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Assessing Santa Marta: Using Evaluation Tools to Inform Parametric Urban Design

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Abstract. Lack of affordable housing is a worldwide problem. Rapid urbanization, rural exodus, and poor governance policies have contributed to the problem and, in response, low-income populations resort to self-construction. The result are informal settlements located predominantly in marginalized urban areas (United Nations, 2015) that develop with neither urban infrastructure nor compliance with building and planning codes (Lall et al., 2006; Patel et al., 2018; United Nations Human Settlements Programme, 2012) and, consequently, offer a poor-quality built environment. The goal of this paper is to methodologically identify physical aspects of such built environments that could be improved. We evaluate a case study, the Santa Marta favela in Brazil, using a holistic housing-quality assessment tool and local building and planning codes as reference. Our results identify the physical characteristics with lower quality standards in the case study and demonstrate the efficacy of the methodology introduced for this purpose.

Keywords: housing-quality assessment, building codes, informal settlements, parametric urban design, Santa Marta favela.

1 Introduction

The emergence of informal settlements is closely linked to rapid city growth. First identified in the mid-nineteenth century in France, America, and India, these settlements were promptly recognized as a worldwide phenomenon characterized by illegal occupation of the land (Davis, 2006). In Brazil, informal settlements (also called favelas) first emerged during the late nineteenth century and quickly expanded during the twentieth century, driven by industrialization and a rural exodus that transformed Brazil from an essentially rural country into an urban one (Compans, 2007). According to World Bank

statistics, in 2021, almost 87% of Brazil's total population lives in urban areas, with 16% (as of 2018, the most recent year reported) living in slums or informal settlements.

Brazilian favelas are often located in privileged areas of the urban fabric that are of no interest to the formal city because the steep topography makes them unsuitable for traditional urban development. They constitute an interesting case of a dense settlement model guided by the economy of resources. Furthermore, although favelas present numerous urban problems, it is recognized that eradication is not a viable solution (Skidmore, 2009).

This paper is part of a larger research project undertaken with the purpose of proposing a novel design and planning methodology for affordable housing based on the settlement model of favelas. The case study for this work is the Santa Marta favela, a settlement located in Rio de Janeiro. Our goal in this paper is twofold. The first is to methodologically identify the physical aspects of the built environment that are most in need of improvement and feed this data to the design and planning tool. The second is demonstrate the efficacy of the tool and refine it based on this exercise.

In the literature review, we present some of the most important local legislation concerning urban planning and building construction in Rio de Janeiro that applies to affordable housing and favelas. We also discuss the role of local legislation in the production of affordable housing. We determine the extent to which the Santa Marta favela follows the specifications of local legislation (Poder Executivo da Cidade do Rio de Janeiro 2000, 2009, 2013, 2017). We also evaluate the settlement using a housing-quality assessment method, QUARQ (Pedro, 1999a, 1999b, 2001) to gain a better understanding of the aspects that need improvement. The tool scores the physical characteristics of the settlement according to five criteria—articulation, personalization, pleasantness, safety, and spatial articulation—assigning a score to each in the range of 0.00 to 3.00. The method also provides a report describing how each characteristic of the built environment contributed to the assessment, thereby permitting to identify those that need improvement.

2 Literature Review

In Brazil, building and planning codes are approved at the municipal level. These codes regulate land development and building construction by determining minimum standards for urban indexes and building dimensions. In Rio de Janeiro, all new developments and buildings must meet two main municipal regulations: the Municipal Law for Urban Land Parceling (Poder Executivo da Cidade do Rio de Janeiro, 2013) and the Municipal Building Code (Poder Executivo da Cidade do Rio de Janeiro, 2017). Additionally, the case study for this research is considered a Special Area of Social Interest (AEIS) (Poder Executivo da Cidade do Rio de Janeiro, 2000), with means that there is specific building legislation applicable to the area (Poder Executivo da Cidade

do Rio de Janeiro, 2009). Briefly, the AEIS designation enables the re-zoning of irregular and informal settlements: “Because these areas were not originally zoned for urban uses, they do not have basic city services; the AEIS gives the city an opportunity to legalize and formalize existing communities” (US Environmental Protection Agency, 2012).

