DESIGN AND BUILD!
Re-thinking the Self-Built Informal Housing in Sao Paulo

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Abstract

The favela is a pressing reality in the city of São Paulo, Brazil, concentrating around 10% of its population. Despite the public investments and its higher consolidation status, the favela still lacks some urban infrastructures and services. In addition to that, housing is a key topic both due to the social dynamics embedded and to the poor environmental conditions found indoors, mainly caused by overexposure to solar radiation (particularly on the roof level), under performative building fabric and inefficient openings. From this context, how would it be possible to develop practical and replicable design strategies for the façades of self-built favela houses, environmentally informed, in Subtropical Climates? The research pro-design method applied in this work articulates fieldwork, analytical simulations and prospective exercises that culminate on the construction of a 1:1 prototype entitled "Everyday House", in the second largest favela in the city of São Paulo, "Favela de Paraisópolis", with the aim of promoting its replication within and outside of the local community, showcasing the real application of the design proposal.

Introduction

Among over 12 million people in the city of Sao Paulo, 3 million live in informal settlements, of which 1,6 million live in *favelas* - slums (IBGE 2010). The Favela of *Paraisopolis* is the second largest in the city, sprawling around 800.000 m^2. This informal settlement started in the 60s in an empty area of the wealthy neighbourhood of Morumbi, currently bringing together approximately 100.000 inhabitants (Pizarro 2014) (see Figure 1). Despite the shortages in infrastructure, *Paraisópolis* is indeed a consolidated urban reality as demonstrated by Pizarro (2014), with its constructions continuously to be self-built, characterized by poor informal standards that lead dwellings to either excessive solar overexposure or lack of it, besides insufficient natural ventilation and consequent poor indoor air quality. As a result, thermal conditions in homes are also critical, mainly during the warm periods of the year (Gonçalves et al 2014).

Through this research pro-design exercise, environmental guidelines and design strategies for enhancing thermal conditions in residential units in *favelas,* in São Paulo, were developed, following the logic of the *favela's* morphological existing built mass/environment and building materials. Architecturally, the research is focused in the redesign of the facades of dwellings, which were identified as the main influencing factor of the performance of internal thermal conditions. The ultimate objective is the construction of a 1:1 prototype that applies the guidelines and design strategies developed in this research applying ordinary materials as solid brick blocks and perforated ceramic blocks. The project for the dwelling extension is entitled "Everyday house" and it has been

Figure 1. Favela of *Paraisópolis* and its self-built informal housing structure. Source: Eduardo Pizarro (june 2012).

developed within the context of a university initiative, including design and construction**.**

1.1 Method

From the environmental perspective, the method follows the one presented by Yannas (2015), and is also based on *Evidence Based Design* approaches (Yannas 1989). In addition to that, the methodological approach adopts bottom-up strategies closely developed with the local community, highlighting cognitive knowledge and "learning by doing" (Parekh 2015).

The research method encompasses by three complementary phases: empirical and analytical work followed by a prospective design phase, involving fieldwork, computer simulations and a design proposal, with the perspective of real life construction. From a base case informed by fieldwork, the analytical work defined a few scenarios featuring facades with different materials and openings, which were simulated and compared. The best analytical scenario was then translated into design applicability (guidelines and strategies) and applications, culminating in the construction of a 1:1 prototype in Paraisópolis' community center rooftop.

2. The built environment of favelas

2.1 Urban fabric

The socioeconomic momentum of the slum leads to informal and uncontrolled horizontal and vertical growth of buildings as observed in the case of *Paraisopolis*. Originally, its urban fabric developed on top of a formal parcelling of the territory. As a consequence, whilst main roads were kept within their original size (10 meters wide), a complex grid of alleys grew within the urban blocks to give access by foot to the smaller residential units, located in the core of the informally and densely built urban blocks (see Figure 1). As a result, the built environment is characterized by a diversity of open spaces with contrasting environmental conditions in need of improvement. The compactness of the urban blocks leads to lack of vegetation and space to the accommodation of urban and living activities, which are either castigated by solar radiation or deprived of daylight and air flow between buildings due to the rather narrow canyons. The biggest open space is the area reserved for the football camp, present in every informal settlement in the country.

