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Which way to the city centre? Pedestrian itineraries between High Speed Rail stations and historic centres. Assessing urban quality and tourist behaviour through GPS tracks in Toledo.

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Abstract

In heritage cities close to big metropolitan areas as Toledo, declared Unesco World Heritage, High Speed Rail has become the favourite access mode for single-day tourists visiting the city. The access from the station to the historic centre becomes a relevant subject to study, as tourists can choose between different transport modes: walking, buses, tourist buses and taxi. Walking should be encouraged because it is more sustainable and tourists' experience starts just in the rail station. In the case of Toledo, two pedestrian itineraries have been assessed, considering the quality of public space, the wide of footpaths, the continuity, etc. In addition, the use of these itineraries for reaching the city centre and tourists' behaviour when walking around the historic city have been also analysed using GPS tracks shared in social networks such as Wikiloc. This is a powerful tool to understand the points of interests of the city, the density of use of the different streets and the use of different access to the walled city.

Keywords: High Speed Rail, tourism, urban quality, pedestrian behavior, GPS.

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1. Introduction

As any other transport mean, High Speed Rail (HSR) is used by tourists when it is the most convenient mode in terms of travel time and costs, and when the timetables fit properly to their needs. HSR mainly allows connections between city centers, being useful for urban cultural tourism and business tourism (Coronado, et al., 2013). It also provides shorter travel times than the car or the bus, making same-day tourism trips more attractive in longer distances (Moyano, et al., 2016).

Once the tourist has arrived at the station, he/she must access the historic city center where the monuments and tourism amenities are usually located. The natural itinerary is walking along the "Station Street", a street created in the 19th century in order to connect the railway station to the consolidated city (Santos, 2007). These station streets took the form of tree planted, wide and straight avenues that were flanked by important buildings such as banks, hotels, or family palaces, etc. At the same time, these buildings were attracted by the relevance of the railway at the time (Calvo, 1998) and today are part of the city's visitor experience. In this way, the urban visit starts already at the station gate, or even inside the station, in the cases where the architecture is singular or interesting.

Back in the 19th century, when the city was not too relevant or there were other limitations (i.e. topography, rivers, high land prices, etc.), stations were located at peripheral locations within a variable distance to the city center. Usually, around the station, a neighborhood has grown, more or less independent from the city's historic core. In some cases where the distance between the station and the city was not too long, the city growth has made the location of these peripheral stations become similar to the initial edge locations. In these cases, the connection between the city and the station is not so straight and wide, as it was achieved by old conventional roads turned into regular streets by city growth. This is the case of the station in Toledo, located at the other side of the Tagus River, which has been reused by the HSR (Figure 1). In this case, the pedestrian access to this peripheral HSR station is still possible, but some tourists use taxis or specific buses that takes them right to the city center. Pedestrians have different itineraries to access the city center: a shorter one, the historic pedestrian path, and a longer one, used by cars and public transport.

Figure 1. Toledo in 19th century (left) and today (right). The station was located at the other side of the river Tagus.

Mapa Topográfico Nacional.

The aim of the article is to identify which of these itineraries is more used by tourists, and to assess its physical characteristics linked with its walkability in order to check whether they are relevant in terms of the path's election. The GPS tracks shared by tourists in social networks like wikiloc have been used to identify which are the tourist itineraries throughout the city. Then, the walkability of itineraries has been assessed and compared.

The pedestrian paths in these small and medium cities with edge HSR stations are a key factor for both tourists arriving to the city and residents commuting (or just travelling) by HSR. An adequate, readable and comfortable itinerary will enhance the experience of the former and will promote a sustainable transport mode for the latter. In many cases, the huge investments of HSR construction are not accompanied by small expenditures in urban space enhancements in order to provide a comfortable pedestrian access.

2. Background

2.1 HSR stations and tourist itineraries

One of the main issues on HSR is the way in which cities are served by stations (Garmendia, et al., 2012). As Bertolini and Split (1998) identified, train stations perform a twofold role. First, from the transport approach, stations can be considered as nodal points, where the resulting level of HSR service is of great importance. Second, from the urban approach, stations constitute a landmark in the city. In the case of HSR, stations are often the pretext for ambitious urban (renewal) projects and developments. The role of the historic train stations as "gate of the city", which had been overshadowed by the expansion of freeways and airports, is strengthened by HSR stations (Mannone, 1997).

In order to assess both the impact of a HSR station and the strategies developed by cities to make the most of the new infrastructure, literature on HSR stations establishes different typologies of HSR stations (Troin, 1995; Bellet et al., 2012). These classifications consider different criteria: if the station is new or an adaptation to HSR; the location of the station in relation to the city; and the relevance of the station as a transportation node. However, the key factor that has an influence on the urban development of the city is the location of the station (Ureña, et al., 2012).

When analyzing small and medium cities, Menéndez et al. (2002) consider three types of stations: central, city-edge, and peripheral. Given their weaker position, edge or peripheral settings are more common, making urban projects more difficult to succeed, especially in peripheral settings (Auphan, 1992; Troin, 1995). Literature on the latter has focused mainly on the tertiary or residential developments around HSR stations (Ribalaygua, 2005) and, taking into account their isolated situation, on the connection of these stations to the city center and to the historic train stations. This is the case of France, where new peripheral stations are built for long distance HSR services, and old conventional stations maintain regional and some of the HSR services (Facchinetti-Mannone & Richer, 2011). Finally, edge settings take advantage of the lesser dense urban fabric of the city outskirts, which allows for urban development projects around the station although the urban pattern continuity between the station and city is guaranteed.

