subsection explains the institutional, legal and procurement framework in Spain and Saudi Arabia. The last subsection shows the transport evolution of Spain since the HSR entered into operation and the interurban transport system in Saudi Arabia.

4.1 Geography

Spain is located in Southwestern Europe, has a population of roughly 47 million people, an increase from 39 million inhabitants in 1992. Despite this, the density is only 92 inhabitants per square km which is quite low compared to other European countries. The majority of the population is sparsely distributed except for two areas: Madrid located in the centre of Spain and along the coast. Moreover, Madrid is 700 metres above sea level, whilst the remaining major cities are at sea level. That makes the profile of the HSR lines more difficult than other European countries where there is no need to serve this natural level difference. Figure 1 provides the HSR network by the end of 2016. The distance between the most important metropolitan areas in Spain (Madrid, Barcelona, Valencia, Seville and Bilbao) is between 400 and 700km, which is believed to be a good distance for the development of HS. That is, lower distances do not justify HSR because of the completion with car, whereas larger distance are very difficult because of the competition with airplanes. Rothengatter (2011) noted that strong competition between air transport and HSR can occur on routes with distance up to 1,000 km, but this is most likely between 400 and 800 km. Therefore the main transport networks (highway and conventional rail networks) have a radial typology, with the centre on the country's capital, Madrid. The HSR network follows the same structure, linking Madrid with the most populated cities (Barcelona, Valencia and Seville).

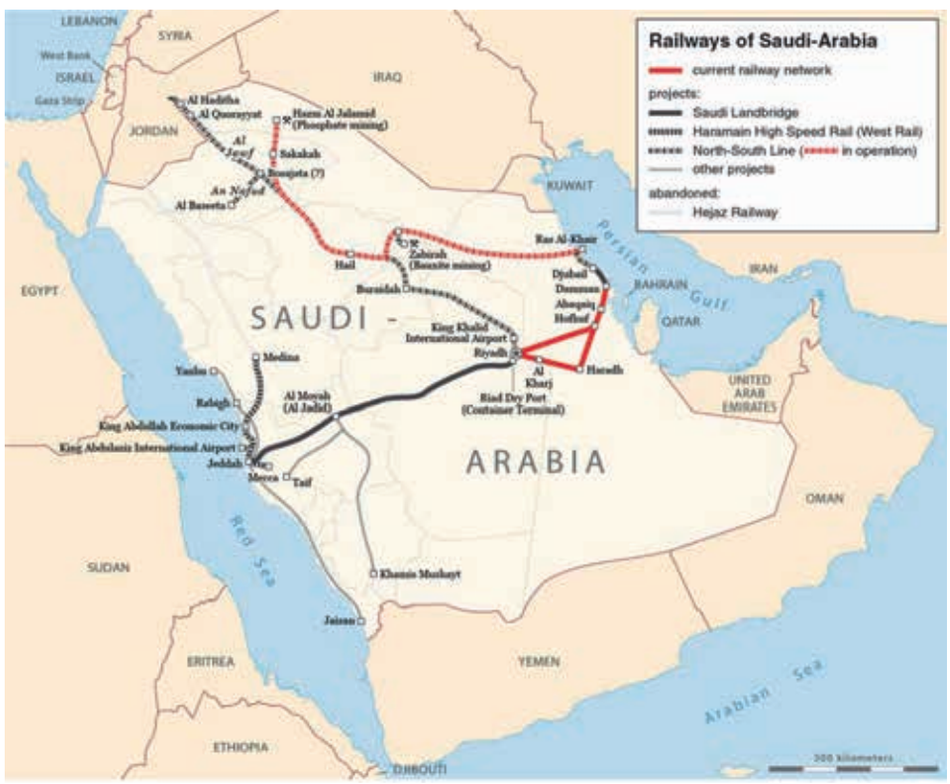
Figure 1. Spanish HSR network by 2016



Source: Figure courtesy of Adif, 2016.

