The spatial congruence effect: exploring the relationship between spatial variables and functional vitality on Lisbon's prime office location.

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Abstract

This paper aims at exploring the relationship between spatial variables and functional vitality in the urban environment. The case of Lisbon's prime office location are analysed and discussed based on the corresponding extrinsic (accessibility) and intrinsic properties (plot size).

Introduction

This paper presents an exploratory study on spatial determinants of urban land uses patterns aimed at exploring the relationship between spatial variables and functional vitality in the urban environment. It investigates the importance of the spatial congruence effect on office location patterns i.e., the adequacy between extrinsic and intrinsic spatial variables. Extrinsic properties refer to topological variables while intrinsic properties consider physical variables, both influencing space use (Hillier, 1999). The research question is focused on the main physical characteristics, which influence use location in the case of prime offices.

Spatial congruence concept emerges from the evidence of two urban phenomena: the existence of hierarchies at both functional and spatial level, and the assumption that they are very directly related. Both phenomena are well documented facts (Hillier, 1976; Tannenbaum, 1995; Hillier, 1991; Alexander, 1965).

Previous space syntax research has shown very consistent correlations between spatial and functional hierarchies (Desyllas, 1999; Hillier, 1999; Kim, 2002). Based on the results of an empirical study of Lisbon's Prime Zone (FA, 2000), this paper argues that healthy urban environments lay on the congruence of global and local spatial properties i.e., on the adequacy between extrinsic and intrinsic properties. Referred study has showed a very consistent coincidence between highest integration values and highest office rents, i.e., a strong relationship between spatial and functional hierarchies. However, within the spaces with highest integration values, one showed a different functional performance when compared to the others. Besides having a different functioning, it also accommodates some activities associated to urban decay.

The paper is organized into 4 parts. The fist one introduces the patterns of office location and discusses the main factors, which influence most location decision-making. The second one refers methodological procedures applied in the research. Third part analyses the case studies. Main findings are discussed in the forth part.

1. Office location patterns

Office activities do show a strong tendency to concentrate and usually locate in the city's centre, creating the business and commercial core, usually named Prime Zone (Carter, 1991). Offices do extensively use space and high standard labour (Castells, 2001). Hence, the need to be closer to several different types of specialized activities forces offices to an extreme accessible location. Moreover, offices work together with multiple diary contacts, which make them depend on each other (Goodall, 1972). Some other advantages come with spatial closeness, as the growth in type, quality and quantity of some common services and facilities, as retail shopping, restaurants, hotels, banking (Tannenbaum, 1995).

These activities, sharing spatial proximity, create a specific order, which reveals a hierarchy of centrality. As a consequence, accessibility reaches a status of prime exigency. Topologic properties as a reflection of "natural" accessibility determine in first instance location, as extrinsic variables. As demonstrated by Desyllas (1999), spatial structure has a major role on patterns of location rents.

However, office location is (very possibly) influenced by intrinsic variables, such as plot geometry, in particularly the façade length. In fact, the front size of each plot (and its relation to its area), influence how visible the business will be, representing an important decision factor (building prominence factor) (Duffy, 1997), since investors tend to choose the plot which geometry maximizes front façade, in order to create extra advantage. Moreover the front size also affects visual complexity and urban diversity (Bentley, 1999).

2. Methodological procedures

The study is based on a comparative analytical example, which combines space syntax with plot geometry analysis.

SS	Connect	ContrValue	TotalInteg	TotalDepth	LocalDepth	LocalInteg	MeanDepth
CS1	20	5,24549	1,12597	127,000	144,000	5,13605	8,134
CS2	29	5,59954	1,22422	118,000	185,000	5,82335	7,562

Figure 1- Space Syntax values of case studies.

Space syntax methodology and analytical tools - Axwoman software - were used to investigate the extrinsic variable (accessibility) in order to correlate with intrinsic properties (plot geometry). Plot geometry was analysed through plot length, area, and density, i.e. the number of buildings/overall length. This measure of density quantifies effective variety and allows for comparing among different sized spaces, reflecting the functional variability potential of each space. In order to compare case studies in terms of their functional diversity potential, other elements, which contribute to increase façade length, such as the existence of "blank spaces" created by crossing streets, were also considered. "Blank spaces" were quantified by means of the syntactic measure of connectivity.

