Global Journal of Human-Social Science: B
Geography, Geo-Sciences, Environmental Disaster Management
Volume 14 Issue 2 Version 1.0 Year 2014
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-460X & Print ISSN: 0975-587X

High Speed Railway Station: Mobility and Spatial Dynamics in Germany and Spain

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From the analysis based on the fieldwork carried out in certain stations in Germany, as well as from the study of their accessibility level, German cases are compared to other examples in Europe, especially to examples in a country in which HSR was implemented at the same time: Spain.

It can be concluded that there are material differences on the ways to approach the revitalisation of stations and the urban surroundings thereof in order to take advantage of the building's renovation project and the reorganisation of the railway environment as an important engine of urban renovation.

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GJHSS-B Classification : FOR Code: 040699p

HIGHSPEEDRAILWAYSTATIONMOBILITYANDSPATIALDYNAMICSINGERMANYANDSPAIN

High Speed Railway Station: Mobility and Spatial Dynamics in Germany and Spain

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I. Introduction

Decades of experience in the implementation of high-speed rail have resulted in expertise thanks to which a position within the framework of the cities served can be adopted. On the contrary, critics underline the (selective) boosting of the transport system, the effects of polarisation, the comparative abandonment of regional railways or the over sizing of the HSR station area and the surrounding developments thereof. The effects are thus highly heterogeneous and sometimes they do not only depend on development and planning activities, but also on traditional models in the context of planning and mobility of each country's reality. While the potential to gain ridership is certainly not the only factor in a project's success (the ability to secure funding, maintain local support, and overcome design and engineering challenges is equally critical), ridership demand is important enough to be used as a preliminary screen of a proposed project's utility. Projected ridership is one way to measure whether rail services can realize their potential benefits, including gains in energy efficiency, economic productivity, reducing greenhouse gas emissions, and others.

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This is precisely the strategic point of the subject of this paper, through an approach to four cases in Europe: Fulda and Ulm in Germany and Toledo and Lerida in Spain.

II. The High-speed Railway Station: A link between the Network and the City

Despite the fact that new transport systems are developed with a unimodal logic, in sight of the attempt to prioritise its competition compared to other transport modes, High-Speed Rail's degree of territorial consumption is as high as that of other controlled access infrastructures, which strengthens the centrality of those locations served -separated by big distances as per the infrastructure's own definition- but does not imply any advantages whatsoever. Under this circumstance, known as "tunnel effect", [1, 2, 3], many scholars, [4, 5, 6], have historically found the threat of a source of territorial unbalance that polarises space and establishes hierarchies within the cities system, and has become a matter of concern even during the first year of this mode's implementation in Europe, as shown in the European Spatial Development Perspective (ESDP), which identifies the risks and warns on the importance of planning and coordination with other networks:

"Spatial development policy should work towards having high-quality transport infrastructure supplemented by secondary networks to bring about their positive effects in the regions", [7].

This way, through the existence and coordination of secondary, the network's polarising effects are not only mitigated but their capacity makes the convergence of greater volumes of traffic to the largest networks possible, which brings about benefits through their profitability and in time leads to a cost-benefit compensation resulting in the service's improvement by means of benefits, destinations and schedules. De Rus et al [8].

Due to the foregoing and despite the fact that a traditional perspective would implicitly assign a crucial role to technological innovation applied to the revolutionary mean of transport as a driver of development, with the danger of accepting this technological determinism as well as perceiving spatial and territorial developments as a simple reaction against the technological conditions and the potentials thereof Luhmann [9], the planning process is essential to turn associated risks thereto into opportunities. In this context, the high-speed railway station and its surroundings have different functions within the city they serve and turn into its most relevant spot since it is a link between the networks(s): spaces with a high accessibility potential, new exhibition pieces where functions, activities and facilities are amalgamated, their regeneration being the flagship of urban planning in many cities served by HSR.

Rail stations will differ depending on their location — downtown, airport transfer, suburban, and small town. While every station area is unique and should reflect local context, culture and climate, some common principles apply to the creation of forms and public spaces regardless of location. This document offers such principles along with different strategies for the creation of places that invite people to stay and enjoy, and that enhance the economy and sustainability of the region.

