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Spatial profiles of urban segments:

Assessing place vulnerability to crime

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Abstract

The studies of space as an important component in order to understand why and when crimes occur increased after contributions prompted by the Environmental Criminology theories formulated by Brantingham and Brantingham (1981), and evidences produced by spatial descriptive analysis Hillier and Shu (1999, 2000), Hillier and Sahabaz (2005), Nesand Lopes (2007). Approaches arising from a multidisciplinary vision, argue that space should not only be considered as the scene of the crime, but also an important component in the development of the fact of a crime, with regard to its timing, sequencing and the conditions that led to its being committed.

Space syntax analysis of macro and micro spatial relations offer research-based evidence to discuss crime and urban design. Hillier and Sahabaz (2008) warn about the need of precise descriptions and spatial measures but also that "design variables do not act independently, but interact, so that all must be got right together if there is to be a genuine reduction in vulnerability".

Thus, we shall present research results on the spatiality of crimes, considering different morphological, typological, and environmental components that are perceived by people, the victims or the offenders, affecting how they move, act, experience and think about the city.

The idea of integrating a series of variables jointly in an analysis led to the proposal of a spatial profile. A profile includes the linking together of a series of traits that are able to characterize an object or phenomenon. Spatial profiles seek to work out the characteristics, sequences and patterns that consistently relate to given types of offenses in a context. It considers the relationship of spatial, social and temporal conditions together to depict a crime situation. This approach makes use of multidimensional statistics, which allows the correlations of complex set of variables such as, accessibility, density, land use, interface, constitutions, visual fields, street lighting and the presence of urban props and deterrents.

In this article, the set of spatial profiles represents qualities of streets or blocks which allow different typologies to be assessed and classified according to a greater or lesser relationship of security, insecurity or the occurrence of different types of crimes. The important output here is to obtain a clear understanding of the socio-spatial elements that together determine such conditions.

This article presents results from a data set from a neighborhood in the northeastern city of Recife in Brazil. This neighborhood represents the typical socio-cultural context of a city with significant social inequality between the groups that use the same space, and where the occurrence of crimes reflects different forms of spatial logic in the perceptions of risks, the assessment of opportunities and choices of situations prone to crime.

The study mapped street crimes (muggings in public places from 2010 to 2012) with ARCGIS which helps to identify patterns of concentration and dispersion of street crimes. A set of urban segments with similar morphological properties but different in crime patterns where selected and had their spatial profiles detailed. The whole set of urban profiles were analyzed by POSA (Partial Order Scallogram Analysis) allowing the identification of morphological and environment traits associated with different crimes patterns.

Keywords

Spatial profile, urban crimes, space syntax, Brazil.

1. Introduction

This study springs from a rising need among urban inhabitants to feel safer where they live. As such, the focus of the analysis is the relationship between cities and criminality, seeking to verify the spatial and architectonic qualities present in different streets, blocks and neighborhoods, and how they shed light in the pattern of occurrence of muggings in these public spaces.

The study was developed in the city of Recife, the capital of Pernambuco, a state in the northeast of Brazil, which until recently experienced high levels of urban criminality[1], and that exemplifies how the search for safety led to a transformation of public spaces transforming the city's public areas into hostile and vulnerable places.

Recife, as most cities that have grown and transformed in recent times, more clearly reflects the culture of fear; the paranoia for security is reflected in houses, streets, squares, leading to a detriment in terms of the quality of urban life. Although the causes and conditions of the crime are complex, their effect is clear and transparent: fear. Urban fear is felt by almost everyone, and the prevailing feeling is that anyone can be a target of an assault, anywhere, and at anytime. The first reaction in terms of looking for protection is to lock oneself up in private spaces, seek refuge in bulletproof vehicles with air conditioning, and only go to controlled public places like shopping centers. You can feel the hostility of space walking the streets of Boa Viagem, surrounded by high walls, deserted spaces, which inhibit taking a walk.

The echoing question is how can we make the city safer?

Urban planners and architects are challenged in their professional fields to design spaces with morphologies and typologies that provide more security. These professionals deal with the existing conformity of built-up urban space, and strive to apply safer places theories and international recommendations most of them, developed in other social and cultural contexts. There is a lack of knowledge about the local crime phenomenon. In order to design safer places is necessary to understand criminals logic and behavior based on the knowledge of habits, flows, times, and movements of a city. Only then, it will be possible to discuss how the spatial characteristics facilitate or deter criminal activities. It is thus considered imperative to gather evidence about criminality in different cultures and social conditions prior to establishing general spatial recommendation for a safer city.

Few inhabitants in Recife understand that the intended security measures adopted individually, such as high closed walls, fortified entrances to buildings, and surveillance cameras (CCTV), cumulatively consolidate an urban space lacking in vitality and without any natural surveillance. Natural surveillance is occurs naturally when dwellers and passersby in in the neighborhood actively use the

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[1]The rate in 2007 was 91.2 individuals killed for every 100,000 inhabitants, according to official DATASUS figures.

streets on a day-to-day basis, and without it coercive policing needs to be enforced. The spatial self-protection of private space leads to a contradiction, as observed in the intensification of vulnerability of public spaces. This was named "architecture of fear" (Ellin, 1997), which has led to an even more serious social problem: social anomy caused by less face-to-face sociability and weak social friction that make connecting within communities difficult.