2.2 Buildings

The buildings in the slums of São Paulo vary from one to four storeys in average, supported by concrete columns and beams filled with brick walls. The area of residential units (one per floor), vary from 30 to 50m^2, for an average family size of four people. Typically, each residence has one façade to the exterior (maximum two), resulting in poor ventilation and daylight. On the other hand, the thermal capacity of the buildings, in addition to the self-shading of the urban fabric and external shading strategies protect internal and external spaces from the harsh impact of solar radiation.

In respect to the social dynamics and cultural values embedded on its self-built housing typology, the boundaries between private and public realm are blurred in the favela. Moreover, each floor of a favela building is treated as a separate property in which several uses, construction techniques and building types and components are found/allowed, and this is combined with different means of access that can be horizontal or vertical. In other words, a multi-storey building in the *favela* works as a set of overlapped and inter-connected independent houses built separately and constantly over time. On this scheme, the rooftop (called "laje", in Portuguese, "slab" in English) plays a very important role, both as a physical structure standing-by for the building's verticalization and also in everyday life for the development of individual and collective activities in semi-open spaces, ranging from hanging clothes to a barbecue and other activities at different times of the week including weekends.

3. Fieldwork: environmental conditions and challenges

3.1 Outdoor environment: walking through the streets of Paraisopolis

Comparing the results found in the streets with those from the alleys in Paraisópolis, the fieldwork showed the significant positive impact of the shading and shaded mass in reducing surface temperatures and by consequence the air temperature in hot days. The unshaded street presented surface temperatures as high as 50ºC and air temperature reaching the mark of 37ºC. In contrast to that, within a short period of time, the protected space of the alley-way had higher air temperatures around 33 ºC, but significantly lower surface temperatures, showing temperatures around 27 ºC, with a major favorable impact on pedestrians' comfort and on the thermal conditions within the rooms facing the alleys.

3.2 Environment and quality of internal spaces

Measurements of thermal conditions in internal spaces were taken in one of the houses facing North-West along the main street. The exposure to solar radiation coupled with the concentration of internal gains and insufficient ventilation rates resulted in air temperatures as high as 40ºC in the living space at 4 pm of a week day (bringing together living and kitchen in one area), when outdoor temperatures oscillated around 33 ºC.

4. Analytical work

From fieldwork, In the sequence, thermal dynamic simulations (Roriz 1995) showed that changing one single standard facade into a 100% shaded and naturally ventilated membrane would decrease the pick temperature in a typical warm/hot day by 3°C (see Figure 2), bringing internal temperatures closer to external ones, therefore, improving thermal comfort. The impact is smaller in the scenario of simply replacing the existing window for a new one with 100% ventilated span. Here, it is worth noticing that the main local climatic issue is global radiation and not external air temperatures.