III. The Station: Location and Development

Major passenger transport stations work best in existing regional centers. By virtue of their employment and residential densities, recognizable built environment, walkability, and connections to local transportation systems, existing regional centers provide a justifi able foundation for high-speed rail passenger stations. When centers are linked to one another, they create robust regional and mega-regional networks. Car-free access at one or both ends of a trip maximizes the convenience of train travel. Once in the regional center, close proximity to destinations can make a big difference in initial ridership and in the continued growth of ridership over time. People will walk from public transport to jobs and major venues when the walk is interesting and not too long.

Also, coherent development, in which the whole is greater than a sum of the parts, requires strong organizing patterns. Establishing a clear hierarchy of public spaces connected by spatial and visual linkages can give new vibrancy, usefulness, and cohesion to station areas. Designing public spaces for use by crowds, small groups, and individuals, can be thought of as designing stage sets for urban theater. Finally, it is necessary to consider the existing development patterns in the region and city in terms of sustainability and memorability. Let the urban design in the station area (the shape and form-making activity) spur a reconception of the regional design — based on a rural-to-urban progression of development form and density; clarity of form and hierarchy; preservation of resources; and sustainable compact development patterns.

IV. Methodology

Firstly, medium-sized cities with the station located in the centre thereof have been chosen within a wide range of possibilities when choosing the case study, since the integration of high-speed rail is more weighable in this kind of cities, Burckhart [10] -where implementation of high-speed rail has a dramatic impact on accessibility [11, 12]- than in bigger ones that already have access to a previously implemented intermodality, leading to shared effects. In addition, countries where high-speed rail has been implemented for more than twenty years have been chosen; these cities are located in countries where there is not only a historical urban planning tradition administratively implemented in the field of physical planning but also with a historical spatial tradition acting as a link between economic and social planning.

This way, the case studies chosen are Ulm and Fulda in Germany and Lerida and Toledo in Spain; despite the fact that HSR was commissioned at a similar time -1991 in Germany, 1992 in Spain- enabling a comparative framework, the differences found in terms of public transport policies and mobility tradition would show significant differences in the results. A prior consideration of them would be appropriate.

a) COND Features inherent to each country regarding mobility and railway

The conventional railway network, developed since 1825, has a very uneven presence in European countries, fig. 1. In Germany, it has 43,800 km in length; in France, 31,939 km; far from Spain, whose conventional railway network has only 14,743 km and a gauge of rails that is incompatible with the rest of Europe. If we compare these figures with those regarding to High-Speed Rail nowadays, the different application policies of the new mode can be found, fig 1.

In addition, as pointed out by Burckhart [10], there are significant differences in the demand for railway services in Europe in a scenario prior to the current economic crisis. Germany, with 1,309 km/year and Spain, with only 576 km/year. Regarding high-speed rail, Germans travel an average of 400 km in high-speed train every year, whereas Spanish only travel 50 km/year, which shows the poor popularity of Spanish high-speed rail network despite recent investments and differences in terms of railway mobility in the different networks. On the other hand, Germany is densely populated and has a tradition in terms of public transport use, which implies .

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high-speed train every year, whereas Spanish only travel 50 km/year, which shows the poor popularity of Spanish high-speed rail network despite recent investments and differences in terms of railway mobility in the different networks. On the other hand, Germany is densely populated and has a tradition in terms of public transport use, which implies good accessibility in the vast majority of cities, whatever their size, [13], far superior to the Spanish one.

In order to check against the different transformations that have taken place in each case upon the implementation of HSR, this paper focuses on two aspects:

- The planning processes of the station and its surroundings, regarding the level of accessibility by applying the "town planning" function. The "town planning" function [14, 15] was created to calculate the different static and dynamic indexes used to study networks through the graph theory by applying the Floyd Algorithm.
- The renovation or replacement of the building hosting high-speed rail.

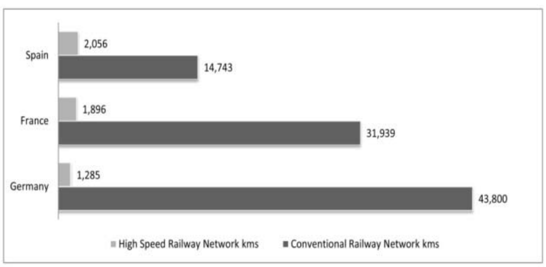

Figure 1 : Length of the conventional and high-speed railway networks in service and planned. Source: Prepared by the author based on data from UIC 2010.

b) Mobility and railway

This in turn enables the transport network to increase access for passengers at the scale of the city. Better access to a number of focus areas attracts development and can help to stem sprawl. Accessibility is a concepts used in several scientific fields such as transport planning, urban planning or geography and plays a key role when establishing economic and social policies. The implementation of High-Speed Rail (HSR) definitely renders the connection between a large number of cities possible, and its competitiveness is based on the transport marketplace, service quality and access time to the main centres of activity; for this reason, in order for it being efficient, excellent connections with the access point of secondary transport networks that spread the node's positive impact are a key aspect. This performance is vital in Europe, where urban agglomerations are located hundreds of kilometres far from each other, which has obvious consequences for the development potential of the regions served the distribution of economic activity in Europe.

