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Relationship between some physical spatial variables and four types of street crimes

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Abstract

This paper's objective is the investigation of the relationship between the occurrence of four types of street crimes (pedestrian mugging, robbery of vehicle, vehicle theft, and theft of items inside a vehicle) in four different periods of the day (each period with six hours, starting at 6:00 a.m.) and physical spatial variables (segments attributes) such as: segment length, connectivity, integration, choice, dwelling types (houses or buildings with three or more floors), land use (residential or non-residential), visual and physical connections, physical and visual barriers, nonvisual physical barriers and street lighting in the segments. The investigation is carried out in two residential boroughs in Porto Alegre, Brazil, namely, Menino Deus and Rio Branco. Data regarding the occurrence of the four types of crimes in the streets were collected in the Department of Public Security of the State of Rio Grande do Sul for a five years period, from 2006 to 2010. These data were tabulated in ArcGIS and related to each segment. Some segment attributes were obtained through the analysis in Depthmap of a segment map obtained from the axial map of the two boroughs. Data regarding dwelling type and land use were collected in the Department of City Planning. Data analysis included a linear multiple regression analysis, having the rates of four types of crimes in the streets as dependent variables, in each of the four periods of the day, to be explained by the physical spatial variables as independent variables. Results show, for example, that theft of items inside a vehicle is the type of street crime with the greatest number of occurrences, followed by the number of robbery of vehicle and by the number of vehicle theft, either in Menino Deus or in Rio Branco Borough. In general, the greatest number of theft of items inside a vehicle occurs during the night period. This is also the period where most robbery of vehicles, vehicles theft, and pedestrians mugging occurs. The linear multiple regression analysis carried out revealed that none of the 14 independent variables explain either rates of theft of vehicles or rates of theft of items inside a vehicle during the morning and afternoon periods. Additionally, a clear tendency for variables related to spatial configuration being associated with a reduction in any of the four types of street crime was found. On the other hand, variables characterizing the relationship between buildings and the street tend to be associated with an increase in any of the four types of street crime.

Keywords

Street crimes, physical spatial variables, segment attributes, integration, choice.

1. Introduction

Without disregarding the importance of other variables to crime occurrence, the relationship between physical spatial variables and crimes has been studied for some time and the importance of these studies have been established (van Nes and López, 2010; Hillier and Sahbaz, 2005; Hillier and Shu, 2000; Poyner and Webb, 1991; Newman 1972; Jacobs 1961). Among these variables are those related to urban configuration such as global and local integration (Hillier and Sahbaz, 2012; Shu, 2009; Hillier and Sahbaz, 2005) and those linked to the relationship between buildings and public open spaces such as visual connections between them (Jacobs, 1961).

Nonetheless, the scarcity of spatial analysis researches that focus on street robbery has been highlighted some years ago (Chiaradia et al., 2009). Therefore, it is necessary to deepen the existing knowledge in order to have a more clear idea, mainly in Brazilian cities, about the effect of these variables on different types of street crime, such as pedestrian mugging, robbery of vehicle, vehicle theft, and theft of items inside a vehicle, in different periods of the day, namely, morning, afternoon, night and dawn. Street crime data must be dealt with according to its temporal distribution; for example, potential of movement, as represented by integration of segments, visual connections between buildings and public open spaces, and street lighting may have different effects on street crime on distinct periods of the day.

Therefore, this paper's objective is the investigation of the relationship between the occurrence of four types of crimes in the streets (pedestrian mugging, robbery of vehicle, vehicle theft, theft of items inside a vehicle) in four different periods of the day (each period with six hours, starting at 6:00 a.m.) and physical spatial variables (segments attributes) such as: segment length, connectivity, integration, choice, dwelling types (houses or buildings with three or more floors), land use (residential or non-residential), visual and physical connections, physical and visual barriers, nonvisual physical barriers and street lighting in the segments. The investigation is carried out in two residential boroughs in Porto Alegre, Brazil, namely, Menino Deus and Rio Branco.

