Redefining the Ahwahnee Principles: Challenges from the Favelas of Rio de Janeiro

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Abstract

With the proliferation of spontaneous settlements across the world, we sit at the confluence between urbanism of the past 100 years and urbanism of the future. Therefore, it is important to examine spontaneous settlements' characteristics in order to accurately conceptualize them. As settlements designed and built by residents themselves with low-cost and readily available materials and technology, spontaneous settlements are a type of contemporary vernacular settlements that responds to exigent human needs. In this paper, we argue that the favelas of Rio de Janeiro, Brazil, are contemporary vernacular settlements with inherently sustainable features. We examine Rio's favelas using the Ahwahnee Principles as a framework for sustainable settlements. We then suggest ways to revise the Ahwahnee Principles based on our findings.

Keywords: Ahwahnee Principles, favelas, informal settlements, sustainability, Rio de Janeiro.

Introduction

Favelas cling to the mountains throughout Brazil's second largest city, Rio de Janeiro (Figure 1). The term *favela* is used in Brazil to describe "a slum or shantytown located within or on the outskirts of the country's large cities" (Wallenfeldt, n.d.). As settlements designed and built by residents themselves with low-cost and readily available materials and technology, Rio's favelas are repeating the organic morphology of historical cities (Hélie 2014). The result is a vernacular architecture that responds to exigent human needs. Favelas are often lacking the basic infrastructural improvements of Rio de Janeiro's more established neighborhoods and have historically been managed by criminal gangs; but they have a rich street life, fine grained economy, and strong social networks that were once common in cities but are missing in contemporary sprawl and closed loop developments (Arias 2004). The extreme density of favelas, their vital sustainable practices, and their *organized complexity*[1] fascinate us.

The Favelas were "settled illegally by ex-slaves and new urban migrants over the course of the last hundred years" (Arias 2004, 2), but have become permanent additions to Rio's urban landscape. One and half million people live in Rio's 1000 favelas (Catalytic Communities, n.d.). It is commonly held that Rio's

[1] How a sizable number of variables all interrelate to form an organic whole (Jacobs 1961, 432).

favelas have grown as a result of massive influxes of rural populations migrating to the city in search of a better life. It is also possible that the urban poor within the city were priced out of their neighborhoods and chose to live 'on the hill'. Either way, favela residents both identify with the culture of greater Rio and are distinct from it (Mafra 2008, 68). Any attempt to bind them as 'the other' or include them as 'us' into the culture of greater Rio ignores Janice Pearlman's observation that "everything in a favela contains its opposite" (Pearlman 2010, 339). Pearlman writes:

> *Whatever generalization you make about favelas can be contradicted by a counterexample. If you show their vibrant side, you risk romanticizing poverty. If you dwell on the violent side, you obscure their vitality and you risk propagating wrong-minded stereotypes and stigma that residents battle every day.*
>
> (Pearlman 2010, 338)

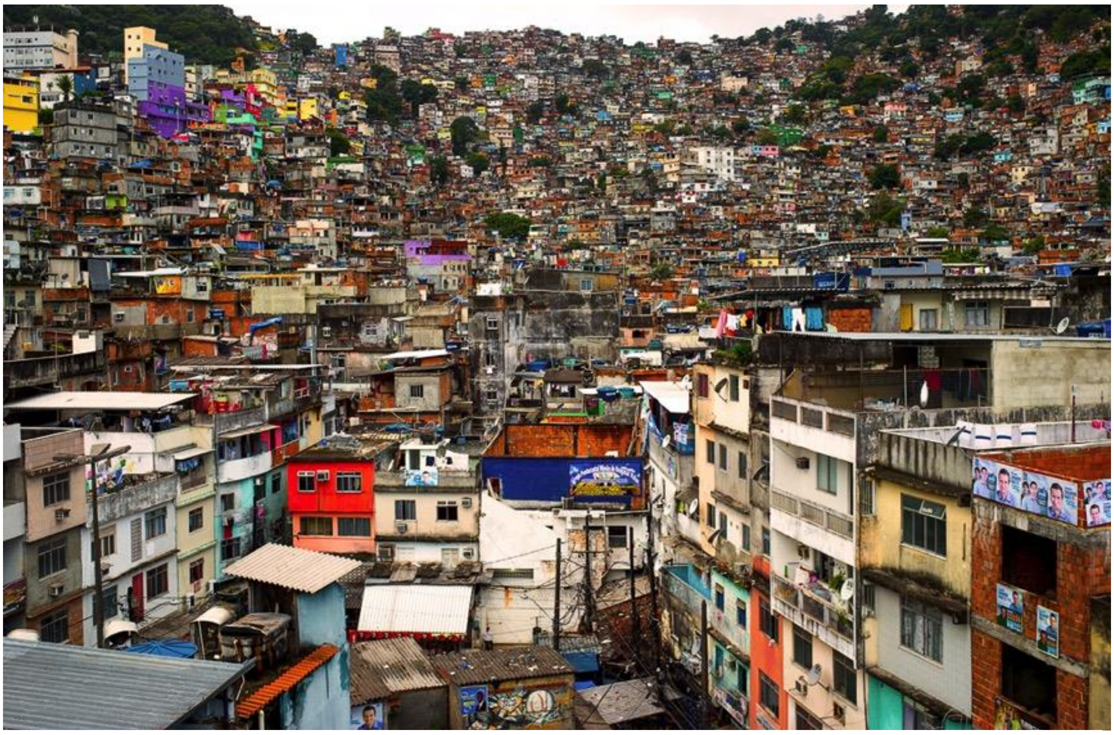


Fig. 1: Rocinha Favela in Rio de Janeiro
(Source: Joe Capra, 2013. Used with permission)

The difficulty in rationalizing these 'opposites' is compounded by the disparity among levels of poverty between/within the favelas. For example, many of the favelas that are higher on the mountain do not have access to clean water or electricity, and the houses are in disrepair. Conversely, certain favela neighborhoods are more upscale, clean, and prosperous. According to a short documentary by RioOnWatch (2012) the Favela Pica Pau, extremely unkempt with trash everywhere, has risk of disease, and the houses are crumbling. Conversely, certain favelas have a much healthier urban and social structure. For example, the Santa Margarida Favela makes a considerable effort to keep their streets clean. As a community, they have hired garbage collectors, planted trees, and organized trash pick-up walks multiple times a month. Organizations like Verdejar Favela in Complexo do Alemão also recognize the opportunities of a sustainable lifestyle. They have organized hiking trails and are determined to connect children with nature so they can understand its importance at an early age.

According to RioOnWatch (2012), Rio's favelas are often "vibrant places that buzz with life and activity" (para. 3). The "favela residents are responsible for generating Brazilian Real R$38.6 billion per year (US $ 297 million) in commercial activity"; thus 65% of them are considered middle class, and "it is unfair and wholly inaccurate to regard their communities as destitute" (para. 3). Using the term 'squatter settlement' to describe favelas is not completely accurate either since many favela residents have tenured and deeded ownership of their land (para. 4). Therefore favelas are not slums, squatter settlements, shantytowns, or even spontaneous settlements. They are contemporary vernacular settlements.