Although arising from good intentions, building and planning codes can undermine efforts to provide adequate housing for low-income people (Lall et al., 2006; Patel et al., 2018; Salingaros et al., 2006) as it requires all new buildings and land development to meet the same general standards. One presumably unintentional result of this scrupulous approach is that codes are often unreasonable in relation to affordable housing construction. Thus, they contribute to making the housing sector unaffordable to lower social classes while keeping density indexes low, stimulating the use of more construction materials and land, and underusing urban infrastructure:

By specifying minimum sizes for rooms, staircases, lobby, and common areas, building regulations establish an amount of built space that must be consumed. Planning regulations also require a certain level of land consumption. (Patel et al., 2018, p. 176)

Patel et al. (2018) also list some specifications set out in planning and building codes that influence land consumption such as lot size, road width, floor space index, maximum ground coverage, and minimum building setbacks. The authors show that by rationalizing planning and building codes it is possible to reduce housing construction costs by 12.7% without undermining construction quality or compromising building safety. They also show that as construction increases housing density and reduces the space for internal roads, it is possible to decrease the total area of planned settlements by 42.86%.

One way to overcome barriers to the production of affordable housing presented by local legislation is to create legislation focused specifically on affordable housing (Lall et al., 2006; Patel et al., 2018; Salingaros et al., 2006). The solution is to make such legislation more flexible and to define special zoning for the urban areas to which it applies. Lall et al. (2006) present examples of Brazilian cities that have established special zones with flexible regulations, such as Belém, where the minimum lot size was reduced to 90 m²; Fortaleza (50 m²); and Belo Horizonte (40 m²).

Since 1992, Rio de Janeiro has had an instrument in place (its Master Plan) through which it can implement specific legislation for affordable housing. Renewed every 10 years, the Master Plan designates a special zone within the city that is subject to specific legislation with this focus. The plan automatically considers areas for affordable housing and favelas (among other types) as AEIS (Poder Executivo da Cidade do Rio de Janeiro, 1992). Legislation for Santa Marta was approved relatively recently, in 2009 (Poder Executivo da Cidade do Rio de Janeiro 2009). It should be noted, however, that the legislation is rather restrictive since new constructions are not permitted and

only existing buildings with up to three floors are considered legal, although the settlement has buildings with up to five floors.

3 Analyzing Santa Marta

In this section, we compare Santa Marta with local building and planning codes, demonstrating that the settlement does meet most of the specifications set out in the relevant laws and decrees. However, informal settlements are an entrenched reality of many urban contexts, and it is recognized that eradicating these places is not an option (Skidmore 2009). To conduct a systematic evaluation of Santa Marta, we used QUARQ, a housing-quality assessment method developed by Pedro (1999a, 1999b, 2001) that is briefly described in Section 3.4.

3.1 Municipal Law for Urban Land Parceling

The Municipal Law for Urban Land Parceling of 2009 specifies limits for land parceling in the urban areas of the municipality. It also includes a city zoning map showing which areas are designated for given land uses, such as commercial, residential, industrial, and AEIS uses. The specifications that apply to our case study concern street width, street slope, block length, and plot size, as described in following:

Minimum street width: Local streets must have at least two lanes in opposite directions, each at least 3.00 m wide, and the sidewalk must be at least 2.50 m wide. However, the favela does not have any streets where cars can circulate due to the steep terrain. Given that the circulation network of the settlement consists of pedestrian pathways, only two areas (Figure 1) comply with the minimum standards.

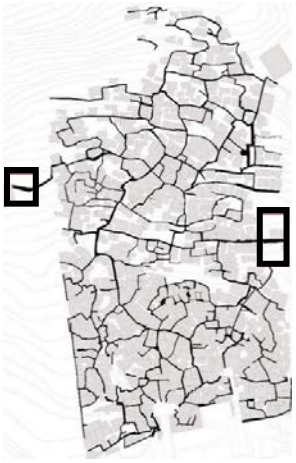

Figure 1. Bold boxes indicate areas that meet the minimum sidewalk width standard. Source: Authors, 2020.