2. Methodology

Most streets in both boroughs, Menino Deus (MD) and Rio Branco (RB), are typically less crowded residential streets predominantly sided by fenced or walled houses or blocks of flats, where two storey buildings clearly predominate over taller buildings, and residential buildings visibly prevail over non-residential buildings. The main busiest streets are mostly bounded by non-residential (i.e. offices, commerce and services) or mixed-use buildings and concentrate most of the tallest buildings and those with non-residential uses at ground floor such as bars, restaurants and supermarkets, which promote movement and presence of people at night.

Data regarding the occurrence of pedestrian mugging, robbery of vehicle, vehicle theft, and theft of items inside a vehicle, in Menino Deus and Rio Branco boroughs were collected in the Department of Public Security of the State of Rio Grande do Sul for a five years period, from 2006 to 2010. Street crime records in this Department are a result of crime occurrences registered in Police Stations. Nonetheless, apart from the fact that some people may not register such street crimes, many registered occurrences were not spatialized according to the block, what prevent the street crime to be related to segment properties. Therefore, these facts may have some impact over the results presented in this paper.

Street-level crime data were tabulated in ArcGIS and related to each segment. Segment attributes such as segment length, connectivity, integration, and choice, were obtained through the analysis in depthmapX of a segment map obtained from the axial map of the two boroughs. The axial map of Porto Alegre was used for each case study (Menino Deus and Rio Branco Boroughs) taking account of a larger contextual area in order to eliminate problems of edge effect. Data regarding dwelling type and land use were collected in the Department of City Planning. These data were transferred to or tabulated in SPSS V-18.

Each of the four type of street crime was analysed through a linear multiple regression analysis (backward method) in SPSS, with the following dependent variables to be explained by the 15 independent variables constituted by segments attributes:

- *Dependent variables*: pedestrian mugging rate, robbery of vehicle rate, vehicle theft rate, and rate of theft of items inside a vehicle; these variables were considered for each of the four periods of the day; these street crime rates were calculated by dividing the number of a street crime on a segment by the length of such segment, allowing each segment to have its specific street crime rate and to compare such rate with segment attributes (independent variables).

- *Independent variables*: connectivity, global integration, local integration (R750 metric), global choice, local choice (R750 metric), density of residential access to houses, density of residential access to block of flats, density of residential access, density of nonresidential access, visual connections rate (between buildings and the streets), physical connections rate (between buildings and the streets), rate of physical and visual barriers (between buildings front yards and the streets), rate of nonvisual physical barriers (between buildings front yards and the streets), rate of poles with street lighting. Integration and choice were measured taken into account global (all the segments in the borough were considered) and local radius (only segments within a radius of 750 metres were considered). Other walkable distances weren't considered in this study due to Hillier's (2007, p.2) argument that "*We would expect local movement to be best accounted for by a local radius choice measure – 800 metres is the current favourite with space syntax limited ...*".

The number of houses (one or two floors), residential buildings with three or more floors, and non-residential buildings (i.e. offices, shops, bar/restaurants, and services) in each segment were counted according to the number of main ground floor access to buildings (1 main access = 1 postal address) in each segment, as already considered in other studies (e.g. Shu 2009). Therefore, either a 10 storey block of flats or a house (with one or two floors) were counted as having one (1) main ground floor access. In addition, a building with a residential access and a shop on ground floor was counted as having one (1) residential access and one (1) business access.

3. Results

Theft of items inside a vehicle, either in Menino Deus (757) or in Rio Branco (563) Borough, is the type of street crime with the greatest number of occurrences, followed by the number of robbery of vehicles (337 in MD; 528 in RB) and by the number of vehicle theft (305 in MD; 319 in RB). In general, the greatest number of theft of items inside a vehicle occurs during the night period. This is also the period where most robbery of vehicles, vehicles theft, and pedestrians mugging occurs. The dawn period, followed by the morning period, in both boroughs, are the safest periods when considering pedestrian mugging, robbery of vehicles and vehicles theft. In relation to theft of items inside a vehicle, the safest period in Menino Deus is the dawn period and in Rio Branco the morning, afternoon and dawn periods are much safer than the night period.