Saudi Arabia is located at the furthermost part of south western Asia and has a diverse topography because of its large total land area of 2,143,865 km^2. It includes a coastal plain in the east which is 610 kilometres long and consists of large sand areas and Salinas. It also includes the Empty Quarter in the south-eastern part of the Kingdom having an estimated area of 640,000 square kilometres composed of sand hills and lava fields. Storms of sand are very frequent and this is one of the main challenges to develop HSR in the country. The population of Saudi Arabia is expected to reach 33 million people by 2017, from nearly 28 million in 2010, which is an average annual increase of 2.54%. The density is 16 inhabitants per square kilometre which is even lower than in Spain.

Figure 2. Plan and existing railways in Saudi Arabia



Source: Figure courtesy of Maximilian Dörrbecker, 2009.

Some important similarities arise from the comparison: both populations are sparsely distributed and concentrated in some cities, with overall low density but inter-urban distances good enough to be covered by HSR, and some topography features that make the development of HSR a challenge. There are also other differences that makes the development of HSR in Saudi Arabia a tough challenge, such as the even lower population density in Saudi Arabia than in Spain and storms of sand in some stretches of the future HSR.

4.2 Economy

When Spain joined the European Union, it lagged far behind the average of the European countries in terms of the most relevant macroeconomic indicators such as income per capita, public capital stock, inflation, interest rates, and unemployment rates. After joining the European Union the improvement of Spain's economy was remarkable. This effect was exceptionally good after Spain began using the single currency in 1999. The development of

the HSR network contributed to the Spanish's boom of the economy. The Spanish GDP (Gross Domestic Product) per capita grew by 103% from 1992 to 2016 (€25,696 in 2016), which is an average annual growth above 3%. Income distribution across the population also improved, and the Gini index (i.e. degree of inequality in the distribution of family income in a country where higher values means higher inequalities) in 2015 was at 34.4. The economy relies heavily on the services sector which accounts for 75% of the GDP (this figure was 61% in 1992), whereas industry accounts for 17% of the GDP (down from 25%), constructions provides 5.5% (9% in 1992), and the remaining 2.5% of the GDP is based on agriculture and fishing activities (down from 5%). Tourism is crucial for the economy since it accounts for around 12% of the GDP. For instance, in 2016, more than 75 million people travelled to Spain, spending €77 Billion.

Due to the high prices of oil in recent years, the economy of Saudi Arabia has grown very strongly, while the rising oil prices and production has resulted in large external and fiscal surpluses. The Saudi Arabian GDP per capita was recorded at €17,481 in 2016. The Gini index was 45.9 in 2013, which was still below other developed countries (Trading Economics, 2016), but higher than in Spain. In 2016, the Saudi economy grew by 1.4% and the nominal GDP per capita at purchasing power parity was €41,227 whilst there is significant impact in reduction of oil prices. This figure was €27,176 in Spain, proving that prices are higher in Spain. Saudi Arabia was the second largest oil producer in 2015 with around 11% of global output and has the largest oil reserves in the world, within over 264 billion barrels. In fact, the importance of oil and mining decreased from 46.47% of the GDP in 2005 to 25.45% in 2015. In this case, the Saudi Arabia has responded to the oil prices crises by announcing its vision 2030 to reduce the dependency on oil and shift its focus on other sectors including education, tourism, transport, etc. Religious tourism is one of the main growth factors of the tourism industry in Saudi Arabia, as it has the two religious cities of Makkah and Madinah. However, the value of the tourism industry in 2015 was €17.42billion, with €4.64billion coming from the religious tourism sector and it is expected to contribute between 5.4% and 5.7% in 2025 of the total non-oil GDP of the country (Pinter, 2014).

