Territorial, Socioeconomic and Sustainability Lessons from Developing High-Speed Rail in Spain

José Mª de Ureña, University of Castilla La Mancha (Toledo) - Nov. 30-2012
Introduction
Complexity of HSR and its evaluation

Socio-economic lessons
Difficult economic investment profitability
Upgrading vs new infrastructure

Territorial lessons
Relevance of Station locations
Articulation of intermediate cities
Short and long term urban renewal

Sustainability lessons
Reduction of CO₂ emissions
High-speed Rail complex system
- Interoperability
- New, upgraded, conventional lines
- Pure and Mixed services
- Long, medium & short distances
- Stations number & locations
- Fares
- Speeds: 200, 300 or higher km/h

Medium-distance HSR
- First experienced in Spain
- Now seven services
Personal advantages of travelling by HSR as opposed to air
- not only total travel time & price
- includes other factors
  - accessibility
  - reliability
  - comfort
  - use of total travel time

Evaluation
- not only investment vs travel
- includes long term
  - territorial
  - environmental

Complexity of HSR and its evaluation
Investment profitability

-6 to 9 million total length passengers
  Spain 4.5 million (before Valencia line)

-Useful lifetimes 45 years
  Increasing towards 60 years

-Cofinancing by public funds
  Spain 30% by European Funds

-Territorial & environmental implications

- Difficult economic investment profitability
Two HSR sub-models based on relative importance of new HSR versus conventional/upgraded lines.

- Preponderance of new infrastructure 300 km/h: France & Spain
- Preponderance of conventional/upgraded infrastructure 200 km/h: Germany

 Arguments pro

Conventional/upgraded
- Less costly & more areas served

New
- Two infrastructures
- Greater flexibility & reliability
Spanish experience building HSR conventional/upgraded lines

-Takes longer
  -New lines - 400 km about 7 years
  -Upgraded lines - 250 km around 15 years (daily building time is reduced to 5/6 hours)
  -Mediterranean line: improvements for more than 15 years and is still not finished

-Costs vary importantly
  -Depend strongly on existing conventional line and topographic conditions
  -Germany: flatter, double tracks, electrified and good design speed
  -Spain: rough topography, less electrified and slow design speed

-Costs difficult to know because composed of many projects and agents

-Spanish Costs experience
  -Galician line upgraded to 205 km/h 22 mill€/km
  -Average new Spanish lines 300-350 km/h 15.7 mil€/km
  -Recent Madrid-Valencia new line 300 km/h 18.2 mill€/km

-German Costs experience
  -Köln-Frankfurt new line 300 km/h 33.3 mill€/km
  -Berlin-Hamburg upgraded line 230 km/h 18.5 mill€/km
### Relevance of Station locations

- **All locations good for travelling from home.**
  - Central: accessible by public transport.
  - Peripheral: lack good public transport, passengers have cars & parking is easier.

- **Peripheral stations frequent in small cities**
  - Preponderance of HRS line rationale
  - Lead to sub-regional/county initiatives

- **Recent peripheral stations located by other transportation means**
  - Valence (France)

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### City, Inhabitants, HSR Station, Traditional and HSR stations

