Spatial configuration analysis to improve the accessibility to light-rail stations

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Introduction

The light-rail transit system (LRT) is a preferential choice among other public transport systems in cities and metropolitan areas, as an alternative to overcome the strong automobile dependency. This preference for a LRT system is based on its structural capacity, its characteristics of environmental innovation [4] and its low requirements. However, the successful integration of LRT systems requires the analysis of several indicators to ensure the achievement of these objectives as far as possible. Regarding some of these indicators e.g. population served [14], population density or the length of pedestrianization have more importance as success indicators than others in the planning of the LRT [3]. The values of these indicators are based on the traditional accessibility analysis [11]. In this context, several authors have written review articles on accessibility measures [1] which are usually divided into two groups; location accessibility [2][13] and individual accessibility [9]. But the accessibility analysis undertaken in LRT planning projects are often reduced to location accessibility measures as coverage based on the Euclidean distance of 500 meters. With these coverages, planners try to maximize the population density or population served [15].
However, station coverage with high values of population density, population served or high level of pedestrianization does not give a guarantee the best location of the station as far as more access and more use is concerned. Thus, when making a LRT station accessible to inhabitants some issues related to the form and structure of street patterns should be considered, in addition to the area covered or population served. This means that the spatial configuration, understood as a result of an aggregation process of objects in the space [5] and their relationship, allows us to know which streets or itineraries have more pedestrian movement [7]. The success of the accessibility to transport stations is closely linked to pedestrian itineraries and their direct connection to stations, their attractiveness [10] and design quality [8] which encourage the access to stations [2], the use of public transport and the urban quality [12].

Method

The method presented in this paper (figure 1) is based on the analysis of the spatial configuration as a key factor for the success of the LRT system regarding pedestrian accessibility to stations. This method could be divided into two steps.

The first step shows an analysis of accessibility based on the population served for each LRT station. Then, according to this analysis, the stations with highest values of population served are selected to apply the second step of the method.

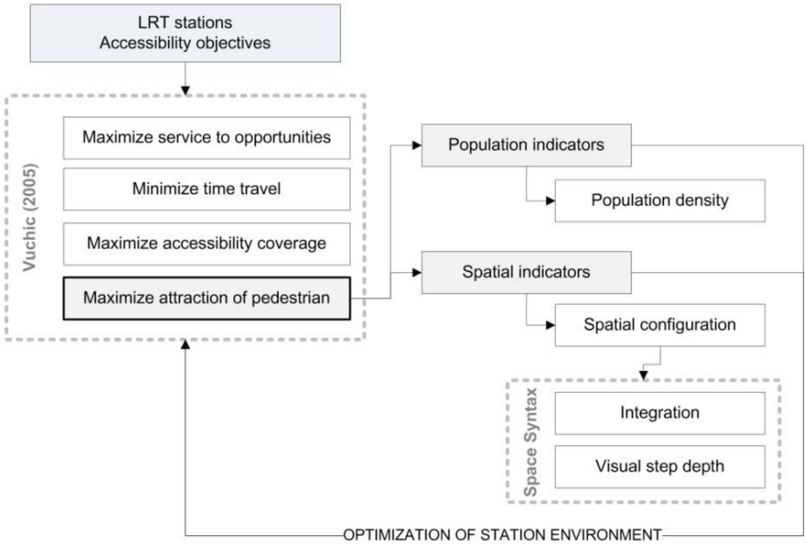
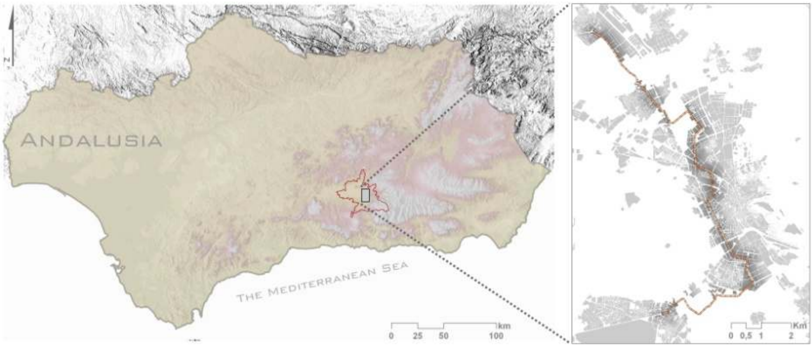


Figure 1: Method.

