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THE IMPACT OF LAND USE IN THE PERFORMANCE OF THE URBAN STREET GRID

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Abstract

The article aims to present the relationship that exists between the flow of people, land use and syntactic indexes based on the Space Syntax theory. In order to achieve that, the theory was applied to the neighborhood of Telheiras, in the city of Lisbon, whose urban grid presents modernist features with contemporary influences, being rather peculiar in terms of morphology. A strong relationship between the flows and indexes of integration was found. When it came to land use, however, it was observed that some streets' potential to encourage the flow of pedestrians is not used to its fullest. On the contrary, the car has become the protagonist in this scenario, which fosters a clear divide between places.

Keywords: *Urban mobility, urban configuration, counting, land use, Lisbon.*

Theme: *Urban Space and Social, Economic and Cultural Phenomena*

1. Introduction

Nowadays, discussing the act of walking implies exploring the heart of urban mobility, a theme which has been recurrent, exhaustive, and to some extent, worn out. The growth of cities and the problems it brings due to the scale of human settlements have made the public transportation systems unviable in most of the world, in the places such system existed to begin with. In addition, with the invention of the automobile after the Industrial Revolution, walking has gradually been replaced by the comfort of motorized transportation. If on the one hand being a pedestrian has become the exception, as if walking was not part of the natural human logics for displacement, on the other hand, the urban spaces are not designed for the perspective of the pedestrian, but the vehicles.

Moreover, as motorized displacements become the norm for carrying out the human activities, an increasingly great (but not new) problem has arisen in the large urban centers: the changes in the constructed environment which are getting further and further away from the human scale, and adapting itself to suit the scale of the car. The growth of cities and the culture of consumerism and status have fostered the excessive use of vehicles[1] in the urban centers in many parts of the world. Consequently, the implementation of street infrastructure based on the erroneous principle of supplying the demand increases, and the infrastructure for walking and biking is neglected or left aside. This is how most cities have replaced the human scale with the motorized scale, failing to provide a better urban life in cities that are for people and not for vehicles.

Apparently, this change in scale can be understood in terms of its different urban geometries and topologies, encompassing the forms and relations between the elements that create the cities[2]. What this means is that the transitions from a human scale to a motorized scale affect, or may affect, the act of walking.

This article aims to present the relationship that exists between the flow of people, land use and syntactic indexes based on the Space Syntax theory. It is important to highlight that the case study was done in a neighborhood whose street layout presents modernist features with contemporary influences, being rather peculiar in terms of morphology.

We should further highlight that this article is part of a research under development, whose main goal is to verify to what extent the urban form interferes in the way people move through space in a city.

2. Theoretical Background

2.1. *Spatial Configuration*

In architecture and traffic engineering, the use of morphological approach has increased, for researching the relations that exist between the constructed form of the cities and its corresponding dynamics. According to the literature (Kohlsdorf, 1996; Holanda, 2002; Amâncio, 2006; Medeiros, 2006), there is a strong relation between the causes and effects of the constructed space for people's ability to live in such spaces. It is believed that spaces are a product of human intention, that is, they follow interests which are clearly established. Such

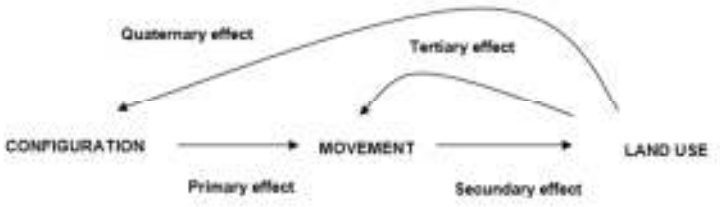
[1] In this article, the expressions/words *motorized vehicles*, *individual vehicles*, *automobiles* and *cars* are used as synonyms.

[2] The concepts presented by Medeiros (2006) are used here, in which topology is seen as the study of the spatial relations that are independent of the form and size, based on a notion of hierarchy and relationship between parts. In its turn, Geometry encompasses the direct description of the physical elements in terms of dimensions, proportions, scale, etc.

interests might be the result of global planning actions or local initiatives. On the other hand, these spaces bring consequences to the human dynamics which many times deviate from what was originally planned.

In that regard, when analysing architecture as the space used socially, Kohlsdorf (1996) and Holanda (2002) both classify it as being simultaneously a dependent and independent variable – that is, a product of human intentions and desires – once its consequences can be different from those based on which it was conceived.