Pedestrian mugging in Menino Deus and Rio Branco boroughs

The linear multiple regression analysis reveals that the prediction model is statistically significant [$F(5, 128) = 81.095$, $p < .001$] and that 76% of the variance ($R2=0.760$) in pedestrian mugging rate during the morning in Menino Deus borough is explained by the following independent variables, according to a decreasing order of positive and negative Beta values (Standardized Coefficients) and p values equal or smaller than 0.05 (this criterion is repeated for the other multiple regression analysis): nonvisual physical barriers rate (+), physical connection rate (+), visual connection rate (+), physical and visual barriers rate (+), and global choice (-). Positive Beta values indicate that an increase in the rate of the independent variable is related to an increase in pedestrian mugging rate during the morning in Menino Deus, while a negative value indicates the opposite. Hence, higher rates of nonvisual physical barriers rate are related to an increase in pedestrian mugging rate during the morning, possibly because these barriers indicates greater insecurity in the area, and so, in the streets where pedestrian mugging takes place. Conversely, an increase in global choice values in the segments is related to a decrease in pedestrian mugging rate during the morning in such segments.

In turn, the prediction model is not statistically significant [F (2, 114) = 1.691, p = .189], and only 3% of the variance (R2=0.029) in the pedestrian mugging rate during the morning in Rio Branco borough (RB) is explained by the independent variables (Table 1).

Table 1: Pedestrian mugging rates in Menino Deus and Rio Branco borough

Dependent variables	R Square	Adjusted R^2	ANOVA	Independent variables that explain the dependent variable	Beta - Standardized Coefficients (Sig)
Pedestrian mugging rates in Menino Deus					
during the morning	.760	.751	F (5, 128) = 81.095 $p < .001$	rate of nonvisual physical barriers rate of physical connection rate of visual connection rate of physical and visual barriers global choice	.398 (.000) .270 (.004) .221 (.009) .174 (.000) -.171 (.000)
during the night	.173	.134	F (6, 126) = 4.393 $p < .001$	local choice global Integration rate of nonvisual physical barriers density of residential access to blocks of flats local integration density of nonresidential access	.304 (.014) .277 (.010) .218 (.032) .176 (.035) -.351 (.014) -.303 (.003)
Pedestrian mugging rates in Rio Branco					
during the night	.146	.100	F (6, 111) = 3.171 $p = .007$	rate of visual connection density of nonresidential access density of residential access to blocks of flats rate of physical connection	.639 (.016) .443 (.020) .409 (.026) -1.365 (.000)
during the dawn	.152	.121	F (4, 112) = 5.009 $p = .001$	rate of physical connection rate of poles with street lighting density of residential access to houses	1.601 (.000) -.991 (.000) -.268 (.016)

Note: F (1, 132) = 44.799: 1= df regression; 132 = df residual; 44.799 = F; $p < .001$ = sig. ANOVA; results of the linear backward multiple regression analysis involving pedestrian mugging during the afternoon and during the dawn in Menino Deus, and involving pedestrian mugging during the morning and the afternoon in Rio Branco were not worth of consideration.

The linear multiple regression analysis involving the dependent variable 'pedestrian mugging rate during the afternoon' either in Menino Deus or in Rio Branco are not worth of consideration since the maximum standard residual was still high (over 4) after two segments with high residual values had been eliminated from each analysis.

While the prediction model is statistically significant [F (6, 126) = 4.393, p < .001], only 17% of the variance (R2=0.173) in pedestrian mugging rate during the night in Menino Deus is explained by the following independent variables: local choice (+), global integration (+), nonvisual physical barriers rate (+), density of residential access to blocks of flats (+), local integration (-), density of non residential access (-). Therefore, increase in the values of these two variables is related to a decrease in pedestrian mugging rate during the night in the segments in Menino Deus. Even though the model is statistically significant [F (6, 111) = 3.171, p = .007], only 14% of the variance (R2=0.146) in the pedestrian mugging rate during the night in Rio Branco is explained by the following independent variables: visual connection rate (+), density of nonresidential access (+), density of residential access to block of flats (+), and physical connection rate (-). Thus, higher physically connected segments have lower rates of pedestrian mugging during the night (Table 1).

