

# Accessibility and security: Syntactic and perceptual analysis in two low-income housing estates

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## Abstract

This article has as its objective the investigation of how the urban spatial characteristics concerning estate accessibility, specifically influence low-income residents' perception of security of their dwellings and open spaces in a comparative study of two housing estates, located in the metropolitan region of Porto Alegre, strongly affected by security problems. It is verified in these specific urban contexts how far greater segregation and depth, and less control determine open spaces perceived by residents as more vulnerable to crime. Also examined is the occurrence of different types of crimes and in which period of the day they tend to occur. The morphology of these estates is characterised by the modernist approach of placing buildings in an open field, without a direct connection with the streets and with no clear definition of open spaces. The housing is arranged in four storey blocks of flats, sold to residents by the public sector, during the 1980s. Residents revealed their perceptions concerning the security of open spaces through 30 questionnaires applied in each estate. In a map showing the housing estate layout, included in the questionnaire, respondents indicated which areas were perceived as more insecure and where different type of crimes had already occurred. Apart from the non-parametric statistical tests performed to reveal residents' perception of crime, data is analysed by reference to global integration, local integration and control. The main results found for accessibility do not allow for a relationship to be established between the syntactic properties examined and the occurrence of crimes and perception of security by low-income residents of the housing estates investigated.

## Keywords

accessibility,  
syntactic analysis,  
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low-income,  
housing estates,  
security

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## 1. Introduction

The existence of a lack of security related to crime has been identified in urban spaces of different countries, although this problem deserves special attention in many major Brazilian cities (see, e.g., Basso, 2002). A whole set of variables has been related to the lack of urban security, including those of social-economic, political and physico-spatial nature, since Jacobs (1961). Various studies have concentrated in the analysis of the relationship between the morphological and configurational characteristics of urban space and the occurrence of criminal events (Hillier & Shu, 1999; Poyner, 1983; Oscar Newman, 1972).

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The problem of a lack of security related to crime has been worthy of particular consideration in housing estates for low-middle or low income people, in many countries, including Brazil (e.g. Basso, 2002; Reis & Lay, 1996). Oscar Newman (1972) affirms that the motivation for his studies was originated from the high crime rate, the feelings of insecurity by the residents of Pruitt-Igoe, in St. Louis, USA (demolished as a result of these problems), and of the possible relationship between the physical characteristics of the housing estate and the criminal occurrences. Hence, Newman assumed that a whole number of specific combined physical factors could diminish the problems of lack of security or even, eliminate them, originating in this way the concept of "defensible space" (Cisneros, 1995; Newman, 1972). Nonetheless, Newman has been criticised in his concept of defensible space by some authors (e.g. Hillier, 1988) for favouring as a main aspect favouring crime, according to them, of more segregated spaces, with lower levels of accessibility.

Accessibility, which means access to a certain space and has implication for potential movement, presence of people, and use of spaces, is one of the configurational characteristics which has been identified as directly related to the occurrence of crimes, mainly by studies involving syntactic analysis (Hillier & Shu, 1999; Shu, 1999). The degree of accessibility and consequently potential of movement and presence of people in the urban space would affect the choice of path to be followed by pedestrians, since people would be attracted by spaces with people and would tend to avoid deserted spaces (Gehl, 1987).

Jane Jacobs (1961) mentions the circulation of people and appropriation of public space as a crucial element to the urban vitality and that the number of encounters diminishes the possibility of crimes, the constant presence of users being important in urban spaces. Among the aspects mentioned by Voordt & Wegen (1983) in the "Delft Checklist" to be adopted in analysis of spatial vulnerability and in design recommendations to increase urban security, is the existence of co-presence, movement and presence of people. The accessibility to specific areas may increase in difficulty, becoming selective and affecting the practice of formal control, as a consequence of restrictions imposed on some types of transport, such as bicycles, motorbikes and cars, due to physical barriers, for example, steps and walls/fences, built randomly, without considering the unrestricted access to the space. This may be verified in housing estates for those less well-off, where buildings are built, by the individual initiative of some residents, in areas planned as being of collective use, making more difficult the visibility and the movement, discouraging the presence of people and, consequently, generating conditions for the occurrence of crimes (Voordt & Wegen, 1990).

