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## URBAN AND SUBURBAN LEGACIES

Space, Form and Urban Vitality in two LEED-ND certified Olympic Villages

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Nicholas Martino<sup>1</sup>; Edja Trigueiro<sup>2</sup>; Cynthia Girling<sup>3</sup>; Marício Martins<sup>4</sup>; Fabrício Lira<sup>5</sup>

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### ABSTRACT

The Olympic Villages built for the games of Rio de Janeiro (Ilha Pura Condominium, IPC, 2016) and Vancouver (Southeast False Creek, SFC, 2010) were both granted LEED-ND certification for sustainable neighbourhood developments based on evaluation criteria devised to foster walkable, livable and sustainable communities. Considering that the attainment of these qualities is partially dependent on morphological and functional properties that facilitate movement, visibility and encounters – ingredients deemed to favour vital public spaces – the purpose of this paper is to verify how the design of these LEED-ND certified Olympic villages facilitates or hinders the vitality of public spaces, by assessing the incidence of urban vitality indicators across multiple spatial scales for each case. Firstly, indicators of accessibility, density and diversity were aggregated at 800m of each street segment. Secondly, land uses and integration were graphically juxtaposed in an attempt to answer how the design of each neighbourhood integrates or segregates different uses. Finally, building-street interface and pedestrian infrastructure maps were juxtaposed over potential pedestrian movement patterns, expressed through visibility and movability measurements ('kneesovist' and 'eyesovist' joined). Findings indicate that intense pedestrian movement patterns – both potential and observed – arise from the location of the SFC within the city, land use diversity and integration among buildings, public spaces, transportation corridors and waterfront. Meanwhile, IPC is segregated both from the city of Rio de Janeiro as a whole and from its immediate surroundings, resulting in an uneven distribution of green and leisure spaces, highly integrated to those living inside the condominium and little integrated to the surrounding communities. It is very unlikely, therefore, that the IPC development does or may contribute to the urban vitality of its surroundings, as prescribed in the criteria that guide accreditation in environment beneficial design. Results also raise questions about the need to apply costly evaluation processes (such as LEED-ND) to attain goals as broad and subjective as those of “sustainability” and “smart growth”.

### KEYWORDS

Urban Vitality, Olympic Villages, LEED-ND, Urban Morphology, Space Syntax

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## 1. SUSTAINABLE LEGACIES?

The neighborhood of Southeast False Creek, SFC, in Vancouver, Canada, 2010, and the Ilha Pura Condominium, IPC, in Rio de Janeiro, Brazil, 2016, were designed to house athletes for the Olympic Games of 2010 and 2016, respectively. Both projects received the LEED for Neighborhood Development, a “green neighborhood” certification system “engineered to inspire and help create better, more sustainable, well-connected neighbourhoods” (GBC, 2014) – even though they appear to be quite different in design aims, occupation pattern and location within the city. The aim of this paper is to explore some of their differences in space and form, and discuss – in a comparative perspective and in the light of studies about attributes viewed as indicators of movement, visibility and encounter – if and how the design of these neighborhoods may contribute to places with more urban vitality.

The efforts towards the development of SFC starts in 2003 with the announcement of the region as a site for the Vancouver Olympic Athletes’ Village. The neighborhood was built on an abandoned industrial area owned by the city with the main goal of creating a sustainable urban community and a waterfront park (City of Vancouver, 2003). After three years of public consultation, the Official Development Plan was approved by the city council in 2006 (City of Vancouver, 2007), and the Millennium Development Corporation was chosen by the City of Vancouver as the developer of the site, through what some consider (McCarthy, 2012) as an unclear selection process. In 2009 the neighborhood was completed and received several awards for sustainable design – including the highest LEED-ND score in the world, to that date, and the UN Livability Award. Although being criticized for demanding investments from the city lest the development would not be finished in time for the games (McCarthy, 2012, City of Vancouver, 2014), the neighborhood is praised by critics and inhabitants.



Figure 1. SFC site before (left, 2006) and after the development (right, 2015). Source: City of Vancouver (2018).



Figure 2. IPC site before (left, 2008) and after (right, 2018). Source: Google Earth.

Despite the suggestion from the Instituto de Arquitetos Brasileiros - IAB (the Brazilian institute of architects) of locating some of the Olympic Games installations at abandoned buildings in downtown Rio (Gismondi, 2010), it was decided, in 2010, that the IPC village would be built at the edge of the city on a site owned by a private developer. This decision would lead to the expropriation of 900 low-income dwellings for the construction of access roads to the neighborhood (Araujo, Torres, & Waldron, 2014). Construction started in 2013 and it was only completed after the games had started. The end of the games coincided with a major economic recession and the development was closed. Sales restarted by the end of 2017, but only for 9 of the 31 apartment buildings.

Both projects include a green public park, high density energy efficient residential buildings and proximity to rapid-transit access, but their location within the cities is significantly different (*Figure 6*). While SFC is located close to downtown Vancouver in a region easily accessible by different modes of transportation, IPC is located almost 35km from Rio's town centre, in a site mainly accessed by cars or by one bus rapid transit line, even though "well-connected community" is a prerequisite for the LEED-ND certification (Welch, Benfield, & Raimi, 2012). While the marketing discourse concerning the IPC is based on sustainability and quality of life, the development is spatially segregated, has low population density and poor street life (*Figure 3* and *Table 1*).