As case studies show differences in size, "blank spaces" strong influence linear density. To diminish this effect, coefficient value (presented in title by each axe's connectivity) was normalised. Thus, resulting value (see table 1), designated Coefficient of Linear Occupancy (CLO) is quantified by: CLO = l / b /c .

l- Overall space length

b- Total number of buildings of each space

c- Each space's connectivity (Space Syntax indicator)

The fact of applying, in CLO calculation, not the sum of building width, but overall space length allows characterising the axes by integrating natural "blank spaces": connectivity in both number and type (number and width of crossing streets).

	Overall length (meters)	Number of buildings	Connectivity	CLO
CS 1	1462	107	20	0,68317
CS 2	1841	198	29	0,32061

Figure 2- CLO - Coefficient of Linear Occupancy.

3. Lisbon's Prime Zone

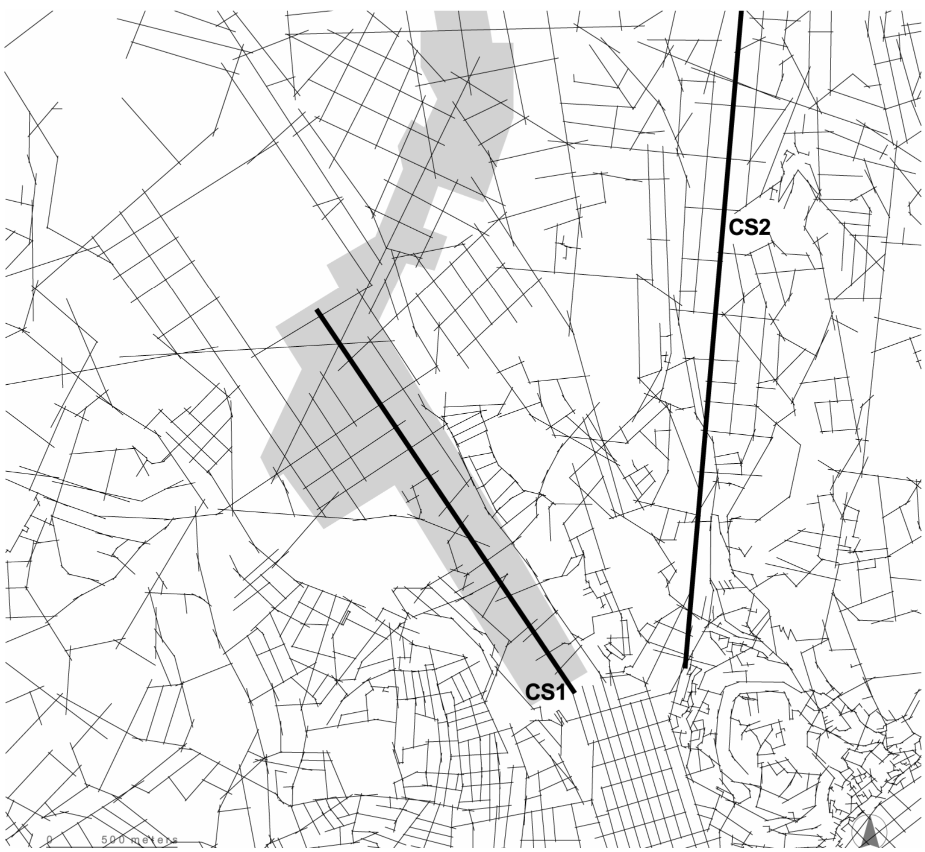

Figure 3- Axial Map of Lisbon's Prime Zone Area. Identification of case study axes. Prime zone shaded.

Lisbon's Prime Zone shows a linear development, and was investigated on a 3000m square context (fig.1). This area integrates a mix urban tissue composed by several periods of intervention, denoting the urban evolution process (Kruger et alt, 1996). In particular, it reflects the "over structure" designed late in the XIX century as the city urban expansion: the opening of a boulevard, following the illuminist orthogonal grid direction into the hinterland. This axe develops from the traditional urban core, becoming "the main avenue" of the city, and is now part of the prime zone (case study 1 - CS1). During the same period, another axe has been developed also from the urban core (case study 2 - CS2). Space Syntax analysis reveals the actual presence of a ringy urban core with a clear directionality to the hinterland, which incorporates CS1 and CS2.

CS1 and CS2 illustrate different types of functional vitality. CS1 homes High standard offices, luxury retail shops and hotels, while CS2 presents less homogeneity, homing low quality retail, few low-cost offices and old industrial premises as several vacant buildings. These features contribute to create unhealthy environment which is in part responsible for security problems.