HSR intermodal opportunities have been studied from three different scales. From a national and regional scale, the opportunities of HSR/conventional rail and HSR/air connections have been assessed (Chapelon & Bozzani, 2003; López-Pita & Robusté, 2004; Givoni, 2006). From a local scale, the literature has focused on the station-city connections. When the station is central, the connection between the station and the transit network is a principal issue (Peters, 2010), while in the peripheral ones specific shuttle services are necessary to assure the connection (Facchinetti-Mannone & Richer, 2011; Menéndez, et al, 2006). In addition, the

station design as an intermodal node is also a relevant issue. The location of the platforms, park&ride spaces, parking, bus stops, etc. are key elements on the internal efficiency of the building (Tapiador et al., 2009; Menéndez et al., 2002). Although there are specific case studies which provide modal share data of access to and from the station (Menéndez, et al., 2002), there are no studies about the quality of the pedestrian link from the station to the city center.

Although there are no systematic studies about the effects of HSR on tourism (Coronado, et al., 2012), scholars coincide on the positive impacts of HSR effects on local tourism (Bazin, et al., 2011; Masson & Petiot, 2009; Van den Berg & Pol, 1998). The possibilities of urban tourism also depend on the local strategies which aim to take advantage of the new accessibility provided by HSR and the centrality generated by the station, including planning, management and promotional strategies (Ribalaygua, 2005; Bellet, et al., 2012). Planning strategies are related to the integration of the station and the coordination between the HSR project and the city/ regional planning. Management strategies aim to make the most of the station's vocation for centrality either as a modal exchange centre or as a developer of the surrounding land. Finally, promotional measures have focused on urban marketing campaigns, trying to recruit economic activity, building amenities and service facilities for congresses and meetings, and linking the image of the city to the modernity associated to HSR.

In fact, cities try to make the most of the HSR station, linking it to concepts such as centrality and/or modernity, but often, when a tourist arrives to the station finds it hard to get to the city center, especially if it is a novel destination and the station is not central. No strategies or policies have been found to make comfortable and legible itineraries between the HSR station and the city center, with walkable and pleasant promenades for city-edge stations.

2.2 Locating tourists using GPS

Assessing tourists' behavior in cities is not an easy task. While it is easy, or at least possible, to have accurate data about the temporal distribution and number of visitors to some cultural amenities like museums and other monuments where it is necessary to buy a ticket to enter, it is not so easy to know their physical distribution or which itineraries they use around the city in both open spaces and in the street network. Tourists blend with city inhabitants and it is not always easy to differentiate them when using cameras or street counting/audits (Ruiz-Apilanez et al., 2015).

GPS are a powerful tool to analyze this behavior as it is possible to register the location of the tourist at every moment. However, there are some restrictions. First, GPS data loggers have a limit in the duration of their batteries, so the visits must not be too long. An interesting alternative is to use smartphones' GPS, but in this case it is necessary to previously contact the users whose behavior is going to be analyzed so they download the Apps to register the tracks, and this is nearly impossible with tourists (Marmolejo & Chaves Custodio, 2016). Second, it is also necessary to have access to the tourist twice in order to give him/her the GPS device and to reclaim it at the end of the day. GPS have been used with cruise visitors taking one-day visits to cities (Ferrante, et al., 2016) that are identified when exiting and returning to the ship, or parks visitors (Santos, et al., 2016) that can be provided with the GPS device at the entry of the amenity (Beecoa, et al., 2014) (Zheng, et al., 2017). Third, the number of tracks that can be registered is limited by the number of GPS devices available, but on the other hand, the amount of information that each track provide is large. The tracks can be mapped depending of the objective of the study, but data usually include density of visitors, time-space distributions, speeds, stopping points, entering and exiting, gates, etc. It is also possible to elaborate statistical analysis of the tourists' behavior: total distance walked, duration of the visit, number of points of interest visited, etc. To overcome this difficulty, shared tracks in social network sites like Endomondo, Strava, MapMyRide, Runtastic, Sports-or wikiloc can be used (Mínguez García, et al., 2015) (B. & Nogueira Mendes, 2016), but only in very popular cities or destinations that will assure a large number of tracks.

2.3 Assessing urban design and walkability

In the mid-20th century the ideas of the Modernism entered in crisis and new ideas began to emerge claiming the recovery of a public space of quality based on the traditional city (Jacobs, 1961). In the 70s, these ideas were consolidated going beyond a mere critique of the functionalist city. The design and maintenance of a good quality public space is synonymous with 'making city' (Gehl, 1987) and that the correct design of the urban environment is a necessary condition for the happening of activities. Specifically focused on the streets, Allan Jacobs identified a number of key factors that make a street, a 'great street' (Jacobs, 1993). These factors go from the physical configuration of public spaces (sidewalks, trees, etc.), to the configuration and use of private spaces (facades, shops, accesses, etc.), and to other more generic aspects such as the urban morphology or the location of the street in the city, to even intangibles like the "magic" of the street. If the works of Jacobs and Gehl, among others, were focused primarily on the use of public spaces, more recent studies have focused on the "walkability". The quality of public space is a key element of the "walkability" concept which has been worked from the health sciences perspective, since walking is considered as part of the "active living" (Ewing et al., 2006; Freeman et al., 2012), and from the transport and sustainability perspective, since "walking" is the quintessential sustainable transport mode.

