ARCHITECTURE AND SAFETY

Safe social housing for the inhabitants of the periphery of São Paulo

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06-07-2023

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Master thesis MSc Architecture, Delft University of Technology
Global Housing studio '22/23: São Paulo, repair and consolidate (AR3AD105)
Main mentor: Harald Mooij
Second mentor: Frank Schnater
Third mentor: Nelson Mota

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Abstract

In São Paulo, Brazil, the urbanization of workers without education or a steady income has caused a large demand for social housing, with 800,000 families forced to live in settlements and slums without a legal basis. At the same time, the crime rates of the past decades brought forth a standard of 'enclavement' of urban blocks, with fences protecting shared outdoor spaces. These add to the segregation of a city that already has immense inequality. Although many have written about creating a safe living environment with architecture in the Western world, applications in the global south are lagging behind. This thesis explores how architectural design can positively influence safety in the periphery of São Paulo, taking into account socioeconomic segregation, local building practices, and social equity. For this, a literature review, a comparative analysis of precedents, a contextual analysis, and research by design are used. The design is made for Parque Cocaía, a greenfield site with environmental restrictions on the outskirts of the city, in Grajaú. It shows how the design of building types that foster the creation of communities, public space that invites life into the streets, and dwelling types that allow watching over the public realm and shared spaces can all contribute to a safer living environment. The design combines lessons learned from Western theory, social housing precedents, and the local context and thereby offers an alternative to enclavement as a means to assure safe living. Future research and design can build on this to prevent further segregation of Brazilian society.

Preface

In front of you are presented the results of ten months of graduation research. It has been a rollercoaster of exploration, self-development, and persistence. It marks the completion of my studies toward becoming an architect, yet also highlights my growth as an individual over the course of these five years at the university. All this, I could not have done by myself and hence I would like to express my sincerest gratitude to everybody who supported and assisted in my development.

Firstly, my thesis tutors, Harald Mooij, Nelson Mota, Frank Schnater, and occasionally Dick van Gameren, for dedicating time to each graduation project and student on an individual basis, even when asked for extra tutoring sessions or rescheduling. Our sessions on Friday sometimes took a lot of time, but I was looking forward to them every week because of your enthusiasm, dedication, and honesty.

Secondly, to the other students of the Global Housing studio '22/23, for their mental support, design inspiration, feedback, and friendships that have developed over the course of the year. We traveled to Brazil, Antwerp, and Utrecht together, and those moments are some of the highlights of the past academic year.

Thirdly, the students and teachers of the FAUUSP, for their assistance during the field trip and for answering my hundreds of questions about the Brazilian built environment, society, and politics. A special thanks to those who provided information even after returning from Brazil.

Fourthly, all those who supported me while going through this eventful year. My parents and brother, for their unconditional love and for supporting me wherever possible for me to solely focus on reaching deadlines. My friends, for providing words of comfort and mental distraction when times were rough, and for staying in touch despite meeting up less often. Thank you from the bottom of my heart.

Muito obrigado a todos,
Huub

Prologue

São Paulo, 24-10-2022

I am working at a lunchroom 200 meters from our AirBNB in São Paulo, alone, as I write down these first lines of my graduation thesis. Although the neighborhood I am in is considered one of the safest in the city and walking to the apartment will take me just three minutes, I am setting an alarm just before dusk to notify me of when I have to start walking before it starts getting dark.

Over the past two weeks, I have been traveling around Rio de Janeiro and São Paulo with the other members of the graduation studio as part of the field trip of the project. Making sure that everybody in the group and their belongings stay safe has been a constant task since entering Brazil. Having grown up in Houten, a prosperous suburb of the city of Utrecht, the Netherlands, staying aware of the constant threats has been an unparalleled experience. Though, for the tens of millions of inhabitants of this city, this is everyday life.

After entering the country two weeks ago, we quickly felt at ease in the neighborhood of Copacabana, Rio de Janeiro. With inhabitants and tourists walking around in their swimwear all day long, the police cars and military police posting every couple hundred of meters are quickly assessed to be excessive. Though, when visiting favela barrio (slum neighborhood) Rocinha a couple of days later, the taxi driver strongly encouraged us to not leave the few main streets where it is busy and guides show tourists around. When even locals warn you like that, it must be taken seriously.

Traveling to São Paulo the week after, the fragile notion of safety becomes even clearer. On the first afternoon, we walk through the old city center just before dawn. Over here, herds of homeless

people roam the streets. This is not a place one should wander around – not for safety reasons but also out of respect for the community. The precarious living conditions are heartbreaking and make you aware of the unfairness of life.

The next day, our visits to various transition projects in the irregular settlements of São Paulo start. Accompanied by local community leaders, we are visiting several social housing complexes that have been built on the periphery of the city. Although these projects drastically improve the living conditions of its residents, they still feel like enclaves in a city of injustice. Gates, guards, and cameras separate the shared outdoor spaces from the surroundings.

On the fifth day in São Paulo, we visit Grajaú, the most populous neighborhood of São Paulo, which contains the site we are to analyze and design an architectural intervention for. Here as well, the notion of safety is constantly on our minds. In the minivan back to our apartment, I have a thorough discussion with students of the Faculty of Architecture and Urbanism of the University of São Paulo that have been accompanying us over the past few days on how to revert this situation of insecurity. I highly doubt there is a single answer to the question, but over the past two weeks, I have often found myself zoning out wondering what the future will hold for the city.

As the sun is setting behind the apartment buildings of São Paulo, I am wrapping up this prologue. Time to get back to our AirBNB before it gets dark. The perception of safety in the city of São Paulo is on my mind, and it will probably continue to do so throughout the rest of my graduation thesis.

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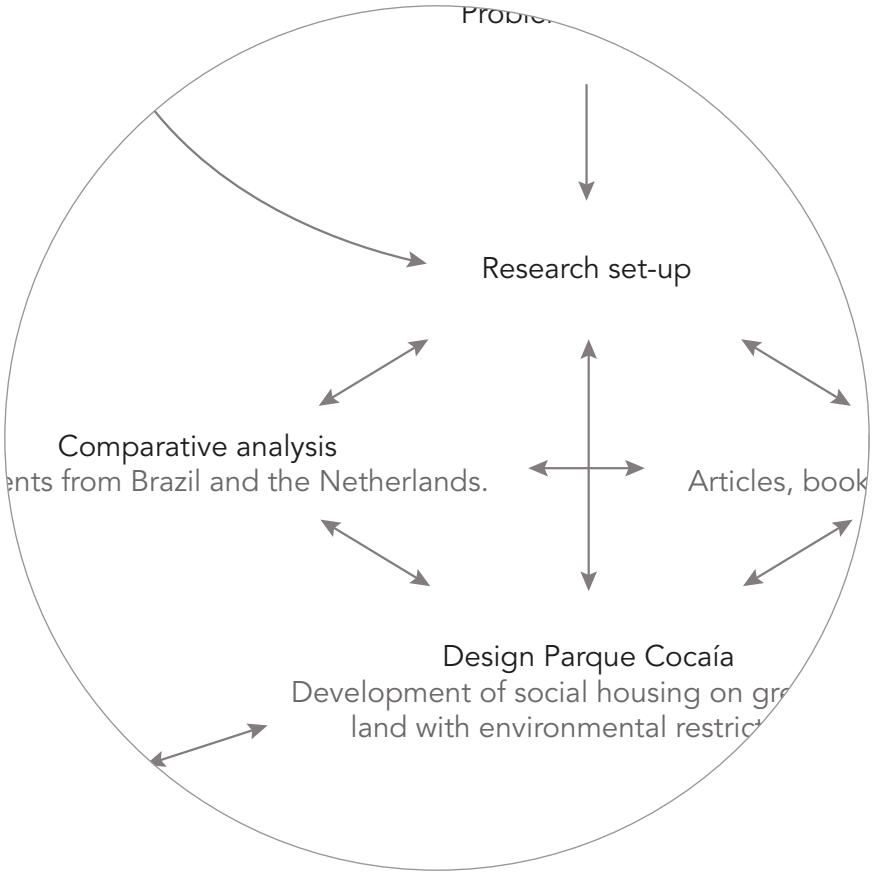
Research set-up
Comparative analysis
nts from Brazil and the Netherlands.
Articles, book
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land with environmental restric

RESEARCH PLAN

goal: determine what problem the thesis is going to research, why, and how

DEFINITIONS

In this thesis, terms specific to the design and development of transformation projects in the irregular settlements of São Paulo will be used. To prevent misunderstandings, the list below defines these terms, as taken from other researchers writing on the topic.

Autoconstruction

The process of workers building their own houses and expanding or upgrading them over time (Caldeira, 1996a).

CDHU

Portuguese abbreviation for ***Companhia de Desenvolvimento Habitacional e Urbano***, or ***Housing and Urban Development Company*** in English, being the part of the São Paulo state government that is responsible for the development of social housing. They provide investments and in-kind help.

Consolidate

Bhan (2019) argues that instead of using the terms ***build*** and ***engineer***, consolidate should be used as the method to reach the outcomes that we want. This is because in southern practices, the network ideal might be far out of reach, and therefore other alternatives might be more feasible for reaching outcomes. Furthermore, it helps one to stay away from purely technical solutions.

Enclavement

"Fortified enclaves are privatized, enclosed, and monitored spaces for residence, consumption, leisure, and work" (Caldeira, 1996b, p. 1). 'Enclavement' is the process of turning a public space into an enclave.

Favelas

The Portuguese word for slums. The municipality defines the term as: *"Precarious settlements that arise from spontaneous occupations carried out in a disorderly manner"* (Prefeitura de São Paulo, 2017).

Fortified enclaves

"Fortified enclaves are privatized, enclosed, and monitored spaces for residence, consumption, leisure, and work" (Caldeira, 1996).

HIS

Portuguese abbreviation for ***Habitações de Interesse Social***, translating to ***Social Interest Housing***. These indicate the user group of a certain dwelling. HIS 1 dwellings are destined for dwellers earning 1-3 times the Brazilian minimum wage, HIS 2 for those earning 3-6

minimum wages, and HIS 3 for those earning 7-10 minimum wages (Guerreiro et al., 2021).

Irregular settlements

Settlements that are less temporary than the favelas, but also lack a legal status: *"Settlements in which the occupation took place based on the initiative of a promoter or commercialization agent, without prior approval by the responsible public bodies or, when approved or in the process of approval, implanted in disagreement with the legislation or with the approved project"* (Prefeitura de São Paulo, 2017). Instead of timber, their building materials often consist of concrete and brickwork.

Minha Casa, Minha Vida (MCMV) program

Brazilian federal housing program created by the Lula government in 2009 investing heavily in the construction of social housing. The program offers subsidies and below-market interest rates to Brazilians with a low income not owning property yet.

Peripheral urbanization

The process of city-making occurring in the peripheral areas of urban regions. It is related to a specific time and place and builders engage in politics to claim land (Caldeira, 2017).

Repair

A transformative redevelopment of the house one lives in, moving forward sometimes but also falling behind (Bhan, 2019).

SDGs

Abbreviation for Sustainable Development Goals. Seventeen goals established by the United Nations (UN) in 2015 for 2030.

SEHAB

Portuguese abbreviation for ***Secretaria Municipal de Habitação***, translating to ***Municipal Housing Secretariat***. The part of the São Paulo municipality responsible for the development of social housing, like the CDHU is for São Paulo state.

Squatting

The process of occupying and building on the land of which the builder does not hold a legal status (Bhan, 2019). After five years of squatting, Brazilian law (Art. 183) assigns ownership of the land to the squatter (Constituent Assembly, 2022).

Upgrading

Compared to repair, Bhan (2019) states that upgrading is ***"incremental improvement rather than transformative redevelopment"***.

Usucapião

Roughly translated as ***urban adverse possession***. The right for families with a low income and not owning other property to claim possession of a piece of land after inhabiting it for a certain duration, often being five years (Benschop et al.).

ZEIS

Portuguese abbreviation for ***Zona Especial de Interesse Social***, translating to ***Special Zone of Social Interest***. These are zones earmarked for the development of social housing. The project site of this thesis is a ZEIS 4 area, meaning an area ***characterized by vacant land, suitable for urbanization and construction, located in watershed protection areas"*** (Prefeitura de São Paulo, 2014).

INTRODUCTION

Walking through the streets of São Paulo, Brazil, one should constantly reevaluate the safety of the ongoing situation. During a two-week field trip to the city, we frequently ran into residents providing us with unsolicited advice on how to safely get around. Coming from a prosperous Dutch suburb where criminality is almost non-existent, this constant assessment of risks was a completely new situation for me. In my mind, my experiences in Brazil will forever be associated with safety, and it also makes me wonder how a safer future for the Brazilian megacity can be achieved.