3.1. Case study analysis

Geometrical dimensions of case studies	Overall length (meters)	width (meters)
Av. da Liberdade (case study 1 - CS1)	1462	89
Av. Almirante Reis (case study 2 - CS2)	1841	25

Figure 4- General geometric dimensions of case studies.

Although being created at the same time, CS1 and CS2 show different urban design options. CS1, follows the design rules of the *boulevard* created under the influence of early 1900's Romantics. It is spatially limited in both extremes by two squares, showing a very homogeneous composition. It is characterized by a single and symmetric cross section.

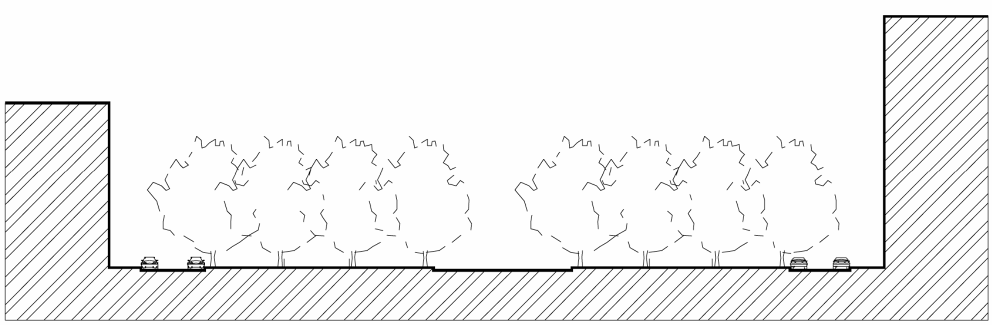

Figure 5- CS1 – Av- da Liberdade – Cross section (aprox. Scale 1:800).

CS2, is characterized by several variations on its cross section, although geometrically consistent along its length. The general profile is characterised by regular sidewalks along buildings, in some areas directly followed by a double way street, or by a parking lane separating the first from the latter.

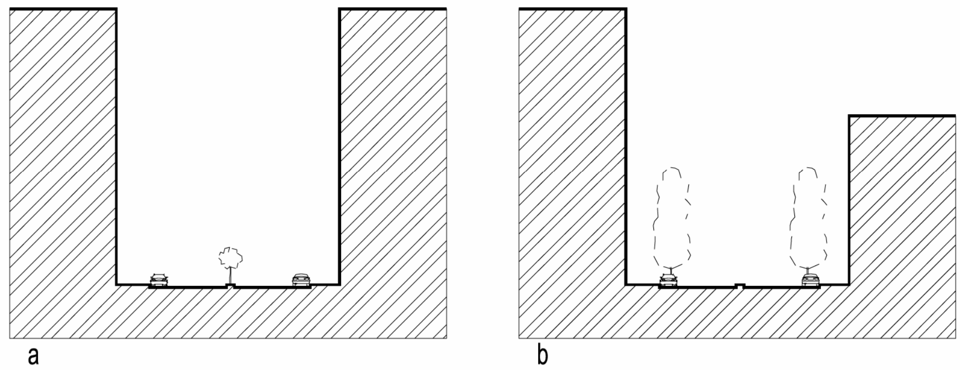

Figure 6- a,b) CS2 - Av. Almirante Reis - Cross sections (aprox. Scale 1:800).

3.2. Density analysis (Number of buildings /overall length)

It is possible to read from CLO values that CS2 has fewer buildings per linear metre of total length than CS1. Note that this is more significant as crossing streets of CS1 do represent wider “blank spaces” in street fronts because of their width which is larger than of crossing streets of CS2.

In order to clearly identifying and quantifying the role of “blank spaces”, see table 2 where Real CLO is calculated. Note that unlike CLO, Real CLO uses sum width instead of street overall length, in order to allowing comparing the relationship between the number of buildings per linear metre of street length considering connectivity (CLO) and the number of buildings per liner metre of total sum façades considering connectivity (Real CLO). The difference between CLO and Real CLO strongly increases in CS1, although CS2 has higher connectivity. This reflects phenomena as width of “blank spaces”, and corner plots, which are properties that make a difference in CS1.

	½ SUM Width	Number of buildings	Connectivity	Real CLO
CS 1	1848	107	20	0,86355
CS 2	1935	198	29	0,33690

Figure 7- Real CLO - Real Coefficient of Linear Occupancy.