Currently, the two study cases present distinct characteristics in location and occupation terms. While SFC holds a relatively high population density, in IPC little more than 200 units were sold (Diniz, 2018). The small number of dwellers and the distance from the town centre may contribute for the poor street life at IPC once that "centrally located neighborhoods are more liveable in comparison to their peripheral counterparts" (Saitluanga, 2014) and relations of centrality and periphery seems to perform an important role in the vitality of a neighborhood (Estévez-Mauriz, Fonseca, Forgaci, & Björling, 2017; Hillier, 2009; Lynch & Mosbah, 2017; Zako, 2015).



*Figure 3.* Southeast False Creek (left) and Ilha Pura Condominium (right).



Figure 4. SFC urban surroundings (1:10,000). Sources: Open Street Maps and Google Maps, modified by the authors.



Figure 5. IPC urban surroundings (1:10,000). Sources: Open Street Maps and Google Maps, modified by the authors.

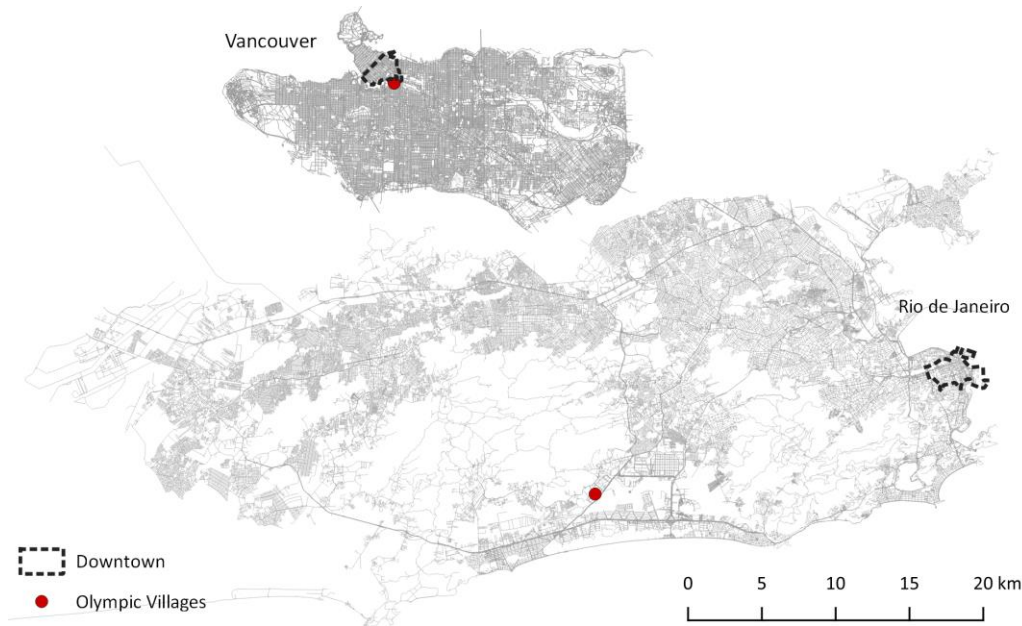


Figure 6. Relation between the Olympic Villages and downtown at Vancouver and Rio de Janeiro at the same scale. Source: Open Street Maps, modified by the authors.

	<i>SFC</i>	<i>IPC</i>
Site Ownership	Public	Private
Total Housing Units	1100	3604
Retail Area (m <sup>2</sup> )	6400	0
Projected Population Density (inh/ha)	579	818
Real Population Density (inh/ha)	185	15
LEED-ND Final Score	81/110	44/110

Table 1: Comparative table between SFC and IPC. Sources: (City of Vancouver, 2009; McCarthy, 2012).

The LEED-ND accreditation process mostly relies on urban form attributes in order to evaluate the “sustainability” or “livability” of urban design plans – about 24 out of the 41 evaluation criteria regard morphological attributes. The idea that spatial relations affect street life is implicit in classic concepts in urban studies such as Jacobs’ “eyes on the street” (Jacobs, 1961) and Hanson and Hillier’s “architecture of community” (Hanson & Hillier, 1987). Studies have been testing different measurements for representing these concepts through spatial indicators (Bourdic, Salat, & Nowacki, 2012; Girling, 2010; Hillier, 2009; Kellett, Fryer, & Budke, 2009; Marcus, 2010; V. Netto, Saboya, Vargas, & Carvalho, 2017; Palaiologou, Griffiths, & Vaughan, 2016; Saitluanga, 2014). This article is an attempt to investigate the relation between space, form and urban vitality in two LEED-ND certified neighbourhoods by analysing how morphological and functional relations may contribute or hinder the vitality of urban spaces in these developments, within a comparative framework and the perspective of findings from previous studies.

## 2. MEASURING URBAN QUALITIES

Considering that cities are complex systems (Blečić & Cecchini, 2017; Hillier, 2009; Luederitz, Lang, Wehrden, & Von Wehrden, 2013; Moroni, 2015; Rauws, 2017; Wohl, 2018), it is hard to model the multiple relations entwined in urban settlements, mostly because they are “composed of a very large number of components whose interaction is iterative and recursive (i.e. non-linear), with many direct and indirect feedback loops” (Moroni, 2015).