In Grajaú, a peripheral neighborhood of São Paulo, the municipality has started transforming irregular settlements into social housing complexes as part of the ***Programa dos Mananciais*** (Portuguese for ***Watersheds Program***) (ISA, 2008). Chácara do Conde is the first project to be completed, and therefore can be considered an example for the other transformations to be realized. In the design of Chácara do Conde, large fences have been put around the shared courtyard to create a feeling of protectiveness. This trend of enclavement is visible all over the city, with gates, security guards, and CCTV separating the lives of inhabitants in hope of a safer living environment (Coy, 2006). This trend also leads to further segregation though (Caldeira, 1996b), and one can wonder whether this is desirable, in a city that is already highly segregated.

Over the past century, various architectural theoreticians have touched upon the relationship between architecture and safety. Although there is no consensus on a single method to design a 'safe' neighborhood, various design concepts are offered that deviate from the concepts implemented in the Chácara do Conde project. In this thesis, the relationship between architecture and safety in the context of the Grajaú neighborhood is analyzed. Through this analysis, an alternative design for transformation projects in Grajaú is explored, that can hopefully offer safety to its inhabitants, as well as prevent further segregation of the city.

ENCLAVEMENT ALL OVER SÃO PAULO

Figure 1. Courtyard Chácara do Conde, Grajaú.

Figure 2. Conjunto Celso Garcia.

Figure 3. Parque Novo Santo Amaro V.

Figure 4. Gleba A Heliópolis.

PROBLEM STATEMENT

São Paulo has to deal with a big shortage of affordable housing and a widespread feeling of urban unsafety, causing a growing percentage of public spaces to be enclaved, thereby adding to the segregation of its community.

Worldwide, one billion people lived in urban slums in 2020, as reported by the UN (United Nations) in their ***Sustainable Development Goals Report*** of 2022. Intensifying focus on providing adequate and affordable housing is the first step in achieving SDG number 11, ***"Make cities and human settlements inclusive, safe, resilient and sustainable"*** (p. 18).

For decades, Brazil, the largest and most populous country in Latin America at 215 million inhabitants (CIA, 2022; UNFPA, 2022), has been known for having a large urban precarity, alongside having one of the highest income inequalities worldwide (Marques & Saraiva, 2017). In 2018, 16% of the urban population of Brazil lived in favelas (The World Bank, 2018), despite the right to adequate housing being included in the Brazilian constitution (Constituent Assembly, 2022). The creation of the favelas can be traced back to massive urban migration when Brazilian cities started to industrialize, with the urban population growing from 18 to 82 million between 1950 and 1980 (Fix & Arantes, 2021). A large part of the migrants did not manage to find a home in an official settlement or a job with a sufficing wage, therefore, they were forced to squat, a process that is well-known in other cities in the global South as well.

São Paulo is with its 22.4 million inhabitants the largest city in Brazil and is considered its economic center (CIA, 2022; Marques & Saraiva, 2017). The city is also known for its housing problems though (Marques & Saraiva, 2017). This situation brings forth social, economic, and environmental challenges for both the inhabitants and the entire metropolis (Walker & Alarcón, 2018). To deal with this, the SEHAB has been investing heavenly in improving the living conditions in irregular settlements, favelas, and watershed areas since 2005 (Serapião, 2016). There is still a long way to go though, with the number of households in favelas and irregular settlements being estimated at almost four hundred thousand each and the slum dwellers making up 11.6% of the population in 2017 (Prefeitura de São Paulo, 2017; Marques & Saraiva, 2017).

In Grajaú, one of the poorest and most populous neighborhoods of São Paulo (São Paulo Data-Driven Envirolab, n.d.; Pinheiro, 2021), the municipality had to remove the inhabitants of

5000 irregular lots in 2008 as part of the Cantinho do Céu project (Lara, 2019). The former settlements of the inhabitants were built within close vicinity of the waterfront of the Billings reservoir, one of the two large water bodies of São Paulo providing the city with drinking water. Due to a lack of sewerage and waste collection, the inhabitants were polluting the water of the reservoir. To relocate these inhabitants, as well as be able to provide space to the influx of residents, the neighborhood is in serious need of adequate housing that is affordable for the lowest-income groups. Though, development is lagging due to a lack of economic incentives – a trend that is visible all over São Paulo (Ribeira et al., 2016).

At the same time, Brazil has been dealing with crime and violence for decades. As a data analysis by Murray et al. (2013) shows, there were 1 million homicides in Brazil between 1980 and 2010. According to their research, these high numbers stem from ***"rises in inequality, more young men in the population, greater availability of firearms, and increased drug use"*** (p. 1).

Since the 1970s, gated housing communities have appeared in various Latin American cities, as noted by Coy (2006). Coy states that at first, gated condominiums were designed as exclusive housing projects that offer a more distinct contrast between private and public. These first projects were taken as examples for designs of future housing complexes. With crime and violence rising in the following decades, gated condominiums became more popular for the middle and upper class (Murray et al., 2013; Coy, 2006). The physical barriers became a symbol of wealth, thereby leading to further segregation of Brazilian communities (Caldeira, 1996b).

From 2017 to 2020, the number of homicides in Brazil has finally been dropping, by 29% (Worldbank, 2022). What remains though, are fear, psychological health problems, and injuries (Andrade et al., 2012; Gawryszewski & Rodrigues, 2006). These might well have an impact on Brazilian communities for decades to come. The Chácara do Conde project in Grajaú is an example of this, with the design setting a standard of enclavement for future transformation projects in the region.

The problem statement was visualized using a video that can be watched via this link:
https://youtu.be/SrZS7x6niXw

SETTLEMENTS IN DIFFERENT PARTS OF SÃO PAULO

Figure 5. Irregular settlements near Cantinho do Ceú.

Figure 6. Irregular settlements along the Billings reservoir.

Figure 7. Dump site along the Billings reservoir.

Figure 8. Irregular settlements in Heliópolis.

Figure 9. Irregular settlements in Santo Amaro.

Figure 10. Favelas in Grajaú.

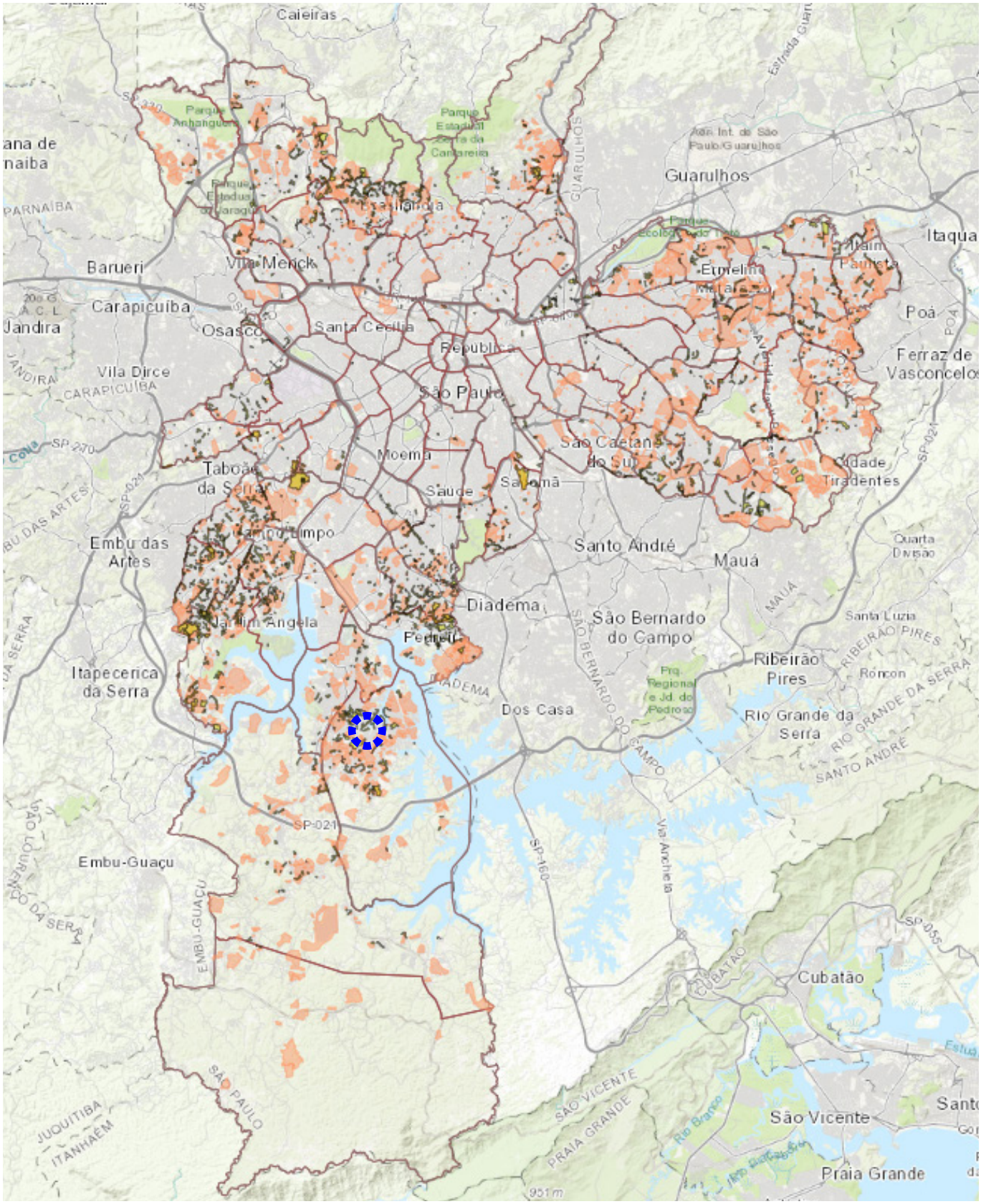


Figure 11. Map irregular settlements in São Paulo (Prefeitura de São Paulo, 2017).
Favelas marked in yellow, irregular settlements in orange, project site demarcated in blue.

RESEARCH QUESTION

In this thesis, the relationship between architectural design and safety is studied, to explore an alternative design for the transformation projects in Grajaú. An alternative design that can hopefully offer safety to future inhabitants, as well as prevent further segregation of the city. The following research question and sub-questions will be used:

How can architectural design positively influence safety in the development of social housing in the periphery of São Paulo, taking into account socioeconomic segregation, local building practices, and social equity?

i. Which architectural interventions have proven to positively influence urban safety?

ii. What lessons can be learned from the development of housing in São Paulo and the Netherlands on dealing with safety, segregation, and local building practices?

iii. How does the context of the project site operate and which factors should be taken into account when designing?

THEORETICAL FRAMEWORK

In the global north, a lot has been written on the relationship between architecture and safety. Jacobs her ***The Death and Life of the Great American Cities*** (1961), Jeffery his ***Crime Prevention through Environmental Design*** (1971), and Newman his ***Defensible Space*** (1972) all remain frequently quoted in research on the subject. Over the past decades, new research has mostly been on testing or elaborating these theories, like the works by Macdonald & Gifford (1989), Newman (1996), Tijerino (1998), Ham-Rowbottom et al. (1999), Brunson et al. (2001), Sennett (2019), and Cozens et al. (2019). Reynald & Elffers (2009) point out that Newman his defensible space theory still is largely ambiguous, especially when taking into account the amendments he made after applying the theory in three experiments in the United States (Newman, 1996). Furthermore, a critical review by Cozens et al. (2019) proves that architectural design based on Jeffery his theory is largely effective in reducing both crime and fear of crime in a community. The fact that CPTED (Crime Prevention through Environmental Design) guidebooks and classes are offered still, shows the lasting relevance of his work.

Urban areas in the global south, and more specifically São Paulo, present a context totally different from that of northern cities. Even terminology and fundamental societal processes should be reconsidered when trying to grasp this context, as argued by among others Caldeira (2017), Medrano and Recaman (2018), Lejano and Del Bianco (208), and Bhan (2019). Examples of this are the definitions listed on the first page of this report.