The analysis makes possible to read from CLO values that CS2 has fewer buildings per linear metre of total length than CS1. Note that this is more significant as crossing streets of CS1 do represent wider “brakes” in street fronts.

3.3. Plot Area analysis

There is a difference between maximum and minimum values measured, evidencing a bigger individual homing capacity of CS1, in relation to CS2, although a similarity in range is observed. More relevant in evidencing building capacity is MEAN value. The magnitude of values does allow the presence of additional services and functions, which do not use such big areas. Coefficient of Variability (V)[1] evaluates relative homogeneity among each universe. CS1 and CS2 values are close to each other revealing similar homogeneous distribution of area values at both case studies universes. Positive SK (Skewness) values do show a skewed distribution to the right, which means that in both case studies lower values are in less number than higher ones. However, SK values are small, denoting little differences between the mean and the median revealing very consistent universes with continuous distribution.

PLOT AREA STATISTICS	COUNT	SUM	MAX	MIN	MEAN	STD DEV	V	MD	SK
CS 1	107	59778	1964	61	559	378	0,67620	453	0,84127
CS 2	198	50775	1320	27	256	188	0,73437	212	0,70213

Figure 8- Plot Area statistics. V- Coefficient of variability; MD-Median; SK-Skewness.

3.4. Plot Width analysis (façade length)

There is an evident disproportion between the number of buildings (COUNT) and the sum of their lengths (SUM) between case studies. This evidence is reflected at MEAN values, as CS1 almost doubles CS2. In accordance to the total length of the axes, this result was expected. Very similar Coefficients of Variability (V) do reveal homogeneity of case studies universe. Universes distribution is skewed to the right, especially CS2.

The analysis reveals the importance of other variables than buildings' width, which contribute to total length of the street, namely connectivity, which influences through number and type (as mentioned when analysing Plot width/overall length). MIN and MAX values do show evident similar range magnitudes although CS1 offers highest values.

PLOT WIDTH STATISTICS	COUNT	SUM	MAX	MIN	MEAN	STD DEV	V	MD	SK
CS 1	107	3696	140	10	35	23	0,65714	29	0,78261
CS 2	198	3869	82	3	20	13	0,65000	15	1,15385

Figure 9- Plot Width statistics

3.5. Plot Width /Plot Area analysis (number of linear façade meters by each square meter of area)

Results do show in MEAN terms a slightly better appetence in promoting visibility to CS2, as it shows higher results. CS2 do also presents the highest MAX value and the lowest MIN value, revealing a less homogeneous universe of plot geometry.

This can be a reflection of a progressive occupation in time, rather than a time concentrated intervention.

Coefficient of Variability V is unexpectedly lower in CS2, although difference between MAX and MIN values being considerably different than in CS1, revealing very much homogeneity in CS1's universe.

Although Plot Width/Plot Area analysis reveals MAX, MIN, and MEAN values on CS2, CS1 reveals more homogeneity.

[1] Due to significantly different mean values (MEAN), each groups relative homogeneity should be analysed through Coefficient of variability (V) instead of by analysing absolute magnitudes of standard deviation (STD DEV).

WIDTH/AREA STATISTICS	COUNT	MAX	MIN	MEAN	STD DEV	V
CS 1	107	0,201	0,024	0,07075	0,03625	0,51236
CS 2	198	0,333	0,022	0,08650	0,04362	0,50427

Figure 10- Width / Area statistics

4. Main Findings

The comparative analysis reveals that beyond the evidence of similar topological role (extrinsic properties), case studies differ in terms of plot geometry, which reflects their ability to support urban activities. In particular it was clear the appetence of CS1 for covering bigger needs of space. In fact, building density analysis (CLO and Real CLO values) shows that CS2 has fewer buildings per linear meter of total length than CS1, although this is more significant as crossing streets of CS1 do represent wider “brakes” in street fronts. Besides, plot width analysis reveals the importance of other variables than buildings’ width which contribute to total length of the street, namely its connectivity which influences through number and type (as illustrated when analyzing Plot width/overall length). MIN and MAX values do show evident similar range magnitudes although CS1 offers highest values. Although Plot Width/Plot Area analysis reveals MAX, MIN, and MEAN values on CS2, CS1 reveals more homogeneity.

This exploratory study continues trough further investigating several layout/design features in relation to both land use and extrinsic properties.