Results from previous studies suggest a number of assumptions, such as: a constant pattern of movement, characterising spaces with the presence of people, which would increase the security of users of urban spaces (Hillier, 1988); spaces with greater potential of movement would imply spaces less frequented by criminals and, hence, would be more secure spaces (Hillier & Shu, 1999; Voordt & Wegen, 1983); places where the lines of vision are interrupted would have less potential for movement and would tend to favour the occurrence of crime. Hillier (1988) argues that, independently of density of a certain area, if the configuration makes the natural movement of pedestrians more difficult, there will not be a sufficient number of people to generate the perception of a well appropriated and used space. In a study carried out in Barnsbury, London, Hillier (1988) found that the more integrated spaces presented a small number of robberies, while more segregated spaces presented a greater number of robberies. Hence, various studies involving the analysis of the levels of accessibility of urban spaces indicate that places with greater integration levels and, consequently greater potential of movement of pedestrian and vehicles, tend to present a smaller number of criminal occurrences than places with greater levels of segregation and, consequently, smaller potential of movement of pedestrians and vehicles (Hillier & Shu, 1999; Shu, 1999; Jones & Fanek, 1997).

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However, in a recent study (Basso, 2002) carried out in four housing estates in the metropolitan region of Porto Alegre, relationships between levels of integration and occurrence of crimes were not found. In Cavahada housing estate, there were more crimes in the most integrated lines and fewer crimes in the most segregated lines. In Loureiro da Silva, there were more crimes in the most integrated lines, and there was no occurrence of crime in the 3 less integrated lines, although in this estate, 2 of the most integrated lines are spaces only for pedestrians. In these two housing estates and in Costa e Silva the most integrated lines were those where the greater number of crimes were reported. These results appear to give some support for the argument that a relationship exist between the facility for an offender to escape and high levels of integration, or high accessibility, which generates greater facility for entrance and escape of a certain place, making easy for a criminal to escape because of the many existing escape routes. Therefore, there appears to exist, a need for new investigations that help to clarify the relationship between accessibility and the occurrence of crimes.

Apart from this need, studies which are characterised by methodological approaches which involve the analysis of existing relationships between the configurational characteristics of accessibility, the occurrence of crimes and the perception of security by users of urban spaces, have not been conducted, with some exceptions (e.g. Basso, 2002). Hence, the objective of this article is to investigate

how the spatial urban characteristics of accessibility are related to the occurrence of crimes and influence the perception of security, specifically of residents of low or low-middle housing estates.

## **2. Methodology**

A comparative study was carried out between two housing estates with large dimensions and a large number of residents, consisting of four storey blocks of flats, located in the metropolitan region of Porto Alegre, strongly affected by security problems. The Guajuviras estate, in Canoas, started its occupation 1987 through a process of invasion or illegal occupation of its units, the selected sample area is constituted by 576 flats in 39 blocks in an area of 50655.2 m<sup>2</sup>, some 5 hectares. The Sapucaia estate, in Sapucaia do Sul, was occupied from April 1981, with the selected sample area comprising 1152 flats in 36 blocks in an area of 63655.2 m<sup>2</sup>, some 6.3 hectares.

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Initially, information about these estates was provided by the Research Project financed by the Caixa Econômica Federal, including the layout of the housing estates in CAD, photos and description of its physical characteristics. Later on, a field work was carried out in the selected sample areas, where data were collected by means of physical measurements and questionnaires with closed questions related to security, applied to a sample of 60 flats, 30 in each housing estate. Areas known as places of occurrence of different types of crimes and areas perceived as being insecure were indicated on plans of the layout of the two estates, by the respondents of the questionnaires.

The data obtained through the questionnaires, related to the occurrence of crimes and perception of security by the respondents, were analysed quantitatively by means of non-parametric statistical tests. The analysis of the levels of accessibility in the estates was made by the identification of syntactic characteristics of their configurations, namely, global integration, local integration and control, using Axman 4 (Hillier & Hanson, 1984). In the analysis of results related to the syntactic characteristics of the urban grid of the Guajuviras and Sapucaia estates, the following parameters were considered: values of Relative Asymmetry (RA) tending to zero, indicate an urban grid near to the theoretically most integrated (RA=0), favouring the movement of visitors; values of Relative Real Asymmetry (RRA), which allow for a proper comparison between systems of different sizes, oscillate below or above 1, with values from 0.4 to 0.6 representing highly integrated systems, while those which tend to or are superior to 1 reflect grids with segregated areas; values concerning the degree of control, smaller than 1 indicate spaces with little control while values greater than 1 indicate spaces highly locally controlled, since the degree of control

represents a local parameter, referring only to the relationship of a restricted area with its nearest neighbours. The monochromatic axial maps represent the distribution of different integration levels of the axial lines, with integration values varying from the black (most integrated lines), to the light grey (representing the most segregated lines).