Based on the modelling of the real object, i.e. the public transport network, the analysis of the way the networks are linked and the organisation into hierarchies of their links has traditionally been carried out by applying the graph theory through the connectivity's topological features. This way, each spot can represent a city, a station or a computer belonging to a network (or any set of linked objects). The lines that link them can represent roads, railways or cables (or any physical element linking certain objects). Those spots are called vertexes and those lines are called edges. A graph can thus be defined with elements that are related to each other and applied to situations where data modelling so allows, ranging from road, and transport and telecommunication networks to the Internet or industrial processes.

In this paper we also focus on the study of connected graphs, if there is a trajectory between any pair of node (vertexes), i.e. a road that links them, and on the study of labelled graphs, if the segment (and/or nodes) are assigned any kind of data.

In the case of labelled graphs, a value is generally assigned to an edge and the trajectory's value is thus defined as the addition of the values of the segments that are part of it.

By applying the Floyd algorithm to this case, i.e., the urban bus transport network in one of the studied cities, Ulm (Germany), matrixes of minimum distances of 177 rows and 177 columns are obtained 31329 data. In order to operate them, a commercial program of symbolic calculation has been used, the "town planning" function having been created- see Planning of the implementation of high-speed rail. A comparative study on the planning policies from the analysis of the territorial implications thereof , by Carmen Mota, doctoral thesis presented at the UCLM-to calculate the aforesaid static and dynamic indexes. In this function, the Floyd algorithm to the matrixes defined between two bus stops directly connected.

V. The German Case

In the German case, infrastructure investments in the node has traditionally had a particular interest, conceiving it as a link between city in mobility (tramway, metro, cycle paths and bus station -in the surroundings- normally converge) and functions, attaching great importance to the urban development that feeds back its performance Wulfhorst et al [16]. Most German cities have a street at the railway station -Bahnhofsstraße- that is the most important link between the city centre and the railway station and becomes a counterpoint of the original mall Schivelbusch [17]; as pointed out by Bodenschatz [18], this way it contributes to stimulating administrative activities and services. In the early 90s, a phenomenon commonly called Renaissance der Bahnhöfe, Köhler [19] appears, precisely together with the implementation of high-speed rail. This phenomenon claims that the station must be the core of urban life again, a show display of the city for visitors and a driving force for new passengers that contributes to a sustainable urban development. In the 90s, the railway company crystallised these objectives through advertising examples that underlined that "Staying in the railway station must not be seen just as something necessary but as an opportunity to feel something" and in half of the 6,500 stations in Germany, the station's rebirth was seen as a revitalisation of stations and their urban surroundings simultaneously with a search for the sector's liberalisation, aiming at taking advantage of the building renovation project and the rearrangement of the railway environment as an important driver of urban remodelling. Deutsche Bahn, by means of "Die Marke Bahnhof" and "Bahnhof der Zukunft" [20] performed renovation and modernisation works through the service extension to new offers related to the trip, such as the "travel centre", which studied the trip "from door to door" and extended transfers by train to destinations were are not linked and established new retail sale services, such as post offices, premises aimed at catering and food services, boutiques and even chemist's. All this policy was also accompanied by a travelling exhibition called "The stations' rebirth. The city in the 21st century".

a) Ulm

The motto used for the NU21 project should be underlined, "Leben in der Stadt. Neu Definiert" (Living in the city. A new definition) by breaking the traditional railway barrier by relocating the tracks at a lower level and partially burying it.

The Ulm case falls within the "Stuttgart 21" project, fig. 2. Ulm's central station, with an average of 40,000 users everyday and built in 1954, was already a maximum centrality spot -the most accessible spot out of 188 of the local network according to the aforesaid function- within the city and region before high-speed rail was implemented, fig. 3.

Figure 2 : Magistrale für Europe.