The aim of this work is to explore the relationships between the morphology and typology of urban space and the levels of criminality within the cultural context of Recife, which in turn is a reality already molded by the fear of crime. The Boa Viagem neighborhood was chosen as the study case in this work. The neighborhood is located at the seaside, and it is characterized for being a middle-class district with shopping streets, plenty of urban movement and vitality, as well as high rates of urban criminality, mainly muggings.

2. Boa Viagem– the morphology of crime

This study aims to analyze muggings, which is a street crime involving passersby because this produces fear and insecurity among people using public spaces. Mugging is defined here as an infraction led by a transgressor using force and/or a threatening weapon most of the time it is armed robbery.

The study identified the exact location of the street crimes, which was difficult due to the sheer number of incident reports filed with imprecise data, due mainly to the incipient process of computerizing the collection of information about such crime. Chart 1 shows the total number of crimes registered during the three years and those presenting precise location. As such, it was only possible to use 25% (1,301) incident reports involving street crime committed in the period between 2010 and 2012 in Boa Viagem.
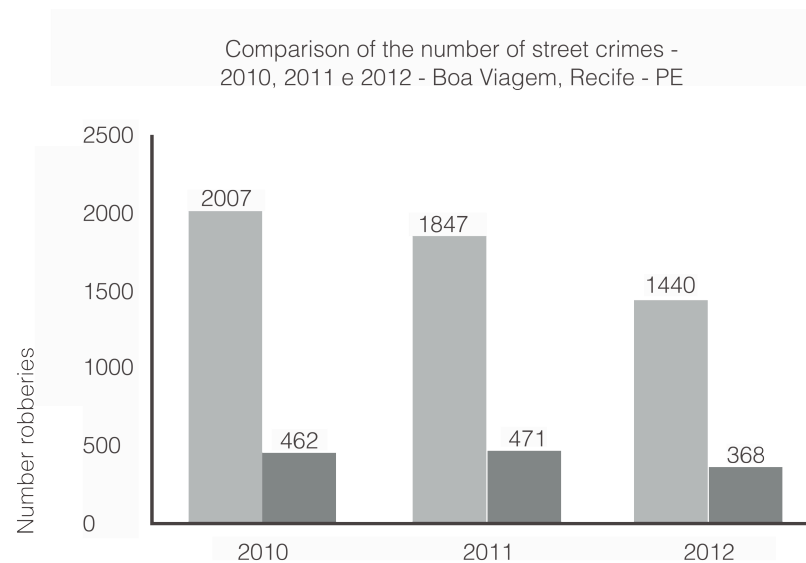

Chart 1: Comparison of the number of muggings involving passersby (light grey bars)and the numbers of cases used in the study (dark grey bars) - data provided by the Secretariat of Social Defense in Pernambuco in the period between 2010 and 2012 in the neighborhood of Boa Viagem.

Figure 1 shows the location of the muggings reported in the neighborhood, making clear the difficulty of a visual understanding of the distribution of crimes in the space, as the image suggests crimes are committed throughout the neighborhood.

How, then, to understand the spatial pattern of distribution of street crimes? Is there a relationship between the neighborhood's spatial configuration with the location of the robbery? How are these crimes distributed in the neighborhood's streets – are they concentrated or dispersed?
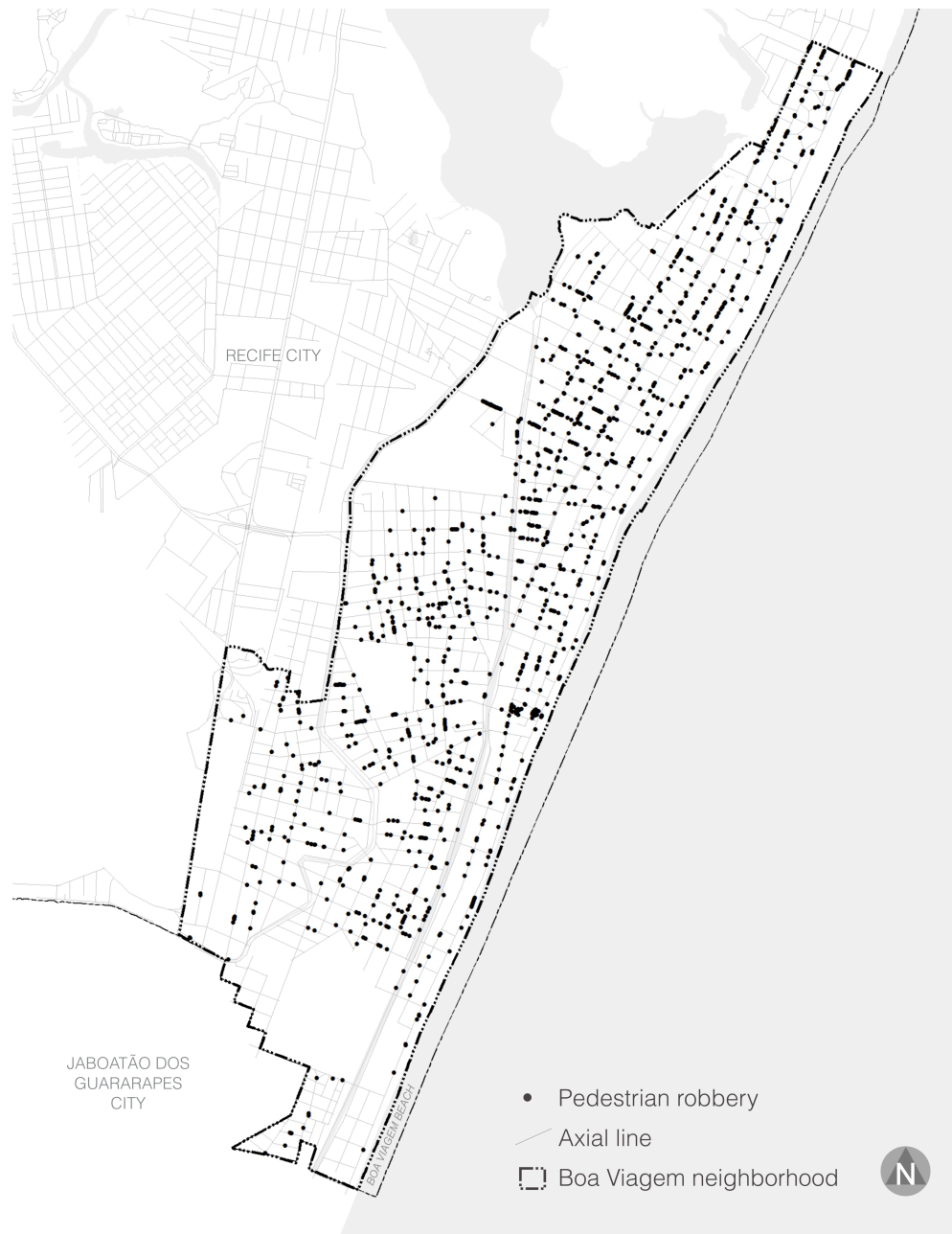
Figure1: Distribution of muggings in Boa Viagem between 2010 and 2012.