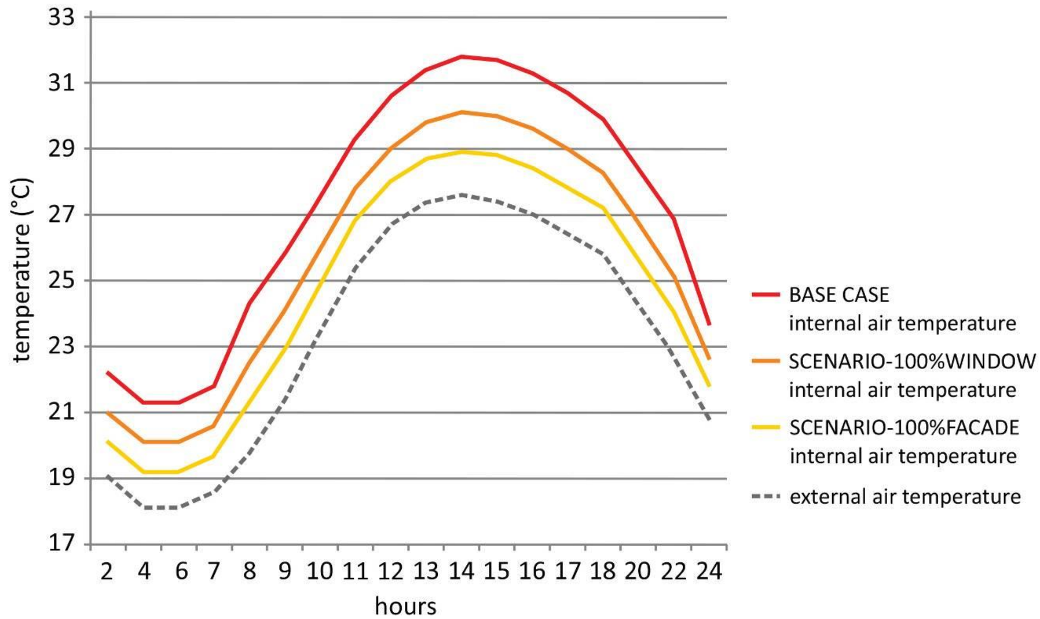

Figure 2. Air Temperature in a sunny summer day, comparing different scenarios: base case internal temperature; proposed scenario 01 (replacing window) internal temperature; scenario 02 (room with new facade) internal temperature; and external temperature.

5.Design approach

5.1 Applicability

Based on the analytical results, the prospective step of the work develops a set of design strategies for solar shading and permeable facades for natural ventilation, featuring ordinary materials as different kinds of concrete and ceramic blocks assembled according to the facades' solar orientation and exposure which are translated into printed-out booklets and "lambe-lambe" posters (see Figure 3), promoting DIY interventions.

5.2 Application

The design applicability gives rise to a design application intended to be built as 1:1 prototypes in the community, in other words, as real case scenario, in order to evaluate the strategy's feasibility and its local environmental and social impacts, whilst stimulating its replicability among the *favela*´s inhabitants.

The application is developed as a housing vertical extension in the center of Paraisópolis. It is entitled "Everyday House", in the sense that keeps and reinforces the role played by the rooftop in promoting fundamental everyday

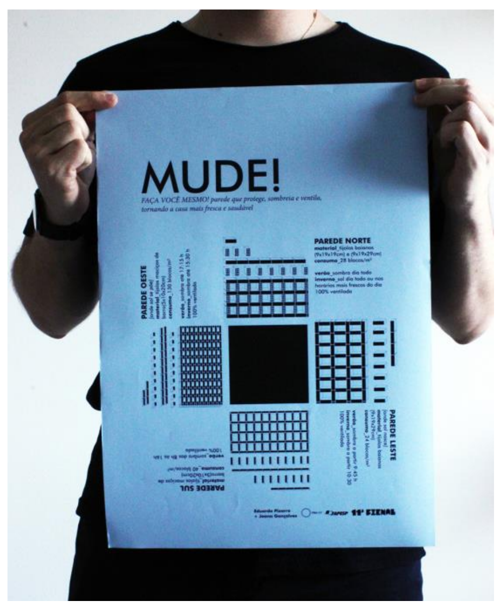

Figure 3. "MUDE!", or CHANGE! is a *Lambe-lambe* poster to environmentally inform self-built construction in the community with DIY schemes for different facades' orientation. Source: Eduardo Pizarro, 2017.

dynamics for the houses in the favela. It is composed by three facades with different perforated brick works based on their solar orientation (Northern, Western and Southern) besides a light roof following a shed typology and painted in white. The facades and roof are structured by a concrete skeleton built over an existing slab on the fourth floor of a building in Paraisópolis. The prototype was designed as an open plan that permits the development of multiple activities by the dwellers and even their neighbours.

