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DAILY BUSINESS AND TOURISM TRIPS:COMPETITIVE ADVANTAGES FOR HSR CITIES

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ABSTRACT

This paper aims to establish a systematic methodology, applicable to an entire network, to compare High-Speed Rail's (HSR) relative contribution to various cities. Specifically, the objective is to assess the potential impact in different HSR cities depending on their characteristics, their position in the network and operating services. The methodology, based on the calculation of the time available at the destination and travel costs, has been applied to the Spanish case for two travel purposes (business and tourism) and for day trips. The results indicate that cities that a priori appear to be in similar situations should not expect the same benefits from HSR.

Keywords: High-Speed Rail, Contactability, Time Geography, Efficiency, Network

INTRODUCTION

Since the opening of the Tokaido Shinkansen line in 1964, and in particular, since the opening of the TGV in France in 1981, High-Speed Rail (HSR) technology for passenger transportation has expanded all over the world. Because HSR was conceived as a competitor to transportation by air between large metropolitan areas, initial HSR development resulted in separate and independent lines even within the same country (Madrid-Seville and Madrid-Barcelona in Spain, for example).

However, as the isolated HSR lines that different countries began to build in the 1980s and 1990s, primarily in Europe, are being expanded and connected, the HSR system is becoming more complex. On the one hand, when an HSR line becomes an HSR network, the cities in the line multiply their possible connections and therefore the competition among HSR cities increases. On the other hand, different operating models have been described that consider a connection between HSR and conventional rail (Campos and De Rus, 2009).

Additionally, the first HSR services were quite homogenous with regard to fares, travel times and the quality of rolling stock. However, since the introduction of medium-distance HSR services (AVANT) between Madrid, Ciudad Real and Puertollano in Spain in 1992, different HSR types have emerged: short-distance metropolitan services with reduced fares and high frequencies (Garmendia et al., 2012), medium-distance regional services with reduced fares and low-quality rolling stock (Ureña et al., 2005; Fröidh, 2005) and long-distance services with high-quality rolling stock (Plassard, 1991).

In this new context of HSR expansion, more important than having a station is the quality of the operating services and the new possibilities generated by these services: available destinations, time available at those destinations, and the cost of connections. These qualities constitute the real utility of HSR for a city and its citizens.

Different territorial situations have been described that depend on city size, city position on the line, station location, possible connections to the other cities on the line and operating services: small cities close to metropolitan areas, large intermetropolitan cities, small intermediate cities one hour away from metropolitan areas, etc. (Ureña et al., 2012).

Although changes in the mobility patterns resulting from new HSR connections have been widely described and documented with objective data (Froidh, 2005; Klein and Claisse, 1997; Ureña et al., 2005), the literature on territorial and socioeconomic effects addresses opportunities and expectations introduced by HSR and are usually based on surveys or interviews with different stakeholders (Garmendia et al., 2008; Burmeister and Colletis – Wahl, 1997). Expectations take much time to materialize, and when they do, it is difficult to determine the real extension of HSR impact beyond stakeholders' impressions. In addition, research on HSR effects usually involves specific case studies, so it is difficult to reach global conclusions.

To compare the real utility of HSR in different cities, it is also necessary to consider that the HSR dinamyses, specifically those activities related to large cities (Plassard, 1992), that is, tertiary activities. Limited or even negative effects have been described in industrial cities despite the existence of HSR (Ureña et al., 2005; Bieber et al.1991). HSR's main impacts have been reported in terms of commuting (Menéndez et al., 2002; Froidh, 2005), business (Klein and Caisse, 1997; Burmeister and Colletis-Wahl, 1997; Chen and Hall, 2010) and tourism (Masson and Petiot, 2009; La Rocca, 2008). The increase in accessibility generally contributes to polarization and benefits large cities, to the detriment of small cities (Auphan, 2002; Burmeister and Colletis –Wahl, 1997). However, new HSR connections also introduce opportunities for small cities that may increase their visibility and improve their image (Bertolini and Spit, 1998) and may extend their potential market, considering HSR's usefulness to business, tourism and commuting activities.

This paper focuses on HSR's potential contribution with regard to business and tourism day trips in Spanish cities. Depending on the quality of the connections provided by HSR and the nature of the city, in relative terms, HSR will contribute to some cities more than others. Therefore, the aim is not to measure effects but to quantify the real opportunities provided by HSR in different cities in the network. Usually, HSR cities initiate different types of strategies to take advantage of the introduction of the new infrastructure, and often, these strategies are motivated not by objective data but by expectations and excessive assumptions regarding the impact of HSR. The analysis of operating services and HSR's usefulness for specific activities has clear policy implications for different types of cities, depending on their position in the network, the existence of reduced fares or adequate schedules, city characteristics, etc.

BACKGROUND

Transport networks have typically been studied using different types of accessibility indicators. For example, Bruinsma, F. and Rietveld, P. (1993) studied cities in transport networks at the European level using a gravity-based accessibility index considering travel times. Usually, the mass factor is related to the populations of the other cities, or other data are used to measure the relevance of the cities such as GDP. This indicator denotes economic potential, as it measures the ease of accessing a volume of economic activity in a city. As with the gravity formula, accessibility is proportional to mass and decreases with distance, which is generally represented by travel time.

Another tool for measuring accessibility is the weighted average of travel times obtained using this mass. These indexes are useful when assessing accessibility changes resulting from new infrastructures or comparing different scenarios. In both cases, the results for a system of cities are conditioned by their location, as central cities obviously offer shorter travel times to most cities than peripheral cities. To eliminate this difficulty, Gutiérrez et al. (1998) used route factors created by comparing real travel times with ideal travel times when studying the improvement of the Spanish infrastructure master plan of 1993-2007.

Another variation of this index is the daily accessibility indicator, which measures the amount of mass (population, GDP, employment, etc.) that can be reached from a city within a maximum travel time. This time limit is usually fixed at 3 or 4 hours, as this amount of time is sufficient for a day trip and still offers sufficient time at a destination for the development of an activity (business, meetings, etc.) (Vickerman, 1995). As Gutiérrez (2001) proposed, this indicator is adequate when measuring the impacts of new high-speed train lines, as travel times are reduced significantly.

All of these accessibility indicators require accurate measurements of travel times, which are easy to estimate when studying road networks, usually by using GIS when finding the shortest/fastest routes. Travel times are also easy to obtain for types of public transport such as air transport or HSR. In the case of a driver, the trip can begin whenever the individual wants it to begin, but rail or air transport passengers are conditioned by frequencies and timetables. Conventional spatial accessibility indicators usually introduce different time penalties to address this limitation: the amount of time required to reach a station, the amount of time required to arrive in advance of a flight departure, average wait time for the next flight or train, the amount of time required for connections, etc. When analyzing the accessibility of large cities, these penalties may be sufficient, as timetables are generally designed for travel to these cities and frequencies are high because of their population (mass). In contrast, when analyzing small cities, closer attention to timetables must be considered.

The daily accessibility indicators mentioned above result in dummy variables when analyzing pairs of cities, depending on whether the travel times are above or below the four-hour limit. The methodology we propose in this paper addresses this limitation by measuring the time available at a destination instead of the existence of travel times under a certain limit. Travel time and costs (ticket prices) are considered to calculate the efficiency of the money and time invested in the trip. This methodology, based on time geography principles (Hägerstrand, 1970), was proposed by Törnqvist (1970) for the measurement of the ease of having direct contacts, which he called ‘potential contacts’, at the national scale in Sweden.

Using the time available at a destination and considering all transport modes, Erlandsson (1979) analyzed accessibility in the European system of cities and calculated the number of people potentially reachable from a point (outbound potential contacts), and the number of people who can reach a point under the same conditions (inbound potential contacts). Today, the development of the Internet and videoconferencing may be alternatives to face-to-face contacts, but the literature indicates that for business, scientific and creative activities, physical contact is still necessary (Denstadli et al., 2013; Storper and Venables, 2004).

Despite being a powerful tool, time available at a destination has not been used regularly in the analysis of transport networks. Gutiérrez (1991) used this methodology in assessing the public transport accessibility of the villages north of the Madrid metropolitan area. After establishing the minimum or maximum departure and arrival times, commutes to Madrid were determined to be possible within reasonable timeframes, possible with overly long wait times, or not possible. In the same manner, the possibility of having four hours of time in

Madrid for shopping or administration purposes on a work day or the possibility of leisure travel on Sundays was determined.

