SEGREGATION PATTERNS IN THE STREET INTERFACE OF THE BRAZILIAN CITY.

TOWARDS A METHOD TO READ THE EFFECTS OF LOCAL SPATIAL SEGREGATION.

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ABSTRACT

The results of recent urbanisation in Brazilian cities have been consistently represented through terms such as ‘gated city’ or ‘the city of walls’. These words reflect an emerging pattern of segregation in cities, what is sometimes described as ‘anti-urban’. This process of segregation is one out of the many spatial reflections of the extreme inequality that characterises the country. As cities continue to transform following this anti-urban model, the risks of exacerbating social and spatial divide increases, and possible progressive responses are made very difficult. Segregation in this context follows a new logic, no longer a mere opposition centre-periphery but a hybrid and intertwined set of ‘...architectural typologies, spaces and transportation systems that favour a few ways of life over all others.’ (Figueiredo 2012, 2)

Such anti-urban patterns in the Brazilian city represent a challenge for the types of segregated spaces generally defined in sociology studies as the ghetto, the enclave and the citadel (Marcuse 1997) which implies a spectrum of external control and biases related to a desire to exclude and to be excluded. In most of the urban studies focused on Brazil and in the anti-urban phenomena, aimed at enclaves and gated communities, the scale of analysis and discussion is the neighbourhood or larger fragment of cities. This study brings the focus to segregated spaces at the building scale. This paper provides an understanding of the impact of a specific typology of the street interface in the location of activities in cities in Brazil.

KEYWORDS

Segregation, Brazilian urbanisation.

1. INTRODUCTION

This paper is part of a more extensive study that examines to what extent the street interface of buildings can influence urban activities in the Brazilian city. This study builds upon previous research that has focused on the recent urbanisation in Brazil and has pointed to distinct social-spatial patterns in the urban environment with various effects on urban activities. The study aims to relate the street interface with the capacity to promote encounter or segregation of people in urban environments and to shed light on the role of planning in the mediation of these processes.

Street interface refers to the physical boundary between private and public spaces, the contact zone for domestic and urban activities. It has been present in the discussion about urbanity and urban vitality where it is described as the place to negotiate the demands of the private and public realm and to provide the means or affordances to sustain public life (Dovey and Wood 2011; Karssenberg et al. 2016).

This research explores a different approach regarding the connection between urban form and activities, placing the attention on what prevents an urban environment rather than the formulation of principles to foster it. Although other studies have used this approach before, this is still an issue to be further explored, especially in the space syntax domain (Koch 2015).
The full study aims at the mechanisms behind the types of street interface and offers an understanding of the connections between urban form, planning codes and urban activities. The first part, the connection with planning instruments was the object of a previous paper (Carvalho Filho and Van Nes 2017). In the present article the focus shift to understanding the effects of a specific typology of the street interface in the distribution of activities.

The paper has two parts. The first part analyses the current process of urbanisation in Brazil. This part contains a brief description of types of segregated spaces - the ghetto, the enclave and the citadel - which are used to frame the current setting of the Brazilian city. The second part of the paper selects one case study: Recife, a city in the northeast of Brazil, where the location of buildings with segregated street interfaces is used to analyse the divergences between the potential present in the city layout to the actual distribution of activities.

The paper concludes with the first steps towards a method to identify, characterise and, to a certain extent, predict the emergence of segregation patterns at the building scale in the Brazilian city. That represents a contribution to social and spatial studies and the planning domain.

1.1. Urbanisation in Brazil and segregation.

In Brazil, the recent process of urbanisation ignited in the 1940s and 1950s has pushed the urban population to the current number of 85.93%\textsuperscript{1}. Furthermore, 39.54% of Brazilian people will reside in agglomerations with more than one million people by 2050 (Da Mata et al. 2007). Those figures are not particular to the Brazilian case. They are typical projections for most of the Global South, including African and most of the Asian countries (Shatkin 2016). What typifies and makes the study of Brazilian cities more critical and relevant is the high level of inequality\textsuperscript{2} that arises in the urbanisation process, and moreover the reflection of this adverse social context in the transformation and use of urban space.