Mike Davis argues that the proliferation of slums is an apocalyptic problem[2] where "few [residents] eat more than once a day, …two-thirds or more of residents earn less than the cost of their minimum required daily nutrition," and "child mortality [is] a horrifying 320 per thousand" (Davis 2003, 24). Squatter residents, according to Davis (2003, 121), are "pioneer settlers of swamps, floodplains, volcano slopes, unstable hillsides, rubbish mountains, chemical dumbs, railroad sidings, and desert fringes." He delineates the unsustainable practices of squatter settlements using a barrage of portentous data (Davis 2003, 134). However, in Rio's favelas people are making modest but growing changes. While many of the issues cited in *Planet of Slums* are well documented, there is something more we can clearly see at work in Rio's favelas. There is a relationship between building for one's self and a settlement's sustainability. The local networks of squatter settlements, as John Turner points out, "achieve their savings and match their infinitely variable demands with the access they have to locally available resources" (Turner 1977, xviii). Considering that economic, social, and ecological sustainability are infinitely varied demands, we start to see how local networks contribute to sustainable settlements. However, "as soon as the communications network, or network of networks, breaks down, or is rendered impotent by monopolization of resources by centralized organizations or institutions, the range of amount of accessible resources shrink" (Turner 1977, xviii). Therefore a settlement's environmental sustainability benefits from its social sustainability. There is evidence that, as given above in Santa Margarida Favela, residents working within local communities have developed their own systems for maintaining sustainable and livable environments. Such scenarios lead us to ask the questions: Could we consider favelas as sustainable environments? What can we learn from these vernacular approaches to sustainable living?

Studies of vernacular settlements focus on their physical features and historical significance (Silva 2011), which is why scholars make "passing reference to informal settlement…because they [do] not appear to share any of the positive formal characteristics which were so 'self-evidently' an inherent part of traditional vernacular environments" (Kellet 2011, 4). This 'superficial approach' causes vernacular architecture to seem static, but also decouples informal settlments from their exemplary merit as vernacular settlements because they only share superficial similarities. If vernacular settlments are only artifacts, then any surface similarities they share with spontaneous settlments does nothing to overcome the ugliness, chaos, idiosyncrasy, and stigma of spontaneous settlments. However, an understanding of the process, product, and use of vernacular will reveal its congruence between culture, built environment, and ecological environment, and that understanding will show informal settlments as vernacular settlements; both

[2] Cited in Sansom (2006).

having identical merit (Rapoport 1976, 1988; Kellet 2011). Because, unlike 'high-style' designs where architects can generate multiple iterations in controlled environments, taking months or even years to decide on a solution, vernacular/informal settlements must respond to immediate needs of the site. This intimate interaction with constraints is why vernacular built environments are generally considered sustainable settlements (Oliver 2006, 420). The question then is, what are the specific sustainable features of informal settlments? In this paper, we look for sustainability in Rio's Favelas.

Method of Study

For this study, we analyzed secondary data, such as documentaries, video footage available online and Google Streetview. A short documentary by RioOnWatch titled "Favela como Modelo Sustentável" (Favelas as Sustainable Models) shows examples of existing grassroots sustainable practices in Rio's favelas and interviews with residents. We analyzed the video footages to identify the practices that residents have developed which could be considered sustainable. We recognized strategies such as building environmental awareness, adaptive reuse, zero waste, pedestrian friendly streets, solidarity, organic architecture, living near work, and clean transport. We conducted detailed content analysis utilizing scenes from Google Streetview to determine the common building practices of the favelas. This allowed us to recognize the incremental building construction process that the favela residents have developed to accommodate their naturally sustainable lifestyles. In order to establish how these practices could be considered sustainable, we compare and contrast them with the Ahwahnee Principles developed by The Congress of New Urbanism. Finally, based on the findings, we propose amendments to the Ahwahnee Principles to reflect vernacular settlements' effectiveness of response to climate, economy, and social needs.

Environmental Sustainability: A Theoretical Framework for Analysis

In 1991 New Urbanist architects and planners Peter Calthorpe, Michael Corbett, Andres Duany, Elizabeth Moule, Elizabeth Plater-Zyberk, and Stefanos Polyzoides gathered in the Ahwahnee Lodge in Yosemite National Park, California where they developed a set of urban design principles that would encourage environmentally sustainable cities. These principles were named *The Ahwahnee Principles*. They are widely accepted as models for future growth. For example, the National Council of Architectural Registration Board (NCARB) in the USA encourages architects studying for the Architectural Registration Exam (ARE) to be familiar with the principles, and there are questions on the exam derived from them. The 'Preamble' of the document states:

> *Existing patterns of urban and suburban development seriously impair our quality of life. The symptoms are: more congestion and air pollution resulting from our increased dependence on automobiles, the loss of precious open space, the need for costly improvements to roads and public services, the inequitable distribution of economic resources, and the loss of a sense of community. By drawing upon the best from the past and the present, we can plan communities that will more successfully serve the needs of those who live and work within them. Such planning should adhere to certain fundamental principles.*
>
> (Calthorpe *et.al*., 1991, 2)

These principles are:

1. All planning should be in the form of complete and integrated communities containing housing, shops, work places, schools, parks and civic facilities essential to the daily life of the residents.

2. Community size should be designed so that housing, jobs, daily needs and other activities are within easy walking distance of each other.
3. As many activities as possible should be located within easy walking distance of transit stops.
4. A community should contain a diversity of housing types to enable citizens from a wide range of economic levels and age groups to live within its boundaries.
5. Businesses within the community should provide a range of job types for the community's residents.
6. The location and character of the community should be consistent with a larger transit network.
7. The community should have a center focus that combines commercial, civic, cultural and recreational uses.
8. The community should contain an ample supply of specialized open space in the form of squares, greens and parks whose frequent use is encouraged through placement and design.
9. Public spaces should be designed to encourage the attention and presence of people at all hours of the day and night.
10. Each community or cluster of communities should have a well-defined edge, such as agricultural greenbelts or wildlife corridors, permanently protected from development.
11. Streets, pedestrian paths and bike paths should contribute to a system of fully-connected and interesting routes to all destinations. Their design should encourage pedestrian and bicycle use by being small and spatially defined by buildings, trees and lighting; and by discouraging high speed traffic.
12. Wherever possible, the natural terrain, drainage and vegetation of the community should be preserved with superior examples contained within parks or greenbelts.
13. The community design should help conserve resources and minimize waste.
14. Communities should provide for the efficient use of water through the use of natural drainage, drought tolerant landscaping and recycling.
15. The street orientation, the placement of buildings and the use of shading should contribute to the energy efficiency of the community.

Consider how heavily these rely on alignment between design professionals and policy makers. The end user is not part of the process. Compared to the layered congruence between culture, environment, and builder that characterizes vernacular architecture, the Ahwahnee Principles take a 'high-style' approach to city design in which complete designs are laid on or dug into the site. Nevertheless, as these principles would most likely lead to more environmental sustainability, and are considered by many has models for future development; we use these principles to study the favelas' sustainability. We also explore how these principles could be altered or improved, based on our findings, in order to create more holistically sustainable communities. Such a revision would help architects and planners to reorient themselves to take full advantage of the economic, cultural, social, and environmentally sustainable aspects of Rio's favelas.