More recently, in the Nord – Pas de Calais region, L'Hostis and Baptiste (2006) evaluated the quality of public transport connections for commuting and study purposes, considering the complete trip chain during a single day, following the principle of the fast train at the right moment (Fig. 1). This principle means that a link between two cities achieves the requisite level of service when the user can find a fast train for the morning and evening trips.

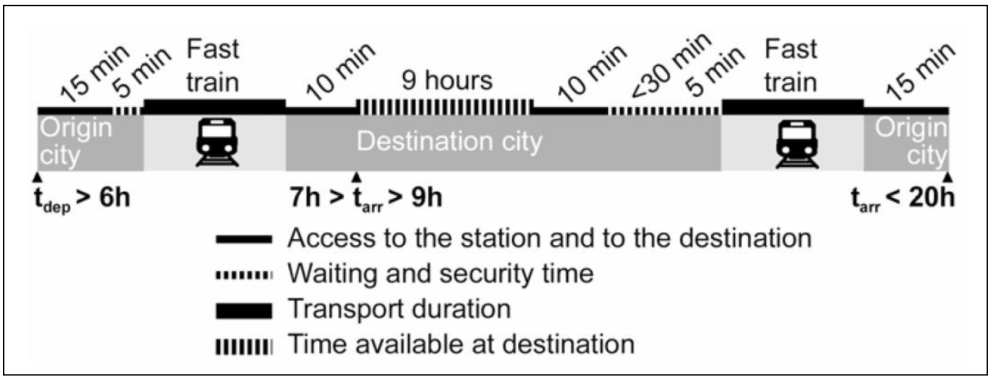

Fig. 1: Trip chain according to the principle of a 'fast train at the right moment'. Source: L'Hostis and Baptiste, 2006.

In a European ESPON project, L'Hostis and Bozzani (2010) reintroduced this methodology when analyzing the contactability of air transport and rail at the European level, finding connections between cities that allowed for more than six hours at the destination and indicating differences between inbound and outbound "maximum stay time". In Fig. 2, the different time structures considered for the trips are synthesized. L'Hostis and Leysens (2012) have further developed this methodology and proposed its application in modeling future rail offerings. In addition, contactability indicators such as number of contactable cities (time at destination > 6 h) have been developed.

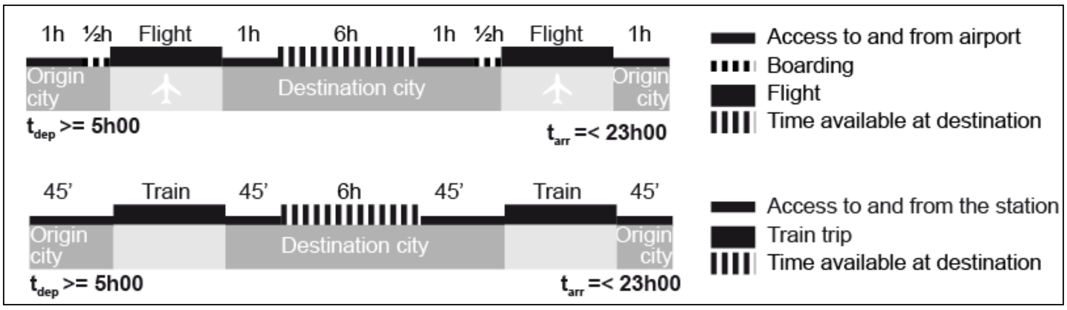

Fig. 2 - Trip chain for business air and train day trips. Source: L'Hostis and Bozzani, 2010.

In this paper, we present a systematic study of all of the Spanish cities with HSR, considering the usefulness of the actual timetables for different travel purposes, with the objective of comparing HSR's contributions to each city in relative terms. First, we detect which connections are possible with a hypothesis regarding day tourism or business trips. Then, we calculate the "efficiency" of these connections, considering the costs necessary (time and/or money) to have a certain amount of time available at a destination. We used these efficiencies to make estimations regarding the potential market for these trip purposes using a gravitation model, and finally, we produce measurements of HSR's relative utility HSR for each city and travel purpose, which are compared to identify the cities that gain the most from HSR.

THE CASE STUDY: THE SPANISH NETWORK AND CITY SYSTEM

In the last 20 years, the HSR network in Spain has expanded from the initial Madrid – Seville line to more than twenty stations[1] on six main lines (Fig. 3). Furthermore, several cities not on these lines can be reached by high-speed gauge adaptable trains that partially utilize the new lines. The HST is changing from a phenomenon limited to one line and selected cities to a national (and soon, international) system.

The homogeneity that existed during the initial years of the system has disappeared. Today, frequencies, prices per kilometer and commercial speeds change from station to station depending on the existence of regional HSTs (AVANT), city position in the network (intermediate stops reduce commercial speed), or city size: the larger the city is, the higher frequencies will be. Concerning location in the network, some cities are located on dead end lines, such as Toledo, which is linked directly to only Madrid. Others are close to a divergence point in the network, such as Cordoba, which is integrated into both the Madrid – Seville and the Madrid – Málaga lines.

The existence of a by-pass in Madrid between the lines in the South (Malaga and Seville) and the lines in the North-East (Barcelona) allows for direct trains that do not stop at Madrid. However, the Madrid-Valladolid line is penalized because it ends at the Chamartin station instead of the Atocha station, and at least forty-five minutes are necessary to travel from one to the other. In 2013, this problem will disappear with the opening of a new tunnel linking both stations, although not all of the trains will be able to use it. In 2012, a new by-pass connecting the lines from the south to the line to Valencia was opened, so in the near future, it will be possible to travel between Malaga or Seville to Valencia without passing through Madrid.

Fig. 3: HST lines in Spain in 2012. Source: Own elaboration.

The twenty-two HSR cities considered are very different. In terms of size, this research includes a range of cities, from large metropolitan cities such as Madrid or Barcelona to small

[1] Currently, there are 25 HST cities in Spain. In this research, only 22 are considered because the others are on the Galician line, which is not integrated into the network.

towns such as Calatayud or Requena. Most of these cities are provincial capitals, which means that they have some administrative relevance, whereas others are only small towns with either industrial (Puertollano) or rural character (Requena or Calatayud).

Some HSR cities are characterized by high touristic attractiveness, such as Toledo, Segovia and Tarragona (designated as World Heritage by the UNESCO), others have a significant CBD and, finally, others are not specialized in terms of either of these sectors (business or tourism).

The cultural tourism relevance of each city was estimated using the number of monuments (real state) designated BICs (Bien de Interés Cultural - Heritage of Cultural Interest) in the city[2]. However, the value of a BIC as a tourist attractor is not the same for all monuments. Some BICs have higher tourist interest than others (i.e., the roman aqueduct in Segovia), and some cities' historic offerings are more interesting than the addition of individual monuments. Number of BICs indicates the relevance of a city as a cultural destination for tourism, although some characteristics, such as fairs, events, or commercial offers, are not included. Unfortunately, no better data, such as number of tourist visits, are available.

The business relevance of each city was represented by the number of High-Level Jobs (HLJ), obtained from the CNO 94[3] from Census Data.

Table I - Population, number of BICs and number of high-level jobs for each HSR city. For consideration of their hierarchy, the percentages of these factors are also included. Source: Census data 2001.

	POPULATION	BICS	HLJ	% POPULATION	% BICS	% HLJ
BARCELONA	1,619,337	110	99,256	17.36	6.19	**20.44**
TARRAGONA	140,184	60	4,516	1.50	**3.37**	0.93
LLEIDA	137,387	26	4,324	1.47	1.46	0.89
HUESCA	52,347	16	1,866	0.56	**0.90**	0.38
ZARAGOZA	675,121	93	27,819	7.24	5.23	5.73
CALATAYUD	21,717	10	405	0.23	**0.56**	0.08
GUADALAJARA	83,789	19	2,726	0.90	**1.07**	0.56
MADRID	3,273,049	335	222,281	35.08	18.84	**45.77**
SEGOVIA	55,748	88	2,114	0.60	**4.95**	0.44
VALLADOLID	315,522	59	13,407	3.38	3.32	2.76
CUENCA	56,189	70	1,888	0.60	**3.94**	0.39
REQUENA	33,869	9	475	0.36	**0.51**	0.10
VALENCIA	809,267	99	37,340	8.67	5.57	7.69
ALBACETE	170,475	9	4,321	1.83	0.51	0.89
TOLEDO	82,489	246	3,329	0.88	**13.84**	0.69
CIUDAD REAL	74,345	23	2,872	0.80	**1.29**	0.59
PUERTOLLANO	52,300	2	760	0.56	0.11	0.16
CÓRDOBA	328,547	242	9,644	3.52	**13.61**	1.99
SEVILLA	704,198	151	29,635	7.55	**8.49**	6.10
PUENTE GENIL	30,245	2	315	0.32	0.11	0.06
ANTEQUERA	45,234	39	642	0.48	**2.19**	0.13
MÁLAGA	568507	70	15762	6.09	3.94	3.25
TOTAL	9329866	1778	485697	100	100	100

[2] A BIC is any piece of real estate or personal property with any artistic, historic, paleontological, scientific or technical interest, as declared by the corresponding administration. Any areas with documentary and bibliographic heritage and green areas or parks with certain artistic, historic or anthropologic value can also be declared BICs.