### 3. Results and discussion

#### 3.1 Syntactic properties

The medium depth in Guajuviras is equal to 3.84 (Table 1), indicating a grid with much less depth and much less segregated than that of Sapucaia, with a medium depth of 7.31 (Table 1), indicating an extremely segregated morphological configuration, with relatively few choices for access which determines the movement through a number of specific intermediate spaces in order to reach the intended space.

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<p><b>Guajuviras estate</b></p> $md = \frac{\sum d}{k} = \frac{196}{51} = 3,84 \quad (1)$ $RA = \frac{2(md-1)}{k-2} = \frac{2(3,84-1)}{51-2} = \frac{5,84}{49} = 0,116 \quad (2)$ $RRA = \frac{RA}{Dk} = \frac{0,116}{0,132} = 0,87 \quad (3)$	<p><b>Sapucaia estate</b></p> $md = \frac{\sum d}{k} = \frac{234}{32} = 7,31 \quad (1)$ $RA = \frac{2(md-1)}{k-2} = \frac{2(7,31-1)}{32-2} = \frac{12,62}{30} = 0,42 \quad (2)$ $RRA = \frac{RA}{Dk} = \frac{0,42}{0,174} = 2,41 \quad (3)$
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**note:** md = medium depth; (d = total depth; k=n] of lines; RA = relative asymmetry; RRA = real relative asymmetry; Dk = coefficient related to the n] of lines

**Table 1: Values of medium depth, Relative Asymmetry and Real Relative Asymmetry**

Comparing the values of Relative Asymmetry (RA=0.116) and Real Relative Asymmetry (RRA=0.87) in Guajuviras and in Sapucaia (RA=0.42 and RRA=2.41), it can be seen that the far higher values in Sapucaia reflect the high level of segregation of its configuration, which tend to reinforce the movement and control by the resident in detriment of the movement and control by the visitor (Table 1).

Guajuviras estate					Sapucaia estate				
n° of lines	global integration	control	local integration	depth	n° of lines	global integration	control	local integration	depth
2	1,658	1,26	2,719	4	1	0,932	2,5	2,299	4
4	1,579	0,817	2,482	4	3	0,718	0,75	1,274	3
5	1,219	2,25	2,598	4	4	0,575	1,5	1	2
14	1,579	1,311	2,661	3	5	0,474	0,5	0,211	1
15	1,675	0,603	2,566	2	6	0,718	0,75	1,274	5
16	1,843	1,611	3,022	3	7	0,575	1,5	1	6
17	1,579	1,458	2,482	2	8	0,474	0,5	0,211	7
19	1,43	1,15	2,689	3	10	1,287	2,2	2,601	7
20	1,61	0,942	2,719	2	11	0,911	0,7	1,379	8
24	1,468	1,033	2,354	4	17	0,911	0,7	1,379	8
27	1,113	1,367	2,273	3	18	0,693	1,5	1	9
28	1,306	1,567	2,601	3	19	0,552	0,5	0,211	10
29	1,219	1,367	2,238	3	21	0,911	0,7	1,379	8
48	1,906	2,093	3,72	3	22	0,693	1,5	1	9
50	1,928	1,95	3,454	2	23	0,552	0,5	0,211	10
51	1,71	1,492	2,979	1	32	0,693	0,25	0,704	5

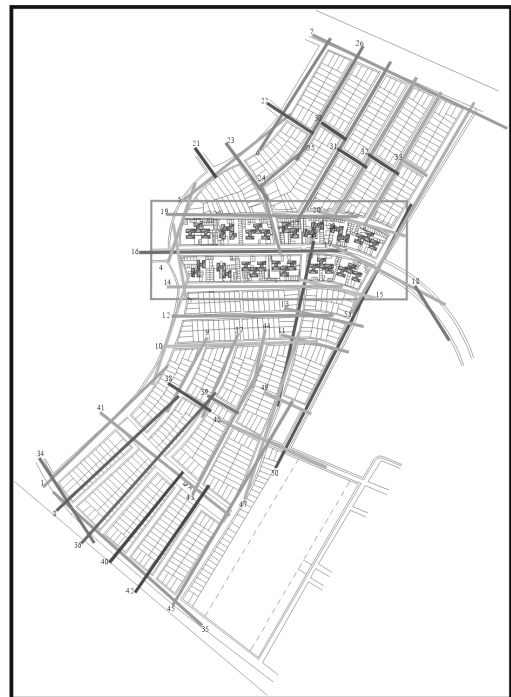
**note:** higher values indicate greater global integration, control, local integration and depth

**Table 2: Values of axial lines in the selected sample areas of Guajuviras and Sapucaia estates**

There is no balanced distribution of accessibility in the grid of Guajuviras, existing the punctual distribution of more integrated nucleus and others more segregated (Figure 1), where 1.928 is the maximum value of global integration (line 50, Table 2) and 0.873 is the minimum value (line 30; it is not in Table 2 since it is not inside the selected sample area of the estate).