The next section presents a systematic analytical process to deal with crime in public spaces. The first analysis considered crimes alongside a street or axial lines representing streets. This procedure allowed us to work with a larger number of occurrences, but that resulted in a shallow reading of the relationship between space and crime. We then included the complete address of where the crime was committed, which led to a smaller sample, but gave a more detailed reading of the real spatial location of the crime allowing analyses insegments of the streets.

Based on segment analysis, the measurements of local integration (r3) produced by the space syntax highlighted the main routes through movement in the neighborhood. Correlations were then made between the values of accessibility of the segments with the locations of muggings in the neighborhood.

As a result of the analysis of integration, the neighborhood's main thoroughfares show the highest values of local integration (r3) (Figure 2). It also shows that local integration was the highest in

locations predominantly commercial in nature and offering services, with the exception of the avenue running along the seaside, which is mainly residential (Avenida Boa Viagem).

Figure 2: Global and local integration by segment.

Among the more integrated local routes are the main avenues parallel to the seafront and a transversal road. The longer routes in the neighborhood accurately reflect the structure of local movement. The global analysis identified the longer routes interlinking the neighborhood with the city center, at the same time the ones with greater flow of motor vehicles. The local integration analysis highlighted the movement between places identifying routes with more local appeal that can be easily walked on foot.

As the segment analysis of accessibility contributed to describing the center of the neighborhood's integration, these were questioned as routes that could explain the location of criminal incidents. So do these crimes take place on more or less integrated routes? To better visualize the standard distribution of crimes, they were accounted for as scaled and spatialized with the number of crimes per urban segment (total of 1456 segments) as shown in Figure 3.

Figure 3: Distribution of the 1.301 located muggings in three years per segments (N=1456)

3. Describing the spatial patterns of muggings in Boa Viagem

Associating maps 2 and 3 it is possible to identify:

- The existence of segments with both a lot of crimes and few crimes in locations with high and low values of integration;
- Approximately 63% of the segments do not presented no crimes, 25% of the segments presented 1 to 2 crimes, and 9% 3 to 5 crimes;
- Slightly more than 2.5% of the segments presented 6 to 15 incidents and, at the same time, variations in the values of global and local integration, indicating some segments with high and some with low values of integration;
- The main access routes to the neighborhood in the north – south direction, and east – west presented a minimum of 1 to 2 muggings in almost all segments.

4. Exploring the morphology of criminality

How do different components of space contribute to the occurrence of urban crimes? How to understand the patterns of concentration and dispersion of crimes often present along routes with the same integration value? These questions have motivated several studies, notably those developed by Sahbaz and Hillier (2007), Hillier and Sahabaz (2008), and Monteiro and Puttini (2009) in the local context.

For Hillier (2004), space syntax is an adequate instrument to investigate standards of urban criminality, for various reasons: it simulates the potential of movement and can be used as an alternative to investigate the probable effect of movement on crime; allowing for the investigation of not only the spatial differences between the areas, but also the micro-standards of differences within them using the same system of measurement; as well permitting a correlation of qualities of space with the behavior of other social or economic variables (Hillier and Sahbaz, 2008).

The methodology chosen in this study, explores the contribution of space syntax and spatial profiles in the integrated analysis of the influence of different qualities of urban space in an area with high levels of muggings.

To achieve this, it was first decided to run a quantitative analysis verifying the relationship between accessibility and movement with the phenomenon of criminality, then to proceed with a second qualitative analysis of spatial profiles in selected blocks of the neighborhood.

5. Analysis of Negative Binomial Regression: Global, local integration, length of the segment and crime

Different statistical models were developed with the aim of finding the model that best adjusted to the nature of the data, or that were capable of explaining the correlation between the values of accessibility, segment length and street crimes.