As in the previous subsection there are some common points and some differences between both countries. Despite some economic turmoil in the period both countries have enjoyed buoyant growth and have redirected their economies to make them more services-oriented. The main differences arise in the GDP configuration and how income is distributed across population. Whereas Spain is a country with a developed economy, services-oriented economy and with an income distribution similar to other Mediterranean countries, that is not the case in Saudi Arabia. Apart from GDP growth, two topics could influence future HSR demand. Firstly, the economic structure of a region with regions where the economy is based on tertiary and administrative tasks with higher demand than industrial related economies (Garmendia, Ureña and Coronado, 2011). Secondly, the effect of tourism on HS demand. Tourism has helped boost HSR, particularly in cities with strong tourism activities (Campa, Lopez-Lambas and Guirao, 2016). However, the opposite is not necessarily always true as there are examples of both cases, where HSR stations helped attract more tourists and where HSR stations did not have any influence on visitors (Albalate, Campos and Jimenez, 2017).

4.3 Legal & institutional framework

4.3.1 Spain

Transport infrastructure in Spain is delivered through two approaches. The first one is the so called Contractual PPPs, where the best-known model is the concession model, which is characterized by the direct link between the private partner and the final user (Commission of the European Communities, 2004). In this approach the remuneration for the contractor will consist of charges levied to the users that may be supplemented by subsidies from the

public authorities. Concessions have a long tradition in the Spanish legal framework, have been particularly used to construct highways, and have been characterized by the allocation of considerable risk —demand, acquisition of the right of way and financial risks— to the private sector in the contracts; but also by important guarantees by the government (Ortega, Baeza and Vassallo, 2015).

The second approach to deliver transport infrastructure is the Design-Bid-Build (DBB) or DesignAward-Build (DAB) where the public administration develops contract documents with an engineer consisting of a set of plans and a detailed specification. Based on these documents the contract is then awarded to the bidder with highest qualification. This is done largely on the basis of an "open procedure." Unlike other long-term infrastructure contracts in the world —i.e. Design-Build-Finance-Operate contracts in the UK, and most of the PPP contracts in Germany— (Tang, Shen, & Cheng, 2010), public works in Spain are hardly ever awarded by means of a negotiated procedure.

This open procedure means that any company that fulfils the minimum requirements set out by the government in the tender provisions is allowed to participate in the process. The government chooses the winner in terms of a set of criteria —both economic and technical— according to which the offers presented by different bidders are qualified. Contracts are not negotiated in this approach since the government submits standard contracts to the bidders along with the bidding terms. This was, for instance, the procurement process used in the new HSR trains awarded by Talgo.

Sanchez and Gago (2010) prove that the transaction costs of the open procedure, for both bidders and the government, are much lower than those of the negotiated procedure. These low transaction costs are likely the most important reason why the number of participants in the tendering processes in Spain is often quite large (Vassallo & Sánchez, 2007). However, most of the construction companies are well-known Spanish firms since the lack of publicity and transparency of the tendering and awarding processes in Spain creates strong barriers that prevent foreign companies to compete fairly. Despite this problem, the construction cost of HSR in Spain is cheaper than in other European countries, which could be explained by labour cost, the existence of less-populated areas outside the major urban centres and also by the construction procedures (Campos and De Rus, 2009). The long experience of Spanish companies in public works, which have enjoyed competitive advantages against their competitors, could also partially explain the technological and scientific innovations developed in Spain linked to the HSR market (Guirao, 2013).