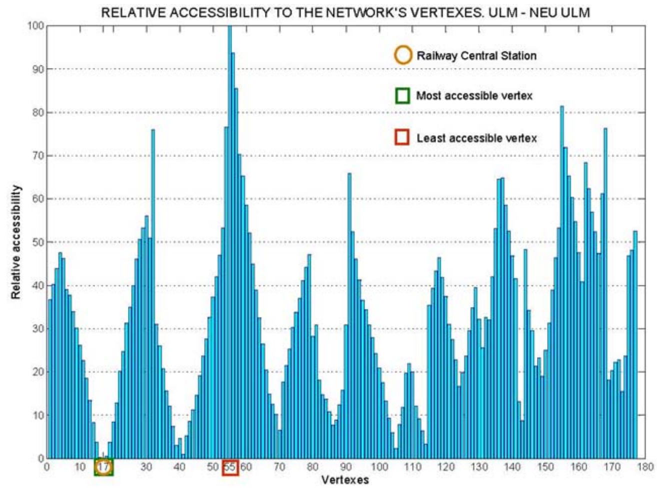

Figure 3 : Graphical representation of the relative accessibility of the vertexes of Ulm´s bus transport network

In order to establish a perfect link for all the transport modes, the bases for a public tendering process were set to present a project for the station and its urban surroundings. The project included the station's general layout, with 2,000 m² for railway functions, 5,000 m² for retail sale and 2,000 m² of service areas. The general public was given the opportunity to participate in the tendering process through different local actions. The actions started to be developed on 1st October 2004 and are ongoing at present; the estimated total cost amounts to 160 million euros and have a priority objective: a new positive definition of life in the city.

This modification became part of the *Städtebau Rahmenplan* (Local Master Remodelling Plan), fig. 4, approved on 2012: north from the street that covers the tracks are located those blocks dedicated to trade in order to invigorate the area, as well as residential blocks with commercial premises.

Figure 4 : Städtebau Ramhmenplan, 2012. Ulm-Neu Ulm's Master Remodelling Plan. Source: Neu Ulm City Council.

b) FULDA

Its connection to the German high-speed network in 1992 contributed to its positioning as an important transport node within the German railway network that serves 20,000 passengers everyday approximately. It is a class 2 Deutsche Bahn node that amalgamates an Intercity-Express stop, interurban and regional services. The original station was inaugurated as part of the Frankfurt-Bebra line in 1866; it was destroyed during World War II and rebuilt thereafter. The strategies developed in the city centre with the implementation of high-speed rail are especially interesting due to the policy of coordination with other transport networks (urban, regional and national) and to the role played by the station in its surroundings. The station, which serves a population exceeding Fulda's population, is used as a spot that links and coordinates the different transport modes. This way, the station becomes the fourth out of 249 most accessible vertex of the entire local network, according to the aforesaid "town planning" function.

About the urban planning, in the mid-80s, the implementation of HSR was finally approved and the city started to get ready for the planning of the station and its surroundings. The first action performed was the transformation to reduce traffic volume by promoting the use of taxi and urban bus. This way, the adjacent bus station was built between 1989 and 1991. The total renovation of the station area was carried out, the surroundings were pedestrianised and the first floor was raised, opening accesses for car traffic, fig. 5. The entire traffic system of the city was modified and in 1992 all the historic quarter was closed to vehicles. Despite the city has a high heterogeneity of uses, administrative uses inherent to its hierarchy, residential, industrial use, etc., the number of houses in the station surroundings increased and commercial uses were promoted.

Figure 5 : Station working schemes. First floor. Source: Prepared by the author

VI. The Spanish Case

The Spanish case has big differences compared to the German model regarding not only the implementation of railway transport but the mobility culture, and many high-speed railway stations, especially those of small-sized cities, are located in the city outskirts. Nevertheless, these cases chosen do opt for the renovation of the existing station to implement the mode.

a) Toledo

The high-speed line with stop in Toledo, in service since 2005, is conceived as an independent line of the Madrid-Seville line, inaugurated in 1992.

When the high-speed line was implemented, the General Urban Planning Plan of 1986 was in force. Another document, the Local Planning Plan of 2007 is currently in force, although it is has been suspended by the High Court of Justice, fig. 6. While the General Plan of 1986 was in force, amendment no. 19 was introduced in order to arrange the land plots in the station surroundings before the implementation of high-speed rail but it was not executed. In the suspended plan, the analysis of the area crystallises in the action unit (UA27) that intends to complete the residential fabric around the station, guaranteeing its connectivity. It does not achieve this objective at present, since the station is the 73rd most accessible spot within the local transport network.