Rio's Hidden Sustainability

Although "windshield"[3] urbanists only notice the penury and chaos of Rio's favelas, careful observation reveals that several of the Ahwahnee Principles exist in favelas, making favelas sustainable settlements. Because favelas are developed by the residents without intervention from architects, planners, and policy makers, favelas display an 'organic'

[3] Angotti (2006, 962) uses this term to critique the approaches taken by researchers like Mike Davis. Angotti's most stinging criticism of Davis' *Planet of Slums* is Davis' seeming lack of understanding of the agency and political will of "slum" residents.

sustainability that developed over time without a pre-planned design strategy. As these sustainable practices are organic, they do not get much attention or go completely unnoticed. These practices include: pedestrian friendly roads; use of bicycles and collective transportation; local commerce; incrementally developed architecture; and social values such as solidarity and a natural sense of collectivity (RioOnWatch, 2012). These strategies are observable in the ways people construct their homes, conduct their daily lives, and through their collective community mindset.

Housing construction in favelas exemplifies the fourth and the thirteenth Ahwahnee Principles. The thirteenth principle aims to conserve resources and minimize waste. This correlates to Rapoport's "efficiency in use of resources" seen in vernacular design (Rapoport 1988, 68). If the goal of this principal is to make an efficient urban form, it is important that each house or shop in the city contributes to this goal. In her ArchDaily article, French architect and researcher Solène Veysseyre (2012) provides an example of how this Ahwahnee Principal is embedded in favela home construction. The buildings in Rio's favelas are only as large as they need to be because each addition is built only as need arises, and oftentimes the project is passed down through generations (Figure 2).

> *'Building a house takes time and money,' said Marcio, a local resident of Complexo do Alemão. This is why a house is often built over several generations: a floor may be laid, columns erected (rebar protruding), and a thin tin roof placed, but this is just to mark where the next builder should finish the job.* (Veysseyre 2012, para. 1)

Fig. 2. Photomontage of Marcio's House, showing the stages of construction (Source: Solène Veysseyre 2012. Used with permission)

This method is also efficient in use of resources because the building fits the precise spatial needs of the owner (Rapoport 1988). Also, building materials must be locally manufactured and usually limited to what one person can carry because transport is difficult and expensive (Oliver 2006). In contrast to such incremental practice, when urban spaces are built all at once, their redundant vacancies create a drain on resources.

The fourth Ahwahnee Principle calls for a variety of housing types. Since home construction often spans multiple generations and multiple generations usually live in the same house at the same time, this incremental housing provision generates a variety of housing types within a single favela settlement. This incremental housing process is tied to the income level of the residents: The gradual expandability of the houses allows for the incremental changes in the household incomes, and since there is a wide diversity of income within the communities, it leads to a diversity of housing types. Rapoport calls this design-construction practice 'open-endedness in design', that allows additive, subtractive, and other changes (Rapoport 1988, 1995). Favela buildings "can change to accommodate changes in life cycle, life style, income, acculturation, and the like" (Rapoport 1988, 70). Therefore, achieving income diversity in a community can be achieved through incremental building and dweller control without undersupplying housing through rent control (Turner 1977, 9; Glaeser and Luttmer 1997, 3).

The dynamics of favela life also encourages the first Ahwahnee principal: mixed-use buildings. In this case, buildings are usually arranged with a retail or community purpose at the street level with the residences located above. This allows for complete and integrated communities containing housing, shops, work places, schools, parks, and civic facilities essential to the daily life of the residents (Calthorpe et.al. 1991). Each favela is able to operate independently because there is a large range of job types within each community. As a vernacular settlement, Rio's favelas are naturally, economically and environmentally sustainable because of their "open-endedness regarding activities" (Rapoport 1988, 67), where the need and opportunity come together to create overlapping activities such as "informal businesses and workshops and combinations of work with childrearing" (Montgomery 1988, 98). These combinations of mixtures of activities, not separate uses, are the key to successful urban places (RioOnWatch 2012). It is not enough to design for mixed-use. Conditions have to allow for activities to change both rapidly and over time, congruently with the culture and social networks, and allow for the architecture to reflect these changes.

This mixed-use settlement also aligns well with the second, third, and fifth Ahwahnee Principles because residents live in the same place they work, play and socialize. Most daily activities happen within walking distance, thus reducing their reliance on cars or other vehicles. Favelas' density and mixture of activities allows for low-speed, low-energy dependent transportation. Many in the community, despite age or economic status, use bikes as their primary form of transportation (RioOnWatch 2012). The narrow streets that wind between buildings allow bikers to reach their destinations quickly and easily. This directly correlates with Ahwahnee Principle number 11, which aims for a system of low-speed, fully-connected and interesting routes to all destinations. And, in favelas these occur without the help of urban planners. The favelas have developed in this way because these methods naturally contribute to the fluidity and pace required by their communities.

The twelfth Ahwahnee Principle states that natural terrain should be preserved. In general, vernacular settlements develop unique responses to their landscapes (Rapoport 1988, 67). Rio's favelas are certainly no exception. Orthogonal city grids are not found in the favelas. Each building curves with the topography, forming narrow streets that can be too small for cars (Figure 3). The favelas grow organically because there are very few properties with legitimate addresses, and people construct their homes wherever they can. Because many favelas blend naturally with the terrain, there is easy access to the highlands surrounding the city. There are community organizations that even facilitate the conservation of the natural terrain and landscape. For example, a grassroots environmental education center called Verdejar Favela organizes hiking treks through the forests along the edge of the Complexo do Alemão. Their goal is to educate the favelas' youth on the importance of nature and its conservation.

Fig. 3. The houses following the terrains of the natural landscape in the favelas
(Source: Solène Veysseyre 2012. Used with permission)

Favelas residents have "unspoken rules" that inform how residents build (Veysseyre 2012). One such rule guides residents to create an air space between neighboring buildings (Veysseyre 2012). This practice allows buildings to shade each other without losing all natural light and views. It corresponds to Ahwahnee Principle 15, which states that building placement and shading should contribute to energy efficiency.

As discussed above, favelas meet nine criteria out of the 15 Ahwahnee Principles. What about the other six principles? Since this paper deals with the sustainable aspects of favelas, we do not evaluate them in terms of principle six because it is concerned with the aesthetic character of transit networks. However, if the greater goal of principle six is to increase interconnectivity of public transportation and increase people's ability to use public transportation, this is something favela residents could accomplish through petitioning the Brazilian government through collective action. The literature does not provide information on favelas' transit connectivity; however, there are many bus routes in Rio that connect to an extensive subway system. Ahwahnee Principal seven, having a central focus that combines commercial, civic, cultural and recreational uses, may or may not exist in favelas. It is unclear, however, how this principal contributes to environmentally, economically or socially sustainable communities. The community could just as easily have a diffused focus on communal reciprocity (Kellet 2011), families and friends.