4.3.2 Saudi Arabia

Saudi Arabia is one the fastest growing markets in the world and considered as the largest construction market in the Middle East. The value of projects that were announced by King Abdullah during the G20 summit on 14-15 of November 2008 in Washington was €333 billion to guarantee finance for development projects, including different sectors such as transport, utilities, infrastructure, healthcare, education, etc. (Alrashed *et al.*, 2008). However, the largest allocation for the 2015 budget was paid toward the transport and infrastructure sectors of €155.44 billion to complement the growth and development across Saudi Arabia. On the other hand, construction is the largest non-oil sector in Saudi Arabia and many mega projects are anticipated to be launched in the next year, including Haramain High Speed Rail, North-South Rail, Riyadh Metro, etc. In this case, Saudi Arabia has experienced problems that have caused delay in many projects. Alofi et al. (2016) mentioned that the procurement system is one of the major factors that affect the construction performance in Saudi Arabia. There are three different types of the Saudi Arabian procurement system, including public procurement competitions, and direct and specific purchases. The public procurement competitions have the majority of acquired purchases whilst projects under this category starts with the first phase of

submitting the proposal that cannot be less than 35% below the project budget (market prices), including sending an announcement to all competitors regarding to the date of the pre-bid meeting, the location where the bids will be opened and the deadline of submitting bids. The selection phase will start directly after opening all the bids at appointed date and location, as the main factor of this phase is determining the winning contractor who has given the lowest price. The final phase is the proposals formulation and all the documents include in this phase, including contracts, project specifications, time of the tasks, drawing, and correspondence need to be in Arabic if possible, but another language such as English is accepted by the Ministry of Finance (Alofi et al., 2016). Alkharashi and Skitmore (2009) found out that construction project delay is considered to be one of the most serious issues in terms of follow on consequences in Saudi Arabia, which affects the direct costs of the project. In Mecca, 37% of construction projects were believed to be delayed by contractors whilst 84% of all projects that were under the supervision of the consultants had serious delays (Elawi et al., 2015). In fact, the Spanish companies wanted to extend the deadlines of the work due to the delays accumulated by the Sino-Saudi consortium in charge of phase one which included the construction of the platforms. In addition, they claimed for the Saudi Arabian Government to pay a series of extra costs for the unforeseen events that arose in the course of the work. Finally, the consortium believes the expected demand is overestimated by 30% and the loss could be up to €1 billion so it is an important risk for the companies. Initially, Saudi Arabia was reluctant to negotiate more funds because the original contract did not include the payment of extra costs, but neither the extra developments nor stations that have been finally constructed. Moreover, there are budget constraints due to the fall of the price of oil. Nonetheless, the Saudi Arabian Government finally seek a comprehensive solution to all project problems. So an agreement was reached to pay an extra cost of €150 million and to extend the work 14 months to finish the phase 2. The pact also acknowledges that delays in the work are attributable to the delay of phase one, which is in charge of the Sino-Saudi consortium. In this way, Spanish companies were exempted from the penalty for delay fixed by the contract. Although after the agreement the official date of completion of the works is set for the end of 2017, some stretches could be inaugurated sooner. The start-up of the corridor will be progressive, so that some stretches of service in the upcoming months.

In terms of the political, Saudi Arabia is divided into 13 administrative regions, with a Prince who performs the role of the governor (Chairman) and deputy governor (Vice-Chairman). Each province has its own council that gives advice to the governor regarding the needs of the province, as well as monitoring ongoing projects and considering future development plans.

In April 25, 2016, the Saudi Vision 2030 was announced by Crown Prince Mohammed bin Salman, which plans to reduce the dependency on oil in Saudi Arabia, diversify its economy, and develop service of other sectors such as infrastructure, transportation, health, recreation, education, and tourism. There are other specific goals besides increasing the share of non-oil from 16% to 50%, in terms of GDP, include the following objectives:

1. Increase the contribution of the private sectors from 40% to 65%, and raise the nonprofit sector's contribution from less than 1% to 5%, in terms of GDP.
2. Improve the quality of Umrah services including visa application procedures, to make it possible for over 15 million Muslims per year to perform Umrah and satisfy with their pilgrimage experience by 2020, and 30 million by 2030, compared to 8 million in 2015.
3. Facilitate the listing of private and government owned companies, on the local stock market, including Aramco.
4. Increase the average life expectancy from 74 to 80 years.