Boeing (2018) recognizes the difficulty of describing urban systems, but suggests that their components may be potentially handled – “Cities are complex human ecosystems: population, density, employment, wealth, traffic volume, etc. can be (potentially) identified and (potentially) calculated at various scales to describe the evolutionary state of the system” –, and Hillier argues that space syntax research “has brought to light structures underlying the complexity of cities” (Hillier, 2009) embedded in the way urban space is structured. In general view, spatial attributes at multiple scales are measurable with geospatial tools and have been relatively accepted as a way of abstracting urban complexity in studies relating built form and urban qualities (Bourdic et al., 2012; Hillier, 2009; Kellett et al., 2009; Ramiller, 2018; Yamu & van Nes, 2017; Zhang & Li, 2012).

Methodological approaches for evaluating cross-scale urban qualities provided the basis for evaluating potential vitality in Southeast False Creek and Ilha Pura Condominium, the cases studied here, following an analytical matrix that comprise morphological and functional attributes regarded as potential enhancers of urban qualities *related to sustainable ways of life* (mostly in terms of mobility and social interaction) and *measurable at different spatial scales*.

Most of the studies in this regard investigate aspects of form and uses as indicators of a certain urban quality. Most studies adopt a geospatial approach, and in some, the analysis is complemented with the application of questionnaires, pedestrian counting from in-field observations or a detailed auditing of the physical form of the place. Most studies that address relations with the city as a whole, or with its immediate neighbourhood, apply indicators of density and diversity. The ones that analyse plot/building relations with the street include visual permeability as a key indicator of urban quality, mostly based on Jacob’s ideas of urban vitality.

An analysis with urban form variables may help to describe the current state of SFC and IPC, but it does not provide sufficient subsidies to claim whether a space is sustainable or not, either because of the complexity intrinsic to urban systems (Boeing, 2016; Moroni, 2015) or by the complexity of the concept of sustainability (Luederitz et al., 2013). The four conditions to generate urban *vitality* defined by Jacobs (1961) – short blocks, compact constructions, building diversity, density of people – involve social and environmental effects whose potential can be measured at different spatial (Hillier & Sahbaz, 2008; Jalaladdini & Oktay, 2012; Long & Huang, 2017; Mashhoodi, 2011; Montgomery, 1998; V. M. Netto et al., 2012; Sung, Lee, & Cheon, 2015; Tenorio, 2012). The term vitality is used as a quality of lively and animated urban spaces. A morphological analysis alone cannot judge whether a space is alive or not, but can help identify key factors and relationships that allow or hinder that vitality.

As a general view, it is believed that accessible, dense and diverse neighbourhoods sustain urban vitality, while segregated, dispersed, homogeneous spaces hinder it, qualities that were, for instance, emphasised by Marcus, (2010) for assessing the “social performativity of the urban form”. Accessibility, density and diversity were, therefore, taken into account for comparing the potential vitality of public spaces in the studied cases. However, these potential neighborhood vitalities based on the relationship of spaces with their surroundings can be sustained or impaired by local factors that contribute to or hinder movement and interaction amongst subjects and between these and the spaces they occupy. Local aspects such as

frontage permeability, visibility, and infrastructure for pedestrians are also crucially important – as so often pointed out in the literature – and were, therefore, also graphically explored.

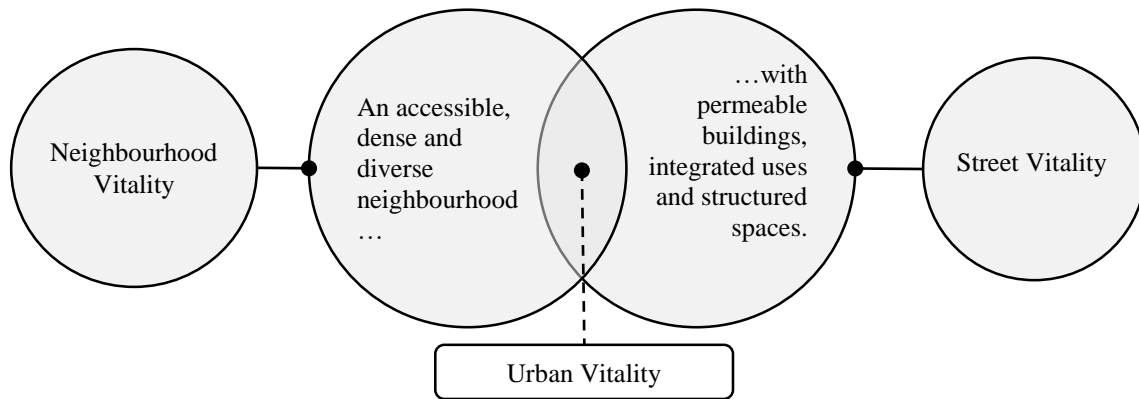


Figure 7. Conceptual framework for guiding the research.

### 2.1. Neighbourhood vitality

In order to evaluate how the SFC and IPC designs contribute to places with more or less urban vitality, quantitative and qualitative attributes of the neighbourhood (building-environment relationships) and public spaces (public-private relations) were analysed and compared. The definitions of these attributes were based on previous studies of urban qualities related to vitality as shown in Table 2. For each neighborhood a comparative measure of potential neighborhood vitality, *pnv*, was calculated based on accessibility, density and diversity variables equally weighted. As SFC and IPC have different sizes, the data was not analysed for the official neighbourhood boundaries, but for all the streets within an 800m catchment radius from a central point in the neighbourhoods (Figure 8).