[3] The **CNO-94** lies within the ISCO-88(COM) conceptual framework, and therefore, the CIUO-88 framework as well. The classification criteria used are type of work performed and qualification. Qualification is understood as the capacity to perform the tasks inherent to a determined job, for which two viewpoints are considered: the level and the specialization of said qualification.

In Table I, when the percentage of BIC or HLJ is higher than the population percentage, the figures are highlighted in bold. Although Madrid and Barcelona are the only cities with highlighted HLJ percentages, indicating the tertiary relevance of metropolitan cities, in the case of tourism, BICs are not related to city size.

METHODOLOGY

The systematic assessment of the entire HST network is based primarily on the useful time available at the destination for every travel purpose. Regarding this time, daily trips have different requirements. Tourists attempt to maximize their time at a destination so that their costs are profitable, whereas business travelers only require that the time at a destination fits the maximum meeting duration to the extent possible, minimizing wait times. For consistency with the literature, the maximum meeting duration was limited to 6 h (L'Hostis and Leysens, 2012) so that any additional time at a destination was not considered useful time.

RENFE timetables (www.renfe.es) were used to measure the time available at each of the twenty-two destination cities connected by High-Speed Lines, in addition to the Mediterranean link between Barcelona and Valencia (Fig 3). This upgraded line was included so that the model would be as realistic as possible, as it is more convenient for travelers to take this line than to take the HSR through Madrid.

The days chosen for the calculation of the time available at a destination were Saturday, for tourism trips, and Wednesday, for business trips. In the first case, Saturday is the best day for travelling because it is not a work day for many employees and shopping is possible and tourist attractions (museums, expositions, etc.) are open for visitors. For a business trip, Wednesday was considered the most representative working day. HST service differs depending on the day of the week; the frequency and number of Regional HSTs (AVANT) decrease on Saturdays because of the lower number of commuters.

This methodology is based on hypotheses related to the choice of one train or another. These hypotheses have a certain arbitrary character, but they are consistent for all cases, allowing for exclusively comparative analysis among all HST cities.

The choice of the outward and return trains depends on user's preferences. Tourism trips are more influenced by the ticket price, giving priority to the Regional HST when available. Conversely, business trips are usually paid for by companies, so ticket cost loses some relevance with regard to travel and wait times.

With this in mind, in the case of tourism trips, the last low-priced train arriving before 9:00 am was chosen. If the low-priced train arrives after 9:00 am, the time gained at the destination was compared with the cost increase of taking a more expensive train. To make comparisons in a systematic way, it was necessary to use a time-value ratio, which allowed for assessment of the convenience of taking one train or another. The ratio used for the calculations of all amounts of time available at a destination was 20 €/h (0.33 €/minute)[4]. For the return train, the first low-priced train that departs after 8:00 pm was used.

The useful time available at the destination cannot be considered to be the same as the difference between the arrival time and the departure time of the return train. Therefore, the time available must be reduced because of the security time needed before a train's departure and the time required for access from the HST station to the city center and vice versa. For tourism day trips, fifteen minutes was used for security time for all stations, whereas access time on public transport was only considered for the outlying stations. In the

[4] A survey of HSR passengers in 2007 established the figure 14 €/h for non-mandatory travel purposes and 3.92 €/h for headway time (Román et al., 2007). These values were updated and rounded to 20 €/h.

other cases, the access time was zero minutes because tourists were considered to begin their experience at the station.

In the case of business trips, the train arriving at approximately 8:00 am was used, regardless of ticket cost. For the return train, the first train departing just after seven hours (six hours of useful time + one hour of access and security time) at the destination was chosen. Security time was reduced to ten minutes, as business travelers are more familiar with the trip environment than tourists. A total of twenty-five minutes was considered for access from the HST station to the meeting place and vice versa for all of the cities studied because this is a sufficient amount of time for taxi access to any destination, even in large cities.

In addition, with both travel purposes, connections must be made that require a change between trains. In those cases, at least ten minutes of difference between arrival and departure times were required when the change was to be made in the same station. However, when the change was made between Chamartín and Atocha stations in Madrid, at least forty-five minutes were required.

Figures 4 and 5 show an adaptation of L'Hostis and Leysens (2012) for the different day trip chains for each travel motive:

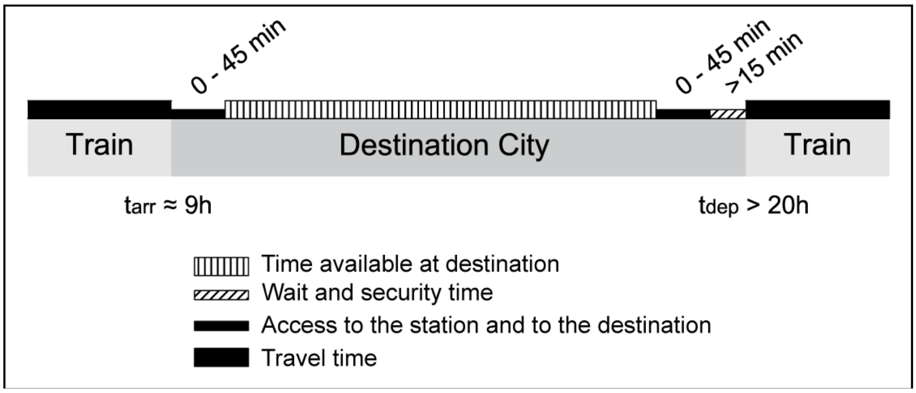

Fig. 4 – Tourism day trip chain considered to calculate the time available at destination.

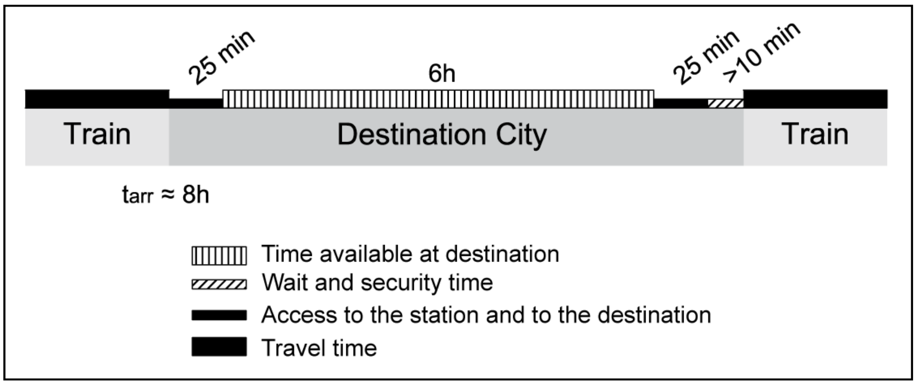

Fig. 5 – Business day trip chain considered to calculate the time available at destination.

With these previous hypotheses, three main pieces of data could be obtained for all relations:

- Time available at destination (t_{dest})
- Travel time (t_{travel})
- Travel cost in terms of time and money ($€_{travel}$)

Using this information, it is possible to calculate three indicators. First, the "efficiency" of an HST connection refers to the quality of the service, that is, the useful time available at a destination in relation to the money invested. In addition, considering the potential market (in terms of population) that can reach a destination, benefiting from link efficiency, the "efficiently accessible potential market" can be measured. Using the same criteria, to assess the "global utility" of an HST connection, it is necessary to include not only the potential market but also what each city can offer to its visitors, depending on the travel purpose (the importance of each city in terms of business or tourism attractiveness).