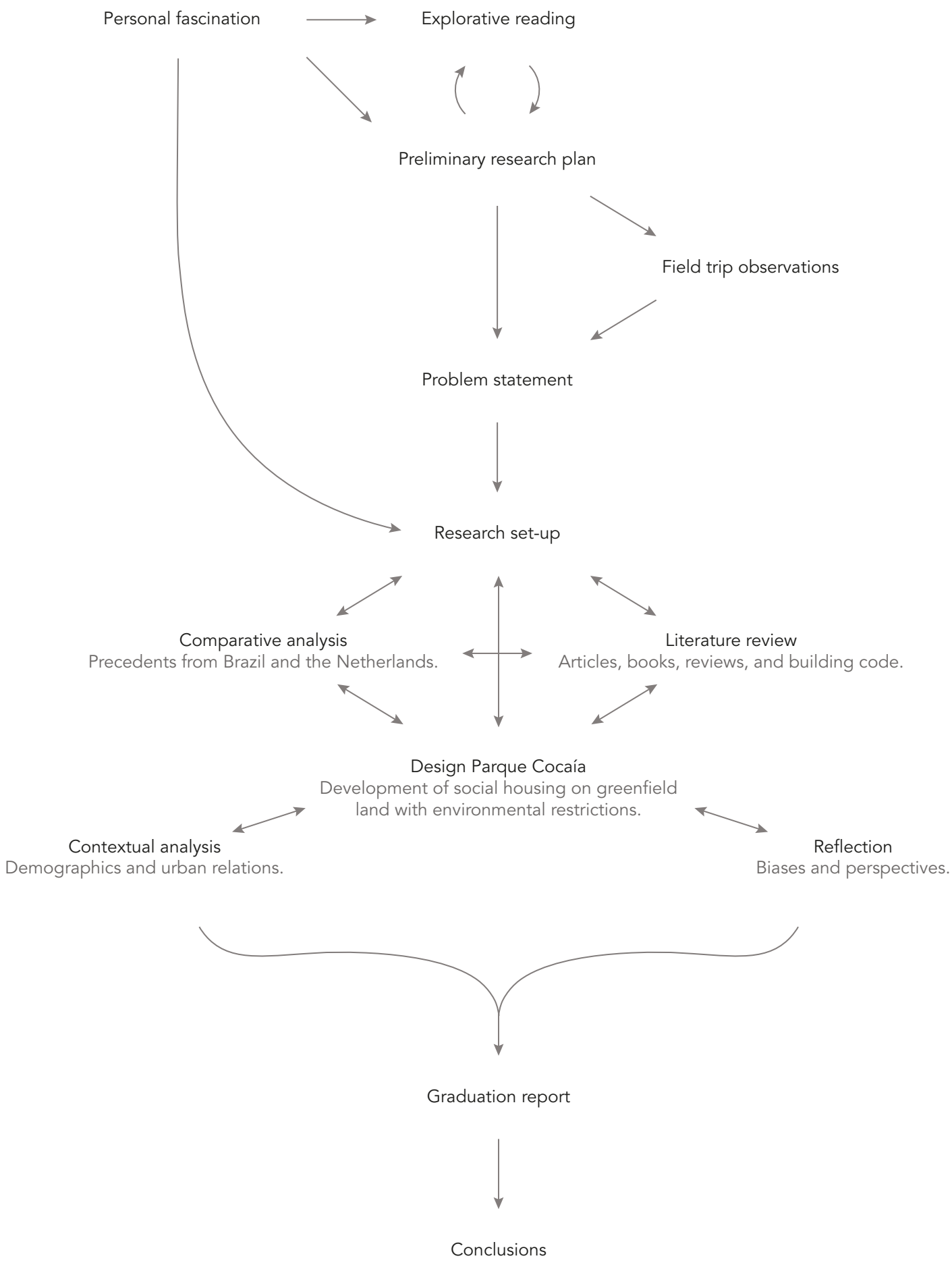
METHODOLOGY

The first part of the thesis will be analytical, for which literature is reviewed, a comparative study of other transformation projects is made, and the site is analyzed. During the second part, the takeaways from these analyses are applied and tested in the design of a transformation project in Grajaú to answer the research question. The design is made in a ZEIS 4 area, meaning unoccupied land designated to develop social housing with environmental restrictions. The site is marked by low socio-economic values and a high density compared to the rest of Grajaú (Prefeitura de São Paulo, n.d.).

For the literature review, books and articles on the relationship between architecture and safety from the 1960s until the present are dealt with. From these, an overview of design interventions is made, which can be tested in the design phase of the project.

A comparative analysis between five transformation projects in irregular settlements in São Paulo and Chácara do Conde will be made to determine how architecture influences safety, focusing on the three themes covered in the sub-questions.

During the field trip in October, these five cases and Chácara do Conde have been visited. At the sites, visual analyses have been made and interviews have been held. The visual analyses cover manifestations of public life, typical design features of the area, and safety measures taken by inhabitants. The interviews give an insight into how residents experience the projects. Though, with these interviews, biases and social limitations should be considered.


Personal fascination
Explorative reading
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Field trip observations
Problem statement
Research set-up
Comparative analysis
Precedents from Brazil and the Netherlands.
Literature review
Articles, books, reviews, and building code.
Design Parque Cocaía
Development of social housing on greenfield land with environmental restrictions.
Contextual analysis
Demographics and urban relations.
Reflection
Biases and perspectives.
Graduation report
Conclusions

IMAGES OF THE PROJECT SITE

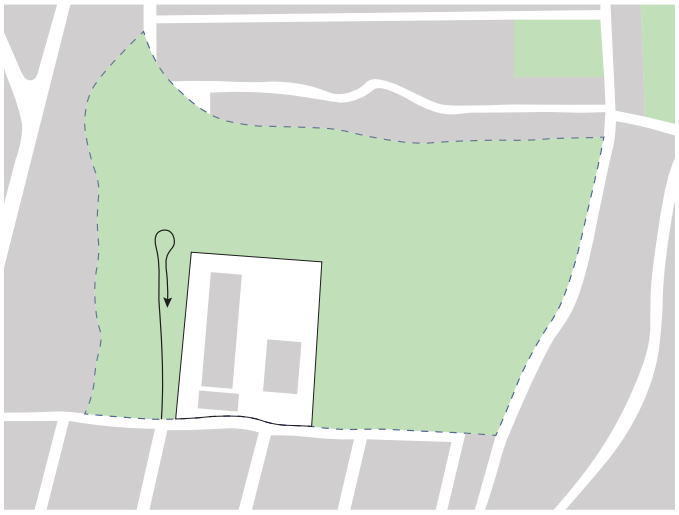


Figure 12. Map project site. Walking path demarcated with arrow.

Figure 13. Entrance site.

Figure 14. Settlements next to entrance.

Figure 15. Backside settlements next to site.

Figure 16. Western part site.

Figure 17. View over eastern part Grajaú.

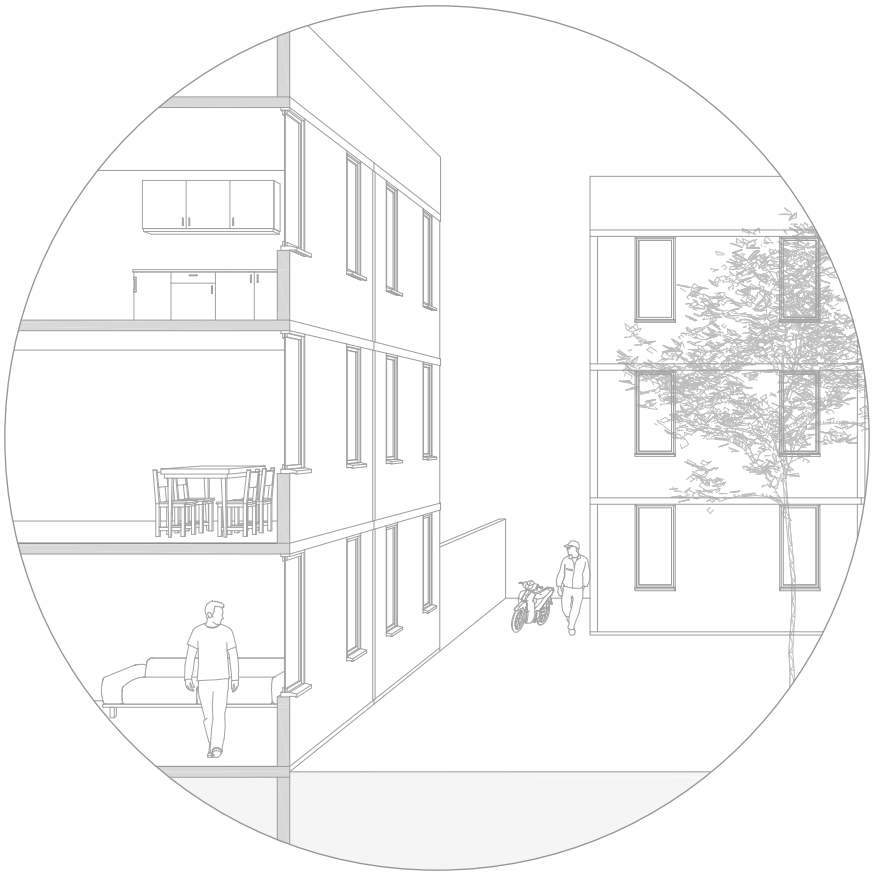
RELEVANCE

Though a lot of research has been done on the relationship between architectural design and safety in northern cities, not much literature was found on this relationship in southern cities, nor specifically for the irregular settlements of São Paulo. Whether this is due to the language barrier, availability of Brazilian literature in Dutch libraries, or accessibility of online Brazilian databases from the Netherlands, this thesis aims to contribute to the collective knowledge of this relationship.

Furthermore, the design made in the second phase of the project can hopefully inspire project developers operating in Grajaú to explore an alternative design for transformation projects. Ultimately, this involves a design that achieves similar safety levels as the Chácara do Conde project, without the public spaces being enclaved.

PERSPECTIVES

This thesis will be executed from a 'northern perspective', being the opposite of a 'southern perspective' – a perspective described by Sheppard, Leitner, and Maringanti (2013) as inherited by: ***"those, everywhere, whose livelihoods have been made precarious by historical processes of colonialism and globalizing capitalism"*** (p. 7). This offers both opportunities to think outside of the box compared to designers from the global south, and creates the danger of making assumptions based on northern societies and their values, especially when assessing the 'successfulness' of design interventions. Throughout this thesis, this should be taken into account when drawing conclusions or making decisions. Research papers by professionals from the global south, like the ones referred to in this research plan, alongside personal experiences from the two-week field trip to Brazil, should help to conceive an understanding of the societal and architectural processes in the global south.



SAFETY INTERVENTIONS CATALOG

goal: find out which interventions have been thought of and proofed already

THE PERCEPTION OF SAFETY

The creation of shelter is as old as humanity. It offers protection from the climate, seasons, and predators. With the evolution of human beings, shelter evolved along. The means and requirements of shelter evolved and architecture, the art of designing buildings, was invented. At the same time, shelter always remained its purpose to offer safety to its users. From animals to opposing tribes, members of different societal classes, nosy passersby, and intruders, humans still have a deeply-rooted desire to protect a claimed private space. Various contexts present completely different manifestations of architecture aiming to do so, however. In São Paulo, the conditions have led to a norm of enclavement of space, leading to further segregation and disconnection of the city.

The case studies of the gated community and Chácara do Conde show how in large parts of São Paulo safety is assured by placing walls and fences. Austrian architect Theo Deutinger studies the architecture of walls and fences in his award-winning book ***Handbook of Tyranny*** (2018). In the book, he describes walls as follows (p. 46):

> ***"Walls are the longest-lasting and most expensive border barriers, as well as the most symbolic, physically and rhetorically. […] It is highly doubtful that walls are more effective than fences at keeping people out. They do, however, signal to outsiders that they are excluded not only from entering but also from seeing the walled territory. In densely populated areas, walls have been preferred in fences since they are more effective at preventing targeted shooting."***

This final note on the danger of arms is seconded by the Belgian documentary producer Tom Waes, who took part in a course ***"prevention of carjacking"*** in São Paulo during the production of a fifty-minute documentary on the city as part of the series ***Reizen Waes Wereldsteden*** (De Mensen, 2023). The need for these courses is not taken away by introducing more walls in a city, yet it lies in societal changes and more subtle design interventions. At the same time, Deutinger perfectly describes the ambiguity of contemporary urban design for safety with his concept of the ***Defensive City*** (p. 85):

> ***"Defensive measures adopted by today's cities mainly target the enemy within. Besides the threat of terrorist attacks, there is a much less violent 'enemy' to the city: the ordinary citizen. […] 'Unwanted behavior' is the accusatory basis for the implementation of subtle design elements that try to influence the use of public space […] others (ref.: examples of unwanted behavior) include lying down, sitting, standing***

in a group, and walking. These are activities that take place in public spaces – the same spaces advertised in real estate brochures as vivid, dynamic, and bustling with life.
It's a battle of realities. The general public does not want a Saturday morning at the shops to be marred by the reality of homeless people […]. But the same general public likes to contribute to the image of an open, welcoming, and unconstrained city. Thus, the smaller and less conspicuous the city's protective elements, the better.
[…]
The city against unwanted behavior is the Western, capitalist city – a clean and bloodless construct that works optimally only until shops close. […] The question is: Are we willing to exchange feeling safe for being more alive?"