Figure 8. Walkable radius of approximately 800m from one of the batches (dot). Map source: Open Street Maps, modified by the authors.

The street network was obtained by downloading the OSMnx python library (Boeing, 2016/2018), Open Street Map land use data was reclassified using python, network data was simplified using QGIS processing tools (Martino, 2019/2019). The *pnv* measure was calculated according to the formulas below. Segment integration was processed in Depthmap (Turner, 2004) and normalized according to Al Sayed (2018).

$$pnv = (Accessibility) + (Density) + (Diversity)$$

<i>Indicator</i>	<i>Description</i>	<i>Formula</i>
<i>Accessibility</i>	Topological proximity to the urban whole of street segments within the 800m buffer zone (mean value).	$z(n_{ain})$
<i>Density</i>	Ratio of residential area over total built area (m <sup>2</sup> ) of street segments within the 800m buffer zone (mean value).	$z\left(\frac{\text{residential area}}{\text{total built area}}\right)$
<i>Diversity</i>	Simpson index of diversity for 5 categories of land uses: residential, commercial, civic, institutional and entertainment; according to the formula on the right, $n$ = the total built area for each land use category and $N$ = the sum of built area in all categories.	$z\left(1 - \frac{\sum (n * (n - 1))}{N * (N - 1)}\right)$

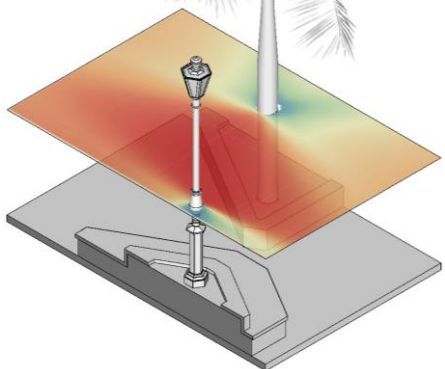
Table 2. Indicators that compose the neighbourhood vitality measure.

## 2.2. Street vitality

The relationship between public and private spaces was graphically represented according to data of spatial configuration, visibility, infrastructure for pedestrians and land use. Permeability of frontages and infrastructure for pedestrians were mapped into points (furniture, trees, doors) and lines (blind or permeable façades) and juxtaposed over visibility graph analysis in order to evaluate if the intensity and distribution of such elements contribute or hinder street vitality.

Visibility graph analysis, *vga*, displays patterns related to “manifestations of spatial perception, such as way-finding, movement and space use” (Turner, Doxa, O’Sullivan, & Penn, 2001). Two graphs were elaborated: one representing the integration of the movable space (kneesovist), in an attempt to analyse the integration among different uses; and another representing patterns of movement in the neighbourhoods – based on the idea that people tend to move to where they can see by avoiding corners through space, calculated by multiplying the isovist area of visible space by the normalized Through vision of movable space (*Figure 9*).

Graphs were generated in Depthmap (Turner, 2001) and spatially joined in QGIS. For the case studies, these visibility models were georeferenced and overlapped pedestrian infrastructure, land uses, transport corridors and building-street interfaces in an attempt to understand how local morphological aspects that may allow or inhibit the vitality of public spaces are combined and differ in the two case studies.

<i>Measure</i>	<i>Definition</i>	<i>Graphic Representation</i>
Isovist Area/ Connectivity (visible space)	The area of visible space from each cell. Proportional to the number of cells directly visible from each cell.	

