CONFIGURATION, LAND USE, PERCEPTION, AND SECURITY:
an analysis of residential burglary

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KEYWORDS: *Configuration, Land Use, Perception, Security, Residential Burglary*

THEME: Urban Space and Social Phenomena

ABSTRACT

This paper examines the relationship between configuration, land use, perception and the occurrence of crime, focusing on residential burglary. Crime has been related not only to socio-economic or political variables but also to physical or spatial variables in distinct urban environments. Some studies have shown that urban configuration tends to play a role in facilitating or inhibiting the occurrence of crime in distinct urban settings. However, it is necessary to better understand its effect on residential burglary, including residents' perception of security, specifically, in the context of residential boroughs in a Brazilian city, and considering a high resolution analysis on the level of a street segment. Hence, there is a need to consider the relationship between aspects related to urban configuration and cognitive aspects related to perception of security. Specifically, the following aspects are considered: axial lines integration levels; segments connectivity values; segments length; land use (residential and non residential); dwelling type (house or flat); street lighting; visual and physical connections between residences and the public open space; perception of residence being safe; existence of security guards in nearby blocks; existence of elements of protection at the residence; visibility of front door from neighbouring doors and windows; perception of street lighting during the night in the residence area. Data gathering means included physical measurements and questionnaires applied to 123 residents in Menino Deus and to 86 in Rio Branco, two typical middle-income residential boroughs in Porto Alegre. Residential burglary data was also collected in the Department of Public Security of State of Rio Grande do Sul, for a period of ten months. Land use and types of housing units were obtained through the Municipal Department of Planning. Data was registered in ArcGIS, allowing the generation of a map with the spatial distribution of residential burglary, as well as in the SPSS/PC software, where data was statistically analyzed. A map of street segments was generated in the Depthmap software from the axial map representing the street network of the two boroughs. Results show, for example, that residential burglary and perception of security tends to be somewhat affected by urban configuration and land uses. Results may add to the understanding about how urban design can contribute in reducing residential burglary.

INTRODUCTION

Crime in urban areas has been related not only to socio-economic or political variables but also to physical or spatial variables in distinct urban environments. The importance of physical and spatial characteristics of urban areas in facilitating or making the occurrence of crime more difficult has already been pointed out by Jane Jacobs (1961) in early sixties. Although she did not carry out systematic or academic research, she made observations of urban spaces and wrote that streets with higher movement of people, such as through streets, and with more visual surveillance from people in adjacent buildings, that is the eyes of the buildings to the streets, would be safer streets, where crime occurrence would be less frequent due to reduction in opportunities for criminal events. This "natural surveillance" is supported by Hiller (1988), that, based on research, argues in favour of more accessible streets, since more movement of people, strangers or not, is beneficial in reducing crime opportunities, and in favour of inter-visibility between buildings and between buildings and adjacent public open spaces, allowing people in the buildings to look at people in open spaces.

Other studies have also shown that urban configuration tends to play a role in facilitating or inhibiting the occurrence of crime in distinct urban settings (i.e. Shu, 2009; Hillier & Sahbaz, 2005). For example, Shu (2009) found that burglary distribution patterns were affected by road types, degrees of road accessibility, and dwellings' front door to front door inter-visibility, with the latest having the strongest effect. Segregated roads, with low accessibility of passers-by and vehicles, were more vulnerable than integrated ones that allow higher accessibility. These segregated streets were found to be particularly vulnerable when characterized by low inter-visibility. On the other hand, streets with higher accessibility and good dwellings' front door to front door inter-visibility tended to be very safe from crime (Shu, 2009). Differences in the street layout configuration between the cities investigated (such as the existence of cul-de-sacs, through roads, through alleys and back alleys), did not overcome the importance of degrees of road accessibility and the front door to front door inter-visibility to protect residential areas from burglary (Shu, 2009). Therefore, Shu (2009; p.102:1) research confirms that "more strangers or passers-by in highly accessible streets with strong inter-visibility can be beneficial as crime prevention strategies due to the mechanisms of informal (natural) surveillance generated naturally in these areas."

Although others also argue that the incidence of residential burglary has been related to the layout of an urban area, there are some controversial arguments. For example, Poyner and Webb (1991), supporting defensible space approach by Oscar Newman (1972), identified cul-de-sac layouts as the most appropriate to reduce opportunities for the occurrence of residential burglary. The cul-de-sac layouts are characterized by restricting access and movement of people. This is supported, for example, by Clarke (1997), who argues that the defensible space approach is fundamental to make urban areas less vulnerable, in particular, to residential burglary type of crime. The importance of investigating residential burglary has already been acknowledged, being a type of crime with one of the highest incidence in urban areas (i.e., Shu, 2009).

Therefore, although, the relationship between urban spatial configuration and the occurrence of crime have been investigated, further research is needed in order to better understand the impact of these variables on crime. The controversies involving the impact of different types of layout on crime, specifically, on residential burglary, exemplifies that there is still a long way to go before a more clear picture of the impact of configurational and morphological variables on crime can be seen. Moreover, there is still the issue of different social contexts affecting the relationships between residential burglary and some of these variables. Although, in his study, Shu (2009) did not find that socio-cultural differences acted as explanatory variables for residential burglary, further investigations may be needed.