The concept of pedestrian Level Of Service (LOS), introduced by Fruin (1971) in the 70s, initially considered just the capacity of sidewalks, but has recently been expanded to include aspects such as the perceived quality of the urban environment (definition of the street, transparency, obstacles and barriers, etc.) in relation to the movement of pedestrians (Jaskiewicz, 2000; Tan, et al., 2007), or even the analysis of the influence of the characteristics of the built environment on the willingness of citizens to walk or riding a bike (Cervero, et al., 2009).

The evaluation of the quality of a route is done by analyzing a number of factors, generally qualitatively, and establishing a set of values and obtaining a final grade (level of service) that allows comparison with other spaces (Clemente, et al., 2005; Gandolfi, 2010). Determining which factors are most influential in the perception of quality from the point of view of the pedestrian, and its weight in the final grade, is usually done through surveys. These sometimes are of a general nature and are intended for residents of a city and focused on the factors that matters the most to pedestrians (Borst, et al., 2008; Kelly, et al., 2011), and sometimes these surveys are performed in areas of interest in situ, asking the reason for choosing a particular route (Weinstein, et al., 2008).

3. Object and Methodology

The aims of the paper are (1) to assess the tourists' behavior in the public spaces during their visit to the historic center of Toledo, which is a walled city that can only be entered through a reduced number of gates, and (2) to assess the different itineraries used when walking between the edge-HSR station and the historic city center. The ideal scenario would be a direct and legible path between the station and the city center in which the station would be the beginning of the tourist experience. However, this is not the case in Toledo due to peripheral location of the 19th century station that has been refurbished to be used by High Speed Trains. The station was originally located in a peripheral setting due to the proximity of the Tagus River, and the different bridges crossing the river have created different available itineraries that can be used by the tourists that must find their way to the city center overcoming several difficulties such as lack of orientation, narrow footpaths, inconvenient street crossings, unpleasant environment, etc. which introduce some friction in this transport link.

The behavior of tourists entering the city center has been analyzed using wikiloc tracks shared online by tourists. Wikiloc is a social network where users share tracks of their trips in the

countryside and in the cities. In June 2017, there were 302 results when searching walking tracks across the city of Toledo. All tracks were checked one by one rejecting those that were too short (shorter than 1 km) or too long (longer that 10 km), as many of these were tracks following rural trails outside of the city. Some tracks were rejected as they were not passing through the historic city center, but the modern neighborhoods of Toledo. Also, some tracks uploaded several times by users were only considered once. Other tracks were not used as they belong to other cities but had Toledo as a keyword (i.e. some tracks in Madrid passing through the Toledo Street). After filtering all the tracks, only 90 were selected for the research.

Subsequently, all tracks were imported to a GIS program. As wikiloc filters tracks eliminating errors like reducing the number of points, it was not necessary to make corrections in the tracks. When a track is imported to GIS, the program finds a list of points that must be converted into lines to be able to make density measurements, counting how many lines pass through the cells of a grid (Zheng, et al., 2017). As GPS precision varies between 5 and 10 meters, several grid sizes were checked, finally adopting a grid of 40 x 40 meters.

In order to assess the pedestrians' paths between the HSR station and the historic city core, two itineraries have been identified from the results of GPS tracks analysis. The origin of the itinerary is obviously the HSR station, and the end was located in the different historic gates where the tourist enters the walled city.

The itineraries are then divided into sections (links) and nodes. The nodes are the street crossings and other points susceptible to introduce discontinuities to the itinerary (i.e. detours, disorientation, etc.), and the sections are the homogeneous stretches between the nodes which usually correspond to street blocks. Sections and nodes have been separately assessed.

For each node, three main data have been collected: legibility, level of detour, and accessibility. Concerning legibility, the follow through in a node can be legible, not legible, or not legible but solved with tourist indications. The level of detour (D) is calculated as the increase of length in the itinerary imposed by a street traffic crossing or any other obstacle. Lastly, the point will be accessible is the width is enough and the curb is adapted.

For the sections, several indicators have been used to quantify the quality of the footpath, the internal band and the external band, all of them in a scale ranging from 0 to 5. The footpath width will have the maximum value (5) when the width is over 5 meters, while it would be zero if there is no footpath at all. The footpath maintenance was assessed in a qualitative way. The quality of the internal band has a value of 5 in parks, squares, and high quality residential blocks with commercial activities in the ground floor, 4 in residential blocks with commercial ground floor, 3 in blocks with only commercial uses or only residential blocks, 2 in blocks with single family houses or public facilities, and 1 for industrial activities or parking lots, and 0 in empty plots. Transparency is measured considering the density of entries, windows and other openings in the buildings in the block. Similarly, the permeability is measured as the density of entries in the block.

The quality of the external band is also assessed in a qualitative way, with a value of 5 for parks, squares or pedestrian streets, 4 for green spaces which separate pedestrians from traffic, 3 for slow traffic streets with parking places or any kind of protection band, 2 for fast traffic streets with parking places or any kind of protection band, 1 for slow traffic streets without protection band, and 0 for fast traffic streets without protection band. Finally, the presence of street trees (T) is also measured, using the distance between trees, with a value of 5 when trees are closer than 7 meters, 1 when the distance is longer that 21 meters, and 0 if there are no trees at all.