Hillier and Hanson (1984) believe there is a virtuous cycle for explaining the law of natural movement (Picture 1), by which the spatial configuration has the primary effect of generating movement (be that of people or vehicles) within the spaces. As a secondary effect, this movement generated by the spatial configuration fosters new land use patterns (that is, new places that will attract and generate movement). And finally, as tertiary and quaternary effects, there is an inverse movement, in which the new land use patterns foster movement and therefore interfere in the spatial configuration.



Picture 1 Virtuous cycle of natural movement
Source: Medeiros (2006)

2.2. *Urban Mobility*

According to the Ministry of Cities (2005), urban mobility is the interaction between the displacement flows of people and goods and the urban structure, encompassing the motorized and non-motorized flows. It is a feature of the city, determined mainly by social and economic aspects, by the appropriation of space and by technological evolution, whereas the urban transport refers strictly to the services and the means of transportation used in the displacements within the urban space.

The ANTP (2002) adds to the concept the variable “dimension of the space”, trying to shyly incorporate the principles of the urban form: “mobility is a feature of the people and economic agents at the moment they seek to ensure the displacements they need, taking into account the dimensions of the urban space and the complexity of the activities carried out there”. In addition, it includes the numerous individuals (pedestrians, cyclists, drivers and users of public transportation) as they move through space. The income, age and gender of these individual are also taken into consideration.

Vasconcellos (2001) further remarks that only the factors ‘age’, ‘income’ and ‘gender’ are not enough and adds ‘occupation’ and ‘school level’. Furthermore, he says that the presence of a car in a household has great impact, and can be measured by the factor ‘income’. He also believes that, in general, men move through space more than women, and the adult male which are part of the economically active population move more than youngsters or elders.

Such concepts show that there is no mention to the urban configuration/morphology, being that the interpretations focus on the relation between means of displacement and social and

economic profiles. It seems that the factors associated to the form of the space and the way the street grid is articulated are not understood as relevant factors that influence the displacement processes within a city.

3. Methodology

For the development of the research reported in this article, two analytic strategies are applied to Zone 2 of Telheiras (Picture 2): (a) axial maps of radius n and radius 3 and (b) counting vehicles and people, in order to validate the results concerning the potential for movement from the space syntax analysis.

For the first strategy, the Lisbon network of transportation – available at the group of transportation from the Instituto Superior Técnico of the Technical University of Lisbon (IST/UTL) under the coordination of Professors José Manuel Viegas and Luis Miguel Martínez - was used for drafting the axial map of Lisbon, based on the axis of the city's transportation system. For the second, the method chosen was the Gate Method (cf. Grajewski and Vaughan, 2001) developed by the group from the Space Syntax Laboratory of the University College London (UCL) under the coordination of Professor Bill Hillier.

Once Telheiras has a considerable size, we opted for presenting the analysis over only one part of its extension, zone 2 (Picture 2). The reason why this particular zone was chosen is because it has the greatest diversity of land uses, which allows us to better present the analysis required in this study.

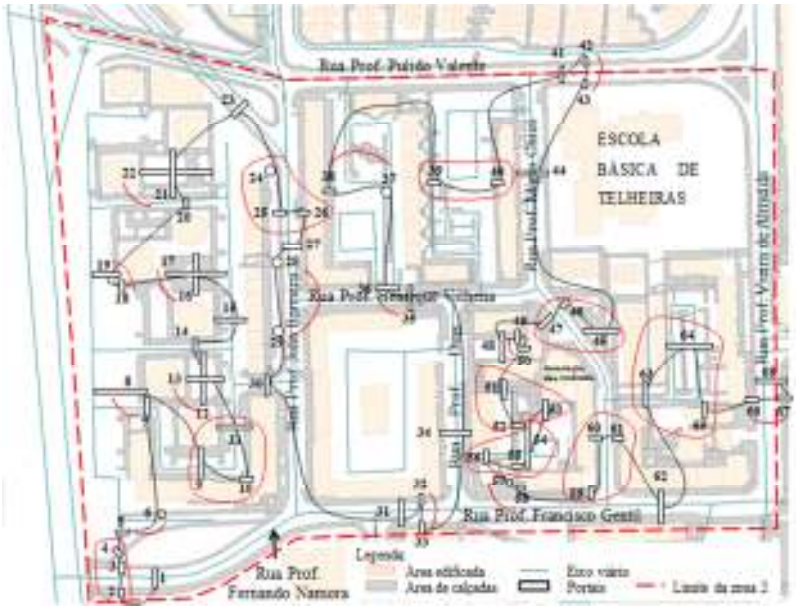
First, the time for the counting of cars and people was chosen, based on the particularities of the city (including natural luminosity) and the interest in analyzing the flows in the neighborhood in typical days and periods, from Monday to Thursday: in order to represent the morning peak (PM), the interval from 7:30am to 9:30am was chosen; and for the afternoon peak (PT), from 5:00pm to 7:00pm (limit of day light availability at this time of the year).