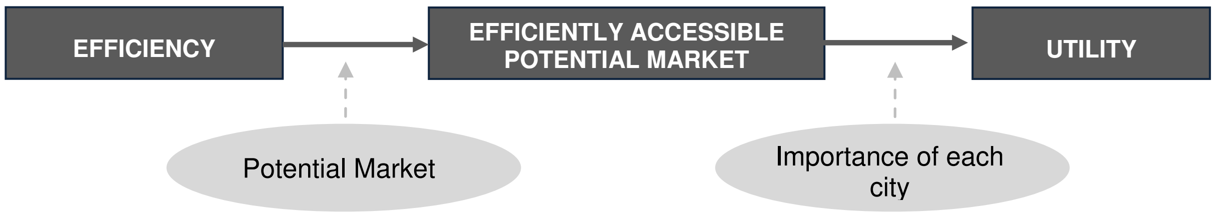

Fig. 6 – Main indicator scheme

The "efficiency" of an HST connection depends on the useful time available at a destination and its associated costs.

$$E_{ij} = \frac{t_{dest\,j}}{€_{travel\,ij}}$$

In tourism travel, the associated cost ($€_{travel}$) is only the ticket price. However, with a business trip, wait and travel times mean relevant added costs. The value of time for a business traveler was considered to be 45€/h[5]. Today, it makes no sense to consider travel time to not be useful because on an HST, travelers can work using laptops and mobile phones. Using surveys on British trains, Fickling et al. (2009) found that senior managers work for 60% of travel time on average. With this in mind, the cost ratio of travel time is 18€/h (0,4*45€/h). These added costs will depend on the convenience of the timetables with regard to travel needs.

Using the efficiency and the volume of population related to each travel purpose, the "Efficiently Accessible Potential Market" was obtained.

$$EAPM_j = \sum \frac{t_{dest\,j}}{€_{travel\,ij}} \cdot P_i$$

The quantity of tourists that a city can receive (inbound) has more policy implications than the ease with which its inhabitants may visit other cities (outbound). Therefore, the population volume (P) associated with tourism trips is the total population that can be received from each origin. Conversely, for the population (P) related to a business trip, the number of high-level jobs was considered. In this type of job, professional meetings are relatively common. In this case, efficiency was considered to be an average of the values of visiting and receiving (inbound and outbound) travelers because professional relations are biunivocal. Therefore, bond quality acquires more relevance than efficiency value in one direction or another.

Finally, a third indicator referring to the "global utility" of HST connections was obtained. This indicator considers not only the potential market but also the destination city's relevance in connection to the travel purpose.

[5] Spanish managers earn an average of 57000€/year. Considering a 30% increment of social costs and 1800 working hours a year, the total cost is approximately 45€/h (INE, Encuesta de Estructura Salarial 2010).

$$U_j = \left[\sum \frac{t_{dest\,j}}{€_{travel\,ij}} \cdot P_i \right] \cdot I_j$$

The tourist importance of a city (I), that is, its capacity to attract tourists, is represented by the number of BICs (Bienes de Interés Cultural), weighted by different coefficients, such as whether a city has a World Heritage Denomination bestowed by the UNESCO or historical areas listed by the Spanish Ministry of Culture. In reference to business relevance, the possession of high-level jobs is considered.

RESULTS

Useful time and efficiency for daily trips

For the tourism trip, eight hours at a destination was established as the minimum amount of time indicating that a tourism day trip is highly convenient. Between eight and six hours is not ideal, but it is possible to visit some cities in this amount of time. Less than six hours at a destination is considered a non-useful daily visit. As shown in the matrix below (Table II), Madrid is the only city that can reach with eight hours of available time the majority of cities and whose visitors have at least six hours for travel from all possible origins. Apart from this case, a reasonable amount of time for tourism is only assured between cities on the same HST line.

Table II: Useful hours available at destination (columns) for all possible HSR links for tourism trips.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
BARCELONA	1	-	12.7	12.1	0.0	12.1	11.1	11.1	10.9	7.3	6.2	4.9	1.2	9.4	6.4	8.3	6.3	4.7	4.4	1.8	1.3	0.0	4.3
TARRAGONA	2	10.8	-	13.8	0.0	13.9	11.1	11.1	10.9	6.6	5.2	4.9	1.2	9.4	6.4	8.3	5.2	4.7	4.4	1.8	1.3	0.0	4.3
LLEIDA	3	10.8	11.2	-	0.0	13.9	11.1	11.1	10.9	6.6	5.2	4.9	1.2	5.6	6.4	8.3	5.2	4.7	4.4	1.8	1.3	0.0	4.3
HUESCA	4	7.4	7.8	8.6	-	11.4	10.5	8.5	8.3	3.3	2.7	2.7	1.2	3.4	1.4	5.8	3.2	2.5	3.4	2.0	0.0	0.0	0.7
ZARAGOZA	5	11.5	10.4	12.2	0.0	-	10.9	11.1	10.9	6.6	5.2	4.9	1.2	5.6	6.4	8.3	6.3	5.7	4.4	1.8	1.3	0.0	4.3
CALATAYUD	6	9.1	9.4	11.2	0.0	12.6	-	9.9	9.6	5.6	4.6	4.9	1.2	3.4	3.4	7.8	3.2	2.5	5.5	4.0	1.9	0.7	2.6
GUADALAJARA	7	5.1	5.4	7.2	0.0	8.6	1.6	-	10.9	6.6	5.2	4.9	1.2	5.6	6.4	8.3	6.2	5.5	6.8	5.0	1.9	0.7	2.6
MADRID	8	11.5	10.4	12.2	0.0	13.6	13.5	9.9	-	11.7	11.1	11.1	6.6	10.0	10.4	11.4	12.2	11.5	10.4	11.0	5.4	4.2	10.1
SEGOVIA	9	3.5	1.4	3.2	0.0	7.1	6.1	4.8	12.4	-	11.1	6.1	1.2	5.6	3.4	8.3	8.2	7.5	6.8	5.0	1.9	0.7	5.6
VALLADOLID	10	3.5	1.4	3.2	0.0	7.1	6.1	4.8	12.4	12.7	-	6.1	1.2	5.6	3.4	8.3	8.2	7.5	6.8	5.0	1.9	0.7	5.6
CUENCA	11	3.5	1.4	3.2	0.0	6.4	6.1	4.8	11.1	6.3	5.7	-	6.6	9.0	10.4	8.3	8.2	7.5	7.1	5.0	1.9	0.7	4.8
REQUENA	12	3.5	1.4	3.2	0.0	6.4	6.1	4.8	11.1	6.3	5.7	12.2	-	6.8	5.1	8.3	8.2	7.5	7.1	5.0	1.9	0.7	4.8
VALENCIA	13	8.1	9.3	3.2	0.0	6.4	6.1	4.8	11.1	6.3	5.7	12.2	13.0	-	3.4	8.3	8.2	7.5	7.1	5.0	1.9	0.7	4.8
ALBACETE	14	3.5	1.4	3.2	0.0	6.4	6.1	4.8	9.9	5.6	4.6	4.7	1.2	3.4	-	7.8	3.2	2.5	6.0	4.0	1.9	0.7	3.6
TOLEDO	15	4.5	3.4	5.2	0.0	7.7	6.1	8.8	11.6	7.3	7.3	6.9	1.2	5.4	5.4	-	8.2	7.5	6.5	4.0	1.9	0.7	4.8
CIUDAD REAL	16	4.8	5.1	5.8	0.0	7.9	6.1	8.8	12.5	8.3	7.3	6.9	1.2	5.4	5.4	10.4	-	11.5	11.9	10.3	5.4	4.2	8.0
PUERTOLLANO	17	5.5	4.4	5.2	0.0	8.4	6.1	8.8	12.5	8.3	7.3	6.9	1.2	5.4	5.4	10.4	11.5	-	11.9	10.3	5.4	4.2	8.0
CÓRDOBA	18	3.8	4.1	5.8	0.0	7.2	6.1	8.8	11.3	7.3	7.3	6.9	1.2	5.4	5.4	8.3	13.1	13.6	-	12.7	9.5	8.2	8.8
SEVILLA	19	3.4	3.7	5.4	0.0	6.9	6.1	8.8	11.3	7.3	7.3	6.9	1.2	5.4	5.4	8.3	13.1	13.6	13.2	-	9.5	8.2	8.8
PUENTE GENIL	20	1.6	1.9	3.6	0.0	5.0	1.5	1.9	7.1	0.2	0.7	2.7	1.2	1.4	1.4	4.3	9.1	8.3	9.9	8.3	-	8.2	8.8
ANTEQUERA	21	1.6	1.9	3.6	0.0	5.0	1.5	1.9	7.1	0.2	0.7	2.7	1.2	1.4	1.4	4.3	9.1	8.3	9.9	8.3	10.2	-	8.8
MÁLAGA	22	1.6	1.9	3.6	0.0	5.0	6.1	4.8	11.6	6.6	5.2	4.9	1.2	3.4	3.4	8.3	9.1	8.8	9.9	8.3	10.2	9.8	-

	Useful time>8 h
	8 h>Useful time>6 h
	Useful time<6 h

Nevertheless, the greater part of HST relations allow for a professional meeting (Table III) and the obtainment of six hours of useful time (282 green of 462 possible connections), with the exception of Huesca, which cannot be visited by HST for daily travel, and Requena, one of the less accessible cities in the network.