This leads up to the research question of this thesis, on how architectural design can positively influence safety in the complex context of the periphery of São Paulo. With this literature review, design interventions are sought that have proved to answer this requirement.

By reviewing nearly fifty articles and books on the relationship between architecture and safety, a list of twenty tangible design interventions positively influencing safety was compiled. The sources vary greatly, from being written in the 60s or recently, and to being written in Latin America, the United States, or Europe. The narrative differs between these time periods and regions, though some founding theories remain frequently quoted. For example, students of the FAUUSP are still recommended to read the famous ***Life and Death of the Great American Cities*** by Jane Jacobs, next to more recent works by Brazilian architect Vicente del Rio.

Although these design interventions have proven to positively influence safety in urban areas, it is important to note that these together do not form a safety utopia. As Souza Neto (2019) rightfully mentions, there are an infinite number of factors influencing the whether a crime will occur, with a large part of these not being influenced by architectural design as well. Hence, it is impossible to design a completely crime-free neighborhood. Furthermore, crime is a heterogeneous concept. The circumstances under which theft occurs are totally different from those under which homicide may take place (Souza Neto, 2019). Though, taking these side notes into account should not hamper the intention of designing spaces that are less likely to be the stage of various sorts of crime.

On the following pages, the twenty design interventions are explained and illustrated. They are bundled into five categories, as to ease the process of integrating them into a design. These categories are:

i. Surveillance of the public realm from the private realm;
ii. Surveillance of the public realm from the public realm;
iii. Territoriality created within a community;
iv. Territoriality perceived by intruders;
v. Physical barriers.

In the chapter ***Design Parque Cocaía***, these interventions are adapted to the São Paulo context, to study their effectiveness and appropriateness.

SURVEILLANCE OF THE PUBLIC REALM FROM THE PRIVATE REALM

Juxtaposition interior and exterior spaces
(Newman, 1972)

By placing much-used interior spaces close to the public realm, surveillance is allowed. The living room and kitchen are perfect for this, as these are not as private as a bedroom and they are occupied for larger parts of the day.

Permeability front facade
(Vivan & De Saboya, 2012)

Windows, doors, porous facades, and other openings all connect the private realm to the public realm. They offer inhabitants the possibility to watch over space and they make intruders aware that they are being watched. Especially the permeability of much-used spaces is important. In hot climates, effective sun shading is needed to allow for this permeability.

Urban greenery
(own reasoning; Li et al., 2015)

Urban greenery, like trees, provides shade to facades, allowing for bigger windows and therefore a better view over public space. Though, the greenery should not block the view from the dwellings. Also, research by Li et al. (2015) shows that urban green even has a direct positive impact on perceived safety levels. Urban greenery also invites inhabitants into the public realm, thereby making for a more vivid and thereby safer neighborhood.

Prevent blind-eyed corners
(Jacobs, 1961)

Blind-eyed corners invite destructive and malicious behavior and should therefore before prevented. Special care should be given to the design of the heads and tails of apartment buildings, as they often contain blind facades.

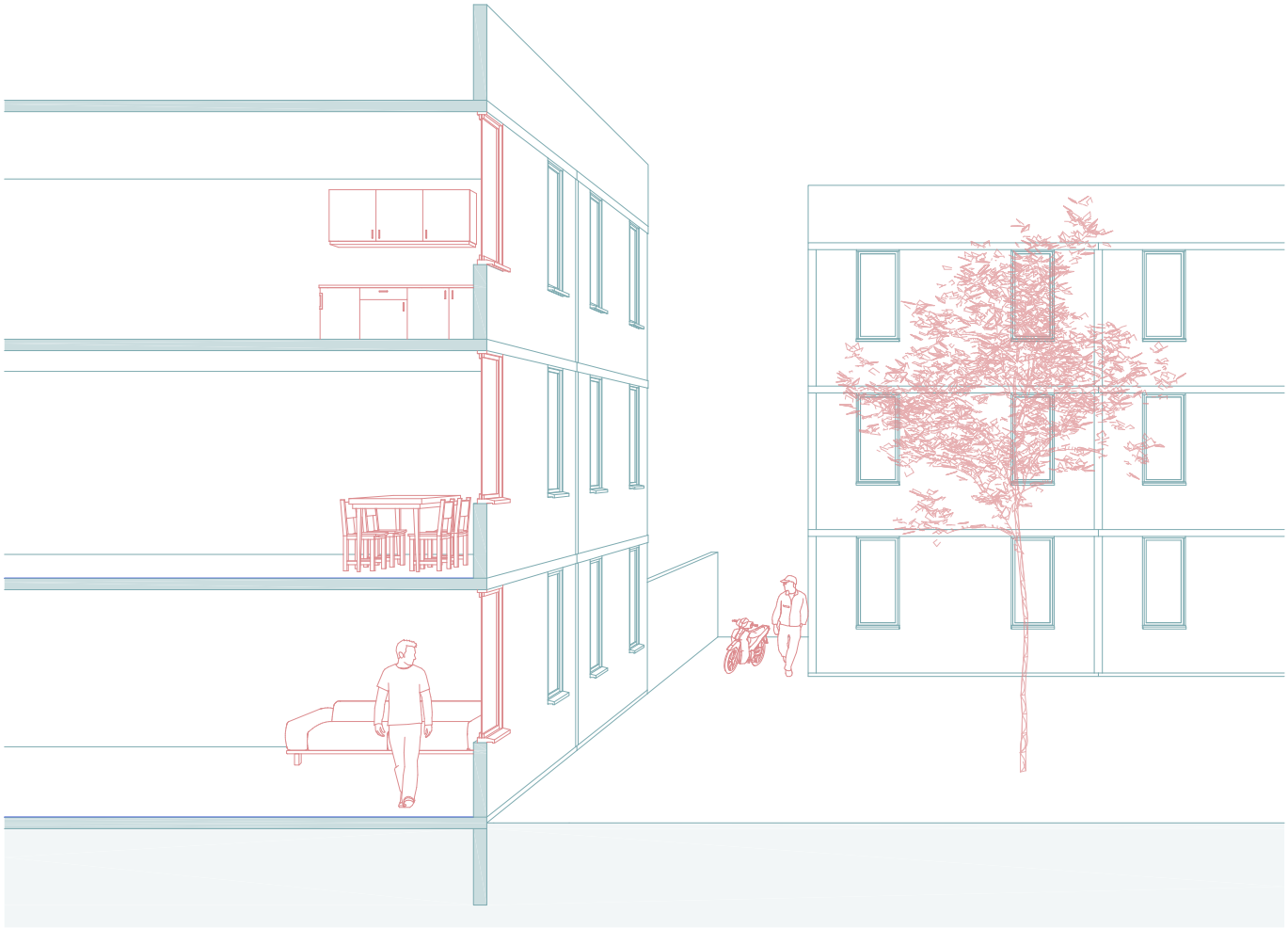


Figure 18. Design interventions “surveillance of the public realm from the private realm”

SURVEILLANCE OF THE PUBLIC REALM FROM THE PUBLIC REALM

Mixed-use development
(Jacobs, 1961)

Shops, bars, restaurants, and other public places invite sidewalk life, thereby providing eyes on the street. Preferably, the amenities attract residents at various times of the day to keep the street watched over all day long.

At the same time, Vivan & Saboya (2012) also showed higher levels of crime being committed around commercial areas. These locations attract pickpockets due to the high flux of visitors and a low catch rate.

Lively sidewalks
(Jacobs, 1961)

Well-designed sidewalks act as a control mechanism for the city by inviting pedestrians into the public realm, thereby providing eyes on the street. Streets can be made more attractive for pedestrians by having clearly defined pedestrian zones and by including speed humps or chicanes for cars.

Welcoming pedestrian routes
(own observations)

Providing walking routes through urban green, along water bodies, or along urban amenities, will increase the number of citizens commuting by foot for leisure purposes. Urban furniture, like benches and water taps, will further add to the livelihood of these routes.

Shared urban amenities
(own observations)

Amenities like communal gardens, sports facilities, or a community center all add to the number of eyes on the street. Furthermore, they also encourage territoriality among inhabitants, making them look out for intruders.

Short housing blocks
(Jacobs, 1961)

Every corner offers an opportunity of encountering somebody or something. Also, short blocks offer various paths for pedestrians to take, increasing the connectivity of the area. Both add to the likeliness of pedestrians roaming around. For intruders, the increased chance of running into inhabitants makes it less attractive to commit a crime.

Presence police stations
(De Souza Neto, 2019)

The vicinity of a neighborhood to police stations influences the likelihood of crime to occur since it influences the chance of criminals getting caught. This factor is not in the hands of architects though.

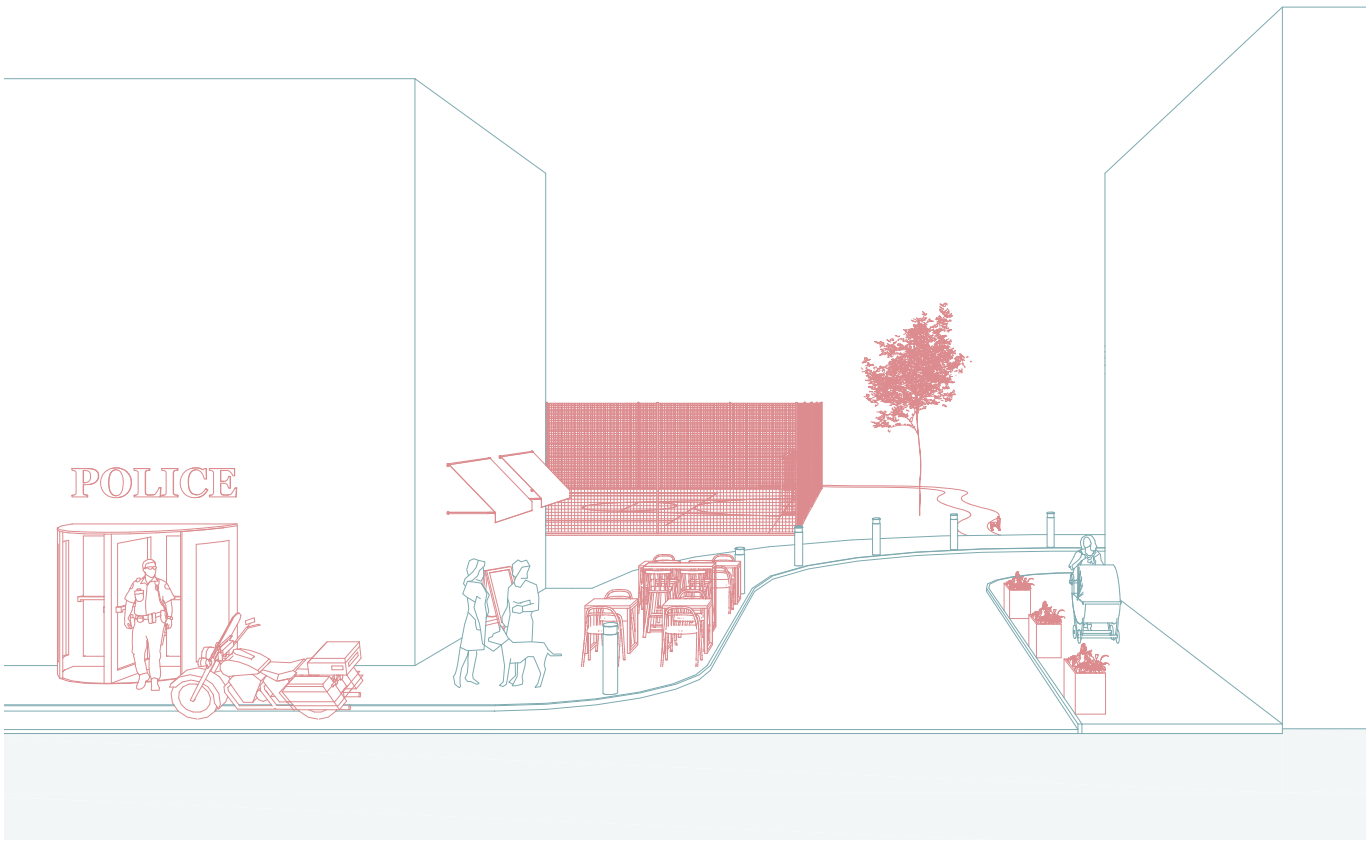


Figure 19. Design interventions “surveillance of the public realm from the public realm”

TERRITORIALITY CREATED WITHIN A COMMUNITY

Appropriation possibilities dwelling

(Newman, 1972; Brunson et al., 2001)

Newman (1972) states that by allowing residents to customize their houses, the sense of ownership will be increased and they are more likely to watch over the neighborhood. This theory was provided a backbone by Brunson et al. (2007), with their study showing that residents that defend that near-home space through appropriation experienced the neighborhood as safer than those who did not.