This process of growing cities where significant parts of the population were not integrated into the formal economy and the land market (Marques 2015, 1017) has contributed to variable forms of segregation, from the well-defined model of centre versus periphery to ones in which inequalities are inscribed into urban space in patterns not immediately identifiable (Caldeira 1996). Some of these patterns have been consistently represented through terms such as ‘gated city’ or ‘the city of walls’ (Caldeira 2000). These words reflect an emerging type of segregation in cities, what is sometimes described as ‘anti-urban’. This process of segregation is one out of the many spatial reflections of the extreme inequality that characterises the country.

As cities continue to transform following this anti-urban model, the risks of exacerbating social and spatial divide increases, and possible progressive responses are made very difficult. Segregation in this context follows a new logic, a hybrid and intertwined set of ‘…architectural typologies, spaces and transportation systems that favour a few ways of life over all others.’ (Figueiredo 2012) The causes of this urban fragmentation process and the consequences for urban activities are the object of extensive discussion. Balbo (1993) traces the main drivers for urban fragmentation in developing countries as strong population growth, the functioning of the urban economy, and the ideology of urban planning and the role of the state.

The study of patterns of segregation or social-spatial divides in the Brazilian city has also been a constant in academic research presented at the space syntax symposia. The scope of the analysis and investigation is broad and ranges from the impact of building typology in pedestrian movement (Netto et al. 2012), the effects of planning in urban form (Carvalho Filho and Van Nes 2017), to marketing strategies to promote isolation and exclusivity in housing (Amorim and Loureiro 2003).

Such anti-urban patterns in the Brazilian city represent a challenge for research as Netto (2015) highlights when exposing the shortcomings of describing segregation in Brazil by only referring to static territorial features. Complementary, the author also mentions that to counteract segregation requires events and places that can offer material conditions for encounter.

\textsuperscript{1} Figures of 2017, IBGE.
\textsuperscript{2} Brazil scores 51.48 on the GINI Inequality index (2015) from the World Bank, the index varies from 0 to 100.
In that sense, it is relevant to understand how far the patterns of segregation in Brazil are from those types of segregated spaces generally defined in sociology studies as the ghetto, the enclave and the citadel (Marcuse, 1997). This classification implies typically a spectrum of external control and biases related to an intention to exclude the undesirable ones and to be kept apart.

One can argue that the extremes in this criterion are the ghetto, as the expression of forced isolation of a group of people and the citadel, where a dominant part of society cuts ties with the rest to preserve and enhance privileges. The enclave, some ‘voluntary developed spatial concentration of a group to promote the welfare of its members’ (Marcuse 1997) has been translated to the urbanised areas in Brazil as the larger gated communities present in some cities.

This type of spatial settlement has raised attention in academia and is the object of most of the urban studies focused on Brazil and in the anti-urban phenomena, where the notion of control is associated with a sense of security and vigilance (Caldeira 1996a). However, due to the demands of vast spaces and other locational aspects, this model of segregated spaces has been restricted to the peripheries of Brazilian cities.

The question in this study is how the definitions of segregated spaces can help to understand the recent developments within the urban core of cities in Brazil. To be sure, this study does not underestimate the impact of gated communities. However, it seems necessary to address more diffuse phenomena that have been identified in several cities and due to its spatial features is easily implemented and rapidly spread.

1.2. The void street interface.

As mentioned before, the underlying motivations for segregation in Brazil are related to the sense of security and control, the prominent feature that emerges in this process is the wall. Although central to the discussion of segregation, the sense of security does not respond entirely to the expansion and dispersion of more massive walls in the city urban core. As the case of Recife shows (Carvalho Filho and Van Nes 2017), changes in planning regulation associated with the expansion of car ownership and parking demand have also contributed in the expansion and upscaling of buildings with void street interfaces.