The Principle number 10, having a well-defined edges consisting of permanently protected green spaces, is problematic because it would create barriers to cross-district mobility. Nikos Salingaros (2000, 315) argues that green spaces must have "a connecting border consisting of commercial and residential elements" and "populated fingers cutting towards the centre". Edges should not be frozen but allow for future development. Permanently protected open spaces, like the esplanades of colonial cities (Kosambi & Brush 1988, 34), or Ebenezer Howard's Garden Cities, work well to segregate groups by whatever qualifier the city planner likes, but they limit spontaneous generation where and when it is needed, and limit movement and interaction between a city's diverse population (Jacobs 1961, 289). A city needs vital density; however, vernacular settlements generate density without consciously defining and protecting the edges.

Principals eight and nine call for ample specialized open spaces and public spaces that encourage 24 hours of activity. Streets and alleys are the public spaces in favelas with very few parks, but they have a pedestrian focus and 24 hours of activity. Rooftops are also important gathering spaces for parties, ju-jitsu tournaments, and kite flying. Many rooftops also have cisterns for collecting rainwater. This practice does somewhat meet Principle 14: the efficient use of water. However, Principal 14 goes further to include natural drainage and appropriate planting. Favela residents need a sustainable solution for their wastewater, which often runs through open sewers, but again, collective action could solve this problem.

Favelas Challenging the Ahwahnee Principles

We argue that there are other dimensions of sustainability – the social sustainability and the sustainable construction knowledge transfer – that are not included in the Ahwahnee Principles.

Social Sustainability

A closer look at Rio de Janeiro's favelas helps us to "regard [favela residents] as people capable of understanding and acting upon their own self-interests" (Jacobs 1961, 271). The difficulties of living in unplanned settlements outweigh the difficulties created by forced evictions in the name of sustainability (Rapoport 1990; Rehönström 2015). Squatter settlements are often painted with a broad brush. Many governments view them as problems that need to be solved, often with covert and overt violence (Oliver 2006). However, a community organizer in Rio declares that, "When people see problems in the favela, we see solutions. Where people see a place of misery, we see a place with opportunities" (RioOnWatch 2012). The social networks of Rio's favelas will not survive practices that "are usually closed to public participation processes as its paradigm is based on governmental control, and in planners paternalistically deciding what is good for the community" (De Rio 2008, 42). Social sustainability personalizes a settlement; creating a sense of ownership, stewardship, and accountability that cannot be replicated in government developments. A favela residents states:

> *Everyone knows everyone, there aren't walls around the houses, everything is open. It's very different from other places you find. You come here and you feel at home. If you get sick just knock on your neighbor's door; it won't bother them, and they'll take you to the hospital, or wherever you need to go.* (RioOnWatch 2012).

Another favela resident says, "Rio's favelas have strong collective action. If you need to get something done collectively, you just do it. - for construction, adding a new floor, cleaning up the community, and so on" (RioOnWatch 2012). Another resident says, "Sure, City Hall should do some things but when they don't, we do it ourselves" (RioOnWatch 2012).

There is no Ahwahnee Principal for this kind of social sustainability.

Sustainability of Construction Practices: Models, Adaptation, and Heuristics

Of the characteristics of vernacular architecture that Rapoport relates to spontaneous settlements, these aspects - models, adaptation, and heuristics - stand out as particularly applicable to Rio's favelas (Rapoport 1990). Models are the "implicit/unwritten design" standards that are shared among vernacular populations (Rapoport 1988, 56). Adaptation is an evolving interplay of human interactions with each other and with nature. Heuristics are the constraints of spontaneous settlements that force builders into "elimination of alternatives" and to find some “congruence with some ideal so as to maximize a set of ranked values” (Rapoport 1990, 22). These three elements - models, adaptation, and heuristics - shape the physical form of favelas more than anything else.

Most of the buildings in Rio’s favelas were designed and built by the residents themselves, who have little to no formal construction training or knowledge. However, problems with construction quality are not limited to favelas. Gaebler (2012, para.9) points out:

> *Historically, Brazil has struggled with maintaining a strong infrastructure in construction. Not only are new buildings going up without the proper safety mechanisms but historic buildings are also structurally unsafe due to disrepair. As well, the strict civil codes require such exacting compliance that it is impossible for any builder to meet them. This has led to the general practice of those codes being disregarded and no enforcement of them by municipal authorities.*

There is a perception of anarchical, limited self-interest in Rio’s favelas due to the lack of building code. However, locals follow several unspoken rules and models of construction (Veysseyre 2012). The first, which is addressed before construction even begins, is the spacing between homes. If a neighboring building has apertures on the side facing the new construction, the footprint of the new building will recede a few feet to accommodate an air space between the buildings (Figure 4). Veysseyre (2012, para. 7) states:

> *And while there are no official rules of construction, there is a law of mutual respect. Eduardo told me he decided not to install a window in his bedroom as it would have opened directly on to his neighbor’s house. After all, the favela is a small world, where everyone knows and talks to everyone else, and so they must come to peaceful agreements among themselves. This said, an extra floor will almost always obstruct a neighbor’s views — in this case, it’s common to leave a space of at least one meter between each house.*

Fig. 4. Proximity between buildings in favelas
(Source: Solène Veysseyre 2012. Used with permission)

Residents walk a fine line between respecting their neighbors’ property and appropriating unclaimed space. One resident says, “The respect generated among residents is due to the fact that everyone respects everyone else's territory. This is what I believe generates respect. These are decent people who created their own space, and they built within the limits that everyone recognizes” (RioOnWatch 2012). The lack of property lines allows residents to be flexible, adapt to their surroundings, and negotiate with their neighbors. The buildings typically expand vertically; however, as a need arises, construction techniques allow them to expand laterally, sometimes even overhanging their neighbor’s roof (Figure 5).

Fig. 5. Buildings sometimes occupy the air space above neighboring buildings
(Source: Google Streetview May 2015)

Before analyzing the construction types common in favelas, it is important to know something about the materials that are common to all types. Most common are reinforced concrete and structural clay tiles. Reinforced concrete is a common material throughout the world in both formal and informal settlements. Structural clay tile "is distinguished by hollow units having parallel cores and thin webs and faceshells," and "due to its relative light weight, large unit size, and ease of construction, the use of structural clay tile" is often used as a load-bearing wall (Bennet & Flanagan 1997, 920). Reinforced concrete with structural clay tile infill is the "form to the endless informal fabric of Brazilian cities" (Lara 2010, 37) (Figure 6).[4] Because of its ease of transport, constructability, and structural stability, the majority of the buildings in Rio's favelas incorporate clay tile (Flanagan & Bennet 1999; Lara 2010).

Although it might not be possible to remotely discover how these expansions occur without prolonged field research, our analysis of Rio's favelas using Google Streetview has allowed us to infer a few strategies that make expansion possible. We have discovered at least three distinct construction types: (1) constructing the structural clay tile all the way to the roof line and placing a tin roof temporarily on top of the load bearing walls (Figure 8 a, b & c); (2) using structural tile to create a parapet with an outdoor space on the roof, covered by the tin roof, secured by temporary steel columns (Figure 9a, b & c); and, (3) laying a floor slab atop the load bearing walls and placing the tin roof temporarily above the slab (Figure 10a, b & c).