The shading masks (see Figure 4) show how the brick assemblage blocks direct solar radiation during the warmer periods at the same time that lets it in when the temperatures are expected to be milder or colder. The facades' pattern is disrupted by steel structures that both frame the landscape or the sunset and address the dwellers' needs, for example hanging birdcages, plant pots and wet clothes. In the case that, in the future, the dwellers decide to turn this rooftop into a new independent house, it would be required to install an internal skin made of glass or polycarbonate in order to permit users' adaptability for the colder days when natural ventilation could be excessive in indoor spaces as a bedroom.

The 1:1 prototype (see Figure 5) was in fact built on the rooftop of the Community Center in Paraisópolis, where the Women's

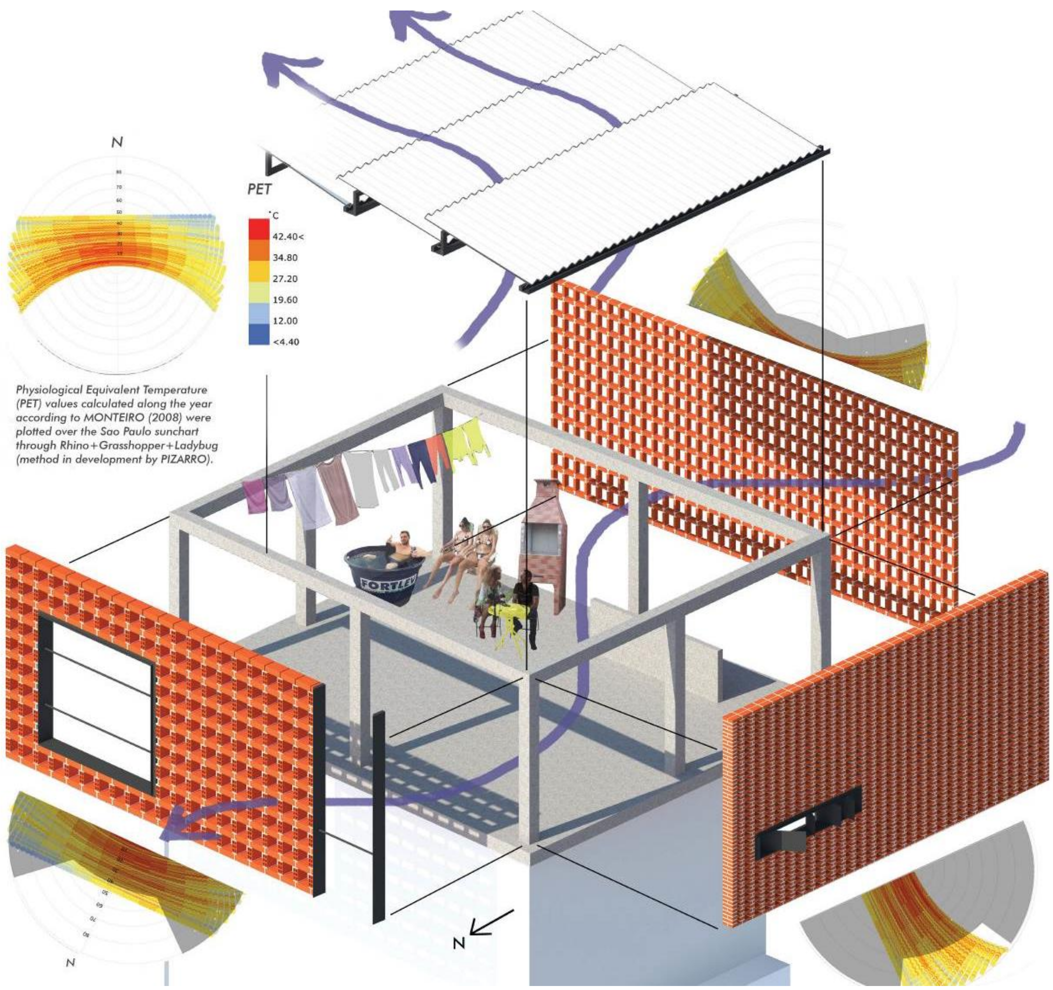

Figure 4. First proposal for intervention in Paraisópolis: Everyday House project. Source: Eduardo Pizarro, 2018.