Table III: Useful hours available at destination (columns) for all possible HSR links for business trips.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
BARCELONA	**1**	-	6.00	6.00	0.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	1.47	6.00	5.67	6.00	6.00	6.00	6.00	4.25	1.70	1.27	4.88
TARRAGONA	**2**	6.00	-	6.00	0.00	6.00	6.00	6.00	6.00	5.55	5.43	6.00	1.47	6.00	5.67	6.00	6.00	5.70	6.00	4.25	1.70	1.27	3.55
LLEIDA	**3**	6.00	6.00	-	0.00	6.00	6.00	6.00	6.00	5.55	5.43	6.00	1.47	5.83	5.67	6.00	6.00	5.70	6.00	4.25	1.70	1.27	3.55
HUESCA	**4**	6.00	6.00	6.00	-	6.00	6.00	6.00	6.00	3.17	3.42	2.60	1.47	3.87	0.67	3.53	3.12	2.57	3.20	1.25	0.00	0.00	0.97
ZARAGOZA	**5**	6.00	6.00	6.00	0.00	-	6.00	6.00	6.00	6.00	6.00	6.00	1.47	6.00	5.67	6.00	6.00	6.00	6.00	4.25	1.70	1.27	4.88
CALATAYUD	**6**	6.00	6.00	6.00	0.00	6.00	-	6.00	6.00	6.00	6.00	6.00	1.47	5.95	5.67	6.00	6.00	5.53	6.00	4.25	1.85	1.42	3.72
GUADALAJARA	**7**	4.33	5.50	6.00	0.00	6.00	6.00	-	6.00	6.00	6.00	6.00	1.47	5.95	5.67	6.00	6.00	5.53	6.00	4.25	1.85	1.42	3.72
MADRID	**8**	6.00	6.00	6.00	0.00	6.00	6.00	6.00	-	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	5.33	4.90	6.00
SEGOVIA	**9**	5.33	3.50	4.40	0.00	6.00	4.72	5.83	6.00	-	6.00	6.00	1.47	6.00	4.67	6.00	6.00	6.00	6.00	5.63	1.85	1.42	4.88
VALLADOLID	**10**	3.75	3.50	4.40	0.00	6.00	4.72	5.83	6.00	6.00	-	6.00	1.47	6.00	4.67	6.00	6.00	6.00	6.00	5.17	1.85	1.42	4.88
CUENCA	**11**	4.75	3.50	4.40	0.00	6.00	4.72	5.83	6.00	6.00	6.00	-	6.00	6.00	6.00	6.00	6.00	6.00	6.00	5.62	1.85	1.42	4.88
REQUENA	**12**	4.17	1.50	2.40	0.00	5.68	4.72	3.70	6.00	5.55	5.43	6.00	-	6.00	6.00	6.00	6.00	6.00	6.00	4.70	1.85	1.42	4.05
VALENCIA	**13**	6.00	6.00	4.40	0.00	6.00	4.72	5.83	6.00	6.00	6.00	6.00	6.00	-	4.67	6.00	6.00	6.00	6.00	5.62	1.85	1.42	4.88
ALBACETE	**14**	3.75	3.50	4.40	0.00	6.00	4.72	5.83	6.00	6.00	6.00	6.00	5.97	6.00	-	6.00	6.00	6.00	6.00	5.17	1.85	1.42	4.88
TOLEDO	**15**	6.00	6.00	6.00	0.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	5.97	6.00	6.00	-	6.00	6.00	6.00	6.00	1.85	1.42	6.00
CIUDAD REAL	**16**	6.00	5.50	6.00	0.00	6.00	4.72	6.00	6.00	6.00	6.00	6.00	1.47	6.00	6.00	6.00	-	6.00	6.00	6.00	5.33	4.90	6.00
PUERTOLLANO	**17**	6.00	5.50	6.00	0.00	6.00	4.72	6.00	6.00	6.00	6.00	6.00	1.47	6.00	6.00	6.00	6.00	-	6.00	6.00	5.33	4.90	6.00
CÓRDOBA	**18**	4.75	5.50	6.00	0.00	6.00	4.72	6.00	6.00	6.00	6.00	6.00	1.47	6.00	6.00	6.00	6.00	6.00	-	6.00	6.00	6.00	6.00
SEVILLA	**19**	4.75	5.50	6.00	0.00	6.00	4.72	6.00	6.00	6.00	6.00	6.00	1.47	6.00	6.00	6.00	6.00	6.00	6.00	-	6.00	6.00	6.00
PUENTE GENIL	**20**	4.75	5.50	6.00	0.00	6.00	4.72	6.00	6.00	6.00	6.00	6.00	1.47	6.00	6.00	6.00	6.00	6.00	6.00	6.00	-	6.00	6.00
ANTEQUERA	**21**	4.75	5.50	6.00	0.00	6.00	4.72	6.00	6.00	6.00	6.00	6.00	1.47	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	-	6.00
MÁLAGA	**22**	4.75	5.50	6.00	0.00	6.00	4.72	6.00	6.00	6.00	6.00	6.00	1.47	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	-

(green)	Useful time=6 h
(yellow)	6 h>Useful time>4 h
(red)	Useful time<4 h

Considering associated costs as well, the Efficiency (available time obtained per euro) of money invested in each connection can be calculated.

For tourism (Table IV), day trips are highly convenient when efficiency is higher than 11 min/€ (a cost of 5.45 € per hour at destination) (numbers in green), as the money invested in train tickets is more efficient than sleeping at a destination (considering a cost of 60 € for the hotel and meals to gain 11 useful hours on the additional day). With this consideration, only 58 of 462 possible connections are economically viable for day trips, whereas for 133 connections (yellow), travelers could consider extending their trip by sleeping at the destination.