[4] This construction method is not only common to Brazil's favelas; it is ubiquitous to informal settlements around the world from Reggio Calabria, Italy to Uganda (Woods 2011) (Figure 7).

Fig. 6. Favelas of Salvador, Brazil, with reinforced concrete structural frame and structural clay tile infill walls
(Source: Doriane Meyer, personal collection. Used with permission).

Fig. 7. Uganda Roadside
(Source: Amos Rapoport Digital Image Archive on Vernacular Design, Flickr Gallery, photograph taken on November 12, 2010. Used with permission)

It appears that the most typical construction method is the first: placing a tin roof *directly* on a load-bearing wall with no substrate for the roofing. The structure is minimal because the roof is considered temporary. This negates overhangs that would expose the unsupported tin to damage by wind and gravity. Exterior walls that are not covered by overhangs on favela structures have dark mold streaks running down several meters. The residents will often adjust this as they construct vertically: adapting their methods by learning from their neighbors.

In the first method, the concrete floor slab is poured and the concrete columns erected *leaving the rebar protruding for future expansion.* Structural clay tile is built up in place, accommodating for openings in the appropriate places. Occasionally, cast-in-place concrete exterior walls are used instead of clay tile. Next, a concrete beam is poured directly on top of the clay tile wall, primarily for lateral support. Lastly, a temporary corrugated metal roof is placed on top.

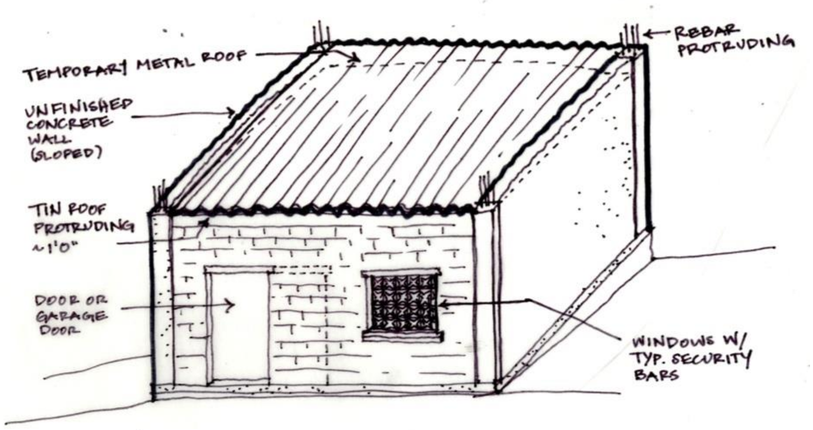
The second method is carried out in this order: first, the concrete floor slab is laid; the primary concrete load bearing columns are poured and the load-bearing structural clay tiles are put in place. Next, lateral support beams are poured, a new slab is poured acting both as a ceiling for the lower level and a floor for the future upper level, and parapet walls are built. Finally, temporary steel or concrete columns are bolted in place and a temporary roof is attached.

Finally, the third method is constructed as follows: Concrete floor slabs are laid; columns are erected, leaving rebar protruding only to anchor-in the future roof slab; the structural clay tile walls are set; a lateral beam is placed; and a new concrete slab is poured and anchored into the columns for the roof. This is the method that allows for the most expansion, as the new concrete slabs usually overhang their supporting walls. Usually this expansion is only a foot or two; however, buildings with overhangs up to four feet are not out of the ordinary. Finally, the temporary roof is placed. As seen below, this temporary roof is occasionally cut and becomes permanent when vertical construction occurs. This method, in our opinion, is the most flexible, because it allows the next set of concrete columns to be placed free of the columns below and the concrete floor/roof slab doubles as a transfer beam. This means that the clay walls can expand outward as well, allowing the room on top to gain higher square-footage. Since there are no official building codes and no property lines, there are no setback requirements and the buildings often overhang the street.

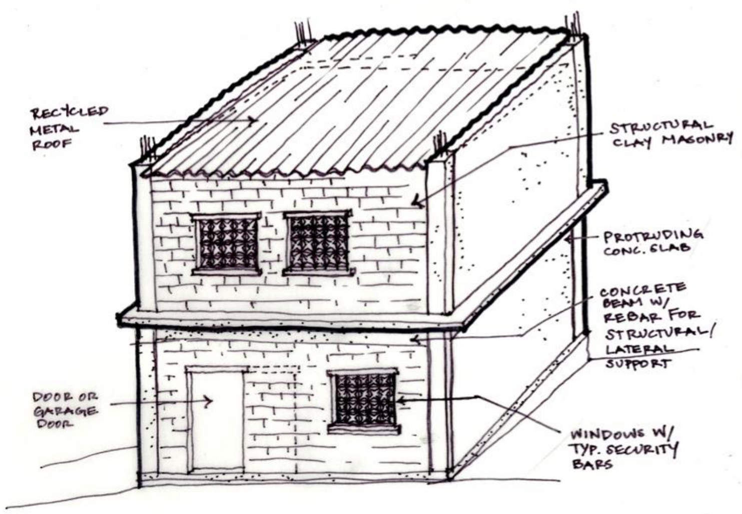
We have simplified these three types to begin to see the extent of sharing of the underlying model or the “schemata” (Rapoport 1988, 56). Although each house has its own variations, they all share common construction methods that have been practiced and adjusted over time. The perception that favelas are chaotic and everyone acts on limited self-interest is clearly inaccurate.

Oftentimes, residents will use the bottom floor of their building for commercial purposes and will live on the floors above their shop. Families will also lease out spaces on the upper floors to other locals. However, families will typically only lease out to other relatives and close friends (Arias & Rodrigues 2006). Residents plan in advance for this additional housing with the room layouts.

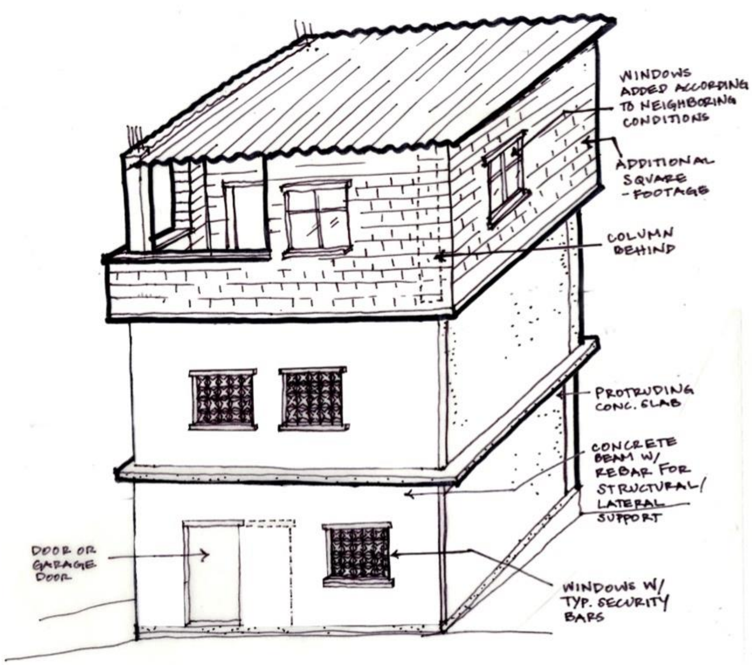
Fig. 8a. Construction Type 1 with corrugated tin directly on a load-bearing wall. Complexo do Alemão. (Source: Google Streetview, May 2015)



Type 1, Phase 1. Rebar is left protruding from concrete columns for future expansion.