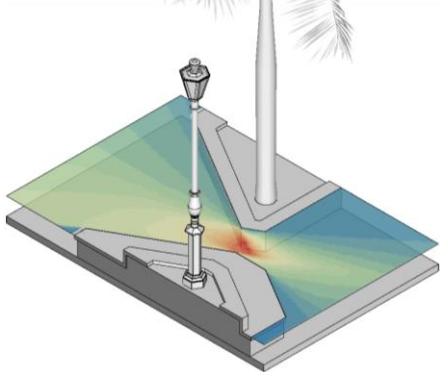
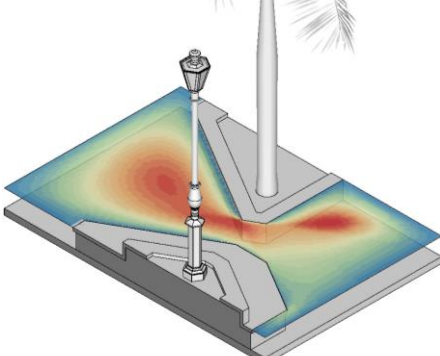
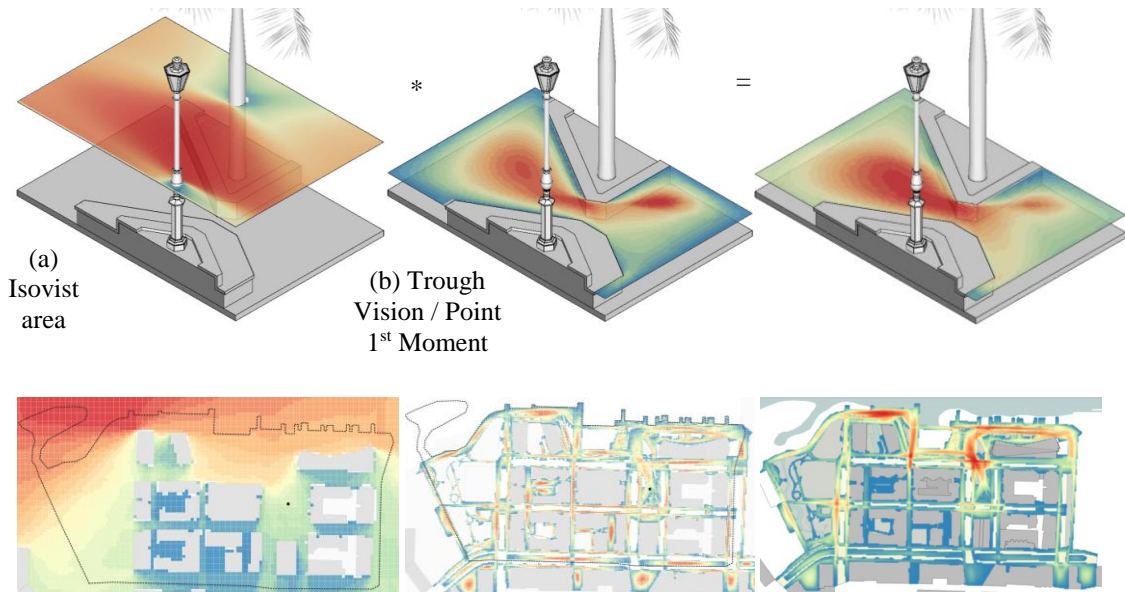
<p>Integration (movable space)</p>	<p>The closeness of each cell from all other cells within the system. Closeness centrality from graph theory.</p>	
<p>Through Vision (movable space)</p>	<p>The amount of times a cell is passed when moving through all the possible origin-destinations in the system (a). When divided by Point First Moment the measure highlights central points and corners (diagram on the right).</p>	

Table 3. Visibility graph analysis measures applied.



$$(IsovistArea) * \left( \frac{ThroughVision}{PointFirstMoment} \right) = indicator$$

Figure 9. Potential pedestrian movement indicator calculated with vga.

A potential indicator of pedestrian movement was calculated by multiplying the isovist area of the visible space to the normalized “Through Vision” measurement, spatially joined in QGIS. The measurement was developed based on the idea that people walk to where they can see while avoiding corners through space. It was graphically compared with existing data of 49 pedestrians that were tracked or followed as they walked through the Olympic village site on two days in February 2016 (Girling, Zheng, Ebnesahidi, & Gao, 2016).

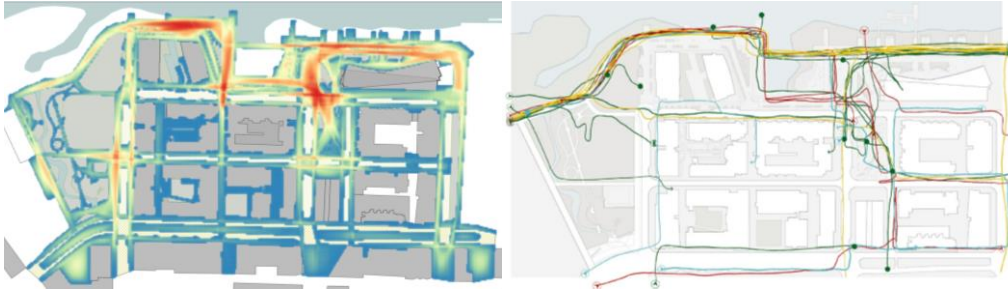


Figure 10. Comparison of the indicator to actual pedestrian movement tracked around the neighborhood. Source: Girling, Zheng, Ebneshahidi & Gao (2016).

### 3. URBAN VITALITY IN SFC AND IPC

Generally, street segments inside IPC have fewer indicators of neighborhood vitality when compared to streets outside the limits of the condominium. In terms of diversity, the lack of diversity in land use within a walkable distance from the dwellings and the low accessibility of the condominium street network with respect to the city as a whole are the factors that most contribute to this result. IPC scores relatively higher than its surroundings in terms of built area density. *Figure 11* represents accessibility, diversity and density values aggregated from data within a radius of 800m from each street segment.

Mostly the predominantly industrial area around SFC and some urban voids still to be developed (see *Figure 1*) causes some streets in the neighborhood to have low *p<sub>nv</sub>* when compared to the surrounding streets. Still, the street grid round SFC compound seems to be more accessible, dense and diverse, when compared to IPC.