It is an apparent case of a successful model that combines a response to fear (Leitão 2009) with marketing strategies (Amorim and Loureiro 2005). These buildings, if we refer to the types of segregated spaces, share central notions with the citadel. The question is to what extent is this isolation voluntary and conscious and if it contributes to enhance or sustain benefits to those within the walls. This question will remain, the focus of this paper is on the external impacts of this typology rather than the internal motivations for its existence. That is not to say that the motivations for isolation do not need to be addressed; in this paper, they will be used to frame and limit what needs and can be done to counteract the dispersal of void street interfaces and moreover to better identify areas where they are likely to appear.

To be precise, the street interfaces referred here as void or segregated are those that result from the construction of a building, they are the opaque frontage of a built volume. That excludes from this classification the walls that merely divide a private open space or vacant plot from the public spaces. This restriction is justified by the need to better compare street interfaces with the intensity of the distribution of activities. The inclusion in the analysis of vacant plots with void interfaces could induce to imprecise results in the comparison.

2. THE IMPACT OF VOID INTERFACES IN RECIFE

The city of Recife has been recurrent in previous Space Syntax symposia. As one of the main metropolitan areas in Brazil, it presents a case that can be used to generalise some of the findings regarding segregation patterns and the role of specific building typologies of street interfaces in the distribution of urban activities. The analyses that will follow have several spatial frames; for example, the syntactic analysis has used a larger frame of 200 km x 200 km of the street network, other aspects such as the location of activities have been restricted to the municipal border.
2.1. Dataset and methods

One of the questions that are recurrent in studies that combine spatial and social analysis is the matter of scale and resolution of data. In this study, the analysis required a method to combine data that have different spatial configurations. The four main classes of data are points, street segments, building boundaries and census blocks. The approach used here was to transfer the relevant information of each of these classes into a geometric grid of 200m side, a scale that fits with the average block size in the city studied and that can capture the level of detail demanded in the next steps of comparison.

2.1.1. Street Network.

This part of the analysis uses the street network of Recife extracted from Open Street Maps. The file with the centre lines of the street network was processed in GIS software in order to isolate loose segments and generate a file with theunlink points for bridges and tunnels. The syntactic analysis was performed using the Place Syntax plugin for Qgis software (Stavroulaki et al. 2017). The analysis involved testing several settings and configurations to obtain global and local measurements. The results presented here use angular choice (5000 m walking distance) and angular integration (250, 500 and 1000m walking distance). The values of the segments have been transferred to the basic grid of 200m.

Figure 1 - Scales of analysis, 200km frame, Recife (in red) and the metropolitan region (in grey).

Figure 2 - Classes of data analysed, point, segment, buildings and census blocks.
2.1.2. The concentration of activities.

In this part, we elaborate on research developed as part of a large project of urban regeneration through public spaces in Recife, the Capibaribe Park (Carvalho Filho et al. 2015). The referred data and analysis consist of a cadastre and classification of urban activities in Recife. The work coordinated by Circe Monteiro and Amanda Florêncio is yet to be published.

In this research, the authors explored the concept of urban vitality and its importance for the park project. The methodological procedures used to identify these areas were, firstly, the collection of information from existing commerce and service establishments in the city; later, the identification of which types of establishments favour urban vitality, using weighted criteria for each category/type. The dataset of the commercial, service and institutional establishments of the city of Recife comes from the database of the National Register of Addresses for Statistical Purposes - CNEFE of the Brazilian Institute of Geography and Statistics - IBGE.

In order to analyse the degree of urban vitality that these establishments possess, after the discrimination of land use, each of the establishments was classified following five categories: size of establishment, opening hours, operating shifts, the flow of people, activity internal/external to the establishment. Weighting has been established for each category and, from the sum of the scores of the categories, obtaining a hierarchy of places as a proxy for the degree of urban vitality.
In this paper, we use the information regarding the concentration of activities obtained in the Capibaribe Park research, transferring the weighted values to the same grid used to register the syntactic values.