Moreover, although research on crime prevention of burglaries have focused on target hardening, such as secured alarms, and other elements of protection against burglary and theft in residences, it is still necessary, mainly in the Brazilian urban context, to investigate the impact of elements of protection on residential burglary. In addition, since perception of an urban area been unsafe affects people attitudes and behaviour and, so, the use of such area, it is still opportune to identify residents' perception of security and related aspects, specifically, in the context of residential boroughs in a Brazilian city, and considering a high resolution analysis on the level of a street segment. Hence, there is a need to consider the relationship between aspects related to urban configuration and cognitive aspects related to perception of security.

Therefore, this paper examines the relationship between configuration, land use, perception and the occurrence of crime, focusing on residential burglary. Specifically, the following aspects are considered: axial lines integration levels; segments connectivity values; segments length; land use (residential and non residential); dwelling type (house or flat); street lighting; visual and physical connections between residences and the public open space; perception of residence being safe; existence of security guards in nearby blocks; existence of elements of protection at the residence; visibility of front door from neighbouring doors and windows; perception of street lighting during the night in the residence area.

METHODOLY

Data gathering means included physical measurements and 209 questionnaires applied to 123 residents in Menino Deus and to 86 in Rio Branco, two typical middle-income residential boroughs in Porto Alegre. Specific questions identified, for example, if respondent's residence has been burglarized or not ("Your house, flat or building has been robbed?") and residents' satisfaction levels regarding home security ("Regarding security to residential burglary, do you think your house, flat or block is:"). Residential burglary data was also collected in the Department of Public Security of State of Rio Grande do Sul (DPS), for a period of ten months. Residential burglary, in this paper, includes not only burglary but also theft in residences, since it is understood that both types of crime, regarding their relationship to physical and spatial attributes (both would tend to benefit from movement of people and visual surveillance), are similar. Land use (residential or non residential - i.e. offices, shops, bar/restaurants, and services, without regard to their periods of operation) and types of housing units (house or flat), were obtained from the Planning Department of the City of Porto Alegre.

The unit of analysis is the segment of a street between junctions. A map of street segments was generated in the Depthmap software from the axial map representing the street network of the two boroughs. Segments and axial lines information such as segment connectivity and length, and axial lines global integration values, were transferred to SPSS/PC, for further statistical analysis. Residential burglary was considered by dividing the total number of burglaries in the residences by the total number of residences in the segment (rate of residential burglary = RRB), since each segment should have its specific rate of burglaries in homes in order to allow for comparisons with physical variables in the segment. Therefore, it would not be appropriate to consider the rate of residential burglary by dividing the total number of burglaries in the segment by its length since the longer the segment the lower the number of residential burglaries it would appear to have. Moreover, it was not used, for example, Shu (2009) approaches to residential burglary rate, based on the number of POAs (points of access to buildings from the public open spaces) offended (number of burglaries) against total number of POAs per type of line and not per line,

because in this research it was important to have a residential burglary rate for each segment in order to be able to correlate with its formal and configurational attributes.

Residential burglary was also measured considering the 'true rate for the risk bands' (Hillier & Sahbaz, 2005), that is, the total number of burglaries over the total number of points of access from the public open spaces to residential units for each band, each being made up by segments having a common number of points of access to residential units. This measured was used to compare the rate of residential burglary for segments with different number of points of access to residential units. Burglarized residences in both boroughs (either residences of respondents of questionnaires as well as those informed by DPS) were registered in ArcGIS, allowing the generation of a map with the spatial distribution of residential burglary, as well as in the SPSS/PC software, where data was statistically analyzed.

RESULTS

Menino Deus and Rio Branco boroughs tend to be characterized by fenced or walled houses or blocks of flats in less crowded streets, and by non residential buildings (i.e. offices, commerce and services) or mixed-use buildings in busiest streets, such as Protásio Alves Avenue in Rio Branco and Ipiranga, Getulio Vargas and José de Alencar Avenues in Menino Deus. These streets tend to concentrate much of the tallest buildings and those with non-residential uses, thus presenting some movement at night due to the presence of bars, restaurants and supermarkets, as well as the Mãe de Deus Hospital in José de Alencar Avenue (Figures 1 and 3). Both neighbourhoods mostly have up to two storey buildings and the taller the buildings the smaller the quantity; there is also a greater number of residential than non-residential buildings.

Residential Burglary in Menino Deus and Rio Branco Boroughs

According to data from the Department of Public Security of the State of Rio Grande do Sul, for a period of 10 month, 52 homes in Menino Deus and 44 in Rio Branco were burglarized. Moreover, 42 (34,1%) of respondents in Menino Deus and 23 (26,7%) in Rio Branco mentioned that their house, flat or block had already been burglarized (Figures 2 and 4). However, this difference is not statistically significant. As the two boroughs are characterized by houses (up to two storey buildings, with residential or non-residential use) and blocks (buildings with tree or more floors, with residential or non-residential use), each house and each block with residential use was considered as one residence. For the purpose of residential burglary it is understood that what matters is the access to the residential building, and not to each flat, since how the burglar access the residence from the public open space is what is crucial. This approach is coincident with that used by Shu (2009, p.102:5) where "...burglaries in flats were counted as ground floor access points because that it is the point the burglars use to enter the building as a whole. No differences between burglaries on different floors of the building are considered in this research."