To statistically analyze the relationship between the values of integration for the segment and the number of incidents we used Negative Binomial Regression, as this statistical model was the best adjusted to the nature of the data available related to muggings. Other statistical models (Simple Linear Regression and Poisson) were also tested, but did not show satisfactory results.

The negative binomial regression model applied to the incidents of muggings showed an excellent adjustment to the data (chisq.p.value:1). It also presented an AIC =3435.4, better than the figure calculated in the Poisson regression model, AIC= 4071.8.

As the global integration variable (rn) of the segment was not significant when analyzed together with the local integration variable (r3), having a high correlation, an analysis was carried out using just the local integration variable. Of note is that the use of the global variable also resulted in an AIC (3445.1) of better than the Poisson analysis, but the local values presented an even better result.

Table (1) of the estimates of coefficients for the Negative Binomial Regressionconsidering thenumberofmuggins per segment

Coefficients	Estimate	Std. Error	z value	P- value	
(Constant)	-1.0117866	0.8858385	-1.142	0.253379	notsignifica nt α=0.1
Lengthofsegment	0.0105825	0.0006660	15.889	< 2e-16	*** significant α<0.0001
Global integration (rn) of segment	-0.0008937	0.0007813	-1.144	0.252686	notsignifica nt α=0.1
Local integration (r3) of the segment	0.0015726	0.0004187	3.756	0.000173	*** significant α<0.0001
AIC: 3435.4				chisq.p.value:1	

Table (2) of the estimates of coefficients for the Negative Binomial Regression considering thenumberofmuggins per segment

Coefficients	Estimate	Std. Error	z value	P- value	
(Constant)	- 2.0190787	0.1194635	-16.901	< 2e-16	*** significant α<0.0001
Lengthofsegment	0.0105930	0.0006645	15.941	< 2e-16	*** significant α<0.0001
Local integration (r3) of the segment	0.0011144	0.0001391	8.013	1.12e-15	*** significant α<0.0001
AIC: 3434.5				chisq.p.value: 1	

The proposed model showed:

Total number of incidents per segment ~ Negative.Binomial (μ, 0.6296), with

log(μ) = - 2.0190787 + 0.0105930 *Length of segment +

0.0011144 * local integration of the segment (r3)

With the adjusted model, the Total number of incidents per segment given the length of the segment and local integration (r3), is adjusted for:

$\mu_{estimated}$ (length of segment, local integration of the segment (r3)) =

exp(- 2.0190787 + 0.0105930 *Length of Segment +

0.0011144 * local integration of the segment (r3))

6. Significant quantitative analyses: The higher the local integration and length of segment – the more crimes are committed in the segment

As such, with a variation in the length of segment of 100 meters, taken together with the other variables, the increase in expected average for the total de number of incidents per segment is given by (2.884351 crimes per segment):

$$\frac{\hat{\mu} \ (Segment \ length+ \ 100, \ local \ integration \ (r3))}{\hat{\mu} \ (Segment \ length, \ local \ integration \ (r3))} = \exp \ (0.010593 * 100) = 2.884351$$

And having a variation in local integration of the segment of 924.881, taken together with the other variables, the expected increase in the total de number of incidents per segment is given by (2.802992 crimes per segment):

$$\frac{\hat{\mu} \ (Segment \ length, \ local \ integration \ (r3) \ + \ 924.881)}{\hat{\mu} \ (Segment \ length, \ local \ integration \ (r3))} = \exp \ (0.0011144 * 924.881) = 2.802992$$

What can be inferred from the analysis at micro level scale (urban segment)? The Negative Binomial Regression analysis indicates significance in terms of length and local integration of the segment, as factors that explain criminal incidents in the neighborhood. Knowing that accessibly and therefore movement have a influence in crime patters, what could explain the different rates of crime in places or segments with same values of integration? In the next section other spatial characteristics will be added in that equation.

7. Spatial profile: A qualitative analysis of segments

The idea of profile includes the linking together of a series of traits that are able to characterize an object or phenomenon. Spatial profiles aims to work out the characteristics differently, using sequences and patterns that consistently relate to a given urban phenomenon.   The use of multidimensional statistics allows for correlations to be made between complex sets of variables it also produces spatial projections of data showing regions of similarity (contiguity). Similar to Space Syntax this kind of analysis reveals the entire data structure rather than isolated relationship between variables.

The elements of spatial profile are determined according to the phenomenon to be analysed. The theories about space and crime indicated as important in the study of crimes in an urban environment include the variety of land use, the density, constitution (number of links or openings) and type of interface between the public and private sectors. Local studies on criminality provide evidence that the accessibility and diversity of land use is linked to the level of risk associated with crimes in urban space (Monteiro and Puttini, 2009 and Monteiro and Cavalcanti, 2012).

In order to handle all of these urban qualities it was necessary to built a scale of values varying from 1 (minimum) to 6 (higher) as shown below.

(a) The varietyofland use

To evaluate the use of land for urban lots, six categories were established: residential (house or residential building), mixed (residential and commercial, residential and services, commerce and services, etc.), service (laboratory, clinic etc.), commerce (bakery, stores, supermarkets, etc.) and institutional (churches, schools, government buildings, etc.) and local environment (parks, squares, beaches, etc.).