Hence, it is possible to define three distinct areas in Guajuviras, based on the values of global integration: two located at the edges of the grid, to the right and to the left, and characterised by segregated spaces, where the local spatial organisation predominates, reinforcing the movement and control by the residents; and the other situated in the centre of estate, where three axes establish the most integrated areas of the urban pattern of Guajuviras, giving priority, in this way, to the global organisation of space, and to the movement and control by the visitors (Figure 1).

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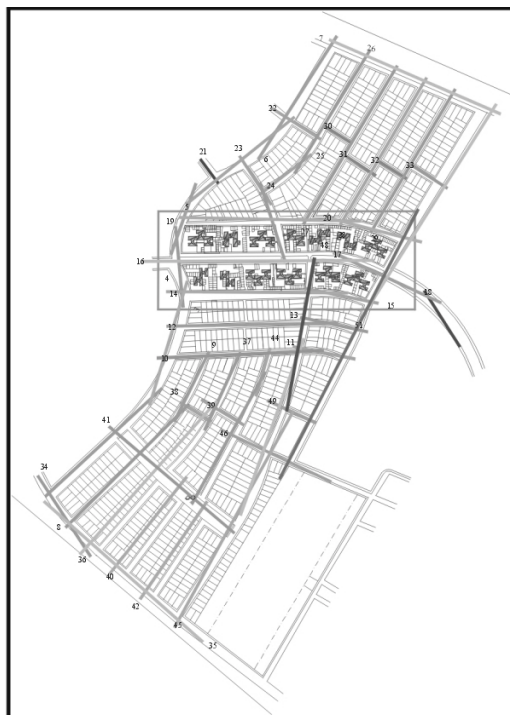
**Figure 1: Axial map of global integration of Guajuviras estate**  
(note: rectangle = selected sample area)

In the analysis of the axial map of global integration of Sapucaia (Figure 2), there is only one integration nucleus in the system, with all the other spaces tending to segregation, as they extend away from this axis, as a consequence of the proposed "cul-de-sac" layout, which accentuates the asymmetry. Hence, the main access route to the Sapucaia estate, as its surroundings, reinforces the movement and control by the visitor, with such control being transferred to the resident as one penetrates into the interior of the estate. The maximum value of global integration is 1.42 (it does not appear in Table 2 since it is inside the selected sample area) while the minimum is 0.47 (line 5 and 8, Table 2), both far inferior to those in Guajuviras (Table 2), reflecting the greater global segregation of the configuration in Sapucaia when compared to Guajuviras.



**Figure 2: Axial map of global integration in Sapucaia estate**

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**Figure 3. Axial map of local integration in Guajuviras estate (note: rectangle = selected sample area)**

Analysing the axial map of local integration of Guajuviras, considering the limit of three steps of depth, it is observed that there is a relative equilibrium in the distribution of integration levels and consequently accessibility, predominantly highlighting two axes, lines 48 and 50, as the most integrated in the system (Figure 3).

The values of local integration in Sapucaia (Figure 4, Table 2), show a maximum local integration value in Sapucaia of 2.601 (line 10) and a minimum value of 0.211 (lines 5,8,13,16,19,23,27 and 30), far inferior to those in Guajuviras (maximum = 3.72, line 48; minimum = 0.704, line 18), therefore, reflecting a far more local segregated configuration in Sapucaia than in Guajuviras.

**Figure 4: Axial map of local integration in Sapucaia estate**



Considering all the 51 lines which constitute the total grid of the estate, the maximum value found in Guajuviras was 2.25 (line 5, Table 2), and the minimum value of 0.20 (line 21, not presented in Table 2, since it is not inside the selected sample area), that is, there are areas which allow the dominant control by the resident, in relation to the activities developed in the open spaces and others which, as a consequence of the proposed morphology, discourage and make more difficult this type of surveillance.