Figure 1 Height of buildings in Menino Deus
Note: The legend indicates the number of floors in each building
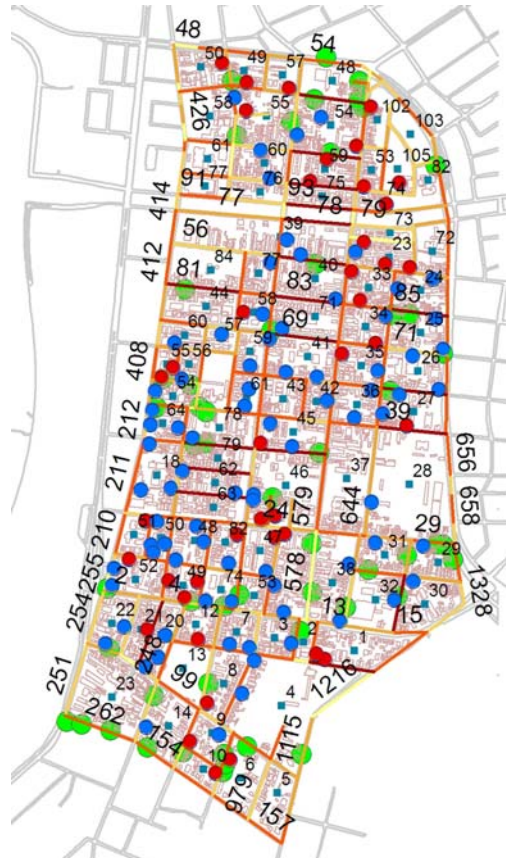

Figure 2 Segments map – Menino Deus
Note: red dots = 42 respondents burglarized residences; blue dots = respondents non burglarized residences; green dots = 52 burglarized residences (DPS)

Perception of Residence Being Safe and the Two Boroughs

Although most residents in Menino Deus and in Rio Branco perceive their residences as safe, there is a statistically significant relationship (Phi value= 0,223; sig= 0,015) between the two boroughs and the perception of residence being safe. The number of those in Rio Branco that perceive their residences as secure (75,6% - 65) is greater than those in Menino Deus (69,9% - 86) and the number of those in RB that perceive their residences as insecure (1,2% - 1) is smaller than in MD (8,1% -10). A correlation was found between perception of residence being safe and perception of block being safe during the day (Pearson, coef.= 0.350; sig= 0.000; 209 respondents) and perception of block being safe during the night (Pearson, coef.= 0.218; sig= 0.002; 209 respondents). Moreover, perception of residence being safe was negatively correlated with period of time the resident lives in such residence (Pearson, coef.= - 0.248; sig= 0.000; 209 respondents) and positively correlated with household income (Pearson, coef.= 0.235; sig= 0.001; 209 respondents). These means that the longer a respondent lives in a residence the less safe he/she feels and the lower the income the less safe he/she feels. On the other hand, considering only the segments where the respondents of the 209 questionnaires live, no correlation was found, either considering the total sample or each of the two boroughs, between perception of block being safe during the day and: axial lines integration values; segments connectivity; segments length, and visibility of front door from neighbouring doors and windows.
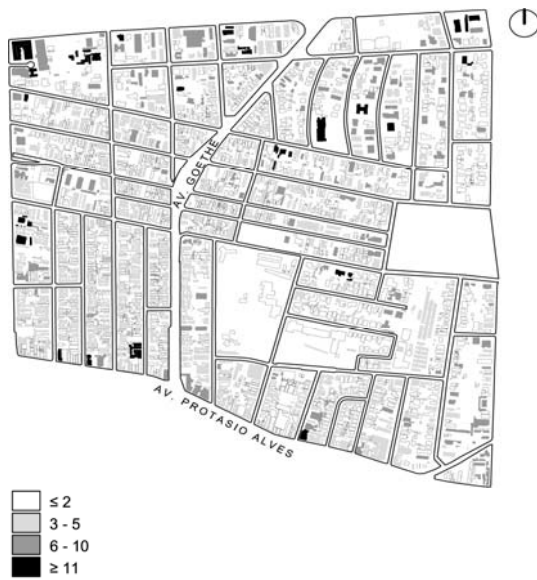
Figure 3 Height of buildings in Rio Branco
Note: The legend indicates the number of floors in each building

Figure 4 Segments map - Rio Branco
Note: red dots = 23 respondents burglarized residences; blue dots = respondents non burglarized residences; green dots = 44 burglarized residences (DPS)

Residential burglary and axial lines global integration (Rn)