Picture 2 The 4 zones of Telheiras with their immediate surroundings – scale not mentioned.

It is important to highlight that the definition of the gates was done taking two things into account: (a) the definition of the routes (Picture 2), so as not to last more than 2 hours (defined in the method as the time for counting/observing) – for both the morning and afternoon peak times; and (b) cover a range of well-used, moderately-used and poorly used streets.

It is worth mentioning that both vehicles and people were considered in the counting. In the case of the vehicles, all motorized vehicles were placed in the same category, once the intention was only to assess the intensity of the movement in the streets under study. In the case of people, they were categorized as follows; *men, women, teenagers, elders* and children, so it would be possible to explain some movements, such as a poorly used street which in peak times would have a high number of children or teenagers, due to the presence of a school. In the categories created for the flow of pedestrians the intention was not to generate a thorough study of the age range of the individuals that walked by the gate; the markings were made by visual perception only.

We further highlight that for poorly-used gates, there is the possibility of counting both people and vehicles at the same time, and incorporating a greater number of points to the counting. The gates counted as a group in zone 2 are highlighted in Picture 3 with arches and polygons in red.



Picture 3 Location of the gates and the routes in Zone 2 of Telheiras.

4. Results

4.1. *Syntactic Analysis*

The neighborhood of Telheiras encompasses a very distinctive layout in comparison to the traditional one, as a result of contemporary experiments based on modernism. The grid does not present a clearly defined pattern, once in some places it resembles a regular grid (chess board) whereas in others it brings to mind an organized irregularity: there are several “X” or “T” crossroads, but also it is easy to find long blocks (irregular in terms of both shape and size). These features result in low integration indexes, such as can be seen in Picture 5 and Table 1, which will be further explained in the following paragraphs.

In order to choose which zone should be analyzed, the choice measure was used (Picture 4), whose aim is to present the streets which most people choose to use in a given street grid. The streets chosen tend to coincide with the greatest levels in the street hierarchy of an urban system, as for example, expressways and arterial ways.

Picture 4 Choice measure of Zone 2 and of Telheiras

It was possible to verify that the streets chosen by the choice measure for Telheiras coincided in great measure to the streets that border zone 2. These streets (Rua Prof. Francisco Gentil, Rua Prof. Vieira de Almeida, Rua Prof. Pulido Valente e Rua Prof. João Barreira – Picture 3) are considered the highest in the hierarchy and, consequently, those with the greatest volume of vehicles in the neighborhood.