Annex 1

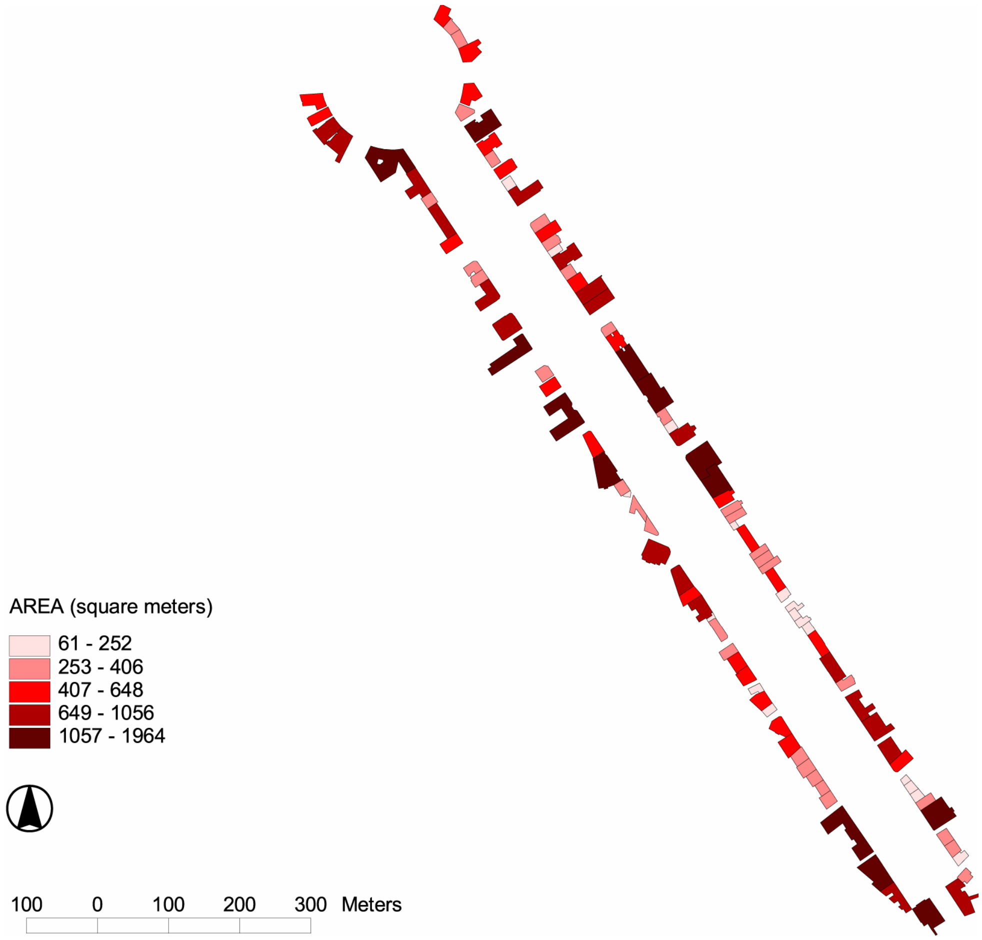

Figure 11- CS1 – Av- da Liberdade – Spatial distribution by AREA (Natural Breaks).