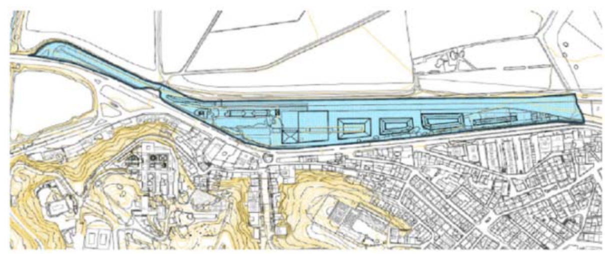

Figure 6 : Modification proposal for the station surroundings. Source: Local Planning Plan of Toledo, 2007

The station's renovated 19th century building, which is small and only had ticket desks, a cafeteria and a waiting area, has the same features today: it is an industrial area, mainly with workshops and garages, surrounded by land plots that are not used at present but recently classified as developable.

Figure 7 : HSR Station Surrondings. March 2013.

b) Lerida

The final implementation Project of high-speed rail in Lerida was approved in 1997, guaranteeing the connection between Figueres (Spain) and Perpignan (France) through a tunnel executed across the Pyrenees that is in service at present.

In the mid-90s, while the study for the optimal implementation of the railway service was being performed, the planning document was a General Plan in force since 1979. The plan being outdated and due to the substantial modifications in the context conditions, the Plan Office was created in 1994. This way and upon rendering the municipal services, in 2003 the Regional Department of Spatial Policies of Catalonia approved the new General Plan, fig. 5, which incorporated the implementation of the new transport mode as one of the major strategies within the context of the urban project and intended to improve the urban environment defined in general plan PE3, aiming at crystallising the demands for improvements in the station area through a specific plan to that end; it was finally approved in December 2008. The strategic objectives sought are giving continuity to the city's neighbourhoods, improving the transport intermodality conditions and rearranging building construction according to the new urban conditions.

The station's building, built in 1929, was remodelled by creating a series of side covers attached thereto that cover the platforms and create a second side access. As in most stations of its kind in Spain, the services offered are cafeteria, bookstore, car rent and ticket desks.

Figure 8 : Urban Development Plan. Lerida City Council, 2003. Source: Lerida City Council

VII. Conclusion

The preparation of roads and walkways plans (Verkehrplanen) is clearly a factor that affects the planning of the station surroundings in the German case, and the competencies thereof cover the modification of sections of streets or squares, the broadening of sidewalks, etc. Regarding the complexity of the station's building, despite the fact that in Spain there is an increasing number of examples with more diversified functions, the huge German tradition makes the station's building act as a powerful driver of urban revitalisation and as a link between the network and the city.

Upon applying the methodology to the study of high-speed railway stations within the urban framework by means of urban bus transport networks, very different results are obtained depending on the city studied. Upon comparing and assessing these results over time, they turn to be a very valuable tool when planning mobility policies that assure both the profitability and the social performance of the inversions made.

The inaccuracy or lack of plans or policies for the integration of the different sectoral areas or lack of coordination between the various territorial levels poses serious difficulties to putting into practice and the consistent implementation of a phenomenon like high speed rail, resulting in severe effects on the different scopes of its integration: the local, the district, the regional and the national scope.

When, on the other hand, planning involves a localized investment programming, the absence of mechanisms linking the necessary sectoral requirements with the execution controls, the solvency of the project is hindered, threatening its economic viability, social and territorial, in the medium and in the long term. Due to the differences compared to Spanish legislation, understanding the scope of the actions carried out by this tool is specially interesting, as well as understanding the need for making mobility become a common tool in the legal framework of spatial planning. In the Spanish cases, to a greater extent in Toledo than in Lerida, the scope of intermodality by connecting the high-speed railway station is poorer, which combined with a lower population density, has a negative impact when taking advantage of the infrastructure, its amortisation and thus of the opportunities to refinance improvements for it.

The existence and permanence of these problems may be indicative of the necessary reformulation of aspects of mandatory compliance with respect to obtaining an effective urban and regional planning, incorporating in a factual manner aspects such as sustainability, territorial planning and mobility management into the integration of a phenomenon, in which the maturity of its integration articulate precisely.

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