Having categorized the types of land use, the challenge becomes how to measure the variety of land use types in the segment. For this purpose, the information related to types of land use were compiled for the segment, using a series of criteria, in order to represent the variety of land use in each on a scale of 1 to 5. The value 1 corresponds to a segment with no variety in terms of land use, with a singular activity, and capable of generating a flow of pedestrians at determined times of the

day, and an absence of movement at others. For example: a segment with all residential lots would be given the value 1, as all the lots are used for the same purpose and tend to generate more movement at specific times. A segment with a value of 5 in terms of variety of use corresponds to at least the presence of four of these six established types of land uses, with one being residential.

(b) Urban interface

Urban interface defines the degree of opening in the front façade of buildings in the lots of an urban segment, and is classified in 5 types: closed, partially closed, mutable, transparent and open.

The classification of type of interface is based on the percentage of closed and partially closed interfaces of the lots in an urban segment. For example: a segment 100 meters in length with 200 meters of adjacent land (the right and left-hand sides of the segment) and with 200 meters of closed and partially closed interface would be classified on the scale of 1 to 5, as 1. If a segment has 10 meters of closed interface and 10 meters of partially closed, it will be classified with a value of 5, as the value obtained with this relationship would be equal to 20%. This 20% would be related to the presence of more open, transparent and mutable interfaces in the segment, which would allow for visual communication between the streets and lots. Based on this logic, the following rules were drawn up:

Table (3) Rules for the classification of urban interface in a segment

Intervals for Integration applied for compiling data base information	Classes
If (100*(∑ closed + ∑ partially closed) / ∑ of the length of the sides is >80%	1
If (100*(∑ closed + ∑ partially closed) / ∑ of the length of the sides is >60% and <=80%	2
If (100*(∑ closed + ∑ partially closed) / ∑ of the length of the sides is >40% and <=60%	3
If (100*(∑ closed + ∑ partially closed) / ∑ of the length of the sides is >20% and <=40%	4
If (100*(∑ closed + ∑ partially closed) / ∑ of the length of the sides is <=20%	5

(c) Constitution

The constitution is defined as the number of existing links between the lots and street that allow the passage of people between these spaces.

To determine how an urban segment is profiled, the number of existing links was considered in the lots and their relationship with the length of the segment. As described below, to classify the level of building profile for each segment in relationship to the others, classes from 1 to 5 were established, based on values able to describe the local context in the city of Recife and the neighborhood of BoaViagem. For example, a lot in Recife has an average of 2 entrances (pedestrian and vehicular) and are 15 meters in length, resulting in 1 entrance every 7.5 m. As such, for a segment of 100 meters, with 200 meters of adjacent sides (on the right and left of the segment) the number of expected constitutionswould be around 27.

(d) Density

To value the density of each urban segment, data on demographic density was used for the sectors, the 2010 census stated the number of inhabitants per square kilometer. The census data was then divided into 5 classes, with each segment classified accordingly. As an urban segment could be included in one or two census sectors, the criterion adopted considered in this case, the highest value to be applied to the segment.

Other important characteristics in terms of the local context could also be evaluated, such as the social status of inhabitants, the presence of attractors or the quality of street lighting, but that were not considered in this study.

8. Multidimensional qualitative analyses

Why are there locations with more muggings and others with less, although with similar values in terms of local and global integration? How do other spatial characteristics contribute jointly with accessibility to influence the concentration and dispersion of crimes in the neighborhood?

To answer these questions, a selection was made based on the results of the Negative Binomial Regression analysis. Figure 4 shows a pair selection model, which helps to determine a sample for observation, the procedure was proposed by Moniruzzaman and Paez (2012).In the present study, these pairs of cases represented segments with similar values of integration (r3) and length, but with a lot or few crime incidents. In this case, the under estimation would be explained by factors that promote more safety, while over estimation would be associated with factors that favor vulnerability.
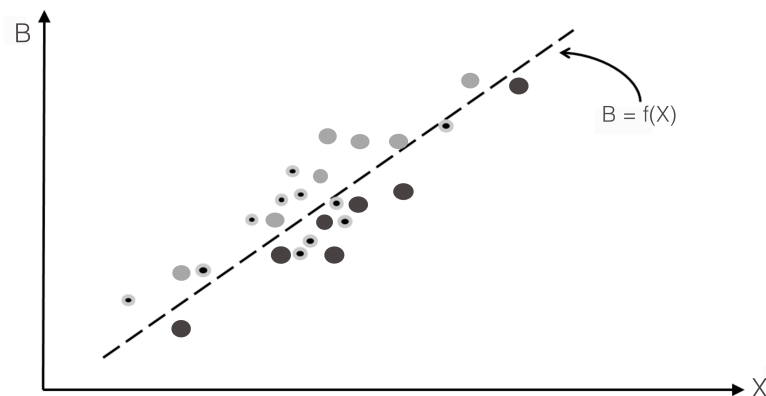

Figure 4: Model for selection of pairs (light and dark circles) with same integration (X) values with under and over estimated cases of crimes (B). AdaptedfromMoniruzzamanand Paez, 2012.

To identify the over and under estimated pairs in urban segments a spatial filter was used that also considered the location in the neighborhood. As a result, a series of 124 segments were identified, and a method of spatial profiling was used in 76 of these, as shown in Table 4.

A multi-scaling method was used to perform a profile analysis (Guttman, 1971). Multiple scaling is a structural perspective used in social and behavioral sciences. From this standpoint, "a structure of the attribute is sought and the measurement of values for each individual item is designed based on an integrated structure" (Shye, 1985).