Unique design

(Viglieca in Troncoso, 2015; Katchborian in Victoriano, 2015)

Both Viglieca, the architect of Gleba A, Santo Amaro V, and Jardim Vicentina, and Katchborian, the architect of Gleba G, state that by designing unique housing, owners will feel responsible for and proud of their neighborhood. Subconsciously, this will make them more protective and watch out for intruders.

Low-rise over high-rise

(Newman, 1972)

Residents of high-rise apartment buildings feel no sense of ownership over shared corridors, staircases, and galleries. Hence, they are less likely to watch over these spaces. This can lead to people feeling unsafe in the shared spaces, strangers entering the building, and (small) crime happening in these spaces. In Newman his first book, Defensible Space, he proves this by comparing two neighborhoods in New York, one with high-rise apartment buildings and the other with low-rise buildings, with the high-rise showing significantly higher crime rates.

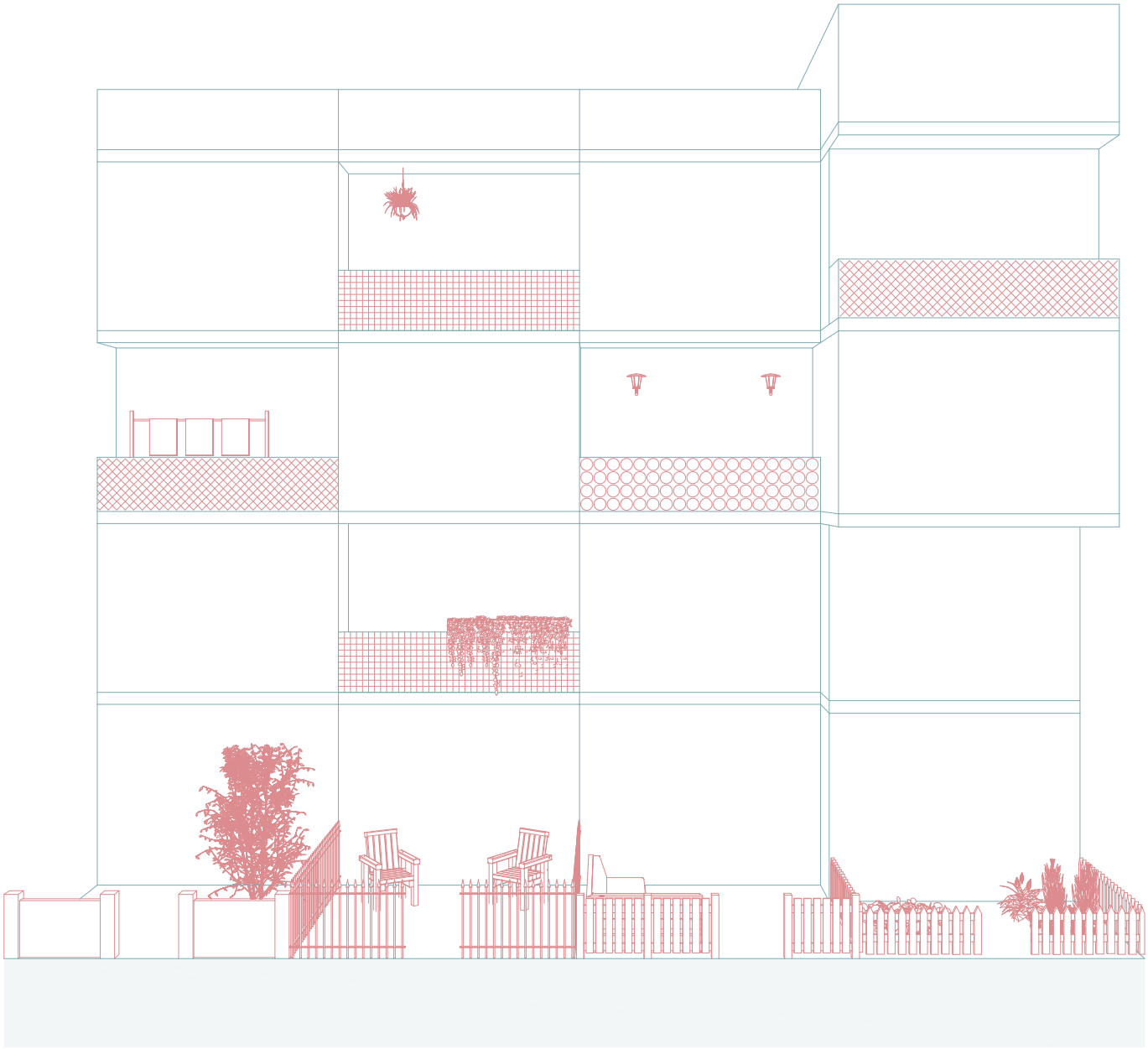


Figure 20. Design interventions “territoriality created within a community”

TERRITORIALITY PERCEIVED BY INTRUDERS

Levels of openness
(Newman, 1972)

A sequence of spaces with various levels of openness makes intruders aware they are entering private space and may therefore divert crime. A square feels more private than a wide street and a small courtyard is even more intimate.

A clear demarcation between public and private space
(Jacobs, 1961)

By creating mental and physical borders between the two realms, the chance of criminal activity occurring is reduced. Instruments to create this separation are front gardens, stairs leading up to the door, or balustrades.

Adequate street lighting
(Jeffery, 1971; Newman, 1972)

At night, illumination indicates territoriality or a place that does not welcome intruders and therefore reduces crime. Also, intruders will have a larger chance to be noted by by-passers or people inside dwellings when the public spaces are well-lit.

Mix dwellings of various income groups
(Newman, 1972)

From his comparative analysis in New York, Newman derives that: "Public housing projects surrounded by other public housing have more crime in them than those surrounded by middle-income communities." (p. 198). An explanation of this could be that a neighborhood consisting of just social housing may seem more vulnerable than one with mixed income groups.

CCTV
(Newman, 1972)

CCTV increases the chance to get caught, hence decreasing the chance of criminal activity occurring.

On the other hand, one could argue that CCTV indicates that there is something of worth around and therefore attracts burglars.

Figure 21. Design interventions “territoriality perceived by intruders”

PHYSICAL BARRIERS

Safe building shapes and materials
(Newman, 1972)

Certain building shapes and materials are perceived safer than others, leading to intruders being impressed and less likely to commit a crime. Also, certain building materials are literally able to resist more force during a break-in.

Gates, fences, and walls
(own observations)

These complicate break-ins, intruding, and serious crime.

Broken windows theory (contested)
(Wilson & Kelling, 1982)

This theory from criminology states that instances of social and physical disorder may create an atmosphere of lawlessness that evokes more serious crime. When the buildings of a street are in a poor state, this might suggest the chances of a successful break-in are higher. The theory is contested though, as it should not impose a zero-tolerance policy and total control on neighborhoods.

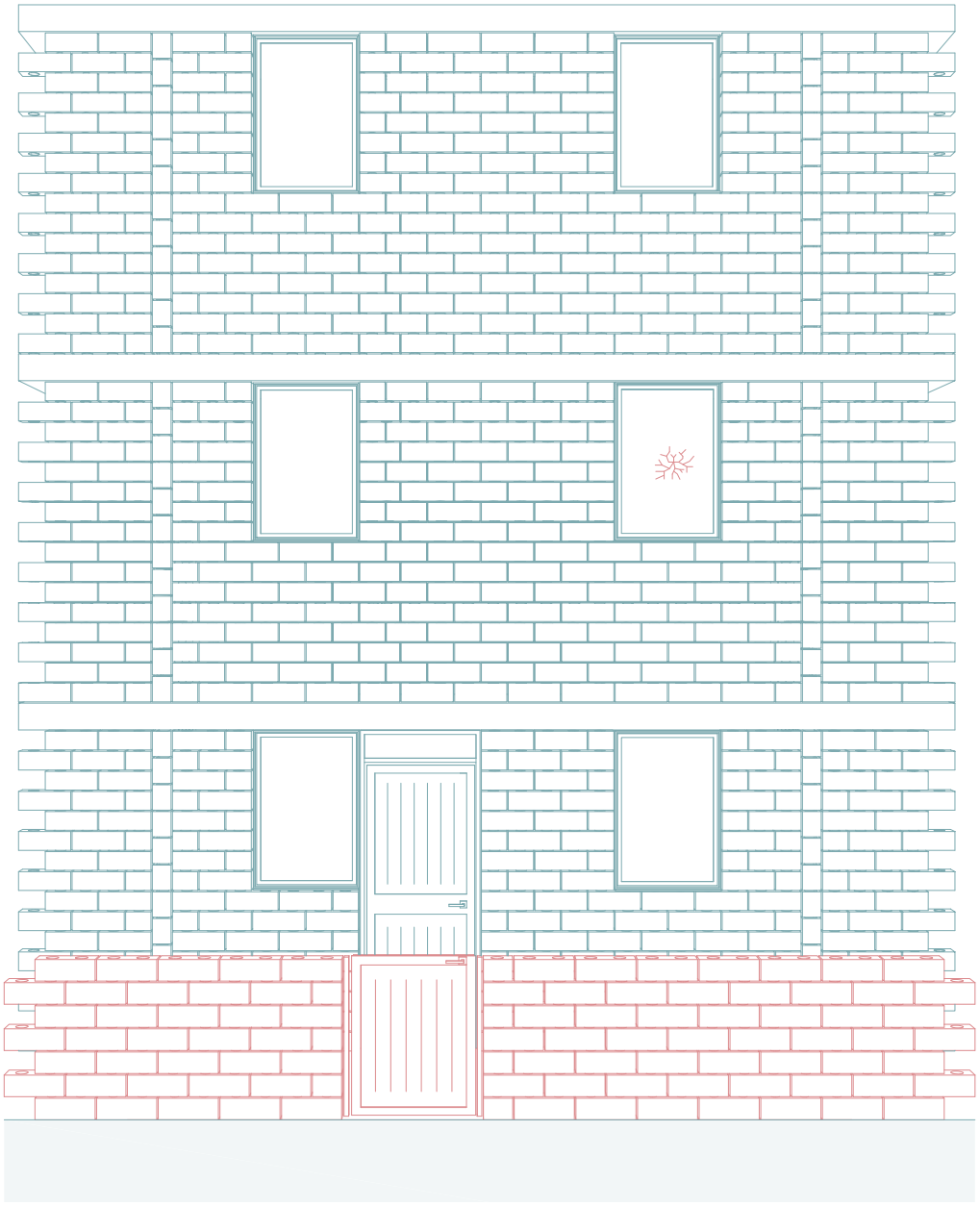
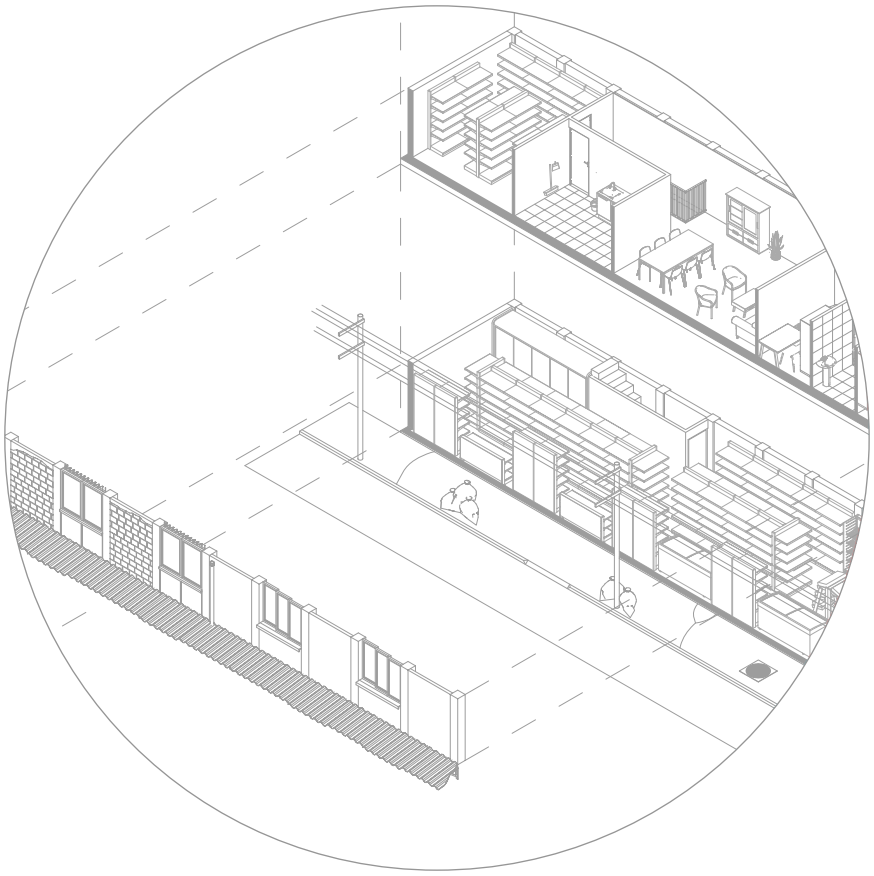