The vision will speed-up the strategies of development and decision making, and enhance their performance through establishing the Council of Economic and Development Affairs, and the Council of Political and Security Affairs. However, making decisions will be based on detailed studies and benchmarks, and a complete analysis of programmes, related performance indicators and plans for each agency. As Saudi Arabia has had a special place in the heart of pilgrims, the number of Umrah performers entering the country from abroad has increased to reach eight million people in the last decade. In terms of serving visitors to the two holy cities, a third expansion of the two holy mosques has begun, as well as increasing the capacities of Saudi airports and finishing the railroad and train projects has been launched to complement this. In Saudi Arabia, building more museums, preparing new sites for tourist, historical and cultural venues, and improving the experience of pilgrimage.

By 2030, the Saudi Vision in terms of tourism, increasing the number of visitors from eight million to 30 million every year and register more than double the number of Saudi heritage sites with UNESCO. Jackson *et al.* (2010) identified that women in Saudi Arabia constitute 45% of the total population and 56.5% have completed university. In this case, the vision is planning to reduce the unemployment rate from 11.6% to 7% and increase the participation of Saudi's women from 22% to 30% in the workforce, through developing their talents, enabling them to the Saudi society and economy. There are some major factors that could act against women participate in Gulf Cooperation Council (GCC) countries. First, most women wish to care for and be with children and families, as it is a common factor in all societies. Second, many women live far away from major cities and would find it impossible to work. Third, transport to the workplace could be one of the factors. One of the main aims in the Vision 2030 of Saudi Arabia is emerging technologies from around the world and participating in large international companies to maximize its investment capabilities whilst this requires an open formation of a capital market and advanced financial to the world. In terms of the business environment in Saudi Arabia, the public-private partnership (PPP) will be pursued to improve the Saudi competitiveness and facilitate the movement of private investment, as well as increasing the reliability and quality of Saudi services through developing the necessary capabilities and creating an environment attractive to both foreign and local investors. As a result, Saudi Arabia is looking forward to increase the share of non-oil trades in non-oil GDP from 16% to 50% and from SAR163 billion to SAR1 trillion of non-oil government revenue.

According to Saudi Arabian law, women are not allowed to drive, and have to go with male relatives or paid services, to school, stores, airport, work, etc. In 2014, Uber operated in Riyadh, Dammam and Jeddah, and estimated that 70% to 90% of Saudi Uber users are women, as the women in Saudi arabia only make up 13% of the Saudi workforce, while there are 60% of university students that accounts for the high demand of daily commutes (Staff, 2015). However, Uber has made a difference in Saudi women's mobility whilst its next step is increasing availability with the cities and take people back and forth between Mecca and Jeddah during Ramadan (holy month). On the other hand, the project of Riyadh Metro planned to be completed by 2019, which will help in travelling cheaper and quicker, and give women greater movement around the city. As a result, it is interesting to see the role of the public transport system within Saudi Arabian develop, given on-going demographic and social changes, thus providing alternative solutions of mobility. This includes the Haramain HSR, the North-South rail, Landbridge Rail, etc. (Alatawi and Saleh, 2014).

Regarding the legal and institutional framework there are not many similarities and the main differences between these two countries are: the absolute monarchy in Saudi Arabia whereas in Spain, which is a constitutional monarchy, the Government can change after elections; the long experience of Spanish companies in public works; construction procedures; transaction

costs higher in Saudi Arabia due to the use of a negotiation procedure and institutional framework; and finally, there are social factors that could pose downside risks for the future demand in Saudi Arabia (e.g. in Spain there are no restrictions for women to travel independently).