No correlation was found between residential burglary (rate of residential burglary = RRB) and axial lines global integration (84 lines in Menino Deus and 64 in Rio Branco), either considering the total sample or each of the two boroughs. Additionally, considering the 10% of the segments with the highest and 10 % of the segments with the lowest rate of residential burglary in each of the two boroughs (Tables 1 and 2), no correlation was found between residential burglary and axial lines global and local integration values, either for the total sample (48 segments) or, specifically, for Menino Deus (28 segments) or Rio Branco (20 segments) boroughs. On the other hand, perception of residence being safe was correlated (Pearson, coef.= 0.162; sig= 0.019; total sample – 209 respondents) with axial lines global integration (Rn) but not with axial lines local integration (R3). Household income was also correlated (Pearson, coef.= 0.187; sig= 0.007; total sample) with axial lines global integration (Rn). These correlations mean that the higher the global integration values of the streets where respondents live the safer they feel their residences are and the higher the household income.

Residential burglary and segments connectivity values.

Although no correlation was found between residential burglary (RRB) and segments (265 segments in MD and 192 in RB) connectivity values in Rio Branco borough, the same did not happen in Menino Deus borough (Pearson coef.= - 0.160; sig= 0.009) and in the total sample (Pearson coef.= - 0.120; sig= 0.010), indicating that the higher the connectivity values the lower the residential burglary. This correlation indicates that the higher the number of connection of a segment to others segments, the lower the number of burglarized residences. Moreover, considering the 20% of the segments with the highest and lowest rate of residential burglary (Tables 1 and 2), a negative correlation (Pearson coef.= - 0.404; sig= 0.033) was found between residential burglary (RRB) and segments connectivity values for Menino Deus. On the other hand, considering only the segments where the residences of the 209 respondents of the questionnaires are

located, no statistically significant relationship was found between the residence of the respondent being burglarized or not and segments connectivity, either in Menino Deus or in Rio Branco. Moreover, no correlation was found, either considering the total sample or each of the two boroughs, between perception of residence being safe and segments connectivity.

Residential burglary and segments lenght.

No correlation was found between residential burglary (RRB) and segments length, either considering the total sample or each of the two boroughs, indicating that the length of a segment, by itself, did not affect the occurrence of residential burglary. This was replicated when considering only the 20% of the segments with the highest and lowest rate of residential burglary (Tables 1 and 2).

Table 1 Segments with the highest and lowest rate of residential burglary in Menino Deus

n° seg.	n° of res.	RBR	TRRB	Rn	segment connectivity	segment lenght	land use	street light	visual connection	physical connection
10% of segmentos with the highest rate of residential burglary in Menino Deus										
7	1	1,00	0,05	1,77	4	44,12	1,00	0,091	0,52	0,23
121	2	0,50	0,02	1,16	5	80,26	2,00	0,050	0,12	0,02
262	5	0,40	1,5	1,34	4	251,54	0,45	0,036	0,28	0,13
54	3	0,33	1,33	1,46	3	149,76	0,00	N/I	N/I	N/I
102	3	0,33	1,33	1,39	5	141,55	0,75	0,021	0,24	0,18
1.115	3	0,33	1,33	1,31	3	177,55	1,50	0,034	0,16	0,07
1.771	3	0,33	1,33	1,34	2	65,45	3,00	0,046	0,26	0,15
122	8	0,25	0,75	1,16	4	123,83	4,00	0,032	0,19	0,08
596	4	0,25	0,02	1,60	5	131,02	1,00	0,031	0,05	0,05
1.327	4	0,25	0,02	1,35	4	126,74	1,33	0,032	0,13	0,06
321	5	0,20	1,5	1,40	5	110,66	0,36	0,027	0,07	0,15
985	5	0,20	1,5	1,23	2	100,44	5,00	N/I	N/I	N/I
1.266	5	0,20	1,5	1,42	5	118,19	1,25	N/I	N/I	N/I
1.934	5	0,20	1,5	1,23	4	81,92	1,67	0,037	0,18	0,11
10% of segmentos with the lowest rate of residential burglary in Menino Deus										
14	8	0,00	0,75	1,77	4	160,89	0,80	0,025	0,20	0,11
33	5	0,00	1,5	1,64	4	22,83	0,00	0,044	0,39	0,13
39	13	0,00	0	1,64	6	232,67	6,50	0,017	0,28	0,10
48	5	0,00	1,5	1,46	5	55,01	1,25	0,036	1,31	0,27
49	2	0,00	0,02	1,46	5	103,02	1,00	0,019	0,63	0,12
52	2	0,00	0,02	1,46	5	110,40	0,67	0,027	0,11	0,04
59	4	0,00	0,02	1,52	4	65,60	2,00	0,015	0,30	0,09
82	7	0,00	0,17	1,60	6	106,01	2,33	0,028	0,54	0,15
83	18	0,00	0,02	1,60	6	227,34	1,13	0,018	0,25	0,19
93	12	0,00	0,2	1,15	6	226,37	0,00	0,044	0,10	0,05
109	17	0,00	0,07	1,38	6	185,40	0,74	0,022	0,23	0,04
110	35	0,00	0	1,38	6	226,37	2,33	0,022	0,22	0,28
111	3	0,00	1,33	1,38	5	75,79	0,30	0,026	0,20	0,18
113	2	0,00	0,02	1,38	4	82,48	0,50	0,048	0,27	0,29

Note: n° seg.= segment number; RBR = residential burglary rate; segments are presented in decreasing order of residential burglary rate; TRRB = 'true rate for the risk bands' ; Rn= global integration values of axial lines; n°. of res. = number of accesses to residential units per segment; N/I = no information

Residential burglary and street land use patterns.