Maximum street inclination: The preferred maximum slope for streets is 6%. However, sections of 100 m or less can have a slope of 8%. In areas with steep terrain, progressive slopes are accepted, alternating between 25% and 15%, for no more than 100 m. None of the streets in the Santa Marta favela is accessible to vehicles, and the general circulation is narrow and steep, with steps being a feature in some areas. Further, the favela includes ramps with a slope of up to 15%.

Maximum block length: A block should have a maximum length of 200 m. All blocks in the favela meet this standard.

Minimum lot size: A lot must have a minimum area of 125 m^2, with a minimum front alignment of 5.00 m. There is no division into lots in the favela, and even if we think of buildings as occupying entire lots, only one building out of a total number of 1,069 would meet the minimum lot size standard.

3.2 Municipal Building Code

The Municipal Building Code specifies minimum limits for openings (windows) for access to daylight, natural ventilation, internal circulation, and so on. Single-family housing units do not have to meet some of these standards. In addition, the code allows affordable housing to have standards lower than its own standards, which are regulated by specific building legislation. As the houses analyzed in the case study are single-family units and the case study area is itself defined as an AEIS, the only specification in the building code relevant to the present research refers to plot setbacks:

Minimum lot setback: The building code specifies a minimum setback of 1.50 m for the lateral and back limits of the lots and a frontal setback of 5.00 m, excluding garages, ramps, and other accessibility elements. As mentioned above, Santa Marta has no plot divisions and all the buildings are very close to each other. Even considering that the open areas surrounding some buildings are part of their lots, only 25 buildings (out of 1,069) meet the standards.

3.3 Specific Legislation for the AEIS

Regarding land use, the legislation applicable to the Santa Marta favela divides the settlement into three subzones: Subzone A, which is considered a high-risk area and, therefore, unsuitable for construction; Subzone B, where buildings can have up to two floors; and Subzone C, where buildings can have up to three floors (Poder Executivo da Cidade do Rio de Janeiro, 2009). The legislation on land use also indicates areas of Santa Marta unsuitable for building—although it does not forbid construction there (Poder Executivo da Cidade do Rio de Janeiro, 2009). Overall, most of the settlement is considered inadequate for construction and the areas that are deemed suitable for this purpose are already occupied by buildings. The code regulating land use and occupation in Santa Marta is incoherent. On the one hand, it limits the number of floors and identifies areas that are risky and inadequate for construction yet stops short of forbidding them to this use. On the other hand, the code forbids the construction of new buildings unless they are initiated by the Public Power and/or designated for relocating residents from one area of the settlement to another.

3.4 Housing-quality assessment (QUARQ)

The housing-quality assessment method (QUARQ) is an assessment system proposed by Pedro (2001) to assess the architectural quality of housing settlements at four scales: rooms, dwellings, buildings, and neighborhoods. In evaluating Santa Marta, we considered only the neighborhood scale, because we were focused on urban space. The systems yields assessment results that are quantitative and scored on a scale ranging from 0.00 to 3.00. The scale is divided into three categories: minimum (0.51 to 1.50), recommended (1.51 to 2.50), and optimum (2.51 to 3.00). A score of less than 0.51 indicates conditions that are unsatisfactory.

QUARQ relies on a computer software program with an interface that is compatible with the Microsoft Access environment. The program aids with the assessment process (Pedro 1999b) by assigning quantitative values to qualitative characteristics in five main evaluation criteria: articulation (comprising privacy and accessibility), personalization (comprising appropriation and adaptability), pleasantness (comprising visual comfort, air quality, and higrothermal comfort), safety (comprising safety in daily routines

and protection against robbery), and spatial adequacy (comprising capacity and spaciousness). The user answers questions concerning the physical aspects of the area to be evaluated related to these criteria, such as the existence and dimension of open and leisure areas, trash collection and disposal, solar orientation, and so on. The system then assigns scores based on the responses and calculates the weighted average for each criteria and the total weighted average.