The method to transfer the values to the grid was first to generate a raster with the kernel density of the activities points and next to transfer the average value to each grid cell.

![Figure 5 - Distribution of urban activities.](image)

### 2.1.3. Buildings with void street interfaces.

The dataset with the location and spatial characteristics of the buildings with segregated interface results from the preliminary data from an ongoing cadastre realised currently by the municipality of Recife using Lidar data. In the process for the cadastre, the raw data was processed in GIS software and the buildings classified according to building height and completion of the construction. One of the classifications provided by the municipality product was the base of buildings. Starting from this class of buildings the next step was to verify the type of street interface of each building and to isolate those with segregated borders. The verification was by samples and relied on the use of images from Google Street View that cover a significant part of the city.

Similarly, to the previous datasets, the information about the existence of segregated buildings was transferred to the grid and the cells classified in two classes, yes or no according to the presence of buildings.

![Figure 6 - Distribution of buildings with the segregated interface, from points to buffer and grid.](image)

### 2.2. Methods to integrate the results

One of the shortcomings in the spatial analysis that integrate social, economic and other factors is to what extent is it possible to model urban dynamics where there is no clarity about all the parts that play a role in the equation. The analysis of the data that has been used in this paper is far from generating a perfect model to predict the intensity of activities in the city. What follows is an attempt to assess the impact of void street interfaces in the distribution of activities, to what extent the location...
of these interfaces explains the deviation from what is expected in the syntactic analysis to the actual values of intensity of activities.

The first step in the analysis was to refine the basic grid used to register the data obtained of the different datasets. The first reduction was to limit the comparison to the cells contained within the boundaries of Recife. The second step was to eliminate the cells in non-urbanised areas, such as water bodies, forests and remaining rural areas. Once the grids were refined, the data was compiled in a single table in order to process the results.

2.3. Statistical treatment of data.

Comparing spatial elements requires an understanding and assessment of the local and global impact of the variables in the study. In this specific case, the comparison between the different sets of data required a statistic measure capable of comparing not only individual cells values but to assess the impact of the values of a cell in their surroundings. The chosen method was Geographic weighted regression; an instrument seldom used to evaluate the impact of spatial and non-spatial values to predict the occurrence of certain phenomena (Mashhoodi and van Timmeren 2018).

2.3.1. Dependent variable

The dependent variable, in this case, is the intensity of activities (IA) extracted from the concentration of activities, weighted by the index attributed in the research of Monteiro and Florencio. The values have been classified into ten classes.

2.3.2. Independent variable

The independent variables used in the analysis are the values for angular integration (r 5000), angular choice (r 250, 500, 1000) and the existence of buildings with the void interface. The numeric values for the first two variables have been classified in ten classes and the last one in two classes.

2.3.3. Geographic weighted regression

The initial step of the method consists of a linear regression model, (see equation 1), assessing and generalising the influence of geographic factors on the IA:

\[ y_i = \beta_0 + \sum_k \beta_k x_{ik} + \varepsilon_i \]  
(equation 1)

Where \( y_i \) represents the estimated value of IA in the cell \( i \), \( \beta_0 \) shows the intercept of the estimation, \( \beta_k \) denote the coefficient slope of the factor \( k \), \( x_{ik} \) represents its value of factor in cell \( i \). \( \varepsilon_i \) accounts for the random error factor in cell \( i \). The second session, GWR model, (see equation 2), is deployed on the same dataset:

\[ y_i = \beta_0 (\mu_i, \nu_i) + \sum_k \beta_k (\mu_i, \nu_i) x_{ik} + \varepsilon_i \]  
(equation 2)