Table IV: Efficiency (useful minutes at destination per euro) of all possible HSR links for tourism trips.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
BARCELONA	**1**	-	26.1	14.2	0.0	7.7	5.4	4.5	3.5	2.0	1.5	1.2	0.2	7.9	1.4	2.4	1.7	1.3	1.2	0.5	0.3	0.0	0.9
TARRAGONA	**2**	25.4	-	29.7	0.0	11.9	7.0	5.1	4.6	2.5	1.5	1.5	0.3	9.4	1.7	3.1	1.9	1.6	1.4	0.5	0.4	0.0	1.1
LLEIDA	**3**	15.0	32.6	-	0.0	17.4	9.4	5.8	5.1	2.7	1.7	1.6	0.3	1.3	1.9	3.4	2.0	1.7	1.5	0.6	0.4	0.0	1.1
HUESCA	**4**	3.4	4.9	6.9	-	27.1	14.0	6.0	4.9	1.6	1.1	1.0	0.4	0.9	0.5	2.9	1.4	1.0	1.0	0.5	0.0	0.0	0.2
ZARAGOZA	**5**	6.6	8.9	15.2	0.0	-	25.0	8.8	6.8	3.4	2.0	1.9	0.4	1.5	2.2	4.3	2.8	2.4	1.6	0.6	0.4	0.0	1.2
CALATAYUD	**6**	4.5	6.0	9.5	0.0	24.9	-	11.1	8.2	3.8	2.2	2.3	0.4	1.0	1.4	5.2	1.7	1.3	1.8	1.2	0.6	0.2	0.8
GUADALAJARA	**7**	2.1	2.5	3.7	0.0	6.8	1.9	-	21.5	8.0	3.5	3.4	0.6	2.1	3.5	10.1	5.2	4.2	2.9	1.8	0.8	0.2	0.9
MADRID	**8**	3.7	4.4	5.6	0.0	8.5	11.5	19.6	-	24.7	13.3	12.5	3.7	4.7	7.9	35.8	17.9	14.1	7.3	5.0	2.6	1.9	4.3
SEGOVIA	**9**	1.0	0.5	1.3	0.0	3.7	4.3	6.2	40.8	-	18.1	4.8	0.5	2.3	2.1	13.3	8.3	6.7	3.2	2.0	0.8	0.3	2.1
VALLADOLID	**10**	0.9	0.5	1.1	0.0	3.1	3.4	3.7	18.2	27.1	-	3.7	0.5	2.0	1.7	8.3	6.0	5.0	2.7	1.7	0.8	0.2	1.9
CUENCA	**11**	0.8	0.4	1.0	0.0	2.4	2.9	3.2	10.8	4.2	2.8	-	7.4	8.8	24.5	6.2	4.8	4.1	2.7	1.5	0.6	0.2	1.4
REQUENA	**12**	0.7	0.3	0.8	0.0	1.9	2.1	2.2	6.3	2.8	2.1	13.8	-	10.3	1.7	4.0	3.4	2.9	2.1	1.3	0.5	0.2	1.2
VALENCIA	**13**	6.9	9.3	0.7	0.0	1.7	1.9	1.9	5.2	2.4	1.8	11.0	19.9	-	1.0	3.4	2.9	2.6	1.9	1.1	0.5	0.2	1.1
ALBACETE	**14**	0.8	0.4	0.9	0.0	2.2	2.5	2.8	7.5	3.5	2.1	10.2	0.4	1.0	-	4.8	1.6	1.2	1.9	1.1	0.6	0.2	1.0
TOLEDO	**15**	1.3	1.3	2.1	0.0	4.0	4.3	11.3	36.6	11.6	6.3	5.4	0.6	2.2	3.3	-	8.2	6.6	3.3	1.6	0.8	0.3	1.8
CIUDAD REAL	**16**	1.3	1.7	2.1	0.0	3.5	3.1	6.5	18.4	8.4	4.8	4.2	0.5	1.8	2.5	10.4	-	68.7	11.3	5.5	3.6	2.6	4.4
PUERTOLLANO	**17**	1.4	1.4	1.7	0.0	3.5	2.8	5.7	15.2	7.3	4.4	3.9	0.5	1.7	2.3	9.1	68.2	-	13.8	6.0	4.0	2.8	4.7
CÓRDOBA	**18**	0.9	1.1	1.7	0.0	2.3	2.1	3.8	6.2	3.4	2.7	2.5	0.3	1.4	1.8	3.9	11.5	15.3	-	24.9	29.3	17.2	13.0
SEVILLA	**19**	0.7	0.9	1.4	0.0	2.0	1.8	3.3	5.1	2.9	2.4	2.2	0.3	1.2	1.5	3.3	7.8	8.8	18.9	-	11.9	8.7	7.5
PUENTE GENIL	**20**	0.4	0.6	1.1	0.0	1.7	0.4	0.7	3.0	0.1	0.2	0.8	0.3	0.3	0.4	1.6	6.1	6.5	28.8	10.3	-	48.6	22.2
ANTEQUERA	**21**	0.4	0.6	1.1	0.0	1.7	0.4	0.6	2.8	0.1	0.2	0.8	0.3	0.3	0.4	1.5	5.6	5.8	20.9	8.8	60.4	-	34.9
MÁLAGA	**22**	0.4	0.6	1.1	0.0	1.6	1.8	1.7	5.0	2.5	1.6	1.5	0.3	0.8	0.9	3.1	5.0	5.2	14.8	7.1	25.7	39.0	-

(green)	Efficiency>11 min/€ (<5.45€/h)
(yellow)	11 min/€>Efficiency>3 min/€
(red)	Efficiency<3 min/€ (>20€/h)

In general, the Efficiency of business travel (Table V) is lower than tourism travel because it is very conditioned by the high cost assigned to travel and waiting times. The convenience of a business day trip depends on the time value of an employee (45€/h, that is, an efficiency of 1.33 min/€). All links that are close to this value (yellow) or better (green) were considered viable connections. Madrid is the city most benefited by the radiocentric shape of the HSR network and the higher frequencies. Conversely, some connections between cities on different lines are not efficient.

Table V: Efficiency (useful minutes at destination per euro) of all possible HSR links for business trips.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
BARCELONA	**1**	-	3.86	2.88	**0.00**	2.10	1.59	1.24	1.24	0.89	0.83	0.82	0.17	1.79	0.73	1.00	0.96	0.82	0.75	0.48	0.21	0.16	0.55
TARRAGONA	**2**	5.82	-	5.00	**0.00**	3.13	1.69	1.44	1.38	0.97	0.85	0.97	0.21	2.31	0.85	1.08	1.12	1.02	0.84	0.53	0.24	0.17	0.49
LLEIDA	**3**	3.69	8.58	-	**0.00**	4.73	2.09	1.65	1.56	1.07	0.92	1.05	0.23	0.84	0.92	1.18	1.23	1.11	0.91	0.56	0.26	0.19	0.52
HUESCA	**4**	1.46	1.71	1.92	-	2.59	2.26	1.80	1.67	0.66	0.65	0.46	0.22	0.60	0.10	0.76	0.58	0.45	0.51	0.17	**0.00**	**0.00**	0.13
ZARAGOZA	**5**	2.10	2.78	4.68	**0.00**	-	5.64	2.30	2.28	1.44	1.27	1.26	0.27	0.95	1.09	1.69	1.53	1.21	1.07	0.67	0.30	0.22	0.74
CALATAYUD	**6**	1.47	1.67	3.00	**0.00**	4.02	-	4.52	2.29	1.72	1.49	1.48	0.29	1.15	1.23	2.04	1.63	1.38	1.20	0.71	0.32	0.23	0.60
GUADALAJARA	**7**	1.04	1.56	1.93	**0.00**	2.48	3.19	-	4.83	2.46	2.02	1.99	0.39	1.43	1.60	3.24	2.37	1.93	1.54	0.75	0.38	0.26	0.73
MADRID	**8**	1.18	1.39	1.72	**0.00**	2.19	2.31	3.13	-	6.04	3.86	3.17	1.35	1.84	2.11	9.05	3.93	3.58	1.93	1.51	1.56	1.34	1.20
SEGOVIA	**9**	0.87	0.62	0.86	**0.00**	1.38	1.22	2.69	7.38	-	3.00	1.79	0.37	1.30	1.12	2.86	2.20	2.09	1.37	1.06	0.37	0.27	0.97
VALLADOLID	**10**	0.54	0.55	0.75	**0.00**	1.23	1.14	2.00	3.81	5.45	-	1.54	0.31	1.11	0.99	2.08	1.60	1.60	1.15	0.84	0.32	0.23	0.84
CUENCA	**11**	0.70	0.60	0.82	**0.00**	1.24	1.21	2.02	3.84	1.69	1.47	-	1.99	2.51	3.11	2.26	1.68	1.59	1.18	0.96	0.33	0.24	0.82
REQUENA	**12**	0.54	0.19	0.33	**0.00**	1.00	0.85	0.72	1.52	1.26	1.06	4.26	-	2.45	2.09	1.40	1.29	1.25	1.00	0.69	0.26	0.19	0.59
VALENCIA	**13**	1.78	2.35	0.63	**0.00**	0.98	0.89	1.36	1.81	1.13	1.03	3.16	4.24	-	0.77	1.39	1.19	1.14	0.88	0.74	0.25	0.19	0.65
ALBACETE	**14**	0.51	0.54	0.73	**0.00**	1.13	1.06	1.60	2.43	1.50	1.33	5.93	1.94	1.72	-	1.77	1.42	1.35	1.09	0.84	0.28	0.21	0.76
TOLEDO	**15**	0.97	1.10	1.30	**0.00**	1.60	1.66	1.95	6.57	2.61	2.02	2.10	1.66	1.40	1.60	-	2.73	2.26	1.45	1.17	0.36	0.26	1.14
CIUDAD REAL	**16**	0.90	0.98	1.14	**0.00**	1.32	1.24	1.78	4.31	1.86	1.67	1.64	0.37	1.22	1.36	2.71	-	13.69	2.86	1.95	2.30	1.90	1.79
PUERTOLLANO	**17**	0.85	0.92	1.07	**0.00**	1.23	1.16	1.66	3.47	1.66	1.51	1.49	0.34	1.14	1.26	2.35	16.51	-	3.57	2.16	2.63	2.14	1.99
CÓRDOBA	**18**	0.59	0.78	0.90	**0.00**	1.06	0.94	1.19	2.01	1.29	1.19	1.18	0.25	0.92	1.03	1.60	2.68	2.92	-	3.34	5.32	4.68	4.04
SEVILLA	**19**	0.53	0.69	0.79	**0.00**	0.92	0.80	1.02	1.56	1.09	1.02	1.01	0.21	0.81	0.90	1.16	1.70	1.77	4.41	-	2.84	2.66	2.42
PUENTE GENIL	**20**	0.55	0.72	0.83	**0.00**	1.05	0.71	1.08	1.56	1.11	1.01	1.01	0.21	0.85	0.94	1.11	2.24	2.06	7.05	3.88	-	8.24	6.28
ANTEQUERA	**21**	0.54	0.70	0.80	**0.00**	1.02	0.69	1.03	1.47	1.07	0.98	0.97	0.20	0.82	0.91	1.07	2.04	2.33	5.33	3.28	9.00	-	8.94
MÁLAGA	**22**	0.51	0.66	0.76	**0.00**	0.96	0.75	0.96	1.46	1.09	0.95	1.02	0.21	0.78	0.85	1.21	1.77	1.97	3.79	2.57	5.15	5.89	-