We used QUARQ to identify the criteria with a satisfactory score (a score of at least 1.51, i.e., with a recommended quality level) and those for which improvement is necessary (any score lower than 1.51, i.e., with a minimum quality level or lower). The settlement scored below 1.51 on articulation, pleasantness, and spatial adequacy. For a more detailed description of how Santa Marta favela was evaluated using the QUARQ tool, please see Verniz (2020). Table 1 shows the scores for each criterion evaluated.

Table 1. Housing-Quality Assessment of Santa Marta

Criteria	Score	Quality Level
Articulation	1.25	Minimum
Personalization	2.87	Optimum
Pleasantness	1.20	Minimum
Safety	1.51	Recommended
Spatial Adequacy	0.94	Minimum

Source: the authors, 2021.

QUARQ also provides a comprehensive evaluation of the neighborhood, indicating characteristics that could be improved to increase the quality score in each criterion and so the overall quality score. For Santa Marta, results indicated how improve the scores for articulation, pleasantness, and spatial adequacy, as follows:

Articulation: Santa Marta's score for articulation is 1.25. Because the settlement is a high-density neighborhood, its area is clearly defined, reinforcing the separation between areas inside and outside the neighborhood, which provides a sense of privacy. However, the area lacks parking spots, and the pedestrian pathways are in poor condition, which negatively impact access within the neighborhood.

Pleasantness: Santa Marta's score for pleasantness is 1.20. The settlement has a very favorable location with a view of the mountains, surrounding urban landscapes, and the Guanabara Bay. However, there is trash on the ground along the walkways and many buildings remain under construction such that piles of construction materials in public spaces are common. In addition, the

placement of the buildings impedes wind tunnel effects. Regarding foul-smelling areas, Santa Marta's only issue is pet waste. The existing covered multi-sport field provides a place sheltered from weather conditions for children to play. Additionally, few areas are protected from unpleasant weather conditions, which is a characteristic that particularly needs improvement. For example, the neighborhood has few structures that provide shade, which is needed to protect pedestrian pathways from the sun during the summer months.

Spatial adequacy: Santa Marta's score for spatial adequacy is 0.94. The settlement does not have much urban furniture, such as trash bins, benches, or fountains, which negatively affects its score. Yet, the settlement does have active local commerce, including small restaurants and leisure places dedicated to specific age groups, such as children, teenagers, and the elderly.

4 Conclusions

As part of a larger research to develop a novel approach to the design of affordable housing settlements inspired in the case of Brazilian favelas, this paper introduces a methodology to identify the physical aspects of favelas that need improvement. The idea is to use this information to transform analytical grammars extracted from the analysis of favelas so that they can be used in the generation of settlements that share their qualities but not their flaws.
The methodology uses two strategies and was tested with a case study, the Santa Marta favela. The first strategy was to check the favela's compliance with local legislation, including general building and planning codes and legislation applicable to special areas of social interest (AEIS). Results showed that only a small area of the settlement complies with the general local legislation. They also showed how the legislation for AEIS is limited because it does not allow new construction. The second strategy was to use a recognized housing quality assessment method called QUARQ, which was developed for formal housing but that we propose to use in the assessment of favelas, to identify the characteristics of Santa Marta that needed improvement. Results showed that, although Santa Marta did not comply with the current legislation, it ranked reasonably well in all the five criteria considered in the assessment method, scoring at least minimum in all of them. For instance, regarding articulation, results showed that the circulation network was neither adequate nor safe. However, they also indicated that it could easily become compliant with accessibility standards by properly adding to stairs and ramps safety devices, such as handrails. Concerning pleasantness, results showed that the settlement needed shaded areas and that trash collection practices were poor. In terms of spatial adequacy, results showed that the settlement lacked leisure areas, commerce, and urban furniture. All these features can be easily improved in the existing settlement and considered in future settlements.

In conclusion, we presented and validated a methodology to identify features of the built environment in favelas that needed improvement. We also showed that building and planning codes are rather restrictive, even if developed with the purpose of addressing the specific needs of AEISs, and that if relaxed planned settlements can still meet minimum quality standards. In future work, we will draw on the results of this assessment of the Santa Marta favela to develop a design tool for affordable housing. Using these results as a reference, we will establish guidelines and parameters for transforming an analytical urban grammar into a synthetic grammar as a basis for improving the quality of the generated outcomes.

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