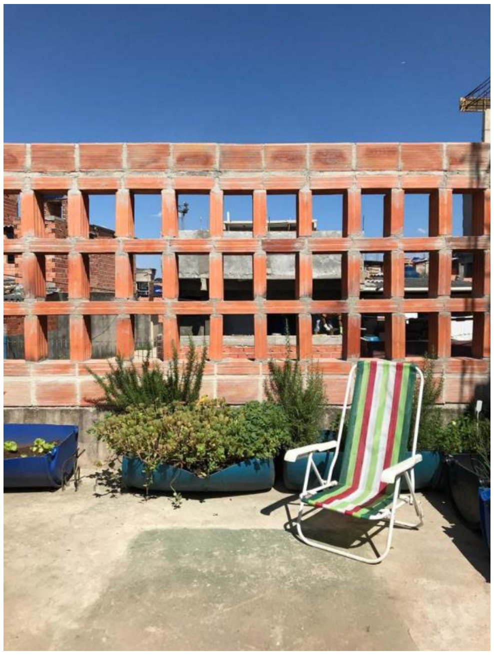

Figure 5. Eastern façade and communal activities embedded. Source: Eduardo Pizarro, 2018.

Association carries out a project for harvesting vegetables and serving food in a collaborative restaurant. The decision of implementing the project on that rooftop took in consideration factors such as feasibility and potential of replication within the community.

The construction was conducted by two "pedreiros" (as the local bricklayers are called) along three months, consuming around 2.000 blocks, and 1.250 Kg of cement. The overall budget of 7.500 US dollars for the construction was supported by the University of Sao Paulo, specifically by the Faculty of Architecture and Urbanism and the Pro-Rectories of Undergraduation, Graduation, Research, Culture and Extension. It was possible as an extension project involving undergraduate and graduate students from FAUUSP, led by a PhD Candidate and his Tutor in the same institution.

Following the completion of the rooftop project, self-built initiatives of perforated environmental façades have been built in *Paraisópolis* by the inhabitants themselves, in different parts of the community, in small/local scale, following the original guidelines disseminated with the "*lambe-lambe*" (Figure 3).

6. Final Considerations

This research pro-design exercise showcases the potential impact of ordinary, practical and localized strategies informed by environmental guidelines in the design of new future possibilities to the informal city in subtropical climates. It's also worth noting that these strategies shall apply to many other self-built neighborhoods in the city of São Paulo, and not just deprived communities.

In addition to that, this approach questions the self-built housing *status quo*, which is arbitrarily replicated, of poor environmental performance and therefore showing a negative impact the overall livability in the informal city, both indoors and outdoors, including the transitional spaces, such as the rooftops, which are used for private and public activities.

There are still a few challenges to be considered as such as: how to effectively convince the *favela's* inhabitants are about their primary right for environmentally responsive houses/shelters and the simple strategies to address that; which would be the best socioeconomic model for applying these environmental strategies in the favela? DIY schemes and open source design? Technical assistance? Or social entrepreneurship? Most likely, the way to the future of the quality of housing in the *favela* is a combination of all alternatives above.

The next step would be to assess *in loco* the environmental performance of the built prototype in typical days of different seasons of the year.

Ultimately, the research process here presented represents an effort in stretching the academic discourse boundaries and applying the research outcomes directly to the existing reality. Moreover, it highlights the importance of articulating research and design activities benefiting from local knowledge, in order to both enrich academic experience and improve the reality of the built environment in the informal city, adding quality to its built environment without major changes of the urban fabric and consequent physical deconfiguration and loss of urban identity.

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