Figure 22. Design interventions “physical barriers”



COMPARATIVE ANALYSIS

goal: analyse how precedents design for safety and the lifestyle of the user groups

METHODOLOGY

To build a knowledge base of design interventions, various projects in Brazil, but also in the Netherlands, and other places in the world were studied. Although these contexts differ greatly, design interventions might offer solutions to problems occurring in either context or inspire alternative problem-solving methods. In this chapter, various precedents will be shown and analyzed that provided valuable inspiration for the final design of Parque Cocaía. Projects that have been studied but have not directly influenced the design have been eliminated for the sake of clarity. The projects that have been included are listed below. Of these, the first six are located in São Paulo, and the final two are in the Netherlands. All projects from São Paulo, apart from the settlements of Grajaú, are social housing projects.

- The settlements of Grajaú;
- Chácara do Conde;
- Parque Novo Santo Amaro V;
- Heliópolis Gleba A;
- Jardim Vicentina;
- Heliópolis Gleba G;
- Amsterdam Plan Zuid;
- Houten Noord-West.

A part of the analyses is made by fellow graduate students of the Global Housing studio, as part of an assignment to build a shared knowledge base on social housing projects in Brazil and the Netherlands. I would like to express great gratitude for their efforts in producing and sharing these analyses. All images and drawings produced by someone other than myself have been included with the author's permission and are referred to as such.

Grajaú
auto-constructed

Chácara do Conde
JAA Arquitetos

Parque Novo Santo Amaro V
Viglíecca & Associados

Gleba A Heliópolis
Viglíecca & Associados

Amsterdam-Zuid
Hendrik Petrus Berlage

Jardim Vicentina
Viglíecca & Associados

Houten
various architects

Conjunto Heliópolis Gleba G
Viglíecca & Associados

Figure 23. Overview projects comparative analysis

SETTLEMENTS GRAJAÚ

Although settlements occur in greatly-varying forms, describing and analyzing them should help to build an image of the current urban tissue of Grajaú. For this, the division is made between favelas and founded dwellings. With 'founded dwellings' auto-constructed dwellings made of brickwork, concrete, or other relatively durable materials are meant. Whether these have a legal status (like in favela barrios) or not (being informal settlements) is neglected here, since the focus is on design in this chapter. The data in this analysis was obtained empirically or by interviews during the field trip, unless stated otherwise.

Favelas

Favela dwellings are auto-constructed dwellings made from whatever material is available for cheap or free. Often, this means timber elements combined with sheets of plywood and corrugated steel sheets. Though, also cardboard, plastic, and earth are used to provide shelter. The fragile materialization of the dwellings makes them vulnerable to heavy rainfall, flooding, and landslides.

The favela dwellings are often built on leftover space on public land. This can be along water bodies, in green areas, or next to industrial areas. Their dimensions depend on the available materials but are often limited to the minimum dimensions needed to provide shelter. The temporary status of the dwellings symbolizes the exclusion and inequality favela dwellers are experiencing. As stated by the UN (2022), 'adequate and affordable housing is key to improving their [slum dwellers] living conditions.'

Figure 24. Pictures of favelas in Grajaú - image 1 was taken close to the Hamada Farm, 2-6 in Anchieta

Founded dwellings

Once slum dwellers secure a higher and more stable income, they often start constructing a dwelling themselves. This is done in the same location as their slum dwelling or in more organized forms such as an association. These associations are founded by groups of slum dwellers that have been evicted from their previous living location and are in search of land to occupy with more rigid dwellings. By joining forces, they can claim larger plots of land and apply for title deeds. Furthermore, they can construct new dwellings together, a process described as ***mutirão***.

Founded dwellings are constructed using less temporary materials. Often, a foundation is made of concrete poured on sandy subsoil. On top of this, the floor slabs are either carried by concrete columns and beams or load-carrying brick walls. The column-beam structures have an infill of ceramic bricks and the load-carrying walls are made of concrete masonry units or structural ceramic bricks. As a roofing material, corrugated metal sheets are popular, although ceramic roofing tiles are also used. At first, facades are usually not clad, but as the family earns more money, stucco is sometimes applied. The majority of the money is spent on the interior of the dwelling though, as expensive electronics are much more common than cladding facades.

The dwellings are often small yet deep, as are the plots on which they reside. These long plots are the result of land being distributed equally among groups of evicted inhabitants during the squatting process. Among the dwellings close to the project site, an average plot size would be 4.5x25m, with a house of approximately 4.5x15m on it. The height of the building increase over time, as new floors are constructed gradually as money is earned. In the informal settlements close to the project site, three stories are common. Not all these stories are necessarily used by a single family, as sometimes parts of the building are put up for hire, used as a store, or shared with other family members.

In case the dwelling is connected to the water system, as the majority of dwellings around the site are, a blue water basin is often installed on the roof. This tank stores enough water for an entire day, allowing the household to stay up and running even during water outages, which happen occasionally in São Paulo. Almost all dwellings have electricity too, with quite some dwellings boosting satellites to connect to the internet and television as well. An analysis by Marques & Saraiva (2017) confirms that this situation is common among the São Paulo favelas, with 98% being connected to the water supply network in 2010. Though, the sewerage infrastructure is lagging, as only 68% of the favela dwellings were connected in 2010 (Marques & Saraiva, 2017). In comparison to electricity and water supply, connection to the sewers is not needed to be able to survive. Hence, it is often up to the municipality to connect new neighborhoods to the sewerage system.

Another common phenomenon is the ground floor facade being porous, like a fence or breeze blocks. Behind this facade, there can be a transition space between the more private spaces and the public space or a garage. When walking through these neighborhoods, inhabitants often came up to the facade to watch our movement as we passed by.