Phase 2. A concrete beams are poured on top of the clay tiles for lateral strength, and a new slab is poured with an overhang. This protects the wall below from rain. The metal is reused to cover the new level.

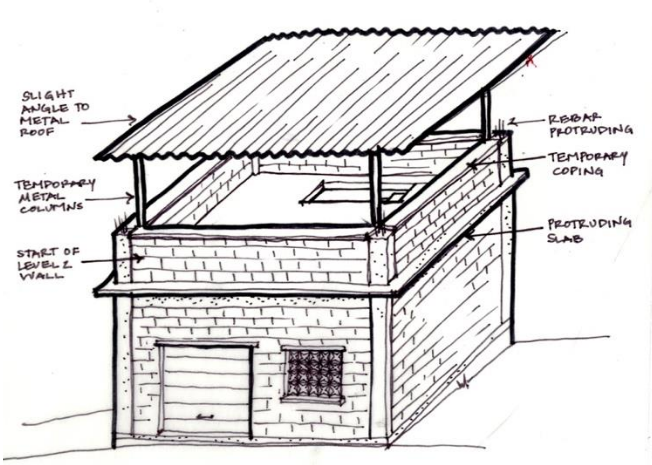


Phase 3. The overhanging slab allows for lateral expansion beyond the original footprint. Often balconies are added on higher levels. Some kind of finish, usually stucco or tile veneer, is applied to the lower levels. This process may continue with variations.

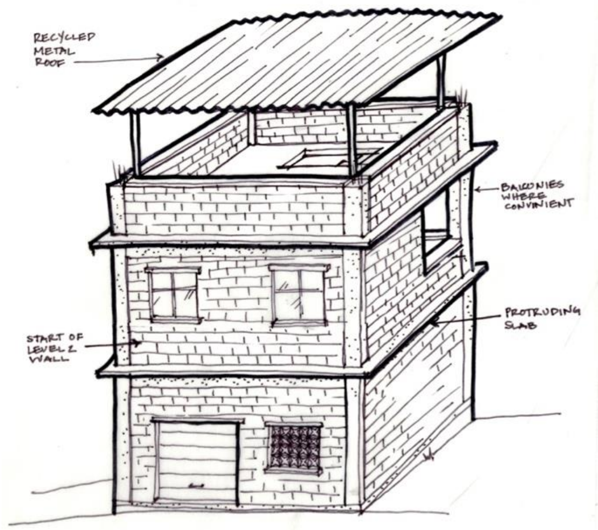
Fig. 8b. Type 1 Construction. Phase 1, 2, and 3.
(Source: Authors)

Fig. 8c. Construction Type 1 seen in Rocinha
(Source: Google Streetview, May 2015)

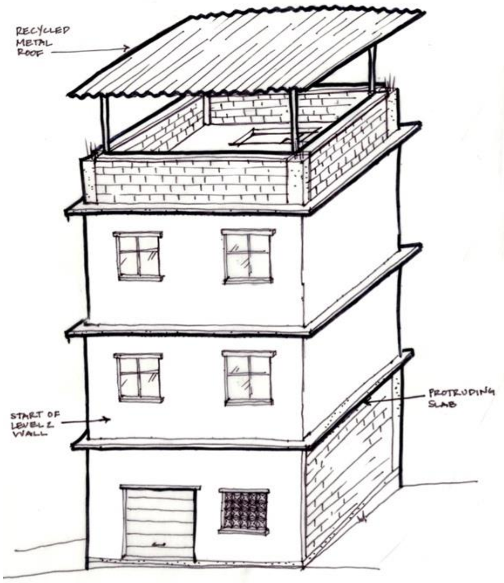
Fig. 9a. Construction Type 2 from Complexo do Alemão
(Source: Google Streetview, May 2015)



Type 2, Phase 1. A parapet is constructed above the extended slab. A temporary roof is placed to cover the terrace. The roof angles slightly to shed water. Rebar protrudes from the tops of the concrete load bearing columns.



Phase 2. The columns are extended and more tiles are layered onto the parapet to enclose the upper level. The steel holding the tin roof is moved to the new terrace.



Phase 3. The process continues and finish is added to the walls when resources are available. (Drawing by the authors)

Fig. 9b. Type 2 Construction. Phase 1, 2, and 3. (Source: Authors)