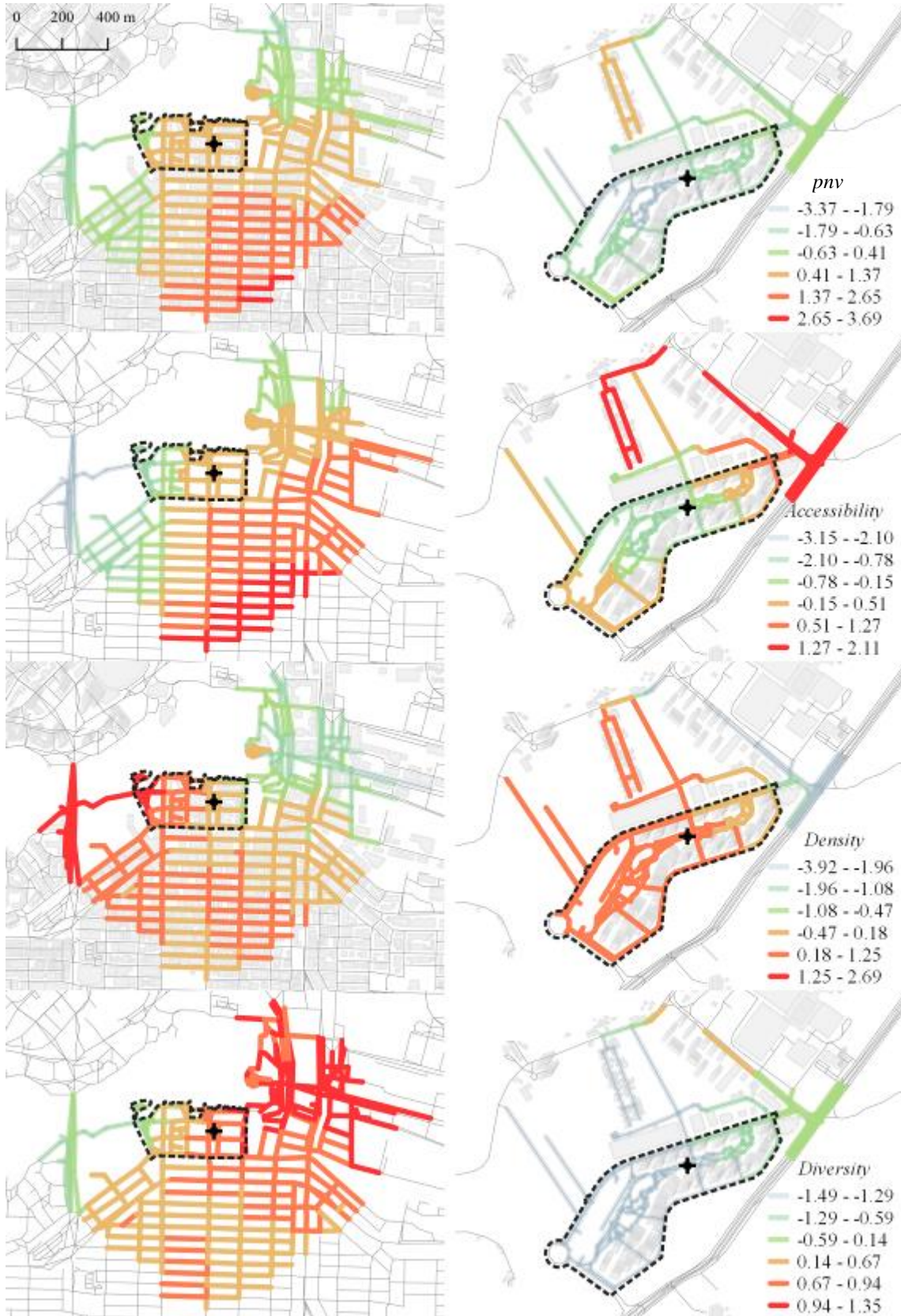


Figure 11. Neighborhood vitality in SFC and IPC. Map sources: Open Street Maps, Google Satellite, modified by the authors.

Figure 12 displays data on uses, mobility and configuration of open spaces. While the most integrated spaces (purple in Figure 12) in SFC connect leisure green spaces, private spaces, transport corridors and waterfront, the most integrated spaces in IPC connect currently unused buildings to urban voids and to the

sales booth of IPC (the only commercial building in *Figure 12*). Leisure green spaces are little integrated to pedestrians that walks through the immediate surroundings of the condominium and highly integrated to those that are inside it. This configures, in fact, an “island” of leisure spaces. In SFC the waterfront is connected to the public spaces a situation that stresses the potential of water as a means of connecting the neighborhood with other parts of the city. IPC turns its back both to the waterfront and to the housing units north of the condominium that already existed before its construction.

