The location of parking sites using Space Syntax: The case study of Leghorn

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Abstract

Parking sites are the very place where pedestrian and vehicular flows are inevitably to match, interface and overlap. The purpose of this study is to use Space Syntax theories and tools, in order to verify if the implementation of these techniques could return some useful information regarding the optimal urban location of parking sites, taking the city of Leghorn as our case study. Since pedestrians and vehicles do actually use different spatial patterns on the same urban area, the idea is to consider two different grids and to analyze them with reference to a wide range of different values of radius, taking into account different transport modes as well as various trip distances. The results, finally overlapped to a real map of the city, appear to highlight this method as a useful and suitable tool for supporting the location of parking areas within the settlements.

Keywords

Parking location, Vehicular movement, Pedestrian movement, Grid configuration, Space syntax.

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Introduction

The urban space is the natural place where different kinds of movement actually flow, coexisting and sharing streets and squares. Such coexistence is anything but easy and problem-free, due to several well known questions: the increase of vehicular traffic, which involves loss of efficiency as well as environmental problems; the need of preserving some urban areas (in particular the historic cores) from traffic; the need of increasing and diversifying transport modes, so as to offer suitable alternatives to private vehicles. Among all the movement modes, this paper concerns those which are arguably the most important and used, as well as hardly compatible with one another: vehicular traffic and pedestrian movement. The theoretical and operational framework of this study is the configurational approach, which was introduced in the mid 80's by Bill Hillier (Hillier, Hanson, 1984; Hillier, 1996a) and since then used and developed by several research groups all over the world. What actually characterizes this approach with reference to other, more traditional methods, is that the urban space, according to the relationships between its elements, does influence the distribution of land uses and activities; and that movement, in such influence, represents the interface between the urban grid and the land use (Hillier, 1996b). Operationally speaking, the configurational approach is carried out by several different methods, aimed at reducing the grid into a system of connected elements and then providing each of them with a set of numerical parameters, whose value depends on its spatial relationships with all the other elements. The axial analysis reduces the grid into a system of lines (Hillier, Hanson, 1984), the visibility graph analysis into a system of visually interconnected vertices (Turner et al., 2001), the road-centre line analysis into a system of road axes (Thomson, 2003), the Ma.P.P.A. into a system of singular points (Cutini et al., 2004), the segment analysis into a system of segments (Turner, 2007), and so on. Whatever technique is used, the combination of the resulting values identifies the configurational state of the system. What distinguishes the several configurational techniques so far introduced and widely tested is the way of reducing the grid into a system. Two main variables appear worth highlighting as concerned with our study: integration, defined as the mean depth of an element with respect to all the others, and choice, defined as the frequency of a spatial element in the shortest paths connecting all the couples of other elements on the grid. Both those parameters have been proved to be reliable indicators of the distribution of urban centrality (Cutini, 1999; Cutini, 2000): roughly speaking, integration can be said measuring and reproducing the attractiveness of an element, that is its ability to work as a terminal point of a path, while choice measures and reproduces its potentiality to work as a preferable route, so as to work as an intermediate point. As it can easily be seen, both those notions ought to be assumed as suitable concepts when it comes at discussing the location of parking areas.

Methodology

The configurational approach faces the matter of parking location, taking space into play. It is the urban grid (the way its streets are disposed and mutually arranged) what will provide the required information about its suitable use, and therefore also about the location of parking areas, in light of the movement behavior along its paths (Hillier et al., 1993). Pedestrian and vehicles, by far the main actors of urban flows, have different behaviors while they move around the city. In fact, it is clear that travel ranges and paths (the physical roadable space) vary, since they use different streets, according to the presence of municipality regulation such as pedestrian zone and ZTL (traffic limited zone).

Therefore, the first step of the work was to create and take into account two different plans of Leghorn: the "pedestrian" plan, including all the streets, and the "vehicles" one, obtained depurating the first one from the areas where the local regulations do actually prohibit vehicular traffic. Those plans were then reduced into systems, converting them into sets of straight paths, named axial maps, composed of the fewest and longest lines connecting all the convex spaces of the grid (Hillier, 1996a). Such axial maps were further transformed into segment maps, in order to use the technique named Segment Analysis, suitable for allowing the adoption of a metric length for the radius and a more intuitive understanding of the results (Turner, 2007). The radius used for the integration was chosen as based on the common life experience: pedestrian would walk for approximately from 500 to 1000 meters during the simulation of a "virtual walk"; the vehicles will travel for a longer path (8000 meters). The choice of different values of radius for pedestrians and vehicles hence reflects our second assumption: the two movement modes are characterized by different length paths. The normalization step was then acted, in order to allow graphically overlapping the results coming out of the analysis. The results are shown in figure 1.a for the pedestrians (R= 1000 m) and figure 1.b for the vehicles (R= 8000 m) (Fig. 1). The overlapping of the different results allows a more complete representation; in order to favour a clearer understanding, the segments with choice values over the 90^{th} percentile were highlighted, thus providing the choice cores for pedestrians and vehicles, suitable for indicating the areas where both values are higher. Such areas, as highly affected by different traffic modes, will hence result specifically suitable for the location of parking. In order to verify the level of proximity of those locations to the actual central areas of Leghorn, the pedestrian and vehicles choice cores were also overlapped to the integration core of Leghorn, computed according to a local (R= 3) radius of integration, as shown in figure 1c.