Multiple scaling extends the notion of Guttman's scaling to wider dimensions, while still adhering to the basic principle that, "measurements of a determined content that are scaled, and the theory about this same content are mutually concomitant", meaning that no methodology can ignore the

study's substantive dominium, but the knowledge of the same can be clarified by the interaction between the idea and data; conceptualization and empirical observations" (Shye, 1985). According to Shye, among multidimensional analysis, the Partial Ordered Scalogram Analysis - POSA provides several advantages justifying its application: the use of raw profiles; the natural transition to spatial representation not making use of mediating statistics; and, the extent to which it facilitates the assignment of meanings to directions in space. POSA considers any number of responses since they are ordered from low to high as well as dichotomous ones.

In this work, the spatial profiles comprised four components that represented ordinals of space quality (variety of use, density, interface and constitution). The variation from low to high in terms of intensity attributed to the components (each was ranked on scale of 1 to 5) followed a common path: the construction of urban vitality and, therefore, the notion of more safety.

Table 4. Examples of the segments selected for the structuring of Spatial Profiles.

Segment	Varietyofland use	Density	Interface	Constitution
1	1	5	2	3
2	1	1	4	3
3	3	5	4	2
4	3	5	2	4
5	2	5	2	5

Theoretically some presumptions were adopted: that a larger variety of activities also determines a wider variety of individuals present, and diversity in terms of hours of movement; more density would be related to the presence of more people, and thus greater vigilance. The other two attributes theoretically follow the same course, where spaces with more open interface favor more visual contact and vigilance, and more constituencywould facilitate permeability and dynamism between public and private space.

9. The statistics of POSA– Partial Ordered Scalogram Analysis

The scaled analysis develops a primary ordered quantitative scaling for the profiles based on scores, or sums. The same are thenscaled for a qualitativedistribution.

The space of the projection is regionalized according to the content values of each profile, and each component analyzed is allocated a region in the space.

The following diagrams show a projection of the points in the Euclidian space, where each point represents 1 of the 76 spatial profiles. Considering the quantitative and qualitative nature, we see that all the points are distributed uniformly in the space with no relation to any one of the axis in particular.

The first measurement in terms of recognizing the standard of these profiles was to identify the urban segments in the projection with a high number of crimes, totaling 10 cases, and the segments with an absence of crimes. This projection was the result of a multidimensional analysis that sought to locate regions of similarity in the space as a function of the components of the profiles analyzed.

As a result of this analysis, each component analyzed presented a projection that indicated the variation of its scaled value, of between 1 and 5, as presented in the four diagrams below. We also identified the profile components related to the urban segments with more or fewer incidents of muggings in these projections.
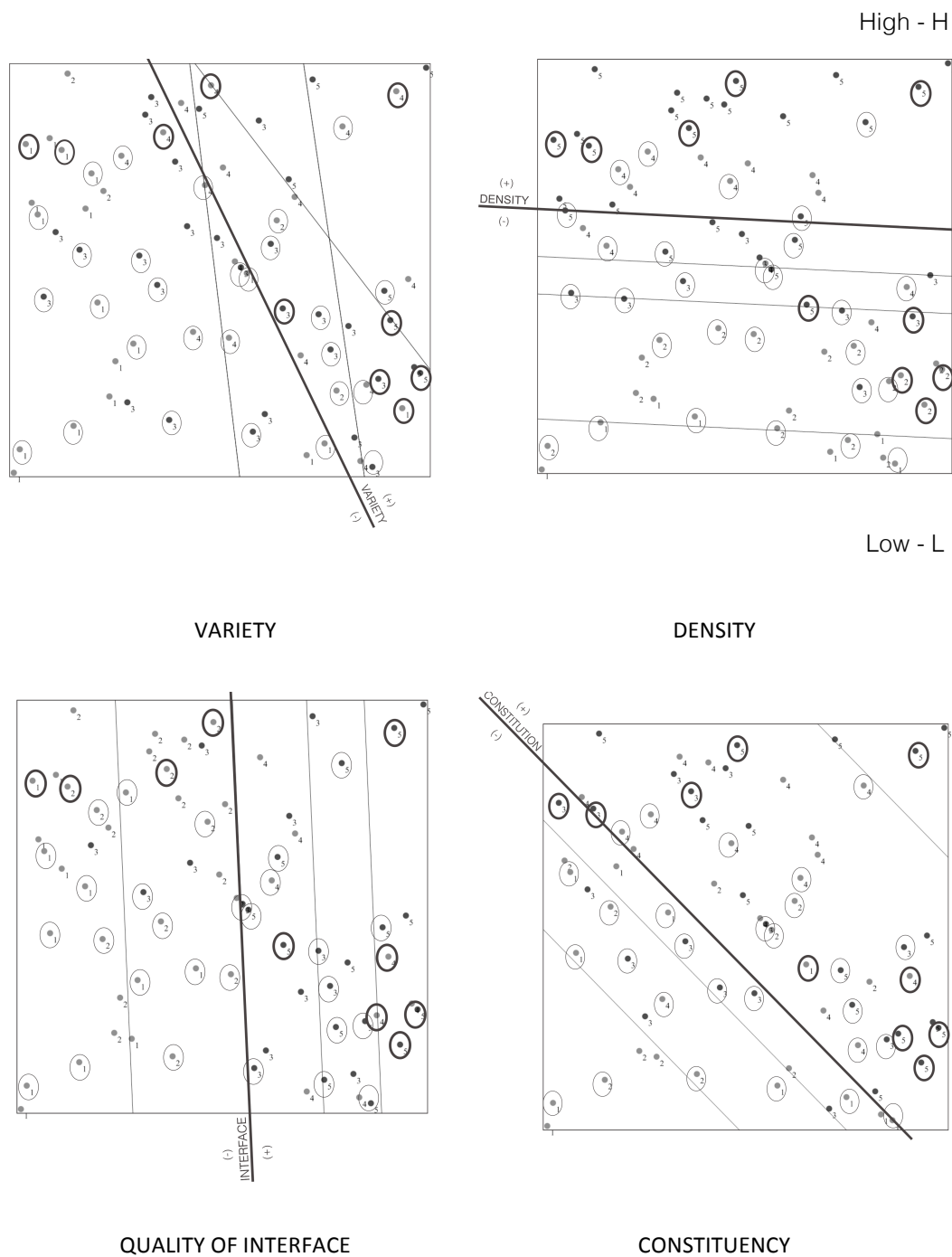