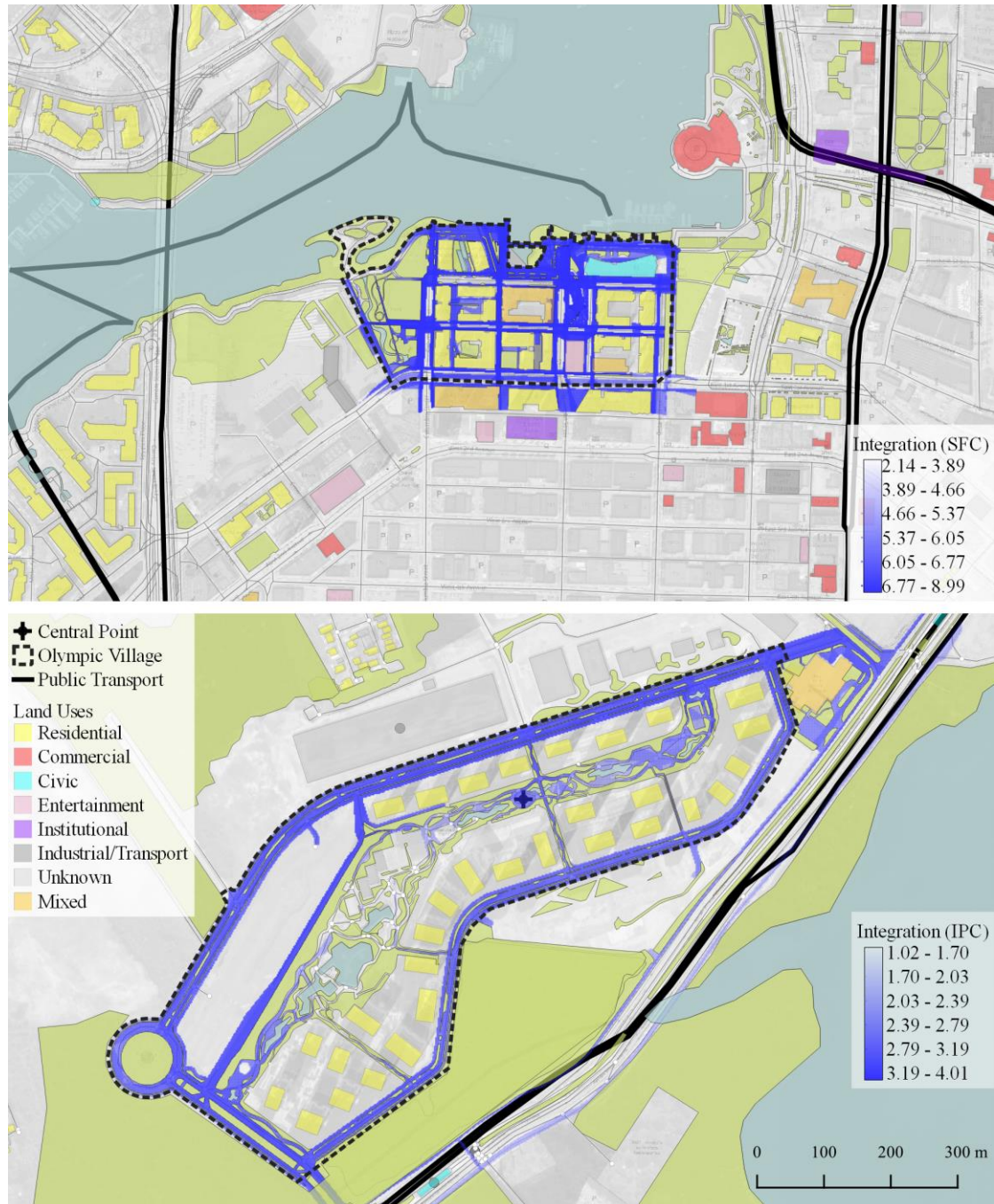


Figure 12. Integration among public spaces, land uses and transport corridors. Map Source: Open Street Maps, modified by the authors.