	Efficiency>1.5 min/€ (<40€/h)
	1.5 min/€>Efficiency>1 min/€
	Efficiency<1 min/€ (>60€/h)

Efficiently Accessible Potential Market

The Efficiently Accessible Potential Market (EAPM) is calculated for each city by adding the products of the efficiency and the related volume of population (total inhabitants for tourism and number of high-level jobs for business). Figure 7 shows the EAPM percentages for business and tourism trips for each city. These results allow differences between groups of cities in the same territorial situation and differences within these groups to be found (Ureña et al. 2012).

The EAPM percentage is higher in cities efficiently connected to Madrid (Toledo, Segovia, Guadalajara, Ciudad Real) and lower in cities located at the ends of lines (Malaga, Sevilla, Barcelona, Valencia, Madrid) and small cities with low efficiency connections (Huesca, Requena). In the case of Madrid, the percentage is lower because Madrid cannot take advantage of its own population.

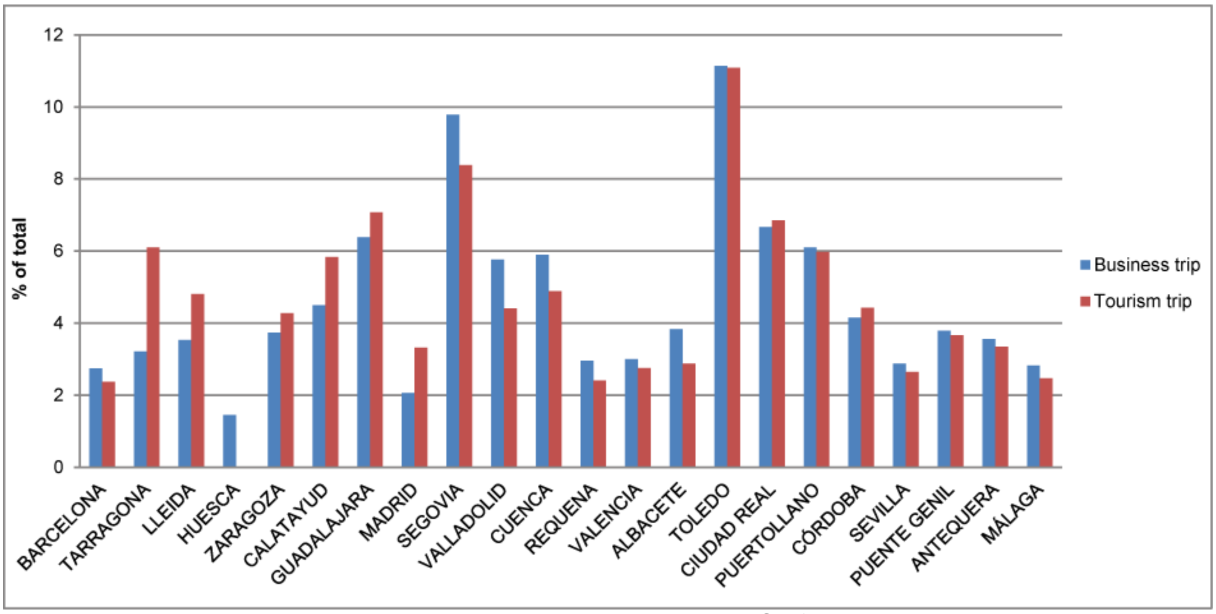

Fig 7: Accessible Potential Market through HSR for day trips.

Comparing Toledo, Segovia and Guadalajara, three medium cities within the Madrid metropolitan area, it is observed that Toledo and Segovia benefit from the direct Regional HSR connection to Madrid but that the latter is penalized by the necessity of changing between two stations in Madrid (Chamartín-Atocha). In contrast, Guadalajara does not have access to a Regional HST, and it is also penalized by the outlying station.

Small cities with intermediate positions on lines, such as Ciudad Real, Puertollano, Cuenca or Tarragona, benefit from their efficient connection to the markets located on both sides of the line. Ciudad Real and Puertollano have a larger APM than the rest of these cities because of the existence of the Regional HST to Madrid and their simultaneous presence on two lines: Madrid-Seville and Madrid-Malaga.

Medium cities between metropolitan areas such as Cordoba and Zaragoza have similar APMs. Both have a similar efficient connection to Madrid, and the benefits provided by Seville and Malaga for Cordoba are equivalent to the benefits provided by Barcelona for Zaragoza.

When comparing the EAPM for tourism and business, although most of the cities have similar values, some differences can be found. Cities with an efficient connection to Madrid and inefficient connections to the remaining cities, such as the cities on the Madrid – Valladolid and Madrid-Valencia lines, are characterized by higher values for business, as in Madrid, the percentage of HLJs is higher than the population percentage. Thus, Madrid provides a higher mass for business than for tourism trips. The contrary is the case in the cities on the Barcelona line.

Global Utility

Once the EAPM has been obtained, the next step is to determine to what extent this Efficiently Accessible Potential Market fits the characteristics of each city. For example, Puertollano has a high EAPM (Fig. 7) for tourism day trips, but its touristic attractiveness is very low. Therefore, the resulting Global Utility for tourism day trips is also very low.