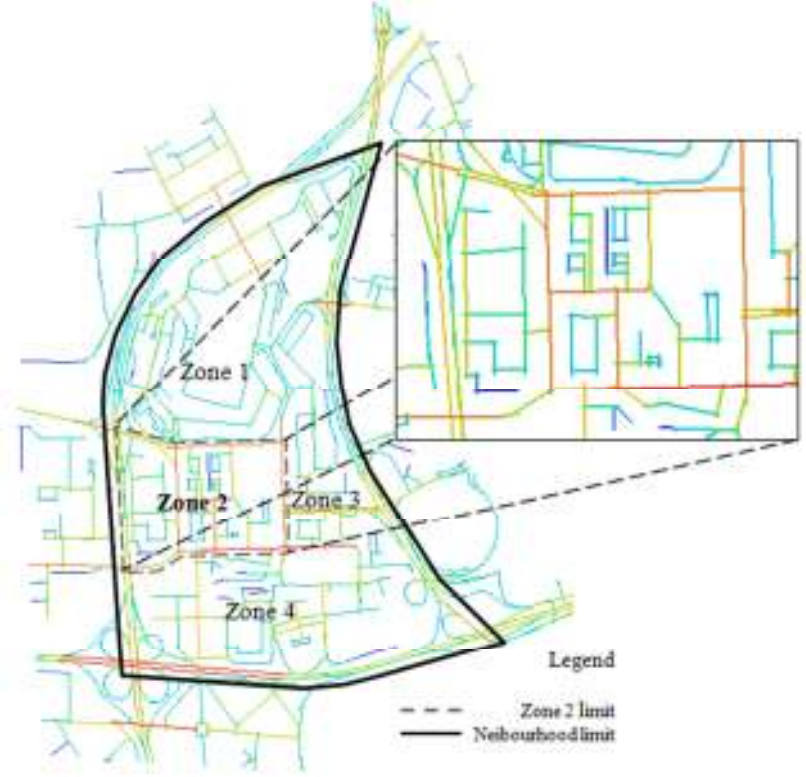
Based on the analysis of the axial map, we can observe that Telheiras (Table 1 and Picture 5) presents an average global integration index of 0,46 and that its system has streets that cross the neighborhood from east to west, making it more accessible in relation to its surroundings. On the other hand, within the neighborhood itself there are connection problems between its zones (1, 2, 3 and 4), which translates into a compromised reading of the space and therefore, a reduced permeability between the zones. With a value of 0,08 (Table 1) the standard deviation it can be inferred that there is virtually no variation around the average integration of the neighborhood, which reinforces its labyrinth features.

Table 2 Syntactic Indexes

Neighborhood	Average Integration R*n*	Minimun Integration R*n*	Maximun Integration R*n*	Standard deviation
Telheiras	0,46	0,27	0,69	0,08

Analysing locally (Picture 6), one can infer that due to the small scale of Telheiras, its urban system presents a index R3 (1,21 – Table 2) higher than the global average (0,46 – Table 1). The standard deviation of 0,39 presents some variation around the average, which goes to show there are meaningful distinctions between the local values of integration for the system of the neighborhood. The same is true for zone 2, however, this region contains the highest values of local integration, being thus more locally integrated.

Picture 5 Axial map (R*n*) of Zone 2 and of Telheiras – scale not mentioned



Picture 6 Axial Map (R*3*) of Zone 2 and of Telheiras – scale not mentioned

Table 2 Syntactic Indexes

Neighborhood	Average Integration R*3*	Minimun Integration R*3*	Maximun Integration R*3*	Standard deviation
Telheiras	1,21	0,34	2,65	0,39

4.2. *Analysis of the countings*

When the data about the flows, gathered in the counting, was incorporated to the analysis of integration, it was possible to verify the correlation between them.

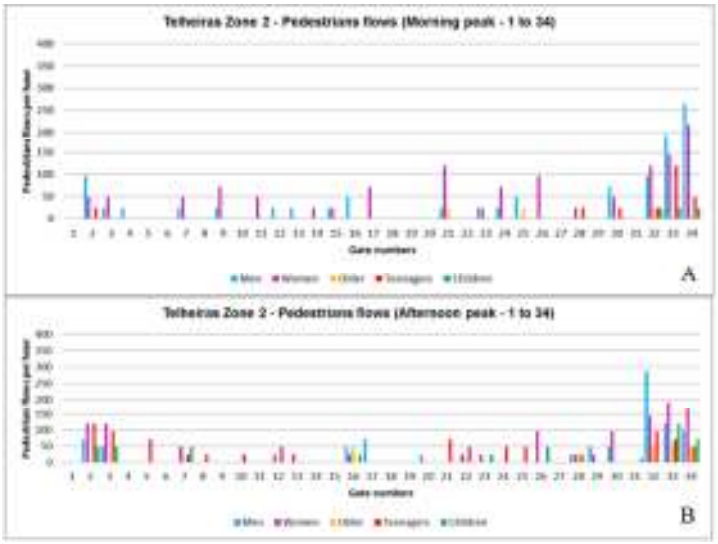
Table 3 Integration values, flow of vehicles and people at the gates located in the higher hierarchy streets of Zone 2 of Telheiras.