Each indicator has been schematically outlined ranging from 0 to 5 following the same criteria, producing three possible assessments: red (poor), yellow (adequate) and green (good-excellent). The different itineraries are compared among them by means of an aggregate star graphic. However, the itinerary may vary a lot along sections, and the aggregate measures of

the itinerary may not be really useful, as excellent resulting sections may cover up the poor ones. Also, no aggregate measures for each section have been assigned, since this aggregation would say nothing about how to address the deficiencies (Jaskiewicz, 2000).

4. Results

Using all the GPS tracks, a map of points' density in the historic center of Toledo can be drawn (Figure 2). This map represents how many registered points are found in each 10 x 10 m cell. In other words, it represents the density of tourists' presence considering how long they stay at a point. If a tourist stays longer in an area, his/her track will have more points registered at that point. In this sense, although wikiloc filters excessive data, this result is not too accurate. However, as it would be expected, hot spots appear at the entries to the monuments, squares were tourists sit, and queuing areas.

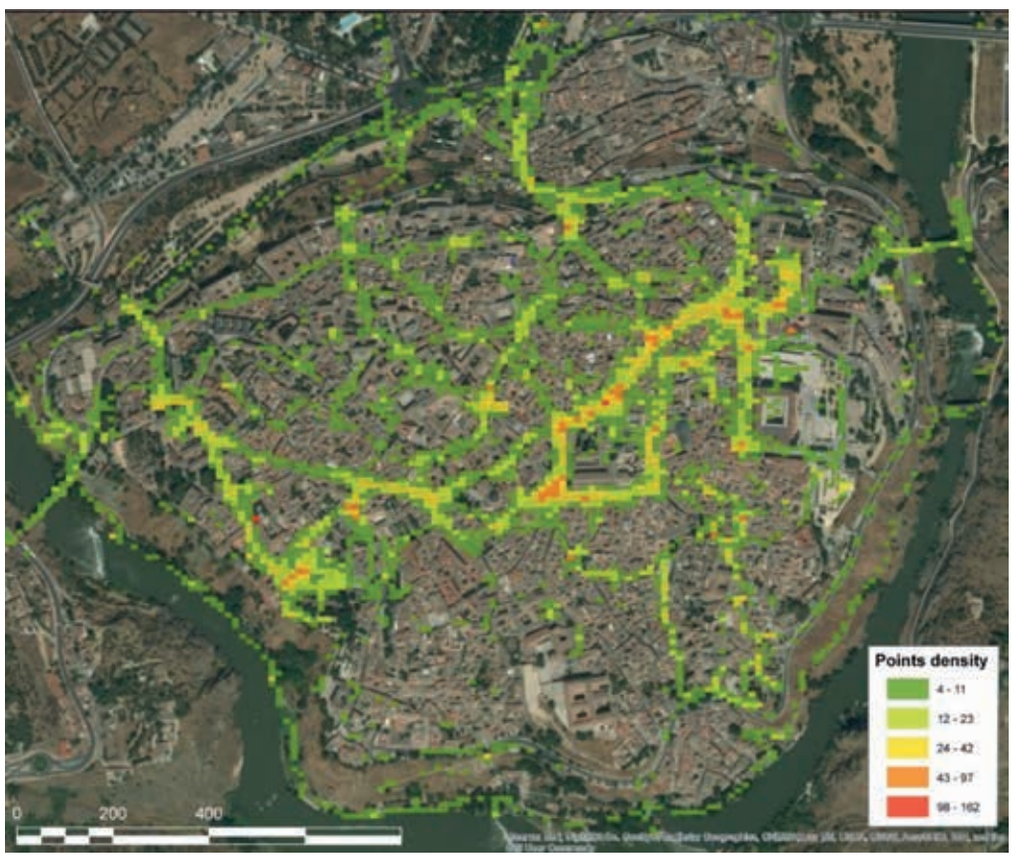

Figure 2: *Point density tracks in a 10 m x 10 m grid. Source: Own elaboration*

The use of a 10 m x 10 m gid introduces some errors as the precision of the domestic GPS is not so high. For this reason, a new map is drawn representing the density of GPS tracks shared trough wikiloc (Figure 3), meaning the percentage of the 90 tracks passing at least once through each of the 40 m x 40 m grid. This map shows how most of the tourist itineraries pass through the 'Comercio' street that links Zocodover plaza with the cathedral (red area in the map). It is also clear how most of the itineraries are concentrated in the north of the city, which was the richest part in the past and, therefore, is where most of the palaces and churches are located. On the contrary, the south part of the city is much less visited. This area corresponds with the historically poorest neighborhoods, and therefore, today, there are less points of interest for the tourist visit.