No correlation was found between residential burglary (RRB) and street land use patterns, either considering the total sample or each of the two boroughs individually. This was replicated when only the 10% of the segments with the highest and 10% of the segments with the lowest rate of residential burglary were considered. Land use was measured by dividing the sum of residential buildings by the sum of non-residential buildings. On the other hand, when considering the segments with the highest and lowest rate of residential burglary (Tables 1 and 2), negative correlations between residential burglary (RRB) and residential land use were found for the total sample of 48 segments (Pearson coef.= - 0.369; sig= 0.010) and for Menino Deus (Pearson coef.= - 0.378; sig= 0.047), indicating that the higher the residential land use the lower the residential burglary (RRB).

Table 2 Segments with the highest and lowest rate of residential burglary in Rio Branco

n◦ seg.	n◦ of res.	RBR	TRRB	Rn	segment connectivity	segment lenght	land use	street light	visual connection	physical connection
					10% of segmentos with the highest rate of residential burglary in Rio Branco					
95	2	1,00	0,02	1,84	4	58,80	2,00	0,051	0,07	0,34
1.728	2	1,00	0,02	1,66	4	70,75	0,22	0,071	1,33	0,59
2.477	3	0,66	1,33	1,66	5	191,34	1,00	0,026	0,18	0,10
76	2	0,50	0,02	1,83	4	144,64	0,00	0,028	0,00	0,00
152	2	0,50	0,02	1,78	4	148,69	0,12	0,020	0,44	0,15
440	2	0,50	0,02	1,80	6	33,48	0,33	0,090	1,52	0,87
1.712	2	0,50	0,02	1,13	4	61,88	0,00	N/I	N/I	N/I
1.734	2	0,50	0,02	1,66	6	140,11	0,00	0,021	0,09	0,04
1.731	3	0,33	1,33	1,66	4	97,93	0,50	0,082	0,80	0,40
303	11	0,27	0,11	1,46	4	178,35	2,75	0,034	0,25	0,15
					10% of segmentos with the lowest rate of residential burglary in Rio Branco					
75	3	0,00	1,33	1,83	4	28,87	1,00	0,035	0,28	0,28
79	35	0,00	0	1,83	5	251,10	4,38	0,032	0,36	0,26
101	18	0,00	0,02	1,77	5	253,82	1,38	0,028	0,20	0,14
115	10	0,00	0,12	1,78	4	51,45	5,00	0,039	0,39	0,33
122	16	0,00	0,15	1,61	5	152,86	1,60	0,033	0,30	0,28
133	2	0,00	0,02	1,36	4	42,77	0,00	0,023	0,23	0,21
138	2	0,00	0,02	2,03	6	143,86	0,67	0,042	0,36	0,17
139	2	0,00	0,02	2,03	6	143,91	0,50	0,035	0,25	0,15
141	1	0,00	0,05	2,03	5	125,88	0,25	0,032	0,13	0,14
146	1	0,00	0,05	2,03	4	99,05	0,00	0,030	0,10	0,10

Note: n◦ seg.= segment number; RBR = residential burglary rate; segments are presented in decreasing order of residential burglary rate; TRRB = 'true rate for the risk bands' ; Rn= global integration values of axial lines; n◦ of res. = number of accesses to residential units per segment; N/I = no information

Residential burglary and residential density

Residential density was measured by dividing the total number of accesses to residential units by segment length. No correlation was found between residential burglary (RRB) and residential density, considering the total sample, Menino Deus and Rio Branco boroughs. Nonetheless, when only the segments with the highest and lowest rate of residential burglary were considered negative correlations were found for the

total sample (Pearson coef.= - 0.391; sig= 0.06) and for Menino Deus (Pearson coef.= - 0.409; sig= 0.031). This shows that the higher the residential density the lower the residential burglary (RRB).

Correlation between residential burglary and non-residential density

Non-residential density was measured by dividing the number of non-residential units accesses by segment length. No correlation was found between residential burglary (RRB) and non-residential density, either considering the total sample or each of the two boroughs individually.

In addition, no correlations were found when only the segments with the highest and lowest rate of residential burglary were considered.

Correlation between residential burglary and density of buildings

Density of buildings was measured by dividing the total number of buildings (residential and non-residential uses) by segment length. No correlation was found between residential burglary (RRB) and density of buildings, considering the total sample, Menino Deus and Rio Branco boroughs. Nonetheless, a negative correlation (Pearson coef.= - 0.472; sig= 0.011) was found in Menino Deus, when only the segments with the highest and lowest rate of residential burglary were considered. This reveals that the higher the density of buildings in segments in Menino Deus, the lower the residential burglary.