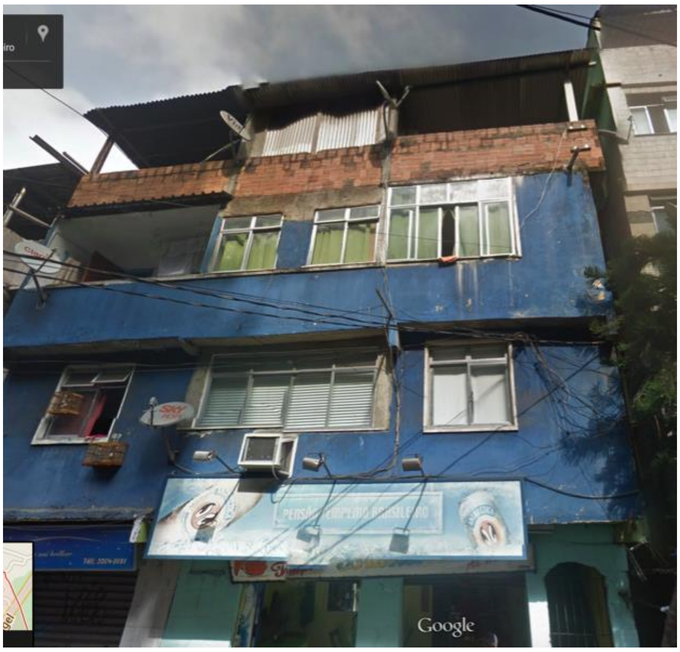
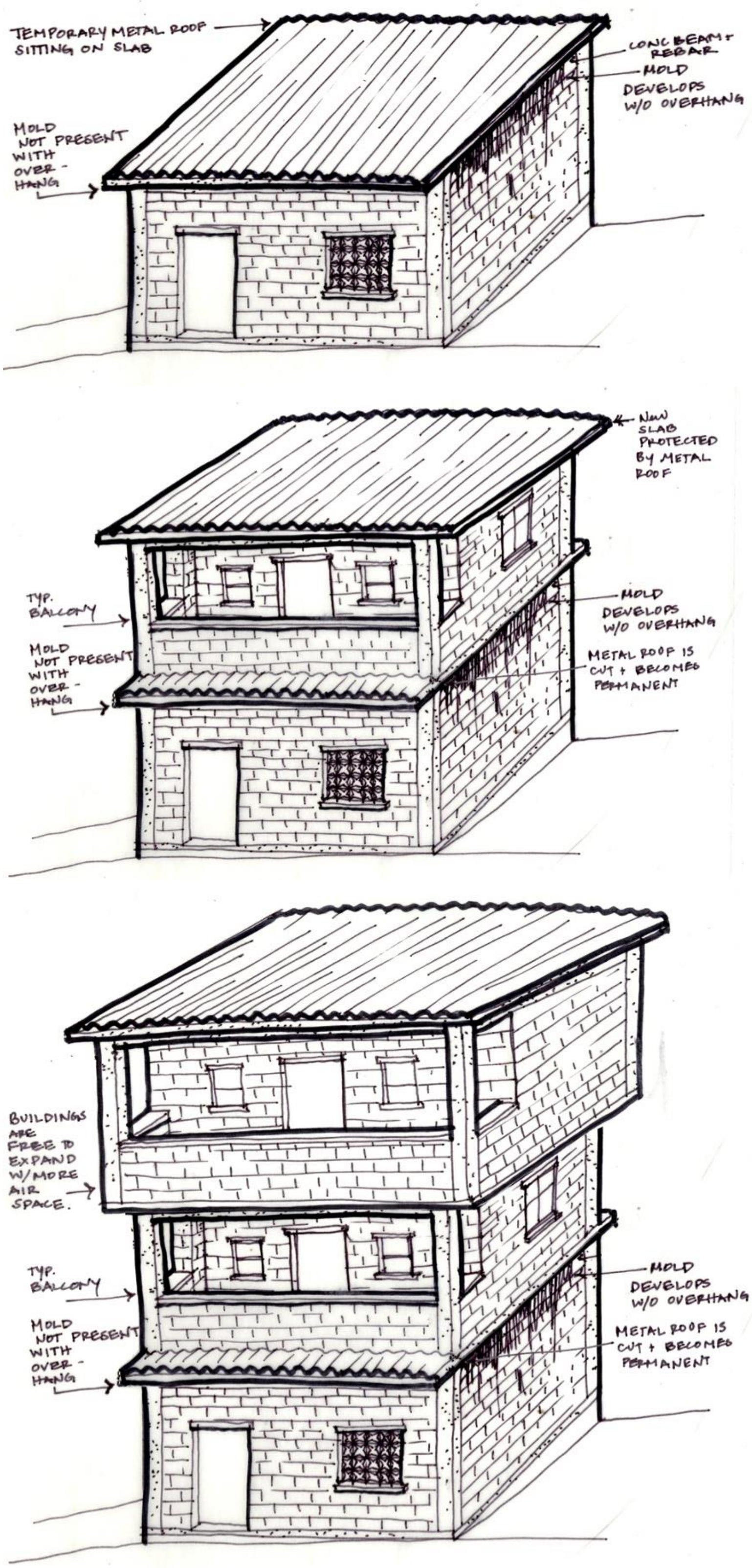


Fig. 9c. Construction Type 2 from Rocinha
(Source: Google Streetview, May 2015)

Fig. 10a. Construction Type 3 from Complexo do Alemão
(Source: Google Streetview, May 2015)



Type 3, Phase 1. An upper slab is poured acting as a roof. Corrugated tin is used to create a slope. This illustration demonstrates how mold appears on surfaces that are not protected by an overhanging slab.

Phase 2. The corrugated tin is removed. However, part of the slab is left covered with metal to prevent water from pooling on the top of the slab.

Phase 3. Corner columns are free to be placed independently of columns below because they are supported by the transfer beam / floor slab below. (Drawing by authors)

Fig. 10b. Type 3 Construction. Phase 1, 2, and 3. (Source: Authors)

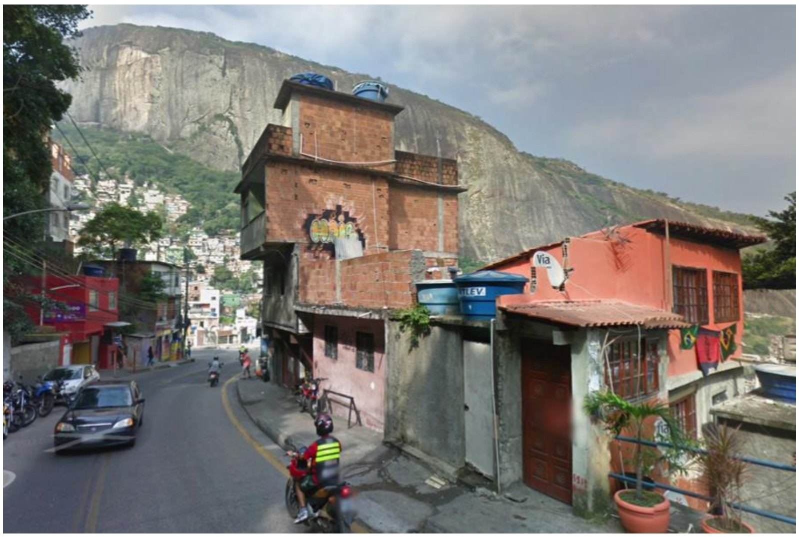


Fig. 10c. Construction type 3 in Rocinha. Massive overhangs are possible.[5]
(Source: Google Streetview, May 2015)

As the same building materials are found throughout the favelas, and due to the practice of leaving the exteriors unfinished, the favelas usually have a uniform character and an austere, unfinished look overall, indicating the dynamic nature of the settlement (Veysseyre, 2012) (Figure 11).

Fig. 11. (Left) Floor Beams and Bricks. (Right) Typical house.
(Source: Solène Veysseyre 2012. Used with permission)

Windows are rather sparse, primarily because of cost. However, the interiors are typically vibrant and inviting:

> *In general, interior spaces are well cared for and clean, painted and decorated, and almost all have big televisions as their centerpieces. Tiles are used frequently – on façades, walls, staircases, floors. It's currently trendy to tile the floor of the last floor – a terrace used for washing and drying clothes, and also for social gatherings – in the iconic "Copacabana pattern." The interior walls of the terrace floor are also painted in particularly brilliant colors: blues, greens, purples, and yellows.* (Veysseyre, 2012)

[5] Note the characteristic blue cisterns on the roofs.

Fig. 12. Interiors of a favela house
(Source: Solène Veysseyre 2012. Used with permission)

The terraces are also very important pieces of the building. This is the space used for cleaning, socializing, and relaxing. Due to the lack of ground space for *futbol*, jiu jitsu has become a very popular sport in Brazil, and tournaments occur on these roof spaces. Frequently, children also use these spaces to fly kites. The flexibility and resourcefulness of space means favela architecture has not only "open-endedness of activities," which we discussed earlier, but also the "degree of multisensory qualities of environment" and "relative importance of semi-fixed features as opposed to fixed-features" that Rapoport (1988, 71) writes about the spontaneous settlements.

Accordingly, another missing element of the Ahwahnee principles is this real-time sustainability of the transfer of tested construction practices through models, adaptation, and heuristics.