High - H

Low - L

VARIETY

DENSITY

QUALITY OF INTERFACE

CONSTITUENCY

Figure 5: POSA Projections – variety of land use, density, interface and constituency. The dark circles indicate the segments with the highest number of crimes and the light circles the lowest.

10. Results

The projections for each spatial profile component were made along four lines, in distinct positions, representing five divisions indicating the higher or lower quality of the item. Figure 6 shows the projection of the structure of similarity between the urban segments with the lines indicating regions of higher and lower quality in terms of density, variety, constitutions and interface. The dark circle points are the urban segments with the highest number of crimes.

The regions close to the right hand side and upper section of the diagram show the highest scaled values (4 and 5), which correspond to the higher variety of land use, more density, the presence of more open interfaces, and constitutions. The regions located close to the left hand side and lower section of the diagram predominantly show the lowest scaled values (1 and 2).

Based on the diagram and the 10 profiles with the highest number of crimes, it can be seen that:

- Seven of the ten points with the highest number of crimes were located in the regions with the greatest variety of land use, while the other three cases are in locations with no variety in terms of use, as they are predominantly residential areas of the neighborhood;
- Six profiles are situated in the region of high population density, with the value 5, and 3 profiles in low-density areas, which indicates the influence of other profile components adding potential and altering the low density effect;
- Six of the ten points with the most crimes have open interface profiles, with values of 4 and 5, and 4 profiles show closed interfaces, with values of 1 and 2 (other points with zero incidents were mainly located in enclosed areas); in relation to building constituency, we can see the existence of a lot of crimes taking place in more linked segments and few crimes in the less linked segments;
- Six of the ten points with more crimes presented high numbers of links or constitutions, at 4 and 5; 3 presented a regular number of constitutions (with a value of 3) and only 1 was less constituted.

When we analyze the four components together, we can see that the spatial profiles with little variety, low density, and less constituted with closed interface have fewer incidents of crime. In addition, the absence of elements of attraction in terms of movement, such as commerce and services, together with low visual permeability and density can influence the low local levels of movement and flow of people.

A combined analysis also indicates that the spatial profiles with the highest number of crimes show a great deal of variety in terms of land use, hign numbers of constitutions, open interface and are located in regions with both high and low density. The low-density areas can be linked, in some cases, to regions with commerce, services, some housing and an intense movement of people during the day, and low movement at night. In the Boa Viagem neighborhood, the areas of commerce and services tend not to be home to a resident population, and thus more transient, with a lot of constitutions that allow for a greater flow of people, and consequently less control.
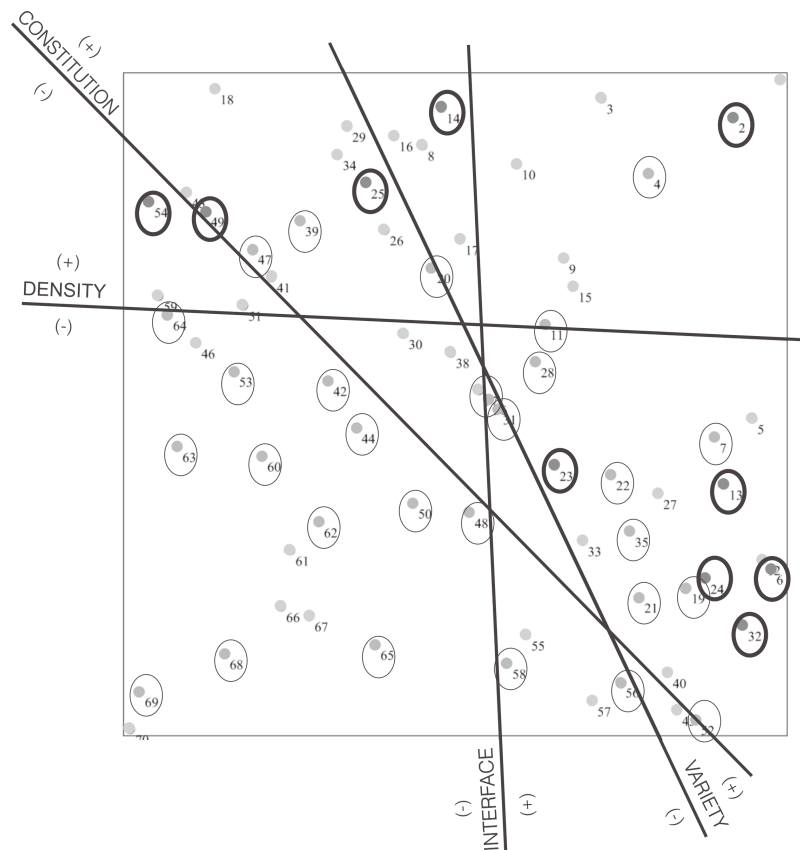
Figure 6: Scaled relationship between 4 components of Spatial Profile.