4.4 Transport

Domestic passenger transport in Spain is dominated by the road mode with almost 90% of the share. This high value is encouraged by the large highway network developed over the last two decades. With regard to the remaining transportation modes for domestic use, it is noteworthy that rail and air transportation have not been able to threaten the road dominance despite the fact that passenger rail's share has slightly increased from 5.2% in 2009 to 6.4% in 2015. Similarly to the French 'avion sur rails', the former goal of HSR investment in Spain was not to change Spanish transport modal share inside out, but rather to change modal share in specific point to point relationships. However, taking advantage of the connection between the main cities, the strategy soon changed to connect every provincial capital to the network and nowadays 67% of the population is linked by HSR. The approach used was a mixed model where some conventional trains, after being adapted to the European standard gauge, are able to circulate on HS lines. Back in 1942 Talgo developed the technology for the interoperability of international services with narrow and standard gauge. A similar system was used and improved to be able to change gauge at higher speed. The main benefit of this approach relies in the saving of rolling stock acquisition and maintenance costs on the one hand and the flexibility for providing 'intermediate high-speed services' on certain routes which are not fully HS on the other hand. However, the majority of the HS network is sanctioned at 300 km/h with a maximum design speed of 350km/h, making its construction more expensive than it could be at lower speed. For instance, an increase of the design speed from 250km/h to 350km/h could make the construction up to 50% more expensive (Gonzalez, 2015). For the sake of clarity, only the effect of HSR on the densest corridors is shown here. Below, Table 1 shows the main characteristics for the most important HS connections.

Table 1. Main routes in Spanish HS network

Origin	Population Metropolitan area in 2015	Destination	Population Metropolitan area in 2015	Distance (km)	Year service opened	Fastest Travel Time by HSR (min)	Million Passengers 2016
Madrid	6,513,075	Barcelona	4,892,634	621	2008	150	3.874
		Valencia	1,619,463	391	2010	102	2.336
		Seville	1,418,233	471	1992	140	2.545
		Malaga	853,516	513	2007	140	1.743
		Zaragoza	753,884	306	2003	75	1.373
		Alicante	459,387	493	2013	136	1.394

In order to have a better idea of traffic evolution in the aforementioned services, Table 2 provides traffic growth in the last decade. Several ideas arise from this table. First, when traffic growth is compared to the performance of the economy, when the economy is doing well, the travellers tend to be more prone to use the HSR. Two reasons could explain this trend. The first one is that the greater the income of families and companies, the higher will be their willingness to pay. The second reason is that the greater the total trips in the corridor, i.e., public and private transport that increases when the economy does well, the more congested will be

other transport alternatives and therefore HSR can become a better option. Second, related to the first one, once the ramp up period is over and traffic is consolidated the Tran Operating Company (TOC) has certain degree of control over demand: commercial speed, frequencies and price prove it. However, *ceteris paribus* HSR demand seems to anticipate economic cycles. The increment in traffic in 2013 is explained by the yield management prices introduced by Renfe. Third, the ramp up period usually lasts the first two years once the infrastructure fully open. As we have already seen after that point two factors influence demand: GDP growth and TOC's policy. For instance, in the Madrid – Barcelona route the first year traffic growth was huge (255.78%), similar to the first year of Madrid to Seville (246.8%), whereas for other routes it was lower with Madrid to Malaga (139.5%) and Madrid to Valencia (149.1%) with similar traffic growths (Fernandez, 2012). These figures do not match figures in the table because the first year of full operation is not the calendar year (e.g. Madrid – Barcelona route was opened on 20th February 2008).

Table 2. Traffic growth in the last decade

YEAR	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
GDP GROWTH	3.8%	1.1%	-3.6%	0%	-1%	-2.9%	-1.7%	1.4%	3.2%	3.2%
Madrid – Seville	-0.6%	0.7%	-5.8%	-7.4%	-3.4%	-7.6%	10.2%	6.8%	6.8%	2.6%
Madrid – Zaragoza	20.9%	33.7%	-20%	-7.7%	-6.6%	-7.5%	8.2%	8.6%	3.2%	4.2%
Madrid – Malaga		140.9%	2.6%	-4.4%	0.1%	-4%	11.5%	6.2%	4%	2.9%
Madrid – Barcelona		178%	26.6%	-2.7%	-2%	5.6%	14.1%	12.1%	8%	4.2%
Madrid – Valencia					161.2%	-6%	7.7%	5.5%	8.2%	10.1%
Madrid – Alicante							32.7%	25.8%	20.8%	4.3%