The analysis of the degree of control in Sapucaia, considering all the 32 lines which constitute the grid of the estate, confirm the tendency to segregation of the spaces in the estates, as a function of 'no exit' streets, with a central axis connecting the two analysed areas, constituted by a highly controlled line, with the degrees of control tending to diminish as spaces are located further away from this axis. The most segregated value found was 3.03 (line 9, not presented in Table 2 since it is not inside the selected sample area), while the most integrated line was 0.20 (lines 20 and 31, not presented in Table 2). Examining only the degrees of control of those lines which are part of the selected sample areas, the highest value in Guajuviras is 2.25 (line 5) and the lowest value is 0.603 (line 15). In Sapucaia, the highest control value is 2.5 (line 1) and the lowest value is 0.25 (line 32). Hence, the examinations of the degrees of control, considered all the axial lines or only those which are part of the selected sample area, reveal that, in general, there are areas far less controlled in Sapucaia than in Guajuviras.

The analysis carried out allows for the conclusion that the Guajuviras and Sapucaia estates have very dissimilar syntactic properties and accessibility characteristics, with the latter presenting a far more segregated and deeper configuration, making more difficult the movement and control by the visitor. Therefore, these results suggest that the problems related to lack of security in the estate should be greater in Sapucaia than in Guajuviras, accordingly to the results revealed by some previous studies (Hillier et Shu, 1999; Shu, 1999).



### 3.2. Perception of security and occurrence of crimes

Comparing the information obtained by the analysis of syntactic properties with the indication by residents of the places where crime has already occurred and of the places considered as the most insecure in Guajuviras estate, it is verified that the street identified as the most vulnerable to crime in the selected sample area, is Avenue 22, constituted, fundamentally, by an integrated axial line (value between 1.66 and 2.5, Hillier & Hanson, 1984) which is the third most integrated of the system (line 16, value of integration = 1.843, Table 2). Moreover, this line has a high local integration, being constituted by one strongly integrated axial line (value above 2.5, Hillier & Hanson, 1984) which is the fifth most integrated in all the estate and the third in the selected sample area (value of integration = 3.022, Table 2), having a high control, seventh greatest in the system and third in the selected area of study (control = 1.611, Table 2), as a shallow depth (depth = three steps, Table 2). Therefore, the area perceived as being the most insecure by residents of Guajuviras, present syntactic properties which should display a high level of movement and co-presence of visitors.

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Observing the axial map of global integration in Guajuviras (Figure 1), it is also verified that street A, which corresponds to the second most integrated axial line in the estate and the first in the selected sample area (Table 2), presents indications of crime vulnerability in almost all the street length analysed. Hence, it is possible to say that in the selected sample area of Guajuviras estate there is no correspondence between the places indicated as insecure and its syntactic parameters of segregation. These results can not be generalised for all the estate of Guajuviras, since the analysis of the relationship between the areas considered insecure or where crimes had occurred and the syntactic attributes was restricted to the selected sample area of the estate. However, it can be verified that the criminal occurrences and the feeling of insecurity of residents may be related to a greater movement of visitors or strangers within the estate, which could not be properly controlled by the residents due to their large number and the restrictive co-presence of residents in the streets, affecting the vigilance of the activities developed in the open spaces.

Analysing the syntactic attributes in the Sapucaia estate and the areas indicated as insecure, one perceives that, in general, the areas coincide with the segregated spaces, where the movement and control by the residents predominates in detriment to the visitors, with a smaller amount of co-presence between resident-visitor and visitor-visitor.

Street 2, considered insecure in all its length, is constituted by two segregated lines (values between 0 and 1, Hillier & Hanson, 1984) global and locally, namely, line 7 (global integration = 0.575; local integration = 1) and 8 (the most segregated

of the grid in Sapucaia, with global integration = 0.474; local integration = 0.211), corresponding to a depth of six and seven steps, respectively (Table 2). Deep spaces tend to asymmetry and to segregation, as well as to a greater control of the open spaces by the residents than by the visitors. However, measures of control reveal spaces highly locally controlled in line 7 (1.5) and spaces poorly locally controlled in line 8 (0.5) (Table 2).

The BR section, also indicated as vulnerable to crime, is represented by line 31, globally (0.932) and locally segregated (0.873). It presents the least controlled space of all the system (degree of control = 0.20) and the depth of seven steps. Therefore, while in Sapucaia there is a perception, by most respondents, of areas more segregated as more insecure, the same does not happen in Guajuviras.