Where \( (\mu_i, \nu_i) \) express the geographic coordinates of the cell \( i \), \( \beta_k (\mu_i, \nu_i) \) and \( \beta_0 (\mu_i, \nu_i) \) are the local coefficient and intercept of factor \( k \) estimated specific to cell \( i \). The local estimates are obtained by weighting the instances around cell \( i \) (equation 3):

\[ \hat{\beta}(\mu, \nu) = (X^TW(\mu, \nu)X)^{-1}X^TW(\mu, \nu)y \]  
(equation 3)
Where $\hat{\beta}(\mu, \nu)$ denote the unbiased estimate of $\beta$, $W(\mu, \nu)$ is weighting matrix obtained using adaptive Gaussian function (equation 4):

$$W_{ij} = \exp\left(-\frac{d^2_{ij}}{\theta^{2(k)}}\right), \quad \text{if} \quad d_{ij} < \theta^{(k)}$$

$$W_{ij} = 0, \quad \text{otherwise} \quad \text{(equation 4)}$$

Where $W_{ij}$ denote the weight of instance observed at cell $j$ for estimating the coefficient at cell $i$, $d_{ij}$ is the bird-fly metric distance between $i$ and $j$, and $\theta^{(k)}$ is an adaptive bandwidth defined as the distance from the $k$th nearest cell distance.

The analysis processed in GIS software is shown in a series of maps that represent the accuracy of the model to indicate IA and the variation of the results according to each of the groups of independent variables.

2.4. Preliminary results.

Figure 7: Predicted values for IA resultant from the geographic weighted regression (left) and the $r^2$ values (right)

Figure 8: Accuracy of the global (left) and local (right) values from the syntactic analysis compared to the IA values.
The results of the weighted regression, as shown in figures 7 and 8 indicates the effect of the location of buildings with the void street interface in the predicted values for IA. That is more evident in the map with the results for $r^2$ where the higher deviations between predicted and actual values are located around the cells with the intense presence of void interfaces.

When comparing global measures (figure 8, left), the results indicate a higher accuracy in the areas connecting the city centre to some of the secondary centralities and towards the west. It indicates the current relevance of one of the historic axes of the city as activities can still be found around it. The case of local measures is slightly different (figure 8, right), the more significant results are found in the suburbs in the west of the city and at the city centre. Again, the areas with a predominance of void interfaces are those where the results differ most.

The results highlight two groups of areas that need a more local analysis, the first, areas with a high concentration of void interfaces and the second with areas where this typology is absent. The preliminary conclusion is that further research should be done in order to identify how urban activities can still appear in the first group, and what lessons can be extracted from the second group of areas. Are there any spatial strategies in these two groups of areas that could be replicable?

3. DISCUSSION

The preliminary results brought in this paper point out to the need for a better understanding of the impact of local scale aspects in the urban dynamics at the city level. The example of Recife shows that local changes such as the presence of void street interfaces can affect urban dynamics at the global structure of a city. Next steps in this field of analysis should look for a more nuanced connection between the changes in local properties and the scale factor, meaning to evaluate how recurrent and spread must be a local scale factor to have a global impact.

It also reinforces the urgency for the debate around the planning framework in Brazil. It sums to the discussion about the rigidity of the national model, the lack of guidelines and moreover indicators for public participation and mainly the question of suitability of a single model for the varied set of Brazilian cities (Villaça 1999).

The critical point to be further discussed is to what extent the limited set of parameters and regulations in use in Brazilian cities can address the issues raised in this paper. It resonates the discussions about how planning by codes, assigning spatial values according to zones and treating the plot as a contained element resulted in the process of standardisation of the built landscape (Lehnerer 2009; Sung Hong et al. 2016). Furthermore, future research about street interfaces should seek for the limits of a model described by Bernardo Secchi as:

“What changes down the history of the city is much more the regulatory sense and role of each device rather than the catalogue of devices, and it is through this regulating action that the city becomes a machine for social integration or exclusion as the case may be.” (Boano and Astolf 2015)

Figure 9 Void street interface in Recife - Source (Leal, L. H., Nascimento, C., Nobrega, L. & Zatti 2012)
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