Correlation between residential burglary and density of houses (up to 2 storey buildings)

Density of houses was measured by dividing the number of houses (up to 2 storey buildings with residential or non-residential use) by segment length. No correlation was found between residential burglary (RRB) and density of houses, considering the total sample, Menino Deus and Rio Branco boroughs. Additionally, no correlations were found when only the segments with the highest and lowest rate of residential burglary were considered.

Correlation between residential burglary and density of blocks (3 floors and higher)

Density of blocks was measured by dividing the number of blocks (buildings with 3 or more floors with residential or non-residential use) by segment length. No correlation was found between residential burglary (RRB) and density of blocks, either considering the total sample or each of the two boroughs individually. However, a negative correlation (Pearson coef.= - 0.396; sig= 0.037) was found in Menino Deus, when only the segments with the highest and lowest rate of residential burglary were considered. This shows that the higher the density of blocks in segments in Menino Deus, the lower the residential burglary.

Respondent burglarized residence and dwelling type

Considering the residences of the 209 respondents of the questionnaires, a statistically significant relationship was not found between the residence being burglarized or not and its dwelling type (house or flat), either for the total sample, or for Menino Deus and Rio Branco. The percentage of respondents that mentioned their houses had been burglarized (30,9% - MD; 30,77% - RB) is similar to those that mentioned that their flats had been burglarized (38,46 % - MD; 25,75% - RB), either in Menino Deus or in Rio Branco, with a bit higher number of burglarized flats than houses in Menino Deus, and with the opposite happening in Rio Branco. Moreover, no statistically significant relationship was found between perception of residence being safe and dwelling type (house or flat) where the respondent of the questionnaire lives, either for the total sample or, specifically, in Menino Deus and Rio Branco boroughs. This means that living in a flat or in a

house in these boroughs did not affect perception of security in the residence. Moreover, similar results were found when dwelling type was categorized as buildings up to 2 floors, and as buildings having from 3 to 5 floors, from 6 to 10 floors and from 11 to 15 floors.

Residential land use, building type house and 'true risk rate for the bands'

Considering the total number of residential burglaries by the total number of accesses to residential units in each band (characterized by an equal number of accesses to residential units in the segment), named as 'true risk rate for the bands' (Hillier & Sahbaz, 2005), no correlation between number of accesses to residential units in the segment (residential land use) and TRRB ('true risk rate for the bands') was found for the total sample (457 segments) and for Menino Deus (265 segments). However, a negative correlation (Pearson coef.= - 0.154; sig.= 0.033) was found for Rio Branco (192 segments), showing that for this borough bands constituted by segments with higher number of accesses to residential units have lower rate of residential burglary. Although no correlations were found for Menino Deus and Rio Branco, a negative correlation (Pearson coef.= - 0.097; sig.= 0.039) between TRRB ('true risk rate for the bands') and building type houses (up to 2 storey buildings with residential or non-residential use) was found for the total sample. This suggests that the higher the number of building type house in the segment the lower the rate of residential burglary of a specific band (characterized by segments with the same number of accesses to residential units).

Residential burglary and street lightning

Street lighting was measured considering the number of streetlights by the length of the segment. Considering the segments with the highest and the lowest rate of residential burglary (Tables 1 and 2), correlations between residential burglary and street lighting were found for the total sample (Pearson coef.= 0.543; sig= 0.000) and for Menino Deus (Pearson coef.= 0.737; sig= 0.000). However, contrary to what might be expected, the higher the number of streetlights in the segment the higher the number of occurrences of residential burglary. Although, in many studies, it may be difficult to know the time a home was burglarized, it is worth mentioning that the time of crime occurrence was not considered in this investigation since this information was not available in the data provided by the Department of Public Security of the State of Rio Grande do Sul. Moreover, it was not possible to be sure that the streetlights counted in the segments were working properly during the night. Therefore, it is not possible to be sure that these criminal events did occur during the night and that street lighting really tended to favour residential burglary instead of discouraging it.

A statistically significant relationship (Phi value = - 0,273; sig= 0,000) was found between the two boroughs and perception of street lighting during the night in the residence area. The number of those that mentioned that there is a lack of street lighting during the night is far greater in Menino Deus (46,3% - 57) than in Rio Branco (19,8% - 17). However, it was not found a statistically significant relationship between the residence of the respondent being burglarized or not and levels of satisfaction with street lighting during the night in the residence area. Nonetheless, 32,3% (21 out of 65) of those that had their residences burglarized mentioned lack of street lighting as a cause for that, this being the most mentioned reason by respondents. Additionally, as mentioned by respondents, there was a clear tendency for residential burglary to occur during the night. Moreover, although no correlation was found between perception by residents of residence being safe and perception of street lighting during the night in the residence area in Rio Branco, correlations were found for the total sample (Spearman, coef.= 0.163; sig= 0.018) and for the residents in Menino Deus (Spearman, coef.= 0.178; sig= 0.049). These correlations suggest that the higher the

perception of street lighting during the night the higher the perception of residence being safe. Furthermore, correlations between perception of block being safe during the night and perception of street lighting during the night in the residence area were found, either considering the total sample (Spearman coef.= 0.186; sig= 0.007), Menino Deus (Spearman coef.= 0.180; sig= 0.046), or Rio Branco (Spearman coef.= 0.215; sig= 0.047) boroughs. On the other hand, no correlations were found, either considering the total sample (209 respondents) or each of the two boroughs, between perception of block being safe during the night and: axial lines integration values; segments connectivity; segments length, and visibility of front door from neighbouring doors and windows.