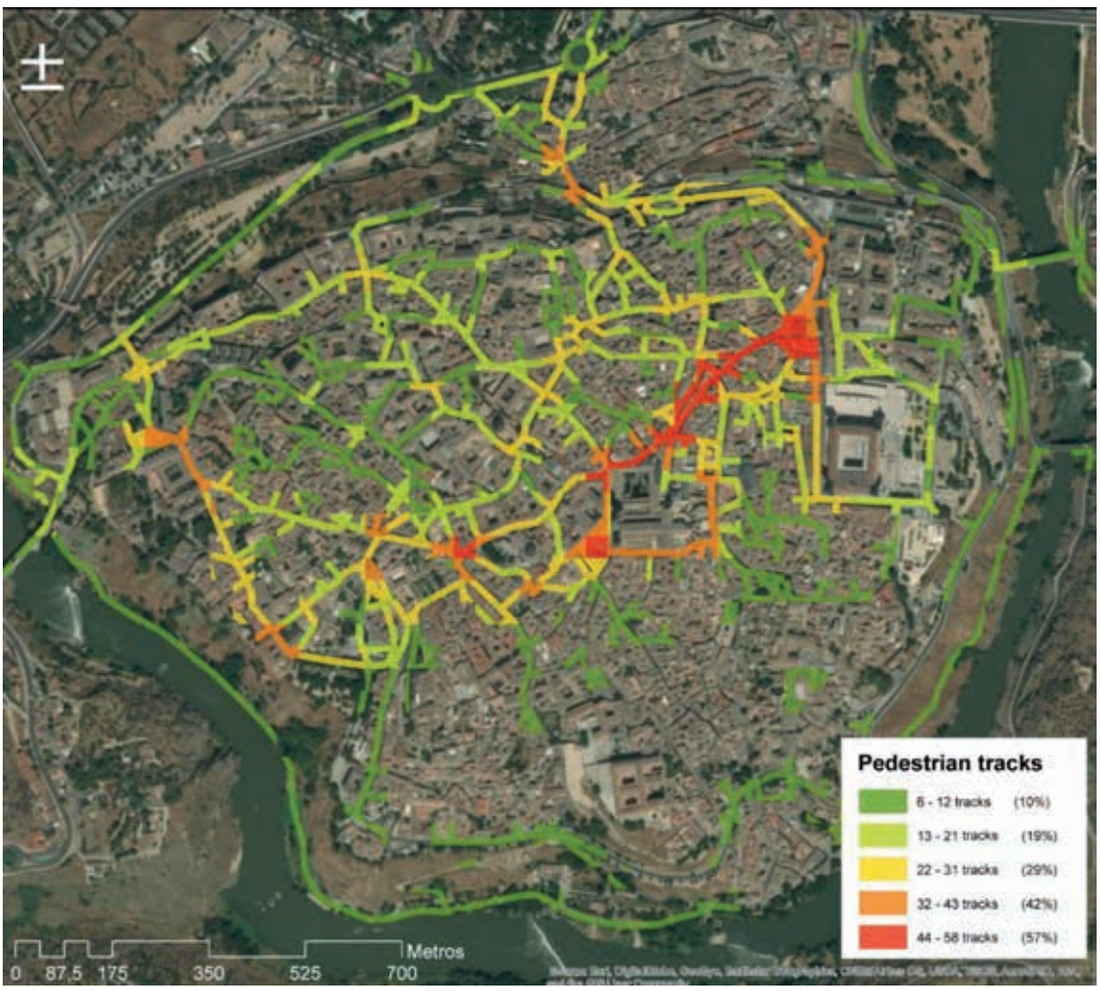

Figure 3. Percentage of all the tracks passing through a 40 m x 40 m grid.
Source: Own elaboration.

It is also possible to identify the use of the different gates of the city. Although the closer one to the station is using the Alcántara Bridge, most of the tourist enters the historic city using the Bisagra gate that corresponds with the road entering from Madrid in the north. This route takes a longer path to access Zocodover plaza, but it is the one used by cars and buses, and therefore, the one that is sign posted. Both routes from the station have been assessed in order to understand why this is happening.

The HSR station in Toledo reuses the historic station located at the other side of the Tagus River, between the flood plain and a residential neighborhood. Historically, the connection of the station to the city center was made through the Alcántara Bridge, to the south of the city, where the river narrowed. Later, with the expansion of roadways, a new bridge was built which connected the peripheral neighborhoods at the other side of the Tagus River (and the station) with the north access to the historic city, the Bisagra Gate, which is the main access to Toledo from Madrid. Today, the historic itinerary to the station through the Alcántara Bridge has been overshadowed by the new bridge connection and the arterial street tangential to the station. Therefore, there are two possible itineraries from the HSR station to the city center. The southern itinerary is the shortest (700m) but it is not very evident unless you are familiar with the city; and the northern itinerary, which is longer (1200m) but might be more straight or evident for foreigners, following the road traffic signs (Figure 5).