The data also indicate the presence of a profile judged an outlier (segment 2), or with results related to crime of far higher than those presented by the other profiles. In this sense, the presence and analysis of this spatial profile allows us to investigate what other types of conditions are in evidence to explain this behavior.

Lastly, the combined analysis of the spatial profile components allows us to identify the relationships between profile qualities, the similarity between the profiles in relation to occurrenceof crimes, and identify the qualities present in the regions with the highest and lowest number of muggings.

11. Discussion

Based on the questions established by Hillier and Sahbaz (2008) about the role of spatial elements in terms of incidents of crime, it was asked: what favors a lower or higher number of crimes in determined areas of Boa Viagem? Does population density favor or make it harder for muggers? Does the variety of land use favor this type of crime or not? Do streets with more or less constitutions favor or hamper these crimes? Do open locations favor or hamper muggings in the neighborhood? Do the levels of variety of land use contribute or not to the concentration of muggings in determined locations?

According to Hillier and Sahbaz (2008) and Monteiro (2010), these variables need to be understood as a whole, as they integrate the urban environment and construct an urban ambience. In the same way, understanding the correlation of each in an isolated manner from crime would provide a fractioned vision of the problem, given the complexity of these relationships in urban space.

The spatial profile allows us to identify different profiles in urban segments with high and low levels of street crime, for example, segments that have a wide variety of land use and low density have

more crime than those with little variety and high density. Based on the results of the spatial profile analysis it can be argued that in the context of Boa Viagem neighbourhood:

1)   Segments with a lot of street crime comprise a wide variety of land use, have more constitutions and open interface. These segments are probably home to a large number of unknown people, based on their accessibility value (integration) and the attractions available in these spaces.

This result reinforces the role of high integration with its positive correlation to muggings in Boa Viagem, as more integrated streets tend to have a wider variety of land use, by stimulating the building of attractions in the area due to the presence of natural movement (Hillier et al, 1993). In addition, the existence of commerce and services would lead to more links between the streets and establishments, and thus more open interfaces to facilitate the approximation of people to these locations, thereby diminishing the effect of co-presence and natural vigilance (Hillier and Sahbaz, 2005).

2)   The data also show that some segments with higher crime rates and a wider variety of land use present a lower density of residents. Could the presence of these residents in these spaces contribute to lowering the number of crimes?

The environments with a wider variety of land use in Boa Viagem are rarely residential locations, and have a variation in movement of people at different periods during the day. For example: areas with commerce and services are completely open during the day and closed at night, thus diminishing local movement and possibly the number of targets for street crimes. According to crime data, it is at these moments of transition that these types of crimes happen.

For Hillier and Sahbaz (2008), the high level of accessibility linked to the absence of residential areas tends to diminish the effect of co-presence, facilitating criminal activities. As such, the more integrated streets with transitional movement tend to be more dangerous, according to the authors; a fact that is underscored in some of the more integrated areas of Boa Viagem.

3)   The elevated presence of highly constitutedsegments in spatial profiles with a lot of crime, a lot of variety and low density, associated with the interface exchange (opening and closing hours) effectively offsets the importance of the number of constitutionsin the area.

This variation, which occurs during the day and night, would influence the movement of people in the area, as they would not enter or leave at certain times. It would also lead to less control of spaces, due to the high number of openings, which could contribute to criminal activities (Hillier e Sahbaz 2005 e 2008).

4)   The data also reveal that segments with little variety, that are closed and with high residential density present zero incidents of street crime. So are these the safer segments with more control in the neighborhood, as proposed by Newman (1972), the defensive spaces?

No, as in similar segments we found a higher level of crime, although these are very few and far between. What explains the number of crimes in these locations, as many of the segments with crime are in accessible locations, with a wide variety and that tend to be open?

The predominantly residential streets in Boa Viagem tend to present more closed interfaces and with few openings, providing more protection and control. This factor has been intensifying over the last few decades, given the rise in feelings of insecurity related to the isolation of buildings and loss of vitality in public spaces.

According to Jacobs (1961), the combination of the absence of: variety of land use, the relationship between public and private space, and other elements that promote movement and natural vigilance, have all contributed to making environments more vulnerable. But we should remember that the city today is unlike the one described by Jacobs in the sixties, as, apparently, in recent times,

the segregated environments, although not a model of urbanity, do register fewer crimes. Are there, therefore, other elements that associated with low movement, variety of land use, visual communication between public and private spaces are contributing to the absence of crimes in these locations? The results produced in the neighborhood of Boa Viagem show the relevance of an integrated analysis of spatial qualities but strongly suggests that other social traits should be incorporated in the analysis such as social status of inhabitants. The contrasting results with international studies reveal a peculiar criminal logic, in a city with very weak public policing and clear impunity, robbers tend to act in places where they could choose their victims, favoring places, which attract higher number of people.

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