<table>
<thead>
<tr>
<th>City</th>
<th>Inhabitants</th>
<th>HSR Station</th>
<th>Traditional and HSR stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Madrid</td>
<td>6052000</td>
<td>Two Central</td>
<td>Same station</td>
</tr>
<tr>
<td>Barcelona</td>
<td>5031000</td>
<td>Central</td>
<td>Same station</td>
</tr>
<tr>
<td>Valencia</td>
<td>1552000</td>
<td>Central</td>
<td>Same station</td>
</tr>
<tr>
<td>Seville</td>
<td>1295000</td>
<td>Central</td>
<td>Same station</td>
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<td>Malaga</td>
<td>953000</td>
<td>Central</td>
<td>Same station</td>
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<tr>
<td>Zaragoza</td>
<td>746000</td>
<td>Edge of centre</td>
<td>Same station</td>
</tr>
<tr>
<td>Coruña</td>
<td>410000</td>
<td>Central</td>
<td>Same station</td>
</tr>
<tr>
<td>Valladolid</td>
<td>409000</td>
<td>Central</td>
<td>Same station</td>
</tr>
<tr>
<td>Tarragona-Reus</td>
<td>382000</td>
<td>10 km from cities</td>
<td>Unconnected</td>
</tr>
<tr>
<td>Córdoba</td>
<td>330000</td>
<td>Central</td>
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</tr>
<tr>
<td>Albacete</td>
<td>171000</td>
<td>Edge of centre</td>
<td>Same station</td>
</tr>
<tr>
<td>Lérida</td>
<td>167000</td>
<td>Central</td>
<td>Same station</td>
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<tr>
<td>Guadalajara</td>
<td>155000</td>
<td>8 km from city</td>
<td>Unconnected</td>
</tr>
<tr>
<td>Gerona</td>
<td>152000</td>
<td>Central</td>
<td>Same station</td>
</tr>
<tr>
<td>Santiago</td>
<td>142000</td>
<td>Edge of centre</td>
<td>Same station</td>
</tr>
<tr>
<td>Orense</td>
<td>132000</td>
<td>Edge of centre</td>
<td>Same station</td>
</tr>
<tr>
<td>Toledo</td>
<td>118000</td>
<td>Edge of centre</td>
<td>No traditional rail</td>
</tr>
<tr>
<td>Ciudad Real</td>
<td>89000</td>
<td>Edge of centre</td>
<td>Same station</td>
</tr>
<tr>
<td>Segovia</td>
<td>72000</td>
<td>6 km from city</td>
<td>Unconnected</td>
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<tr>
<td>Cuenca</td>
<td>57000</td>
<td>3.5 km from city</td>
<td>Unconnected</td>
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<tr>
<td>Puertollano</td>
<td>52000</td>
<td>Central</td>
<td>Same station</td>
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<tr>
<td>Figueras</td>
<td>45000</td>
<td>Edge of city</td>
<td>Unconnected</td>
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<tr>
<td>Antequera</td>
<td>41000</td>
<td>17 km from city</td>
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<td>Unconnected</td>
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<td>Requena</td>
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<td>Unconnected</td>
</tr>
<tr>
<td>Calatayud</td>
<td>21000</td>
<td>Edge of centre</td>
<td>Same station</td>
</tr>
</tbody>
</table>
The Metropolitan Iberian Peninsula
- A central metropolis and several coastal ones
- At distances between 400 and 600 km
- Previous good plane centre/coast connections
- Excellent for HSR/air day return travel competition

The inland Iberian peninsula
- Quite empty
- 3 medium size cities and many small ones

Major interurban effects
- Inland at intermediate positions along HSR lines

Articulation of intermediate cities
Small cities less than 200 km from Metropolises

Discontinuous metropolitan expansion 150/200 km
- Commuting with frequent cheap fares
- Unbalanced relations
- Increased high level services
- New local projects
- Greater change if previously away from transport
  if central station

Metropolitan reinforcement up to 100 km
- Possible metropolitan sub-centres
- Connections to distant cities & other metropolitan parts
- Good quality services and image
- In relevant metropolitan corridors

Distant Small cities
- Previous to HSR difficult day return travel
- Non-polarized relations between small cities & businesses
**Medium-size cities**

**Closer to each metropolis**
- Already existing only advantage

**Connected to inter-metropolitan relations**
- Air transport separated these cities from relations
- HSR reconnects them and attracts activities
- Percentage of inter-metropolitan HSR stopping
- Lower prices and proximity to several metropolises
- Good services and quality of life
- Enough size to house high level business services

**Articulation of intermediate cities**
Relevant Urban Effects

- So far “hard” projects

- Improve urban efficiency & growth – Central stations
  - improve overall urban structure
  - modernity & size of central CBDs
  - facilitating urban renewal and centrality around the station
  - solving inherited urban problems & barriers
  - Córdoba, Zaragoza & Valladolid

- New sub-regional structures – Peripheral stations
  - sub-regional associations (planning)
  - bigger agglomerations around small cities
  - opportunities when stations in “other” municipalities
  - very slow developments
  - Segovia

Need Local Strategies

- Planning
- Management
- Promotion

Short and long term urban renewal
Córdoba central project
- Suppress historic barrier
- Self financed 90 has
- Underground rail & parking
- Ring street & Parking
- Park system
- Urban transport interchanger
- Residential area
CO₂ Emissions and occupancy levels

Madrid-Barcelona Modal Split

Madrid-Sevilla Modal Split

Reduction of CO₂ emissions
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Thank you