Gates	Flow (Cars/h) PM	Flow (Ppl./h) PM	Integration Index
1	804	-	0,61
2	-	168	0,61
3	-	72	0,61
25	-	30	0,66
26	-	60	0,66
27	960	-	0,66
31	1050	-	0,62
32	-	216	0,62
33	-	258	0,62
34	234	246	0,62
35	318	102	0,62
41	2070	-	0,67
42	-	12	0,67
43	-	24	0,67
44	228	186	0,62
62	1002	420	0,64
66	-	210	0,69
67	-	246	0,69
68	690	-	0,69

In Rua Prof. Francisco Gentil, where gates 31 (vehicles only), 32 (pedestrians only), 33 (pedestrians only) and 62 (both) were located, there is a concentration of commercial uses, such as bakeries, grocery stores, drugstores, banks etc and a highest number of pedestrians and vehicles of zone 2 were found (Table 3).

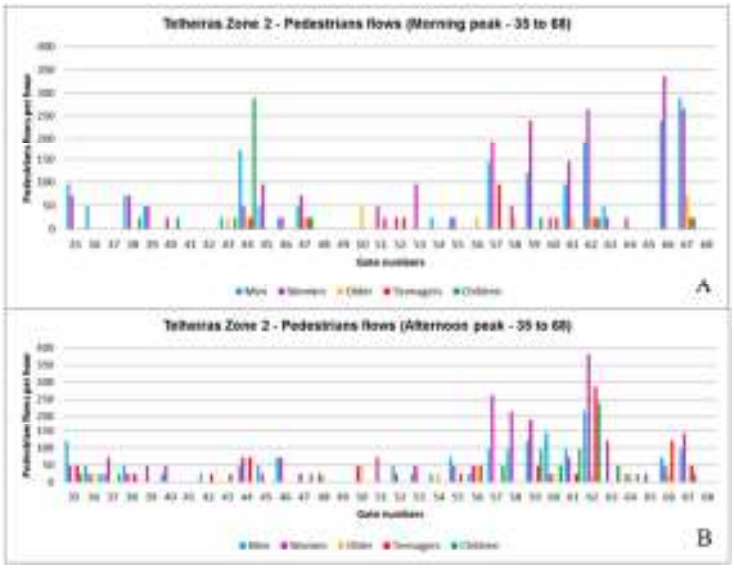
On another hand, Rua Prof. Pulido Valente (Picture 3) presented a highest flow of vehicles of Zone 2, with a volume of 2070 vehicles in gate 41. However, there was low number of pedestrians with only 12 at gate 42 and 24 at gate 43 (Table 3). This is due to the absence of land uses that foster the flow of people, since there are high walls (such as the one from Elementary School of Telheiras – Picture 3) and a morphology of great open spaces, which do not encourage the use of the space.

In Zone 2 (Picture 8) there is a considerably greater amount of children in gate 44 in the morning interval compared to the afternoon one, once in the morning the children are going to Elementary School of Telheiras (Picture 3).



Picture 7 Hourly flow of people in Zone 2, Telheiras – Morning peak (A) and Afternoon peak (B) – 1 to 34.

Another observation concerning the influence of land use in the flow of people takes place in gate 62 (Picture 8), where in the morning there were 420 people, including 24 children, whereas in the afternoon there were 1.152 people (Picture 8) amongst which 240 were children. That means that in the first case the counting was carried out after the children had arrived in school, and in the second, it coincided with the time the children were coming out of school and, thus, the sidewalk that leads to the subway station and the bus stop – where the gate was – presented the different counting values.



Picture 8 Hourly flow of people in Zone 2, Telheiras – Morning peak (A) and Afternoon peak (B) – 35 to 68.

5. Conclusions

The findings confirm the potential for movement flow suggested by the axial maps and the counting, further validating the labyrinth aspects of the contemporary/modern grid, in many ways similar to Brasilia, whose layout presents the same logic of great open spaces.

It was also possible to verify that the configuration is a factor that interferes in the movement and the uses of space are also considered paramount for movement, specially that of pedestrians.

In regard to the uses, it was possible to observe that in certain streets the potential is under used, and there is no encouragement for pedestrian movement. On the contrary, the vehicles have become the protagonist in this scenario, which fosters a clear segregation of spaces.

Therefore, one can conclude that the uses foster movement and, when aligned to the spatial configuration, both can become forces that encourage movement, such as described in the Virtuous Cycle of Natural Movement.

Finally, it becomes apparent once more that there is a lack of spaces whose design and layout foster the interaction of people, instead of spaces that discourage people's presence. Moreover, we reinforce the need for thinking the urban space for people and not motorized vehicles.

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