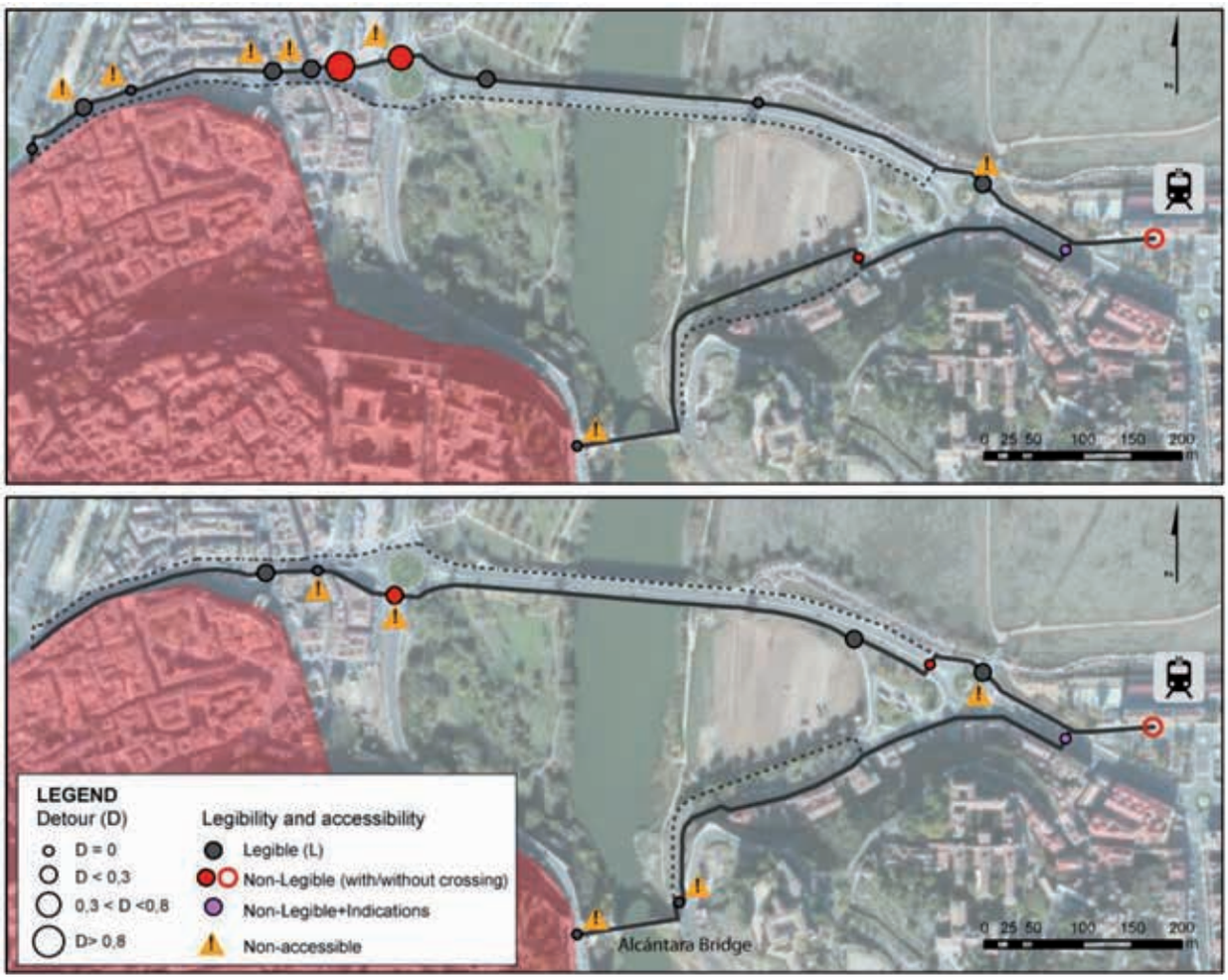

Figure 5: *Toledo: the two itineraries from the HSR station to the city center.*

Source: Own elaboration

The connection of the station with the city center has never been considered from a pedestrian friendly perspective in spite of the short distance between them, due to the presence of the river and the topography, which constitute a powerful psychological barrier. Even more, the city offers a specific direct and non-stop bus service for tourists between the HSR station and the city center with timetables coordinated with the HSR services. In 2007, before this specific tourist bus was implemented, Guirao (2008), through an onboard survey, identified that more than 40% of tourists from HSR walked from the station to the city center, 20% were users of the city bus and a high percentage had no previous information on how to get to the city center.

Both itineraries begin along the tangential main road and cross different unplanned urban fabrics, at the periphery of the city, making their way to the city walls. In both cases, the two sides of the itineraries have been analyzed.

Southern Itinerary

Both sides finish once the Alcántara Bridge is crossed and they also share the first 200 m because of the roundabout and street crossings configuration. Both sides must cross the road to the station at the same point, where tourist can find a small sign on the wall (Figure 6), telling them to follow this historic itinerary. However, this indication is less visible than the road traffic signs and touristic signs in the northern itinerary.

Figure 6. Pedestrians must cross at this point to follow the historic itinerary, only sign posted with a very small sign on the wall of the building across the road.

Both sides present very different characteristics in the intermediate part of the itinerary and must cross the road just once, either at the beginning of the river embankment or just before the Alcántara Bridge.

In relation to the external band, both itineraries present problems in the last 80 m before arriving to the Alcántara Bridge, because pedestrians must walk along narrow footpaths without physical segregation from the traffic (Figure 7). The south side runs along a service lane with a mixture of old and recent residential developments with uninteresting commercial properties. On the contrary, and in spite of the narrow footpath on the north side (2 m which come to have 1.20 m in the narrower section), the existence of a promenade with a view to the river banks and the city of Toledo on this side is an asset. The tree planted promenade provides a quality external band and the view to the river banks and the city of Toledo in the background grades high the internal band (Figure 7). However, in the only street crossing to the north side there are no tourist indications.