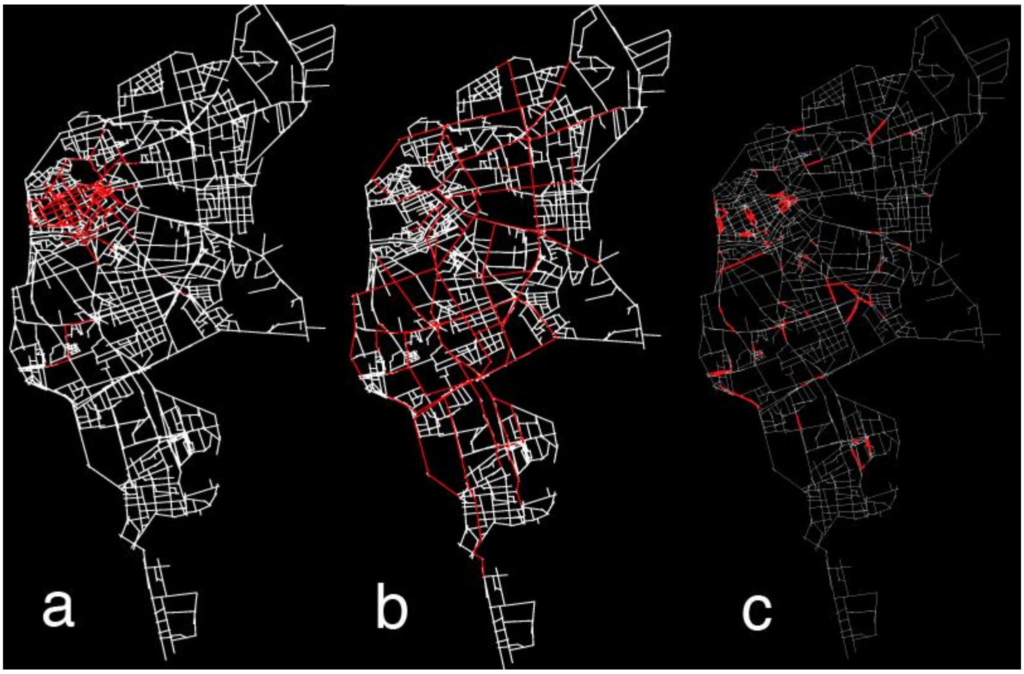

Figure 1 - The defined cores in the grid of Leghorn: pedestrian choice core (a), vehicular choice core (b); local integration core (c)

Results and conclusions

The main results are summarized in figure 2: here the most suitable location for parking sites appears in the close proximity of the pentagonal city center (Fig. 2a), what is hardly casual: the colored lines stand in correspondence of Piazza della Repubblica, one of the largest squares in

Leghorn (about 18000 m^2). It is one of the most relevant tourist areas of the city, accommodating shops and offices, providing a panoramic view on the Fortezza Nuova and Fosso Reale, and pivoting around different movement flows, as a point of confluence of several important streets. It is also worth highlighting that in this area, precisely in via Serristori, a parking zone already exists. The map in figure 2.c represents the actual result of the interception between the pedestrian choice core (R= 1000 m) and the vehicular choice core (R=8000 m) (Fig. 2.c). Those higher values of radius are also concerned with those people (e.g. tourists, people enjoying their free time) who park the car and simply walk long distances. As actually expected, the same area detected before appears to maintain its clear relevance; moreover, it is worth noticing that another area, located south of the centre, thus apparently far away from the most important sites, appears highlighted. This line corresponds to Via Orlandi, actually located in a strategic zone of the city: within 1 km around it, we find the Aquarium, the Armando Picchi Stadium, the waterfront, where people stroll along the sea-side, and the well-known Terrazza Mascagni, looking out over the sea. Via Orlandi is also adjacent to various minor point of interest like sports facilities, beach properties and churches.

This research shows how space syntax can concretely be used in order to help selecting the location for parking sites, providing results that appear to narrowly correspond to the actual situation. A caveat is worth underlining: the present research is a merely theoretical study and is aimed at testing a method for identifying possible locations, which, as a matter of fact, could even not be available for actual parking uses, because of the presence of buildings or constraints of any other kind. Nonetheless, the results so far allow to attest this method, when accompanied and sustained by the outputs of traffic models and detailed urban studies, as a reliable tool for powerfully supporting planning and decision-making. Furthermore, a similar approach can be easily extended to the location of other urban activities, differently related to the distribution and influence of movement.

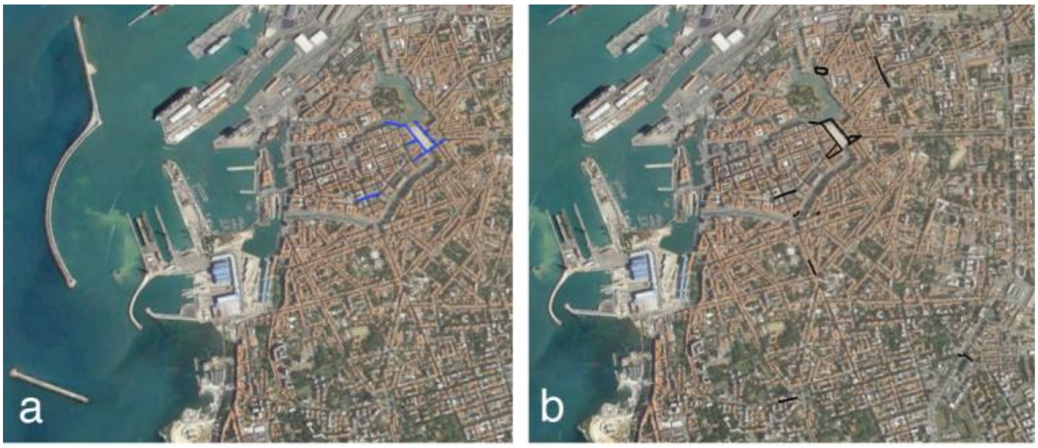

Figure 2 - The resulting location of parking sites in Leghorn

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