Use of open public space and the two boroughs

There is no statistically significant relationship between the two boroughs and a reduction in the use of open public space during the day due to insecurity. All or almost all respondents in MD (95,9% - 118) and in RB (100% - 86) mentioned that such reduction did not happen. On the other hand, a clear reduction in the use of open public space during the night due to insecurity was considerably mentioned by respondents in both boroughs (MD – 61% - 75; RB – 62,8% - 54), revealing a lack of statistically significant relationship between the two boroughs and such a reduction in the use of public open spaces

Residential burglary and visual and physical connections between residences and the public open space

Visual and physical connections between residences and the public open space were measured for the 10% of segments with the highest and the 10% of segments with the lowest rate of residential burglary (according to the data from the Department of Public Security) in each borough (Tables 1 and 2). A visual connection unit and a physical connection unit of 1 meter as a unit of measurement were considered. No correlations were found between residential burglary and visual connections between residences and the public open space, either considering the total sample or each of the two boroughs, suggesting that such visual permeability, by itself, did not affect the occurrence of residential burglary. The same happened regarding the relationship between residential burglary and physical connections between residences and the public open space. Moreover, it was found no statistically significant relationship between respondent burglarized residence and inter-visibility between respondent residence front door or gate and doors and windows of neighboring buildings. The vast majority either in Menino Deus (95,1% - 117 out of 123) or in Rio Branco (98,8% - 85 out of 86) mentioned that the front door or gate of their residences could be seen from neighboring buildings, revealing also no statistically significant relationship between the two boroughs and visibility of front door from neighbouring doors and windows. In addition, 100% (65) of those that mentioned their houses had been burglarized also mentioned that the front door or gate of their residences could be seen from neighbouring buildings. Furthermore, considering only the segments where the respondents of the questionnaires live, no statistically significant relationship was found between perception of residence being safe and visibility of front door from neighbouring doors and windows, either for the total sample or for each of the two boroughs.

Respondent burglarized residence and existence of elements of protection against burglary

In Menino Deus, 28,45% (35 out of 123), and in Rio Branco, 26,74% (23 out of 86) of the respondents informed that their houses had some element of protection against burglary. Considering the number of respondents in Menino Deus (34,1% - 42 out of 123) and in Rio Branco (26,7% - 23 out of 86) that mentioned that their homes had already been burglarized, almost half of them in each borough acknowledged the existence of elements of protection at the buildings where they lived, by the time of such criminal occurrence. Among those that mentioned their houses had been burglarized (65), the percentage of

respondents that revealed the existence of some element of protection by the time the residence had been burglarized (46,2% - 30 out of 65) is very similar to those that did not mention such existence (43,1% - 28 out of 65). The most mentioned element of protection (38,5% - 25 out of 65) by respondents, existing by the time the residence had been burglarized, was fences with iron bars or walls. Moreover, no statistically significant relationship was found between the two boroughs and the existence of protecting element, such as a wall or fence, at the residence. The clearly majority of respondents either in MD (85,4% - 105) or in RB (84,9% - 73) mentioned that there were elements of protection, such as a wall or fence, in their residences.

In addition, no statistically significant relationship was found between the two boroughs and the existence of a front wall or fence at the building where the respondent lives. The clear majority of respondents in MD (81,3% - 100) and in RB (79,1% - 68) mentioned the existence of such elements of protection. On the other hand, a significant relationship was found between the two boroughs and the existence, at the building where the respondent lives, of: a left side wall or fence (Phi value= 0,195; sig= 0,005); a right side wall or fence (Phi value= 0,202; sig= 0,003); a back side wall or fence (Phi value= 0,239; sig= 0,001). In all these relationships, the existence of a left side wall or fence (63,4% - 78 - MD; 81,4% - 70 - RB), a right side wall or fence (62,6% - 77 - MD; 81,4% - 70 - RB), and a back side wall or fence (60,2% - 74 - MD; 82,6% - 71 - RB) were mentioned by a clearly greater number of respondents in Rio Branco than in Menino Deus. However, the inexistence of bars on the ground floor windows at the building where the respondent lives is much more common in Menino Deus (73,2% - 90) and in Rio Branco (86% - 74) than the existence, although it was found a statistically significant relationship ((Phi value= -0,154; sig= 0,026) between the two neighbours and the existence of such protecting element. The inexistence of alarm systems at the building where the respondent lives clearly prevails in both boroughs (86,2% - 106 - MD; 90,7% - 78 - RB), with no statistically significant relationship between these boroughs and existence of alarm systems. Similar results were found regarding the inexistence of camera at the entrance gate and at the garage gate in the building where the respondent lives, and the inexistence of electric fences on all building sides. In addition, the presence of a dog in the building where the respondent lives is almost inexistent in both boroughs.