The second step consists on doing accessibility analysis considering the spatial configuration on the served area of the selected stations. According to some researches (e.g. [6][7]), the Space Syntax can aid to understand the correlation between a spatial configuration and its social effects in a place. Specific software are needed to analyze the spatial configuration, e.g. the software developed by Alasdair Turned, called DepthMap. Using this software, the integration of the street where the station is located and its capacity for pedestrian movement are analyzed. At the same time, the visual analysis of spatial configuration provides values about the relationship between the pedestrians and their objective, the LRT stations.

Study area

The study area is a part of the Granada metropolitan area where the first line of light-rail transit system is being built. This LRT project connects the north of the city of Granada with two metropolitan towns, Albolote and Maracena, and the south with another one, Armilla. The line 1 of LRT project has around16 kilometres and 26 stations are projected. Twenty three of those stations are superficial and three are underground stations that are located in the city centre of Granada.

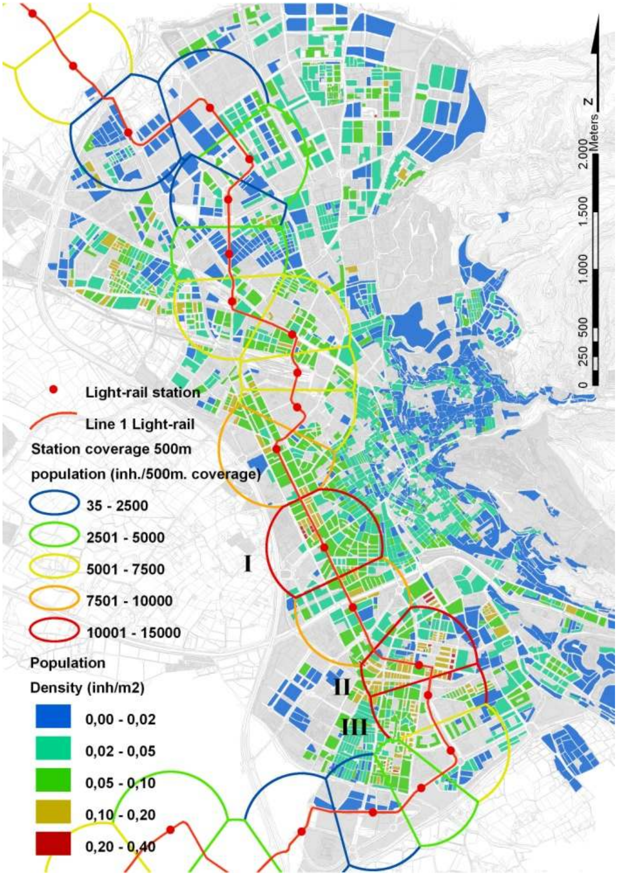


Map 1: The case study. The LRT system of Granada (Andalusia).

The first line of the light-rail transit system is expected to move around nine millions passengers the first year and thirteen millions passengers on the following years.