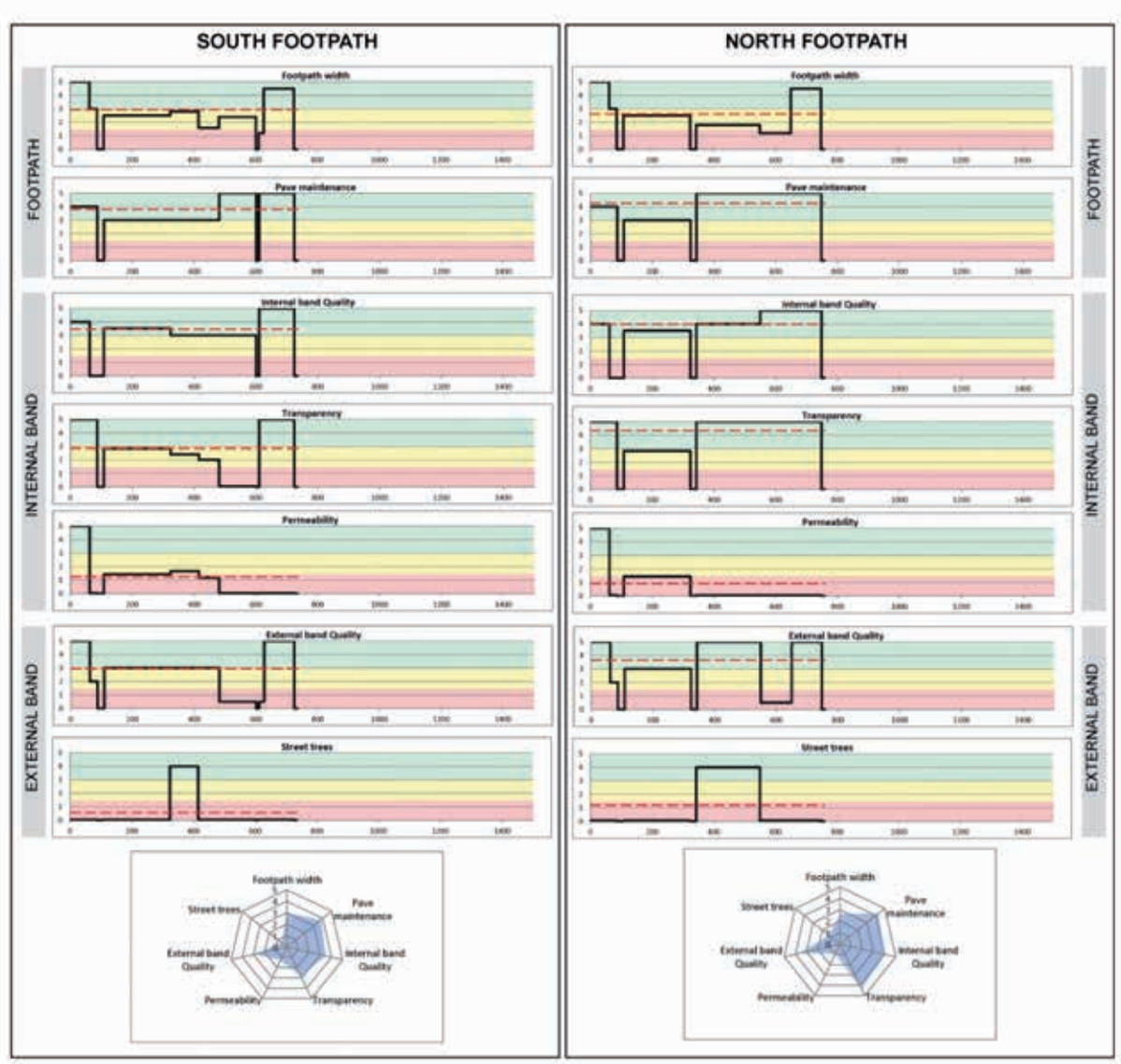

Figure 7: *Longitudinal characteristics of the southern itinerary.*

Source: Own elaboration

Northern Itinerary

This itinerary is more legible than the south one, due to the relevance of the arterial street and the traffic indications. The itinerary is not pedestrian friendly because of the adjacent fast traffic and the narrow footpaths (Figure 8). Both sides have continuity and accessibility difficulties after crossing the bridge, but these are even worst in the north one (Figure 8). In addition, in the south side the views to the river and the historic city are not disturbed by the presence of traffic. However, as in the Alcántara Bridge itinerary, there are no tourist signs indicating this option.