Although no statistically significant relationship was found between perception of residence being safe and existence of elements of protection at the residence in Rio Branco Borough, a statistically significant relationship was found for Menino Deus (Phi value= 0,338; sig= 0,001) and for the total sample (Phi value= 0,234; sig= 0,009). Hence, while in Rio Branco perception of residence being safe is very similar between those who mentioned the existence of elements of protection e those who don't, in Menino Deus, respondents who mentioned the existence of elements of protection clearly perceived their residence as much safer than those who did not mention such elements.

Residential burglary and existence of security guards in nearby blocks

According to respondents of the 209 questionnaires, 32,5% (40 out of 123) in Menino Deus and 37,2% (32 out of 86) in Rio Branco mentioned that there were security guards in nearby blocks, this small difference in the percentages being statistically no significant. In addition, a statistically significant relationship between the residence of the respondent being burglarized or not and the existence or not of security guards in nearby blocks was not found. The number of those that mentioned the existence of security guards in nearby blocks is similar between those that had their residences burglarized (30,8% - 20 out of 65) and those who did not (36,1% - 52 out of 144). Moreover, no statistically significant relationship was found between perception of residence being safe and existence of security guards in nearby blocks, either considering the total sample of 209 respondents of the questionnaires, or the 123 respondents in Menino Deus and the 86 respondents in Rio Branco. Nonetheless, where security guards does exist in nearby blocks, residents tend to

feel slightly safer.   Furthermore, the existence of porters and/or guards in the building where the respondent lives is much greater in Rio Branco (41,9% - 36) than in Rio Branco than in Menino Deus (21,1% - 26), and this difference is supported by a statistically significant relationship ((Phi value= 0,223; sig= 0,001) between these two boroughs and the existence of porters and/or guards.

CONCLUSION

Although most respondents in Menino Deus and in Rio Branco perceive their residences as safe, the number of residential burglary, as represented by respondents' burglarized residences, cannot be disregarded. However, this perception of security decreased according to an increase in the period of time the resident lived in a residence, and also decreased according to a decrease in household income. While the block did not tend to be perceived as unsafe during the day it tended to perceived as unsafe during the night.

Although axial lines global integration values were not found to affect the occurrence of residential burglary, they were found to be characterized by higher income households and to have a positive effect on perception of residence being safe. Segments connectivity tended to positively affect residential burglary, that is, higher connectivity values, implying segments with higher accessibility of people and vehicles, tended to be related to lower rates of residential burglary. On the other hand, segment length was not found to have an effect on residential burglary.

Higher residential land use tended to be related to lower rates of residential burglary, whereas this was not found to be related to non-residential land use. It was not found, however, a relationship between living in a flat or in a house and perception of security in the residence.   Some positive effect on rate of residential burglary by the number of buildings accesses to the segments was also found, with higher number of buildings having some relation with lower rate of residential burglary. The number of accesses to residential units in the segment (residential land use) and the number of building type house tended to have some effect on 'true risk rate for the bands' (Hillier & Sahbaz, 2005), with bands constituted by segments with higher number of accesses to residential units as well as segments with higher number of building type house tending to have lower rate of residential burglary.

Although, according to some findings, street lighting appeared to have some contradictory effects on residential burglary, a lack of street lighting was the main cause for their houses being burglarized pointed out by respondents, these burglaries tending to happen during the night.

Moreover, perception of street lighting during the night positively affected perception of residence being safe and perception of block being safe during the night. In addition, although it was not found a reduction in the use of open spaces during the day due to security problems in the respondents' residential areas, a clear reduction in the use of open public space during the night due to insecurity was found in both boroughs.

Even though, according to the literature (i.e. Shu, 2009; Hillier, 1988), it might be expected for inter-visibility between buildings and open spaces to have a positive impact on residential burglary such effect was not found in this research. For example, all respondents that mentioned their houses had been burglarized also mentioned that the front door or gate of their residences could be seen from neighbouring buildings. The existence of some element of protection against burglary in the residence, generally, fences or walls, did not, necessarily, prevented the residence to be burglarized. Nonetheless, the existence of elements of

protection at the residence did have some effect on perception of residence being safe. Presence of security guards in nearby blocks was not found to significantly affect either residential burglary or perception of residence being safe, though residents tended to fell a little safer where security guards did exist in nearby blocks.

Therefore, results show, that residential burglary and perception of security tended to be somewhat affected by urban configuration and land uses. Although some understanding about how urban design can contribute in reducing residential burglary can be drawn from this study, it is necessary to deepen some aspects. This includes the simultaneous use of multiple variables analysis, what might help to understand the simultaneous impact of more than one (1) variable on residential burglary. The use in this study of analytical methods that were performed only with a pair of variables at a time, and the amount of data used, might have prevented some significant relationships to appear. Moreover, the distinction between periods of the day in analysing a criminal occurrence is a critical aspect to be considered in further studies.

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