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Considering the perception of security by residents in the two estates, while 39% of respondents in Guajuviras consider the access to the dwelling from the nearest public street, as bad or very bad concerning the occurrence of crimes, 13% have the same opinion in Sapucaia. Moreover, while 70% of respondents in Guajuviras consider the open spaces bad or very bad concerning security against crime, 23% express this opinion in Sapucaia. In addition, while 87% of respondents in Guajuviras consider the neighbourhood as bad or very bad in relation to security against crime, 20% have the same opinion in Sapucaia. Also, while 33.3% of respondents in Guajuviras have already witnessed some type of crime in the estate, 13.3% had the same experience in Sapucaia. Hence, it is evident that residents in Guajuviras are far more dissatisfied with the level of security existing in the estate and nearby places than the residents of Sapucaia, and that the occurrence of crime is really greater in Guajuviras than in Sapucaia.

The fact that there is a greater occurrence of crimes in Guajuviras than in Sapucaia is reflected, respectively, in the percentages related to the type of crime of which the respondent was a victim. (Assault in open spaces - 7% and 3%; robbery to the dwelling - 7% e 3%; physical aggression - 3% e 3%; and assault to a vehicle ñ 3% e 0%). To the type of crime witnessed by the respondent (assault in open spaces - 20% e 3%; robbery to the dwelling - 7% e 0%; physical aggression - 7% e 3%; and assault to a vehicle ñ 7% e 7%). To the type of crime that a relative or a friend was a victim (assault in open spaces - 33% e 7%; robbery to the dwelling - 7% e 0%; physical aggression - 7% e 0%; and assault to a vehicle ñ 3% e 3%). Although in both estates the majority of crimes happened during the night, the percentages of crimes in which the respondent was a victim, of crimes witnessed by the respondent or the percentage of crimes in which a relative or friend was a victim, are clearly higher in Guajuviras than in Sapucaia, in any of the three periods of the day.

Additionally, it was found in Guajuviras, but not in Sapucaia, that a relationship between the non utilisation by the respondent of the open spaces in the estate during the night and the mention of lack of security to crime ( $\Phi = -0.437$ , sig. = 0.017), with 43.3%, of the 80% of respondents who do not use these spaces in Guajuviras during the night, pointed to a lack of security against crime as the main reason, while only 6.7%, of the 76.7 % who do not use the open spaces in Sapucaia during the night have the same opinion. Therefore, Guajuviras is also considered by its residents as more insecure during the night than Sapucaia. There was a relationship between the non-utilisation of open spaces of the estate during the day by the children, as well as by the adults, and the mention of lack of security against crime. Hence, the high segregation of the grid in Sapucaia does not appear to have affected, at least to a greater level than in Guajuviras, the use of open spaces, as a function of a possible greater lack of security than in Guajuviras.

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It follows that, although the examination of the syntactic characteristics of the two estates may indicate that the problems related to lack of security would be greater in Sapucaia than in Guajuviras, the contrary appears to be true, suggesting that other aspects, not revealed in the analysis of the accessibility, are affecting the security of the two housing estates.

#### **4. Conclusions**

The analysis of syntactic characteristics of accessibility revealed that the Sapucaia estate presented a far more segregated grid than the Guajuviras estate. Hence, it might be expected, according to the results of previous studies involving syntactic analysis, that Sapucaia would be more unsatisfactory for its residents, concerning security against crime, than the Guajuviras housing estate.

However, the results concerning the occurrence of crime and perception of security by the residents, including a range of aspects such as perception of security by the residents related to the access to the dwelling from the nearest public street, to the open spaces of the housing estate, and to the neighbourhood, revealed that residents in Guajuviras are far more dissatisfied with the level of security existing in the estate and nearby places than the residents of Sapucaia, and that the occurrence of crime is really greater in Guajuviras than in Sapucaia. The more detailed examination of the relationship between levels of integration, control and depth of the axial lines, and the perception by the residents of insecure places and of places where crime had already occurred in each of the housing estates, indicates that although there might exist a relationship between greater spatial segregation, greater occurrence of crimes and greater perception of vulnerability to crime by residents in relation to the open spaces of Sapucaia, the same cannot be said in relation to the Guajuviras estate.

Therefore, the correspondence, revealed by other studies, between the syntactic properties of greater segregation, greater depth, and less control, and a greater vulnerability to crime, since spaces with less social vigilance due to the restrict co-presence of people in the streets who might perceive, recognise and intercept the offenders, has not been confirmed in this investigation.

Concluding, the results found in the investigation carried out in Guajuviras and Sapucaia housing estates do not allow for relationships to be established between the urban spatial characteristics related to accessibility and the occurrence of crimes and perception of security by residents of social housing.

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#### Notes

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