The multiple regression analysis involving the dependent variable 'pedestrian mugging rate during the dawn' in Menino Deus is not worth of consideration since the maximum standard residual was still high after two segments with high residual values had been eliminated from the multiple regression analyses. Although the prediction model is statistically significant [F (4, 112) = 5.009, p =.001], only 15% of the variance (R2=0.152) in the pedestrian mugging rate during the dawn in Rio Branco is explained by the following independent variables: physical connection rate (+), rate of poles with street lighting (-), and density of residential access to houses (-). Hence, segments with higher rates of poles with street lighting and higher densities of residential access to houses present lower rates of pedestrian mugging rate during dawn (Table 1).

Robbery of vehicle in Menino Deus and Rio Branco boroughs

The linear multiple regression analysis involving the dependent variable 'robbery of vehicle rate during the morning' in Menino Deus is rejected due to the fact that the maximum standard residual was still high after two segments with high residual values had been eliminated from the analyses. Conversely, the prediction model is statistically significant [F (2, 113) = 8.562, p < .001] and 13% of the variance (R2=0.132) in the robbery of vehicle rate during the morning in Rio Branco borough (RB) is solely explained by the independent variable 'local integration' (-): higher locally integrated segments in Rio Branco have lower rates of robbery of vehicle during the morning (Table 2).

An expressive percentage (70%) of the variance (R2=0.700) in the robbery of vehicle rate during the afternoon in Menino Deus is explained by the following independent variables, as revealed by the statistically significant prediction model [F (6, 128) = 49.771, p < .001]: global choice (+), nonvisual physical barriers rate (+), physical connection rate (+), density of non residential access (+), physical and visual barriers rate (+), and local integration (-). Therefore, higher locally integrated segments have lower rates of robbery of vehicle during the afternoon. Although the model is statistically significant [F (3, 114) = 6.372, p < .001], only 14% of the variance (R2=0.144) in the robbery of vehicle rate during the afternoon in Rio Branco borough (RB) is explained by the following independent variables: local choice (+), density of residential access to houses (+), and local integration (-). As in Menino Deus, higher locally integrated segments in Rio Branco have lower rates of robbery of vehicle during the afternoon (Table 2).

Table 2: Robbery of vehicle rates in Menino Deus and Rio Branco borough

Dependent variables	R Square	Adjusted R^2	ANOVA	Independent variables that explain the dependent variable	Beta - Standardized Coefficients (Sig)
Robbery of vehicle rates in Menino Deus					
during the afternoon	.700	.686	F (6, 128) = 49.771 *p* < .001	global choice rate of nonvisual physical barriers rate of physical connection density of nonresidential access rate of physical and visual barriers local integration	.357 (.000) .281 (.000) .277 (.002) .161 (.023) .103 (.050) -.262 (.000)
during the night	.357	.337	F (4, 129) = 17.920 *p* < .001	rate of nonvisual physical barriers rate of visual connection global choice local integration	.388 (.000) .218 (.027) -.200 (.007) -.197 (.009)
Robbery of vehicle rates in Rio Branco					
during the morning	.132	.116	F (2, 113) = 8.562 *p* < .001	local integration	-.285 (.002)
during the afternoon	.144	.121	F (3, 114) = 6.372 *p* < .001	local choice density of residential access to houses local integration	.348 (.004) .215 (.019) -.421 (.000)
during the night	.851	.846	F (4, 112) = 159.758 *p* < .001	rate of physical and visual barriers density of residential access to blocks of flats segment length	.783 (.000) .162 (.010) .149 (.000)
during the dawn	.969	.968	F (4, 113) = 882.154 *p* < .001	rate of physical and visual barriers rate of poles with street lighting rate of nonvisual physical barriers connectivity	.499 (.000) .371 (.000) .124 (.017) .068 (.000)

Note: results of the multiple regression analysis involving robbery of vehicle rates during the morning and during the dawn in Menino Deus were not worth of consideration.