Figure 25. Pictures of founded dwellings in Grajaú

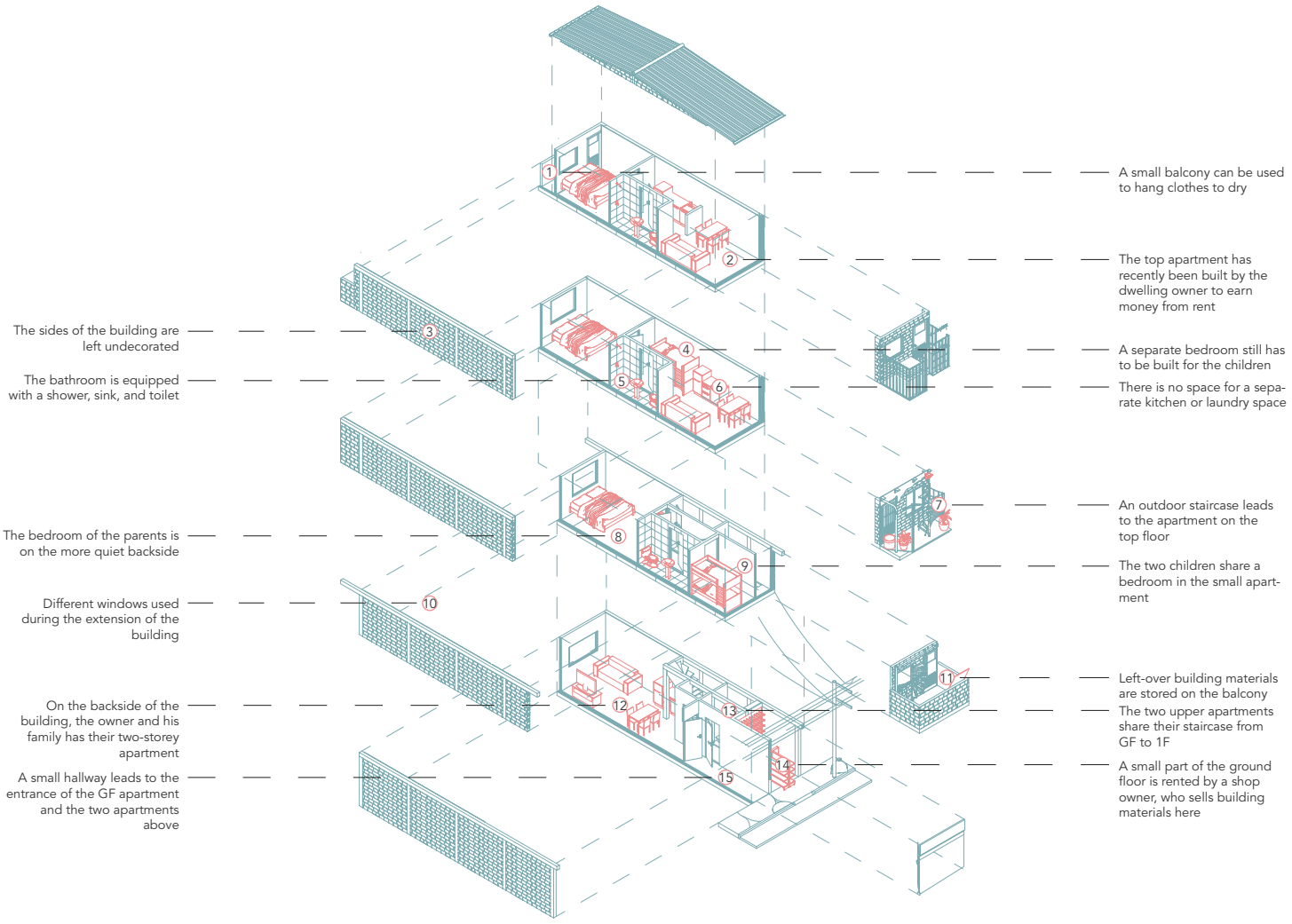


Figure 26. Typological analysis favela dwelling Grajaú

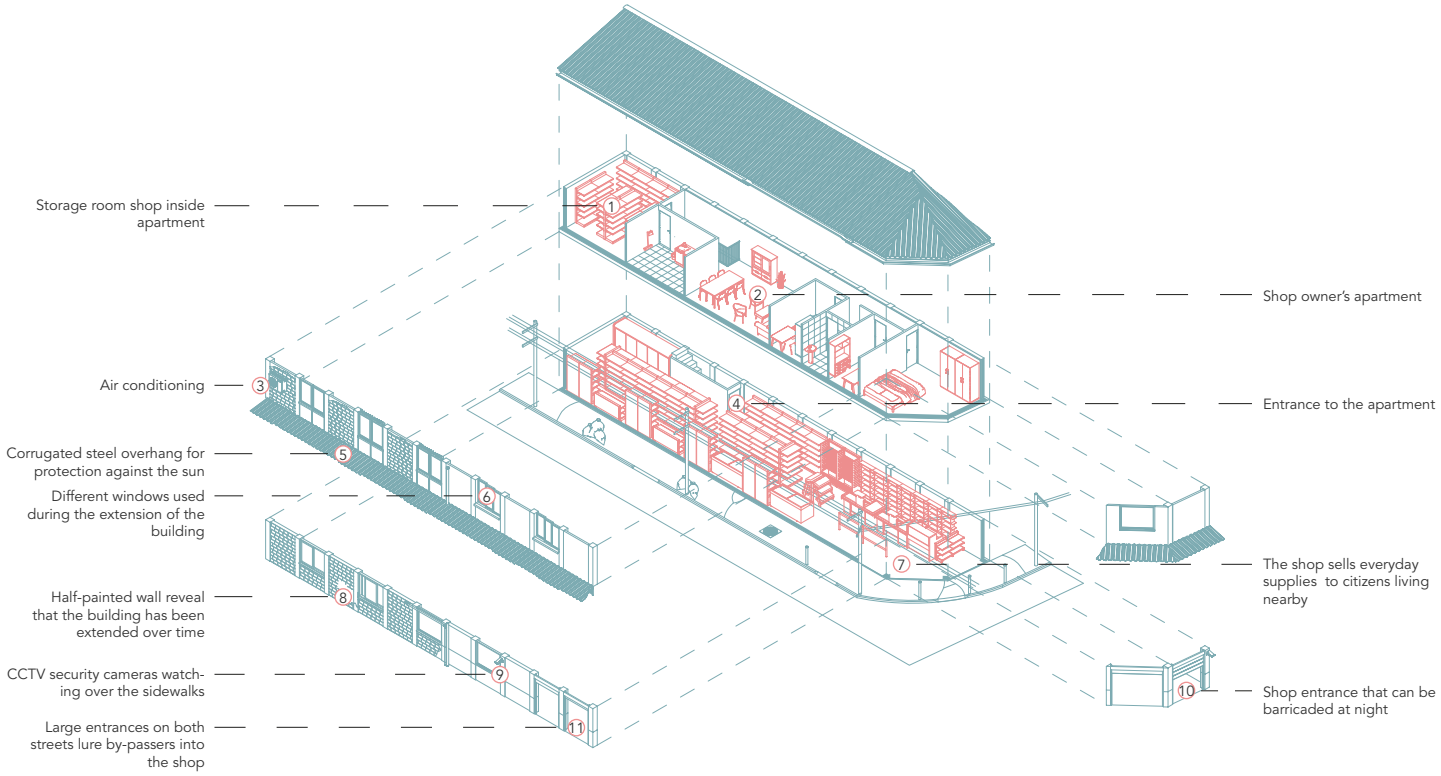


Figure 27. Typological analysis favela dwelling Grajaú

CHÁCARA DO CONDE

Fact sheet

Plot area	10.4 ha (+12 ha park)
Number of dwellings	1290 units
Density	124 units/ha (excl. park)
GSI	0.13 (excl. park)
FSI	0.66 (excl. park)
Unit sizes	45-51 m2
Architect	Marcos Carrilho (JAA arquitetura)
Client	SEHAB / municipality of São Paulo
Years of construction	2018-2022
Tenure	Rent-to-own

Key takeaways

- The urban green around the complex could have added more to the neighborhood with better connections and urban furniture.
- The isolation of the project site disconnects it from surrounding areas.
- The fences around the courtyards provide safety yet disconnect and isolate, thereby adding to segregation.
- The simple construction method benefits from economies of scale and makes for fast and cheap production using local knowledge.
- The apartments offer the basics, yet lack customization and possibilities for appropriation. For families with more than two children, the dwellings are probably too small.
- By combining the wet functions, the piping distance is reduced.
- The small windows reduce the solar gains.

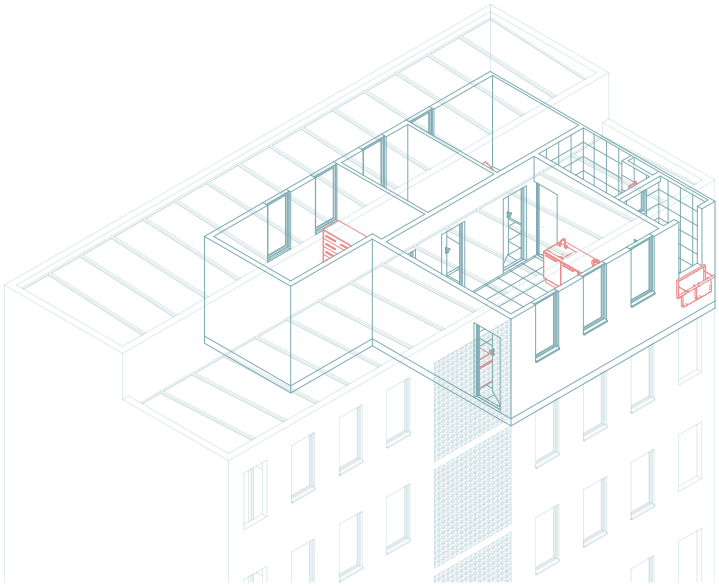


Figure 28. Isometric drawing of a Chácara do Conde apartment

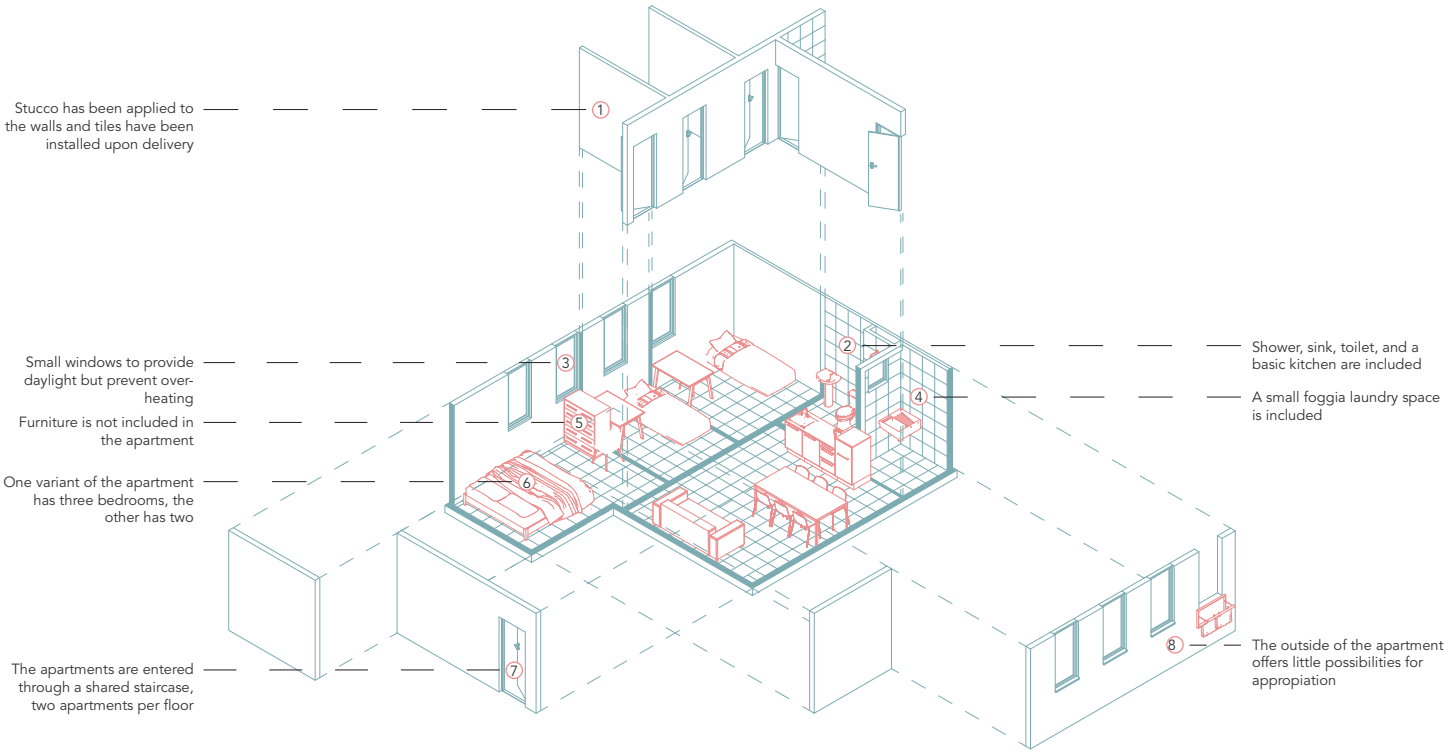


Figure 29. Typological analysis of a Chácara do Conde apartment

Description

The Chácara do Conde project is the first large-scale redevelopment in Grajaú. Hence, it can be considered a benchmark for future redevelopments in the area. This makes it the most important project to compare the design for Parque Cocaía to.

The development of Chácara do Conde is part of the Programa Mananciais by the municipality of São Paulo. In 2008, the project commenced providing housing for dwellers living in the close vicinity of the Billings reservoir. In 2018, construction was finished. The complex is now providing housing to approximately 5000 dwellers in Grajaú.

The project consists of ten rectangular volumes placed on sloped terrain. The area used to be a farm, and remnants of this can be seen in the green strip separating the project site from the existing urban tissue. Between the buildings, courtyards are filled with grass, playgrounds, sports fields, benches, and wheelchair ramps. Fences separate the courtyards from the streets. The streets form an orthogonal grid that is connected to the surrounding urban tissue via three roads. Cars are parked along the streets. The project also includes seven study rooms, seven bike racks, and ten community centers (São Paulo Governo do Estado, 2022). Every building has its janitor for maintenance.

The five-story apartment buildings consist of repetitive and efficient walk-up apartments. These contain a living room with a kitchen, small loggia to wash and dry clothing, a bathroom, and either two or three bedrooms. The walls are made of stacked concrete masonry units and the floors of concrete slabs. Painted stucco is applied to the exterior of the buildings.

Figure 30. Typological analysis Chácara do Conde and favelas Grajaú - autoconstruction versus production (image produced by Robbert Laan, with input by Sanette Schreurs and myself)

Figure 31. Pictures of Chácara do Conde, taken during the field trip

PARQUE NOVO SANTO AMARO V

Fact sheet

Plot area	2.19 ha
Number of dwellings	201 units
Density	79 units/ha
GSI	0.12
FSI	1.36
Unit sizes	45-77 m2
Architect	Viglieca & Associados
Client	SEHAB / municipality of São Paulo
Years of construction	2009-2012
Tenure	?

A more elaborate analysis of the project is included in the appendices. This analysis was made by myself as part of an exercise to build a shared knowledge base of social housing projects in São Paulo.

Key takeaways

- Elevated walkways allow inhabitants to watch over the public space from above.
- Garages on ground level, or flexible spaces that are prone to be used as garages, reduce the control of inhabitants over the streets.
- Replacing all windows on a facade with porous elements leads to a disconnection between the building and the street.
- Sports amenities provide livelihood and safety, even in unsafe neighborhoods.
- Unique design creates an identity for the inhabitants of a building.
- Duplex apartments reduce the number of corridors, allow private and public spaces to be split over two levels, and create a space for spontaneous interaction.
- Waterways can be put underground to prevent further pollution of the water.
- Including various types of dwellings in a project allows it to meet the needs of various households.