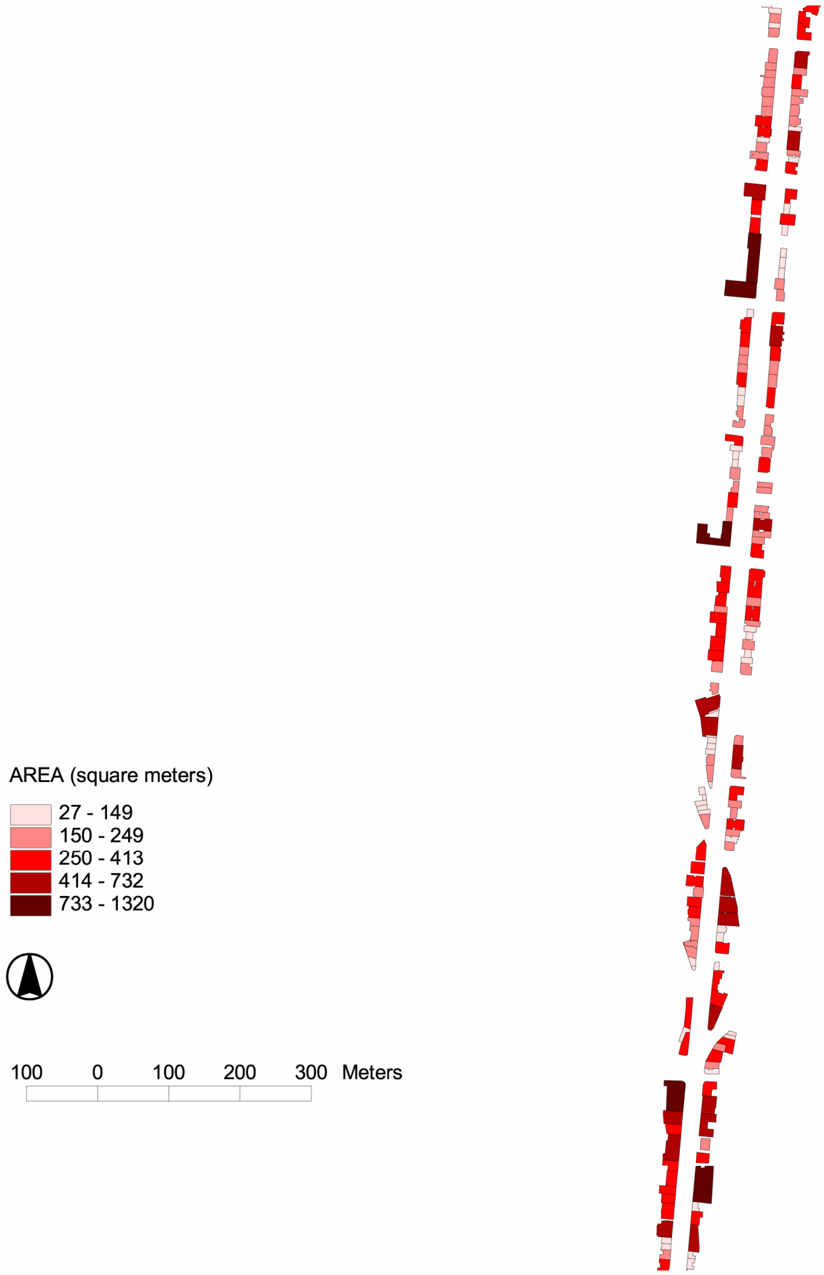

Figure 12- CS2 - Av. Almirante Reis - Spatial distribution by AREA (Natural Breaks).

Reference List

Alexander, C. (1965) A city is not a tree. **Architectural Forum**, **122**, 58-62.

Bentley, I (1999), ***Urban transformations power, people and urban design,*** London: Routledge.

Desyllas, Jake (1999). When downtown moves: Quantifying, representing and modelling the spatial variable in office rents. **Proceedings, Second International Symposium on Space Syntax** (Brazilia, 1999).

Duffy, F and Powell, K (1997), ***The new office,*** London: Conrad Octopus.

FA-UTL 2000 - Lisbon's Prime Office Rent Observatory – Head researcher: Professor João Manuel Carvalho, Economist.

Goodall, B (1972), ***The economics of urban areas***
2, (1st ed. ed.) Oxford: Pergamon Press.

Hillier, B. (1999a) Centrality as a process: accounting for attraction inequalities in deformed grids. **Urban Design International - Routledge - Taylor & Francis Group**, **4***,* 959-978.

Hillier, Bill (1999b). Space as a Paradigm. **Proceedings, Second International Space SyntaxSymposium** (Brasilia 1999).

Hillier, B., Penn, A., Hanson, J., Grajewski, T., and Xu, J. (1976) Natural movement: or, configuration and attraction in urban pedestrian movement. **Environment and Planning B: Planning and Design - Pion Ltd**, **20***,* 29-66.

Kim, H.-K. and Sohn, D. W. (2002) An analysis of the relationship between land use density of office buildings and urban street configuration. Case studies of two areas in Seoul by space syntax analysis. **Cities - Elsevier Science Ltd - Pergamon**, **19**, 406-418.

Kruger, M., Heitor, T.V. e Tostões, A. (1996) 'A Morfologia da Cidade de Lisboa: da Época Medieval ao Espaço Contemporâneo', *Técnica* **1** 1996, pp.19-35

Tannenbaum, P and Lerégle, N (1995), ***Pour une notation des immeubles,*** Paris: Economica.