About a third (35%) of the variance (R2=0.357) in the robbery of vehicle rate during the night in Menino Deus is explained by the following independent variables, as shown by the statistically significant prediction model [F (4, 129) = 17.920, p < .001]: nonvisual physical barriers rate (+), visual connection rate (+), global choice (-), and local integration (-). Consequently, segments with higher global choice and local integration values present lower rates of robbery of vehicle during the night

in Menino Deus. A very high percentage (85%) of the variance (R2=0.851) in the robbery of vehicle rate during the night in Rio Branco borough is explained by the following independent variables, as revealed by the statistically significant model [F (4, 112) = 159.758, p < .001]: rate of physical and visual barriers (+), density of residential access to block of flats (+), and segment length (+) (Table 2).

The multiple regression analysis involving the dependent variable 'robbery of vehicle rate during the dawn' in Menino Deus is rejected since the maximum standard residual was still high after two segments with high residual values had been eliminated from the analyses. On the other hand, the prediction model is statistically significant [F (4, 113) = 882.154, p < .001] and an extremely high percentage (97%) of the variance (R2=0.969) in the robbery of vehicle rate during dawn in Rio Branco is explained by the following independent variables: rate of physical and visual barriers (+), rate of poles with street lighting (+), rate of nonvisual physical barriers (+), and connectivity (+) (Table 2).

Vehicle theft in Menino Deus and in Rio Branco boroughs

Even though the prediction model is statistically significant [F (3, 130) = 4.146, p = .008], only 8% of the variance (R2=0.087) in the vehicle theft rate during the morning in Menino Deus is explained by the independent variables (Table 3). Moreover, the maximum standard residual was still high after two segments with high residual values had been eliminated from the multiple regression analysis involving the dependent variable 'vehicle theft rate during the morning' in Rio Branco. Hence, no further considerations of these analyses in Menino Deus and in Rio Branco are taken.

Table 3: Vehicle theft rates in Menino Deus and Rio Branco borough

Dependent variables	R Square	Adjusted R^2	ANOVA	Independent variables that explain the dependent variable	Beta - Standardized Coefficients (Sig)
Vehicle theft rates in Menino Deus					
during the night	.325	.293	F (6, 128) = 10.250 *p* < .001	rate of nonvisual physical barriers global integration density of residential access global choice	.406 (.000) .267(.008) .214 (.021) -.200(.014)
Vehicle theft rates in Rio Branco					
during the dawn	.097	.057	F (5, 112) = 2.405 *p* = .041	rate of physical connection rate of poles with street lighting global choice density of residential access to houses	.869 (.003) -1.589 (.009) -.258 (.031) -.218 (.052)

Note: results of the multiple regression analysis involving vehicle theft rates during the morning, the afternoon and during the dawn in Menino Deus and involving vehicle theft rates during the morning, the afternoon and during the dawn in Rio Branco were not worth of consideration.

The linear multiple regression analysis involving the dependent variable 'vehicle theft rate during the afternoon' in Menino Deus is not worth of consideration since all the independent variables were excluded by the regression analysis. In addition, the prediction model is not statistically significant [F (3, 112) = 2.239, p = .088] and only 6% of the variance (R2=0.057) in the vehicle theft rate during the afternoon in Rio Branco is explained by the independent variables (Table 3).

Around a third (32%) of the variance (R2=0.325) in the vehicle theft rate during the night in Menino Deus borough (MD) is explained by the following independent variables, as shown by the statistically significant model [F (6, 128) = 10.250, p < .001]: nonvisual physical barriers rate (+), global integration (+), density of residential access (+), global choice (-). Hence, segments with higher values of global choice have lower rates of vehicle theft during the night (Table 3). On the other hand, results of the multiple regression analysis involving the dependent variable 'vehicle theft rate during the night' in Rio Branco are rejected since the maximum standard residual was still high after two segments with high residual values had been eliminated from the analyses.