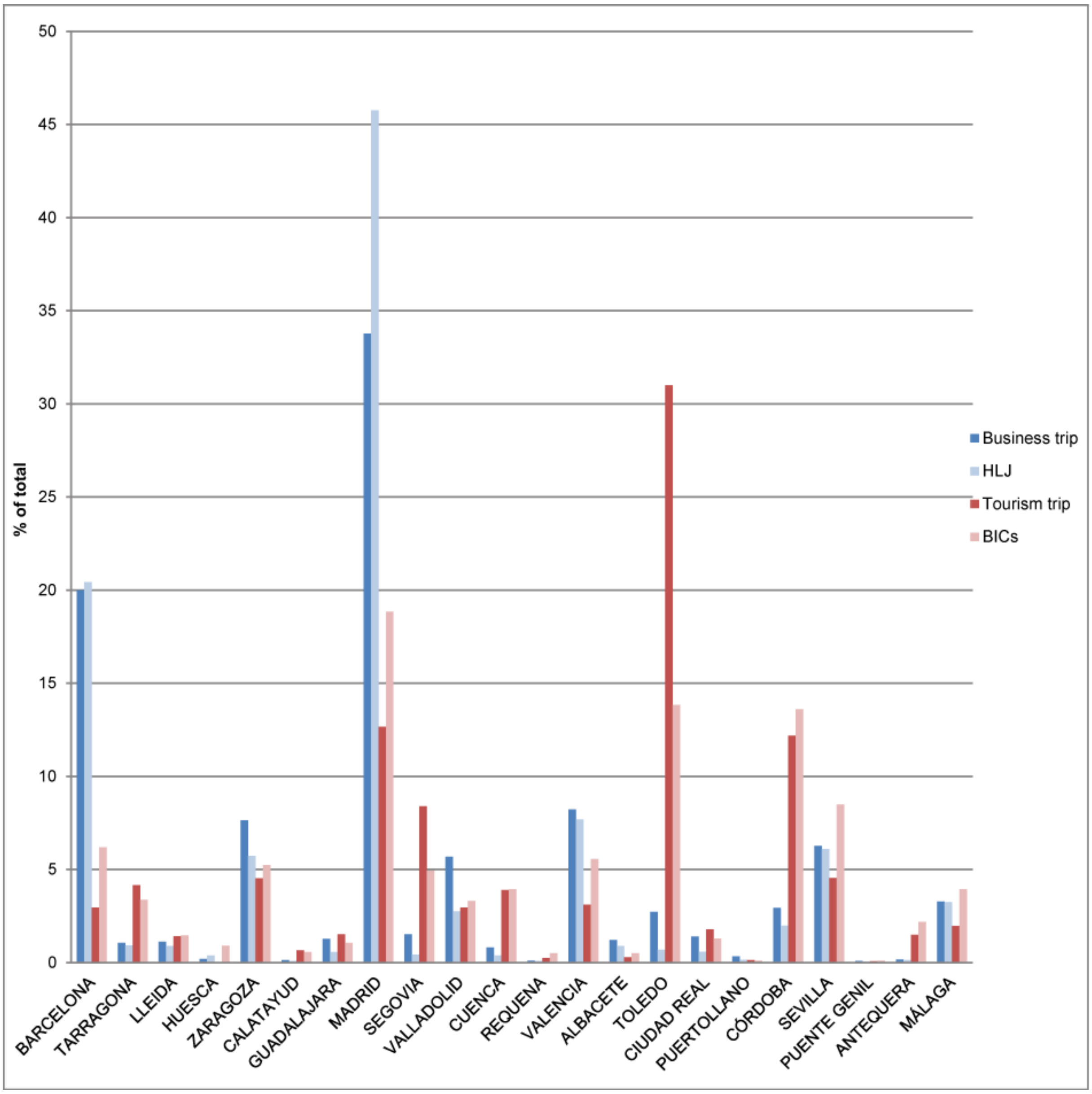

Fig 8: Global utility of HSR links for day trips.

To understand HSR's real contribution to each city, these Global Utility indicators must be compared with the relevance of each city as a tourism or business destination (Percentage of BICs and HLJs, respectively) (Fig. 8).

In Madrid, HLJs represent approximately 45% of the total HLJs of all of the HSR cities considered. However, the relative utility of HSR for business trips decreases to 35%, as Madrilenian HLJs have a low Efficiently Accessible Potential Market in relative terms. In contrast, Toledo is a very relevant touristic destination (14% of all HSR cities), and it also has a high EAPM, as it benefits from its good Regional HSR connection to Madrid. As a consequence, the utility of HSR for day tourism to Toledo is more than 30% of the total.

Nevertheless, HSR's contribution to cities must be measured in relative terms for the degree to which HSR benefits each city and to what extent it could change their position in the city system hierarchy is to be determined.

The relative increases or decreases in utility in comparison to Importance (I) for each city are shown in Fig. 9 so that the winning and losing cities (always in relative terms) within the HST network can be identified.

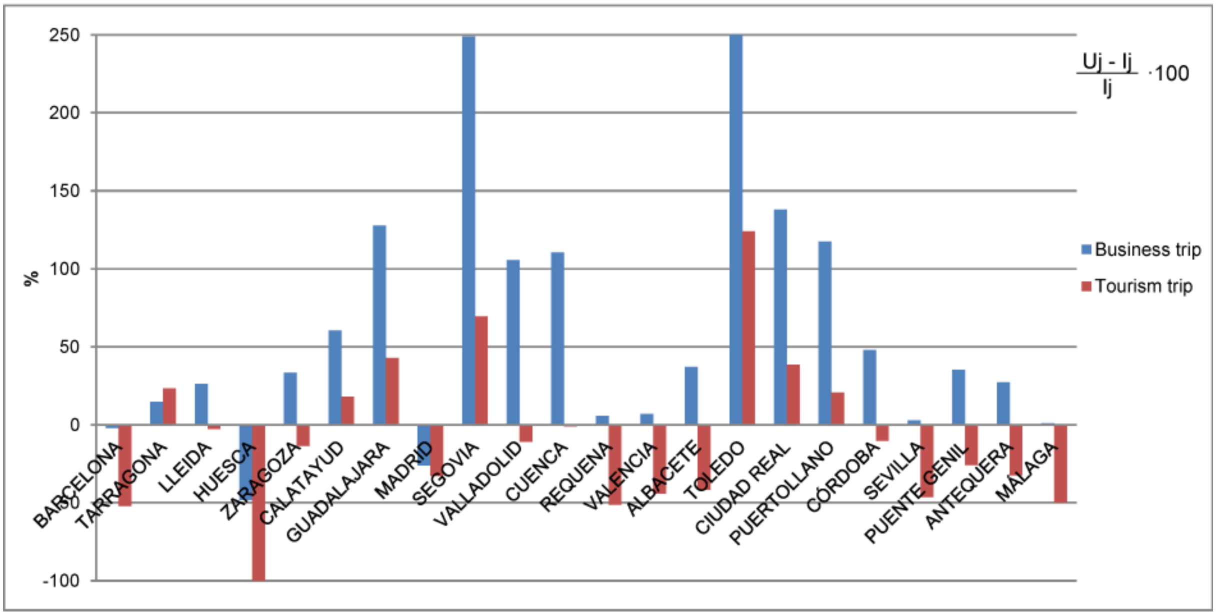

Fig 9: Utility: Winners and losers.

Concerning business day trips, as with the EAPM, in relative terms, the cities that benefit more from HSR are small cities in the Madrid metropolitan area such as Toledo, Segovia and Guadalajara, but again, the latter is penalized by an outlying station and the absence of Regional HSTs. In the same way, although farther from Madrid than Cuenca, Ciudad Real and Puertollano enjoy more benefits, as they have access to Regional HSR to Madrid and good connections to the Andalusian cities. For large intermediate cities such as Cordoba or Zaragoza, their position between large metropolitan areas means that the HSR contribution is larger for business than for tourism trips (Travel times and ticket prices begin to penalize more tourists than businessmen).

In the case of tourism trips, cities with high touristic relevance, such as Sevilla, Málaga, or Barcelona, are the losers in relative terms because their location at the ends of lines increases the costs of day trips from many cities. In contrast, the cities enjoying the most benefits are the small intermediate cities on the lines because of their large EAPM.

CONCLUSIONS

Today, the complexity of HSR networks renders global assessment necessary for an understanding of the real utility of HSR for each city. This utility cannot be fully measured using traditional place-based accessibility indicators based on spatial or temporal proximity. HST services may be very useful for a tourism visit to a city accessible with less than one hour of travel, but its timetables may not be useful for commuting or its price may be too high for some employees.

In the last 20 years, Spanish HSR has reached 22 cities with very different territorial situations and characteristics, resulting in a complex collection of heterogeneous sizes, business activities and levels of tourism attractiveness. In addition, these cities are served by a highly variable number of different types of trains, so HSR's contribution is very different in each case. The systematic analyses of utility proposed allow for the identification of the relative winners and losers in this process.

The methodology based on the time available at a destination is a useful tool for analyzing the viability of each HST connection. Furthermore, the concept of efficiency allows for the assessment of the quality of the links. The EAPM measures the relevance of that efficiency in terms of the population to which a city is connected. Finally, Global Utility indicates HSR's contribution to tourism and business relations related to the characteristics of each city.

The results obtained are consistent with most of the qualitative analyses described in the literature for different territorial situations. In addition, it is advantageous to identify differences in HSR contribution to cities that could appear equal a priori, as they allow for quantification in relative terms of what HST service can provide to each city. In this sense, the existence of regional HST or central station locations improves the utility of HSR.

An HST connection generates opportunities, which every city can exploit through marketing strategies. Most of the cities have implemented different strategies in an attempt to make the most of HSR but, in many cases, without real knowledge of what they could really expect from the new infrastructure. The indicators proposed here may facilitate a more accurate and realistic definition of these strategies.

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