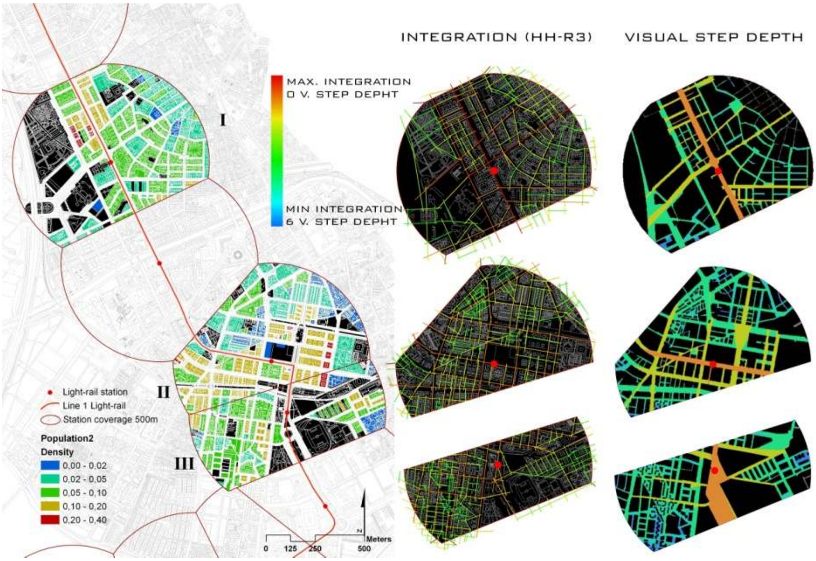
Discussion

The planning projects of LRT systems try to locate the stations in the most accessible places based on analysis of population served or population density. In this way, map 2 shows on one hand the level of population served for each one of LRT stations, and on the other hand the population density of blocks in Granada.
Then, with a selection of the stations with the best level of population served (≥ 10.000 inh. per 500 meters coverage) it is possible to appreciate that these station coverage areas contain blocks with the highest population density. According to this criterion of population served it could be asserted that at urban scale, these LRT stations provide the best levels of accessibility.
Nevertheless if the three LRT stations are analyzed from the point of view of spatial configuration, it could be observed that there are important accessibility differences at the scale of station coverage;



Map 2: LRT station coverage and population.

on one hand, the measure of local integration provides information about the main streets of pedestrian movement. Comparing local integration values of the streets where the stations are located, it can be observed how the station “I” has a better location (HHR3=4,376) than stations “II” (HHR3=3,348) and “III” (HHR3=3,344). Thus, the station “I” provides better accessibility to/from stations of public transport.



Map 3: Measures for analyze pedestrian accessibility to LRT stations.

On the other hand, the "visual step depth" (as a quantification of the complexity of the detours to arrive to LRT stations) shows some differences. The streets in the served area of stations "I" and "II" have lower values of visual step depht (84,3% and 86% ≤ 3 steps) than streets covered by station III (77,5 % ≤ 3 steps)(Figure 2).

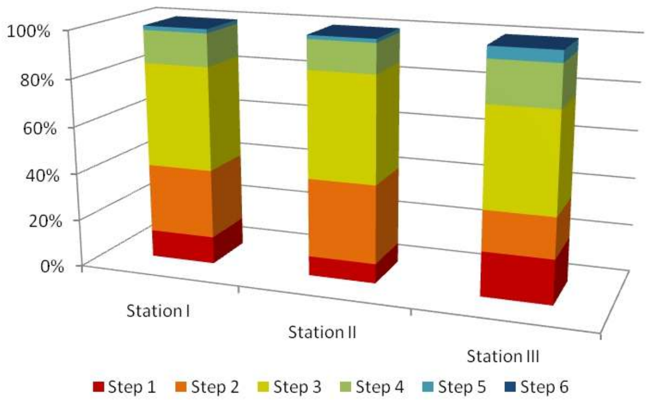


Figure 2: Station comparative about visual step depth.

According to these spatial configuration analysis, station "III" has not a good location in relation to blocks with high population density which are located in streets with worse values of visual steps depth (3 steps). These inhabitants could access to station "II" more directly (2 visual step depth) than the nearest station (station III) although they have to walk a bit more distance. Thus, it is possible to assert that comparing the results of spatial configuration, the station "I" is in a better location to provide pedestrian accessibility.

Finally these results show the need to complement the urban scale of LRT projects with the accessibility analysis at scale of station. That may to improve the location of stations and the environmental design of streets and the use of LRT system.

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