In the case of the route Madrid – Zaragoza, the growth in the first year of service (56%) was lower than these figures, but higher in the second (21.6%) and third (20.7%) year of operation. 2007 was the fourth year in operation and can be seen in Table 2. This lower demand is explained because in the first years of the service, trains were not operating at full capacity (its maximum commercial speed was 200 km/h, but it has been designed for speeds of 350), and there were not enough HS trains to cope with the demand. Once these improvements (higher speed and more frequencies with better trains) were introduced, the demand responded positively. In fact, after five years of operation, the accumulated growth (241%) was quite similar to those reported above. The same can be said with respect to the HSR line to Alicante. The full line entered into service on 17th June 2013, so the first year increment would feed through 2013 and 2014. Moreover, before that date intermediate HSR trains were on the route from Madrid-AlbaceteAlicante providing already time savings.

Finally, with respect to the induced demand triggered by HSR it ranks from the 9% induced demand on the Madrid – Barcelona route to the highest figure found on the Madrid – Seville route with 26% (PWC, 2010). Similar figures are found on the route Madrid – Malaga 11% (AEA, 2008)

and Madrid – Valencia 14% (PWC, 2010). The remaining demand can be attributed to transport mode shift. There are also important differences between induced traffic expectations and reality that can be explained by higher prices and lower frequencies than forecasted as well as economic downturn (Fernandez, 2012). In fact, as Fernandez pointed out official forecasts were revised downwards before the new lines entered into service to take into account the new services and prices. So, forecasting HSR demand accurately is difficult (Guirao and Campa, 2014) and therefore there are usually implicit risks associated with demand. Moreover, official forecasts could also be deliberately biased upwards due to strategic misrepresentation from the Government (van Wee and Flyvbjerg, 2010); they can justify potential demand in the future to develop HSR.

By contrast, domestic transport in Saudi Arabia is composed of three main modes: road, air and marine. Despite the recent increase in air transport demand, road transport has the lion's share of the transport in Saudi Arabia by far, with more than 95% of the national passenger-km. This high percentage can be explained by the easy accessibility to private automobiles as well as low fuel prices, which have increased automobile traffic levels in recent years resulting in congestion problems. Below, Table 3 shows the main characteristics of the existing and planned Railway Network in Saudi Arabia.

Table 3. Main routes in Saudi Arabia Railway network

Origin	Population Metropolitan area in 2014	Destination	Population Metropolitan area in 2014	Distance (km)	Year service opened	Fastest Travel Time by HSR (min)	Passengers 2014	Passengers 2015
Riyadh	6,300,000	Dammam	2,275,000	449	1981	240	1,247,000	1,317,000
		Al-Qassim	1,387,996	352	2017	105	Two million annually (Projected)	
		Jeddah	4,025,000	950	Planned	360	--	--
Jeddah	4,025,000	Makkah	1,780,000	77	2018	30	60 million annually (Projected)	
		Madinah	1,270,000	373	2018	120		

As there are about eight million pilgrims and Umrah performers who arrive to Saudi Arabia every year to visit the two holy cities of Makkah and Madinah in the west of Saudi Arabia and the solution chosen was building the Haramain High Speed Rail (450 km) to European HSR standards. However, there has been a steady decline in the number of pilgrims arriving to Saudi Arabia but the number of tourist has been increased, and this could influence future HSR demand. In terms of transport mode, 93.4% of the total domestic tourism trips were made by land based transport including car, rail, bus, etc., while the air transport captured 6.6%, as shown in Table 4.