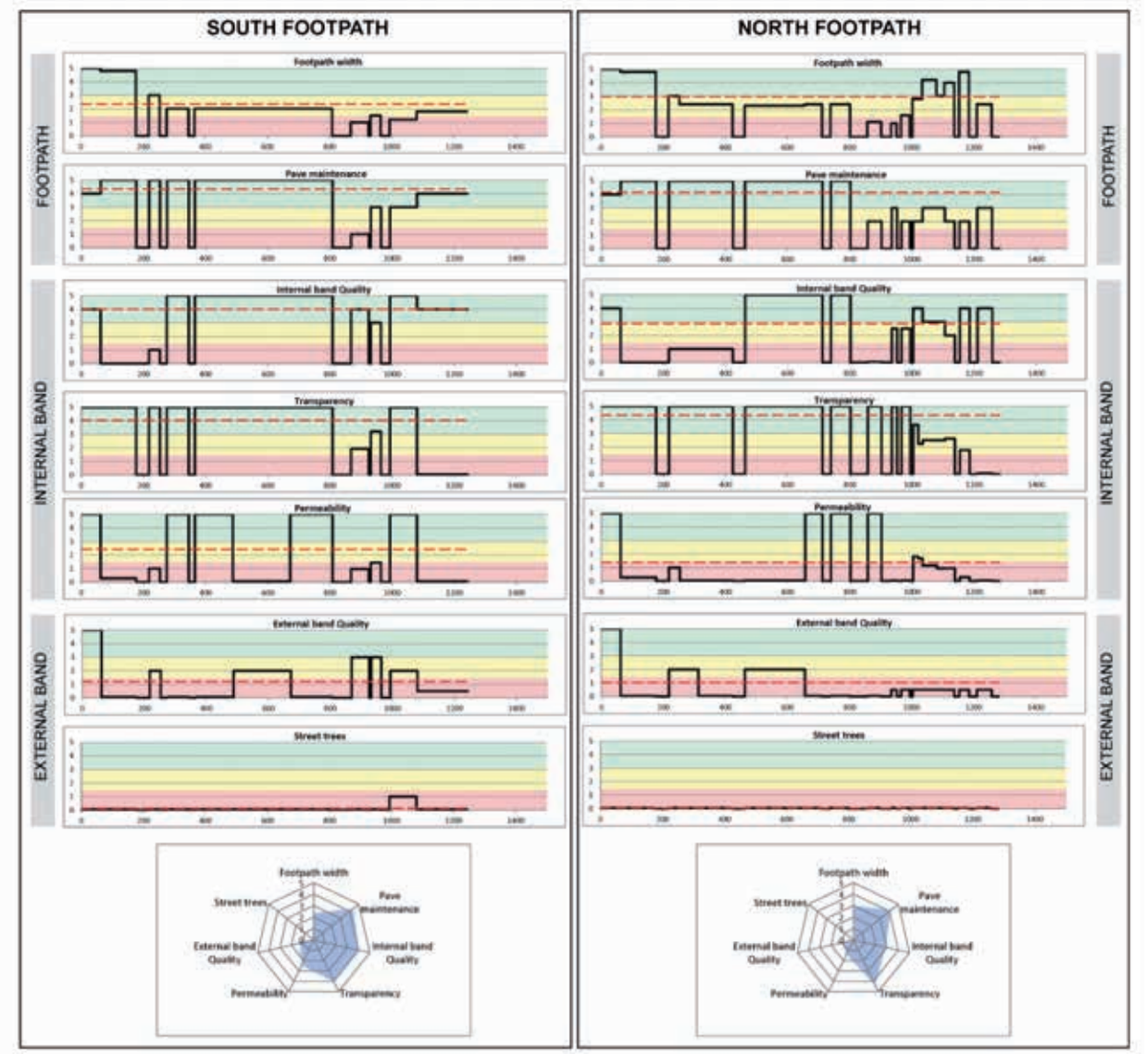

Figure 8: Longitudinal characteristics of the northern itinerary.

Source: Own elaboration

Toledo could have a short and pedestrian friendly access to the city center, following the Alcántara Bridge itinerary, but it seems that the city prefers to provide a comfortable bus connection, maybe trying to ease the ascent to the historic city.

5. Conclusions

In historic cities with large tourist areas it is hard to know where the tourists go and which streets do they follow. The use of GPS tracks may be a helpful tool, but it is difficult to obtain the tracks, as GPS data loggers must be provided to and collected from the visitors. The use of social networks sites as wikiloc, where the users share their tracks, may help in this task. However, the amount of information is reduced as it is impossible to know precisely enough when the route was made and by who. Yet, it is good enough to obtain density maps that show an average of the tourists' spatial distribution. When the number of access points is reduced,

as it happens in Toledo, it is also possible to understand the use of these gates. In this case, we detected an unpredicted use of the longest itinerary to access the city from the HSR station.

The analysis of the itineraries showed the relevance of the legibility and signing. Also, the shortest itinerary has been made by linking different preexistent itineraries, usually with illegible changes of direction. These preexistent itineraries also respond to different periods and origins, and therefore present different characteristics not only in relation to the private space (urban morphology, building heights, setbacks, etc.), but also in relation to the public realm (footpath width, paving, street trees, etc.). On the contrary, the road access has a more uniform cross section.

The article conclusions help in designing measures to improve the quality of the itinerary and enhance the tourist experience. In small cities, HSR stations settings have sometimes followed the pattern of the 19th century stations in the surroundings of the consolidated city, in what could be called an edge location. However, while historic train stations shaped the urban structure with the "Station Street", perpendicular to the tracks and leading directly to the city center, the edge HSR stations have usually been organized based on a tangential connection, parallel to the tracks, and conceived for road traffic.

Cities are concerned with getting a HSR station which always offers a good traffic access. However, it is not so frequent to provide an adequate pedestrian path, in spite of the walkable distance of edge stations to the city center. Considering the investment of cities in HSR accommodation and promotion campaigns, to adequately signpost and adjust footpaths for a comfortable and pleasant walk would be a low-cost measure to enhance the tourist experience.

Central rail stations are important transport nodes but also relevant places in the city, because they have been able to shape the urban pattern around them. On the contrary, edge HSR stations are also important transport nodes but their role as singular places in the city is limited by the bad quality of their pedestrian access. These edge HSR stations have become a hidden city gate and the station-city pedestrian connection has become the missing link in the intermodal transport chain.

6. Aknowledgements

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