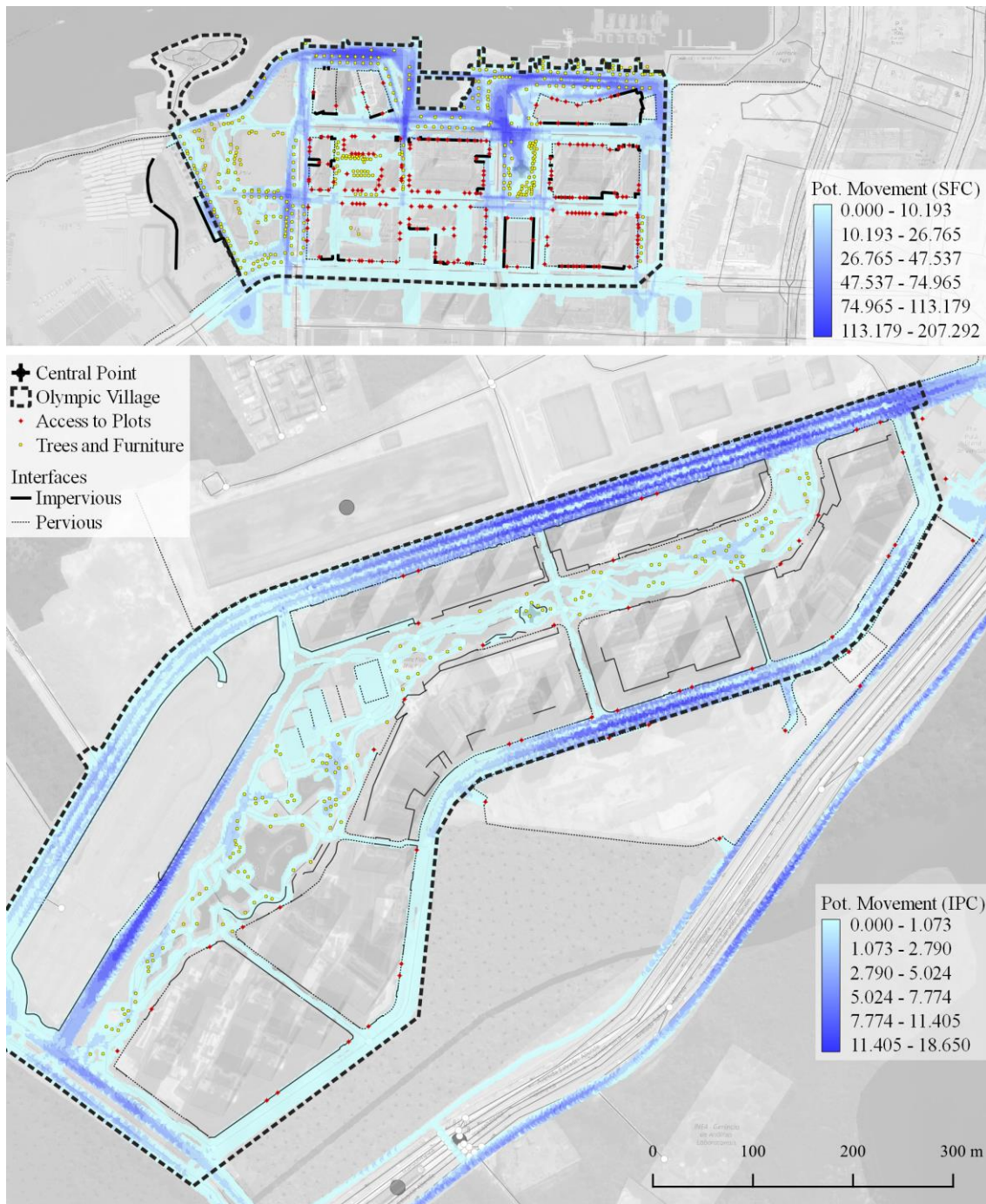


Figure 13. Relation among uses, pedestrian infrastructure, public-private interface and potential movement indicator. Map Source: Open Street Maps and Google Street View, modified by the authors.

Figure 13 displays the relationship among spaces with high potential movement (purple in Figure 13), infrastructure for pedestrians in terms of urban design (furniture and vegetation) and the permeability of frontages, factors often related to the vitality of public spaces (Jacobs, 1961; V. M. Netto et al., 2012; Palaiologou et al., 2016). SFC has a much higher level of frontage permeability than that of IPC, especially in spaces with low movement potential (cyan in Figure 13). Large visual fields near the waterfront exist in both cases, but while in SFC these spaces are integrated into the neighborhood as a whole and equipped with pedestrian infrastructure, in IPC these spaces are separated from the dwellings by the highway that cuts through the area. The pedestrian infrastructure at IPC is concentrated in the central park, segregated from surrounding communities that already existed in the place.



#### 4. ASSESSING URBAN COMPLEXITY

Besides exposing the deep differences concerning the morphological nature of the two studied cases, the analysis that aimed to ascertain possible relations concerning form, uses and urban vitality in the two neighborhoods designed to house Olympic athletes – Southeast False Creek, SFC, in Vancouver and Ilha Pura Condominium, IPC, in Rio de Janeiro – reflects the different intentions underlying their plans.

While SFC was built on public land to connect the city to the waterfront and rehabilitate an abandoned industrial area, IPC was built on private land as a green and leisure “island” in a location surrounded by informal communities, poor infrastructure (Athayde, 2015) and large areas of environmental preservation.

The approach based on the definition of objective indicators of urban vitality is limited by the difficulty of accurately modelling complex systems, but helps to assess possible social effects of architecture and to bring to light the need to discuss parameters and criteria concerning urban sustainability. The LEED-ND certification, received by both neighborhoods, follows a similar approach – the expected performance of an urban development design plan is ascertained by considering several objective indicators that supposedly can foster urban qualities. The certification serves as a guide for the elaboration of urban design plans that should take into consideration formal and functional variables () related to the idea of urban sustainability. However, objective indicators of very distinct natures (such as “connectivity” and “waste management”, for example) combined into a single “sustainability” index may mask some results (Aranoff, Clark, Lavine, & Suteethorn, 2013; Stangl & Guinn, 2011) and overlook the effects of developments with low urban vitality and poor connection to its surroundings, as in the case of the IPC, granting them certification by punctuating aspects such as “hiring a LEED certified professional” (Green Building Council, 2009).

The social and legal context of the projects also seem to contribute to the current situation of the neighborhoods. Even though IPC was designed as a high-density neighborhood, the failure of sales, possibly caused by the country's economic recession right after the Olympics, allowed the creation of an island of abandoned apartments and public spaces. This unexpected consequence may reflect the difficulty in punctuating a “sustainable” neighborhood still in its design phase. The prescriptive legislation of urban codes in Brazil is another factor that potentially hinders many morphological aspects (some even evaluated by LEED-ND) that allow urban vitality and that are present in SFC – connectivity of buildings with the street, internal courtyards, high floor area ratio, for example – confirming the idea that the urban codes in Brazil have encouraged the most dangerous architectural types, in terms of urban vitality (Saboya, Netto, & Vargas, 2013).

The IPC design that does not contribute to the urban vitality of the region and the impossibility of considering the multiple relationships among the innumerable contextual factors that influence urban quality raises the question about the need to use an expensive evaluation process (i.e. LEED-ND) in order to represent broad and subjective concepts such as “sustainability” or “smart growth” in complex and unpredictable systems such as cities and neighborhoods.



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