The multiple regression analysis involving the dependent variable 'vehicle theft rate during dawn' in Menino Deus is not taken into consideration since all the independent variables were excluded by the analysis. Although the prediction model is statistically significant [F (5, 112) = 2.405, p = .041],

only 10% of the variance (R2=0.097) in the vehicle theft rate during the dawn in Rio Branco is explained by the following independent variables: rate of physical connections (+), rate of poles with street lighting (-), global choice (-) (Table 3). Thus, segments with higher rate of poles with street lighting and higher global choice values have lower rates of vehicle theft during the dawn.

Theft of items inside a vehicle in Menino Deus and Rio Branco boroughs

As revealed by the multiple regression analysis involving the dependent variable 'theft of items inside a vehicle rate during the morning' in Menino Deus, the maximum standard residual was still high after two segments with high residual values had been eliminated from the analyses. While the model is statistically significant [F (4, 113) = 2.666, p = .036], only 9% of the variance (R2=0.086) in the rate of theft of items inside a vehicle during the morning in Rio Branco is explained by the independent variables. Hence, no further considerations of these analyses in Menino Deus and in Rio Branco are taken.

Table 4: Theft of items inside a vehicle rates in Menino Deus and Rio Branco

Dependent variables	R Square	Adjusted R^2	ANOVA	Independent variables that explain the dependent variable	Beta - Standardized Coefficients (Sig)
Theft of items inside a vehicle rates in Menino Deus					
during the night	.682	.673	F (4, 130) = 69.805 *p* < .001	rate of nonvisual physical barriers rate of visual connection rate of physical and visual barriers global choice	.521(.000) .329(.000) .151(.005) -.211 (.000)
during the dawn	.607	.595	F (4, 130) = 50.300 *p* < .001	rate of physical connection rate of nonvisual physical barriers rate of physical and visual barriers global choice	.545 (.000) .233 (.005) .131 (.028) -.165 (.004)
Theft of items inside a vehicle rates in Rio Branco					
during the night	.244	.196	F (7, 109) = 5.039 *p* < .001	global integration segment length rate of poles with street lighting local choice connectivity	.295 (.016) .253 (.014) -1.034 (.023) -.267 (.021) -.245 (.016)

Note: results of the multiple regression analysis involving rates of theft of items inside a vehicle during the morning and the afternoon in Menino Deus and involving vehicle theft rates during the morning, the afternoon, and during the dawn in Rio Branco were not worth of consideration.

The prediction model is not statistically significant either in Menino Deus [F (2, 132) = 2.807, p = .064] or in Rio Branco [F (1, 116) = 3.001, p = .086] regarding the rate of theft of items inside a vehicle during the afternoon. On the other hand, the model is statistically significant [F (4, 130) = 69.805, p < .001] and a high percentage (68%) of the variance (R2=0.682) in the theft of items inside a vehicle rate during the night in Menino Deus is explained by the following independent variables: nonvisual physical barriers rate (+), visual connection rate (+), physical and visual barriers rate (+), and global choice (-). Segments with higher values of global choice present lower rates of theft of items inside a vehicle during the night. Around a quarter (24%) of the variance (R2=0.244) in the rate of theft of items inside a vehicle during the night in Rio Branco is explained by the following independent variables, as shown by the statistically significant model [F (7, 109) = 5.039, p < .001]: global integration (+), segment length (+), rate of poles with street lighting (-), local choice (-), and connectivity (-). Therefore, segments with higher rates of poles with street lighting, higher local choice values and higher connectivity values have lower rates of theft of items inside a vehicle during the night in Rio Branco (Table 4).