Table 4. Transport mode for domestic tourism in Saudi Arabia in 2011

Mode of Transport	Total	Market Share (%)
Air	1,489,142	6.6
Private Car	18,325,857	81.5
Rented Car	363,546	1.6
Taxi	23,839	0.1
Bus	2,199,405	9.8
Rail	46,155	0.2

Source: Tourism Information and Research Centre, 2011.

Saudi Arabia wants to complete the national plan of constructing 9,900 km of railways by 2040, which also including the 2,750km North-South Railway from the north to Riyadh and the 950km Landbridge from Riyadh to Jeddah. The only HSR line will be the Medina – Mecca. The remaining links will have speeds from 180km/h to 220km/h and some of the stretches will be designed to accommodate freight transport as well, which could increase maintenance costs.

The two main similarities between both transports systems are the dominance of the road mode for domestic passengers and the design of HSR to serve initially only point to point connections between main cities, although it will be extended afterwards. There are, however, two main differences that make the comparison difficult: there is no actual train transportation from Medina to Mecca and difficulties associated to forecast induced demand will be even greater in Saudi Arabia due to the different context. The induced demand and ramp up period might see important demand increases, due to the great change that the new train services will deliver in the corridor. Traffic growth might be higher than traffic growth in Spain, not only because GDP growth is greater but because the proposed opening-up of the Saudi Arabian economy. However, looking at the broad figures from tables 1 and 2, it seems difficult to reach the expected demand of 60 million users annually even some years after it enters into service.

5. Conclusions

Japan was the first country to develop its own HSR network in 1964. Many countries have followed its example with Saudi Arabia about to join that group of countries. Taking advantage of 25 years' experience in HSR a Spanish consortium was awarded with €6.7 Billion to construct, operate and maintain the second phase of the Haramain HS line, as well as the supply of trains and their maintenance for a period of 12 years. Given the transport and geographic characteristics of Saudi Arabia, the Spanish HSR is a good example to look at. A comparison of the main topics that can influence HSR development and demand has been undertaken. That includes geography, economy, institutional & legal framework and transport characteristics. Derived from this comparison we can offer the following lessons:

The comparison was difficult due to a different culture and the different development of the countries. There are more data and statistics available in Spain than in Saudi Arabia, which makes the comparison even more complicated.

The know-how gained by construction firms, the infrastructure manager and TOCs in Spain has helped drive down costs not only in the construction costs but in the maintenance and operating costs and is key to overcoming the challenge of HSR under extreme climate circumstances. This experience is also useful to promote Spain's own national railway sector, helping in this way the economy afterwards. The case of the Spanish consortium constructing the Saudi Arabia HSR proves this fact.

Although HSR demand is extremely sensitive to the economic cycles and the transport system competing with train, TOCs have control over variables influencing it (commercial speed, prices or frequencies) and therefore must have freedom to adapt their strategy to increase demand and revenues. Table 2 suggests that when the GDP grows positively, demand for HSR services in Spain tends to grow even more positively. On the other hand, HSR traffic tends to decrease even more sharply than does the GDP, when GDP decreases in Spain. The sensitivity referred to previously becomes greater in the cases of seasonal destinations, such as Malaga and Valencia.

There are inherent difficulties to predict demand and although rapid traffic growths can be expected it seems difficult to reach 60 million users per annum for the Haramain HSR line in Saudi Arabia in 12 years. So, taking into account all the culture differences, classical transport models could not be valid to predict demand, and therefore they must be adapted to this particular corridor.

Finally, due to the high risks involved in the project, a greater understanding by the parties of each other's' position is crucial to its success: Saudi Arabia will gain expertise in the development and operation of HSR and will be able to attract international funding in the future, whereas Spanish companies will benefit by improving its technology and the possibility of exporting its know-how to other countries. Failure to do so would be bad for both parties, so they should be open to even further renegotiations or changes of the contract.

6. References

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