Conclusion

The answer to rapid urbanism or squatter settlements may not *always* be social housing. Minha Casa Minha Vida (My Home My Life) is a government program for housing Brazil's homeless. It builds cookie-cutter, suburban style social housing for the homeless with compact houses laid on military barrack style patterns. It was not intended for favela residents, but they seek out these programs, as many favelas are razed to make room for Olympic stadiums and parking lots, former favela residents find themselves separated from their social networks, in homes they didn't build for themselves, and far from the services they need (Benevides 2013). As governments, NGOs, and design professionals discuss the best practice/theory for dealing with increasing urbanization, it is important to remember that favela residents are more than the marginalized proletariat that populate Davis' *Planet of Slums*. They are also the "highly motivated urban pioneers" of Pearlman's *The Myth of Marginality* (Pearlman 2007, 2), and The Minha Casa Minha Vida program, and similar programs throughout the world, seeks to house people in inflexible, monotonous structures that do not reflect the people's shared culture. Instead, "we need to discern, respect and build upon the forces for regeneration that exist in [informal settlements]" (Jacobs 1961, 271). We should look at informal settlements in general and Rio's favelas in particular; with the lens that sees them as 'solutions' instead of problems.

Many articles and blogs available in the Internet are dedicated to showing the sustainable nature of Rio's favelas but there is little scholarly research that reflects this phenomenon. However, by comparing components of the favelas to the Ahwahnee Principles, it is clear that many sustainable elements exist within the physical context of the favelas. Additionally, the community possesses a mindset that promotes and advances the underlying values of a sustainable lifestyle. This community-focused sustainability is officially supported by the Brazilian government:

> *One of the most important trends in Brazilian urbanism is the move towards a sustainable social inclusion: an opposite outcome of most social and economic models of globalization. Urbanism plays an important part in the re-democratization of Brazil in guaranteeing the social function of the public realm, and as a tool in responding to the social function of city. Citizens and political parties realized that the quality of public spaces and services are major aspects for full citizenship. Public urbanism moved towards generating a socially sustainable city, recuperating the city as a pluralist environment, while seeking to extend social and cultural amenities to larger groups.*
>
> (Del Rio 2008, 45)

Most of the residents in Rio's favelas are aware of prevailing issues and are willing to spend additional time and money to improve their surroundings. We see the degree they are invested in their dwellings in the following quote from one of the favela residents; "I don't love many things, but my house is my life... because I know what a battle it was to get where I am" (RioOnWatch 2012). Their collective sense of responsibility for the favelas' enhancement reinforces their sense of community and drives continuous improvement.

If we return to the Ahwahnee Principles, we find plenty about ecological sustainability, but nothing about adaption, social sustainability, and flexibility. In many ways a thorough implantation of the Ahwahnee Principles would threaten the kind of sustainability we find in favelas. This challenge to the Ahwahnee Principles, while also using them as a framework for evaluating Rio's favelas, seems contradictory, but our critique is not over the product of the principles, but their means and methods. Since the essence of vernacular/spontaneous settlements is tied to their processes, and the Ahwahnee Principles relies on policies that preclude vernacular processes, it is important to dichotomize them. However, it is also important to highlight the similarities between the finished products of spontaneous settlments and the desired products of the principles.

Since the Ahwahnee Principles are so widely accepted, it would be more efficient to revise and amend them than to reject them. The essential qualities of building and dwelling, rapid adaption, and widespread sharing of models that favelas represent are at stake if we do not alter those 15 principles. However, we propose keeping each principle that promotes sustainability, fine-grained economy, and close social interaction, removing principles that depend too heavily on top-down imposition, and introducing principles that promote flexibility and self-determination. This will both democratize and decentralize housing. These amendments should be contextualized to allow "the degree of congruence and the nature of the relation between environment and culture" (Rapoport 1988, 56). This means these principles would have to be flexible enough to account for the complexities of time and space. If we take liberty to revise these principles based on our research, we would amend them as given in the Table 1.

Table 1.

Current	Revised
1. All planning should be in the form of complete and integrated communities containing housing, shops, work places, schools, parks and civic facilities essential to the daily life of the residents.	**1. Communities should be allowed to form of complete and integrated communities containing housing, shops, work places, schools, parks and civic facilities essential to the daily life of the residents.**
2. Community size should be designed so that housing, jobs, daily needs and other activities are within easy walking distance of each other.	**2. Community size should be allowed to be within easy walking distance of each other.**
3. As many activities as possible should be located within easy walking distance of transit stops.	**3. As many activities as possible should be allowed to locate within easy walking distance of transit stops.**
4. A community should contain a diversity of housing types to enable citizens from a wide range of economic levels and age groups to live within its boundaries.	4. A community should contain a diversity of housing types to enable citizens from a wide range of economic levels and age groups to live within its boundaries.
5. Businesses within the community should provide a range of job types for the community's residents.	**5. Businesses within the community should be allowed to provide range of job types for the community's residents.**
6. The location and character of the community should be consistent with a larger transit network.	~~6. The location and character of the community should be consistent with a larger transit network.~~
7. The community should have a center focus that combines commercial, civic, cultural and recreational uses.	7. ~~The community should have a center focus that combines commercial, civic, cultural and recreational uses~~.
8. The community should contain an ample supply of specialized open space in the form of squares, greens and parks whose frequent use is encouraged through placement and design.	8. The community should contain an ample supply of specialized open space in the form of squares, greens and parks whose frequent use is encouraged through placement and design.
9. Public spaces should be designed to encourage the attention and presence of people at all hours of the day and night.	9. Public spaces should be designed to encourage the attention and presence of people at all hours of the day and night.
10. Each community or cluster of communities should have a well-defined edge, such as agricultural greenbelts or wildlife corridors, permanently protected from development.	~~10. Each community or cluster of communities should have a well-defined edge, such as agricultural greenbelts or wildlife corridors, permanently protected from development.~~
11. Streets, pedestrian paths and bike paths should contribute to a system of fully-connected and interesting routes to all destinations. Their design should encourage pedestrian and bicycle use by being small and spatially defined by buildings, trees and lighting; and by discouraging high speed traffic.	11. Streets, pedestrian paths and bike paths should contribute to a system of fully-connected and interesting routes to all destinations. Their design should encourage pedestrian and bicycle use by being small and spatially defined by buildings, trees and lighting; and by discouraging high speed traffic.
12. Wherever possible, the natural terrain, drainage and vegetation of the community should be preserved with superior examples contained within parks or greenbelts.	12. Wherever possible, the natural terrain, drainage and vegetation of the community should be preserved with superior examples contained within parks or greenbelts.
13. The community design should help conserve resources and minimize waste.	**13. The community should be allowed to conserve resources and minimize waste.**
14. Communities should provide for the efficient use of water through the use of natural drainage, drought tolerant landscaping and recycling.	14. Communities should provide for the efficient use of water through the use of natural drainage, drought tolerant landscaping and recycling.
15. The street orientation, the placement of buildings and the use of shading should contribute to the energy efficiency of the community.	15. The street orientation, the placement of buildings and the use of shading should contribute to the energy efficiency of the community.

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