An expressive percentage (60%) of the variance (R2=0.607) in the theft of items inside a vehicle rate during the dawn in Menino Deus is explained by the following independent variables, as shown by the statistically significant model [F (4, 130) = 50.300, p < .001] and: physical connection rate (+), nonvisual physical barriers rate (+), physical and visual barriers rate (+), and global choice (-). Hence, segments with higher values of global choice present lower rates of theft of items inside a vehicle during the dawn (Table 4). Even though the multiple regression analysis reveals that the prediction

model is statistically significant [F (3, 113) = 3.103, p = .029] only 8% of the variance (R2=0.076) in the rate of theft of items inside a vehicle during dawn in Rio Branco is explained by the independent variables. Consequently, no further consideration of this multiple regression analysis is taken.

4. Conclusion

The investigation about the relationship between the occurrence of four types of street crimes in four different periods of the day and the 15 independent variables revealed through the linear multiple regression analysis carried out a tendency for some of these independent variables to be more recurrent in explaining the dependent variables and to have a more effective impact in reducing street crime. Only statistically significant explanations and minimally expressive explanations (at least 10%, or very near to this) for the variance of the dependent variables are considered.

Clear differences in the independent variables explaining the four types of street crime during the four periods of the day were found. Concerning pedestrian mugging in these distinct periods, the main difference is the fact that global choice is the only variable to be related to a reduction in pedestrian mugging during the morning, while variables related to space configuration are related to an increase (local choice and global integration) and to a decrease (local integration) in pedestrian mugging during the night. A specific segment attribute such as rate of poles with street lighting is related to a reduction of pedestrian mugging during the dawn. Moreover, variables pertaining to the relationship between buildings and the street are only associated with an increase in pedestrian mugging during the morning, while some of these variables are also related to a reduction in pedestrian mugging during the night (density of nonresidential access; rate of physical connection) and the dawn (density of residential access to houses).

Regarding robbery of vehicles in distinct periods of the day, a main difference is the fact that local integration is the only variable to be related to a reduction in robbery of vehicles during the morning while variables related to space configuration are related to an increase (global choice and local choice) and to a decrease (local integration) in robbery of vehicles during the afternoon. Conversely, variables related to space configuration (global choice and local integration) are the only ones to be related to a decrease in robbery of vehicles during the night. A specific segment attribute such as rate of poles with street lighting is related to an increase of robbery of vehicles during the dawn. Nonetheless, in any of the four periods of the day, a reduction in this type of street crime relates to variables pertaining to the relationship between buildings and the street.

Concerning vehicle theft in different periods of the day, global choice is the only variable to be related to a reduction in vehicle theft during the night and global integration is related to an increase in such street crime, while global choice, rates of poles with street lighting and density of residential access to houses are related to a reduction in vehicle theft during the dawn.

Regarding theft of items inside a vehicle in distinct periods of the day, variables related to spatial configuration (global choice, local choice and connectivity) and to a specific segment attribute (rate of pole with street lighting) are associated with a reduction in theft of items inside a vehicle during the night, while global choice is the only variable related to such a reduction in this street crime during the dawn. On the other hand, only variables characterizing the relationship between buildings and the street are linked to an increase in theft of items inside a vehicle during the dawn, while this type of variables and global integration are related to such an increase in theft of items inside a vehicle during de night.

The linear multiple regression analysis carried out revealed that none of the 14 independent variables explain either rates of theft of vehicles or rates of theft of items inside a vehicle during the morning and afternoon periods. Nonetheless, a tendency for variables related to spatial configuration being associated with a reduction in any of the four types of street crime was found, corroborating results from previous studies about the positive impact of movement of people on streets in reducing street crime (Hillier and Sahbaz, 2012). On the other hand, variables characterizing the relationship between buildings and the street tend to be associated with an increase in the four types of street crimes, what is not supported by some studies (e.g. Jacobs, 1961).

This can be exemplified by the fact that physical and visual connections between the buildings and the streets are related to an increase in pedestrian mugging during the morning in Menino Deus, what does not appear to have a plausible explanation.

Concluding, the linear multiple regression analysis revealed different relationships between the four types of street crime and the independent variables in distinct periods of the day. These results may add to the present knowledge regarding the impact of physical spatial variables (segments attributes) on street crimes concerning its temporal distribution during the day.

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