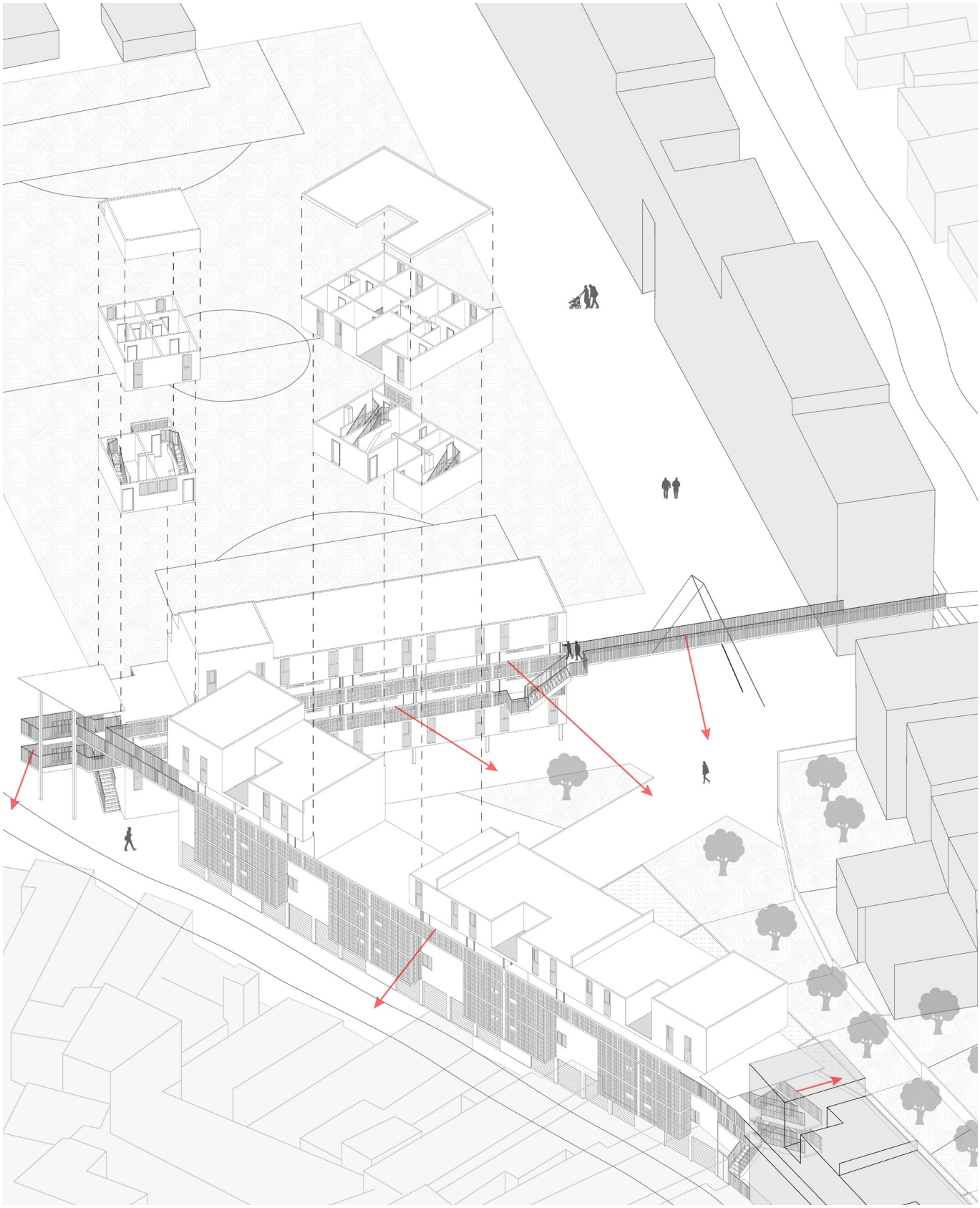


Figure 32. Synthesis drawing comparative analysis Parque Novo Santo Amaro V

Description

The Parque Novo Santo Amaro V is located in a valley containing a stream leading to the Guarapiranga reservoir. The Guarapiranga area is one of the two major water reservoirs of São Paulo. The city depends on the water from the reservoir for drinking, cooking, and washing (Troncoso, 2015). The valley used to be occupied by precarious settlements, living at risk of being struck by floods and landslides, and polluting the water of the stream by not being connected to the sewerage system (Viglieca & Associados, n.d.–a). In 2009, the situation reached a critical level, leading to the municipality expropriating and tearing down the 200 dwellings in the area (Troncoso, 2015). Its inhabitants were temporarily given access to a rental complex nearby, while a new social housing complex was designed and constructed.

In 2012, construction finished and the evicted inhabitants moved to their new homes. The complex consists of several rectangular volumes placed around an axis of urban amenities. The stream was moved underground, to prevent further pollution, and a series of water basins were placed on top as an urban feature and to maintain the site its identity. Furthermore, a football club, skate park, urban furniture, a BBQ area, and a party room offer leisure opportunities for the inhabitants.

In the valley, large height differences made residents have to take detours of about a kilometer to get to their destination. In the Parque Novo, elevated walkways bridge this height difference and greatly improve the connectivity of the area. The elevated walkways are designed to be accessible to all citizens, as is the public space in the area. The walkways should also offer a sense of safety for the public space, by adding eyes on the street from above. In 2018, the project won the Tomie Ohtake AkzoNobel Prize for the inclusion of elevated walkways and urban green in the densely-built area (Saraiva, 2018). As per the vision of the architect, the combination of public areas and irregularly occupied plot settlements try to stimulate the identification feeling of the inhabitants. As per the vision of the architect, the combination of public areas and irregularly occupied plot settlements try to stimulate the identification feeling of the inhabitants.

On the ground floor level of the complex, garage boxes offer residents space to open up a business. The ground floor level of the building perpendicular to the linear axis initially was entirely opened up to connect the open space on both sides of the building. Though, businesses were never opened on the ground floor and all boxes were closed to be used as a garage. Even in the perpendicular building, the ground floor was filled up with garage boxes, thereby disconnecting the dwellings from the street and taking away the sense of territoriality in the area.

Despite being designed as a permeable urban space, three years after its completion, the inhabitants of the apartment buildings decided to close off the area to keep out visitors (arch. review). Some visitors had been driving at high speeds, throwing illegal parties in the basements of the buildings, and dealing drugs. By closing off the area, the inhabitants hoped to increase safety. Though, it also means passing pedestrians can no longer use the elevated walkways to cross the area unless inhabitants open the gate for them.

Figure 33. Pictures of Parque Novo Santo Amaro V, taken during the field trip

HELIÓPOLIS GLEBA A

Fact sheet

Plot area	4.32 ha
Number of dwellings	537 units
Density	124 units/ha
GSI	0.16
FSI	0.74
Unit sizes	48-62 m2
Architect	Viglieca & Associados
Client	SEHAB / municipality of São Paulo
Years of construction	2004
Tenure	Rent-to-buy + rental

A more elaborate analysis of the project is included in the appendices. This analysis was made by Sanette Schreurs as part of an exercise to build a shared knowledge base of social housing projects in São Paulo.

Key takeaways

- Social housing projects in the settlements of São Paulo should take into account the Third Territory, the space between existing and new.
- Long, continuous housing blocks can be split up to prevent daunting over the existing urban tissue.
- Long shared hallways create an unsafe atmosphere. Rather, more vertical circulation should be included in the design.
- Porous facades allow for large cross-ventilation capabilities while respecting privacy, which suits dense neighborhoods.
- A height difference between the courtyard and the staircases makes it less welcoming and therefore less used.
- A narrow entrance may seem protective, yet, it also makes the space hard to watch over and therefore feel less safe.
- Even when fences are not added to the design, inhabitants might directly install them by themselves.
- The courtyards are used for barbecues and parties, but not frequently. The dimensions are small and inhabitants rather go to a nearby square.

Figure 34. Pictures of Gleba A, taken during the field trip

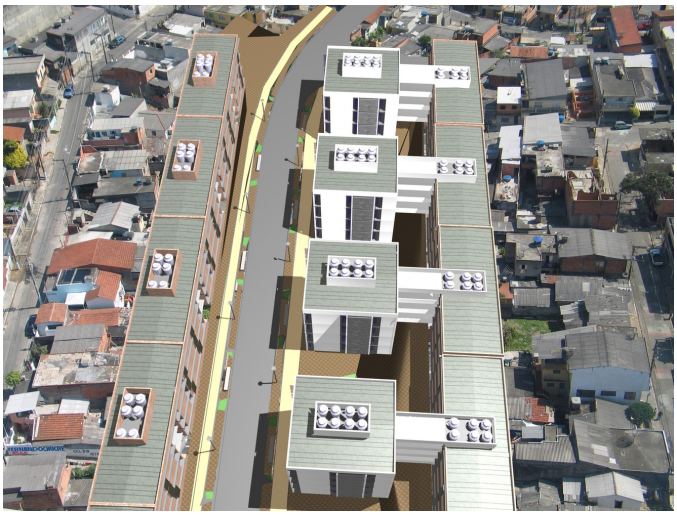
JARDIM VICENTINA

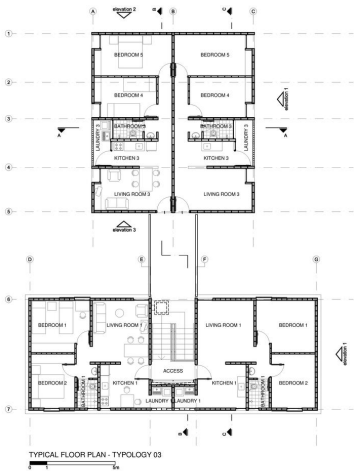
Fact sheet

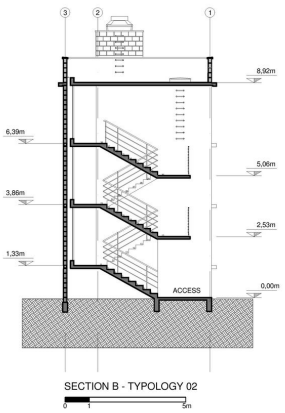
Plot area	4.54 ha (+4.92 ha park)
Number of dwellings	272 units
Density	60 units/ha (excl. park)
GSI	0.086
FSI	0.30
Unit sizes	~49 m2
Architect	Viglieca & Associados
Client	Osasco City Hall
Years of construction	2008-2010
Tenure	?

Key takeaways

- Positioning dwellings along small courtyards creates small communities.
- Movable panels in front of the windows effectively keep out the sun, but also prevent inhabitants from watching over public spaces and reduce the daylight inlet of dwellings.
- Elevated walkways can provide sun shading, especially when used on the north side of the building.
- Even in apartment buildings, water cisterns are often installed per dwelling instead of per building. They can be placed next to each other on the roof, accessible by a ladder from a staircase.







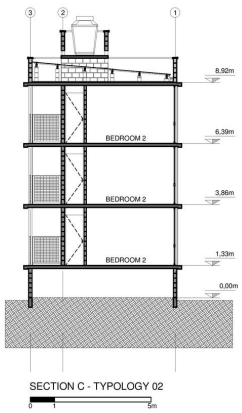


Figure 35. Pictures and drawings Jardim Vicentina
(images by Leonardo Finotti and Vigliecca & Associados, retrieved from ArchDaily)

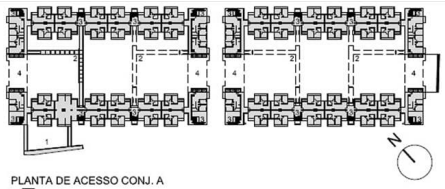
HELIÓPOLIS GLEBA G

Fact sheet

Plot area	1.6 ha
Number of dwellings	420 units
Density	262 dw/ha
GSI	0.56
FSI	1.96
Unit sizes	50 m2
Architect	Artur Katchborian & Mario Biselli
Client	SEHAB
Years of construction	2011
Tenure	?

Key takeaways

- Positioning dwellings along small courtyards creates small communities.
- Movable panels in front of the windows effectively keep out the sun, but also prevent inhabitants from watching over public spaces and reduce the daylight inlet of dwellings.
- Elevated walkways can provide sun shading, especially when used on the north side of the building.
- Even in apartment buildings, water cisterns are often installed per dwelling instead of per building. They can be placed next to each other on the roof, accessible by a ladder from a staircase.



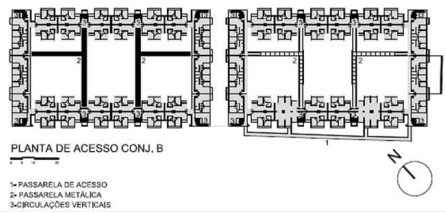


Figure 36. Pictures and drawings of Gleba G
(images by ArchDaily)

HOUTEN NOORD-WEST

Fact sheet

Data calculated using AlleCijfers.nl (n.d.). Approximation including public spaces, parks, and water.

Plot area	4.54 ha (+4.92 ha park)
Number of dwellings	272 units
Density	60 units/ha (excl. park)
GSI	0.086
FSI	0.30
Unit sizes	~49 m2
Architect	Viglieca & Associados
Client	Osasco City Hall
Years of construction	2008-2010
Tenure	?

Key takeaways

- Design public spaces that are not too big or too small.
- Ensure roads along amenities are low-speed by integrating bumps, curves, or poles into the design.
- Playgrounds and public spaces can be 'protected' from nearby roads by placing greenery, small hills, sidewalks, or ditches in between.
- Have public space surrounded by dwellings to create territoriality and ensure eyes on the street.
- Small front gardens create territoriality, yet large front gardens disconnect the dwelling from the public space.

Figure 37. Pictures of Houten

AMSTERDAM PLAN ZUID

Fact sheet

Data calculated using AlleCijfers.nl (n.d.). Approximation including public spaces, parks, and water.

Plot area	31 ha (incl. public space)
Number of dwellings	985 units
Density	32 dw/ha
GSI	0.078
FSI	0.31
Unit sizes	98 m2
Architect	Hendrik Petrus Berlage
Client	Municipality of Amsterdam
Years of construction	1917-1922
Tenure	Social rental + private rental + owner-occupied

Key takeaways

- Certain building types, like courtyard blocks, stimulate the creation of communities.
- One-way traffic slows down traffic and thereby creates safer public space.
- Raised volumes on the corners of an urban block indicate a change in openness.
- The dimensions of an opening of an urban block suggest a level of intimacy.
- Unity in the design of urban blocks creates territoriality. Mass repetition should be prevented though.
- Balconies, bay windows, and winter gardens provide eyes on the street.

Figure 38. Pictures of Amsterdam-Zuid
(images by Google Maps)

CONTEXTUAL ANALYSIS

goal: determine how the context affects safety and design

GEOGRAPHY

Location

São Paulo is located in the south of Brazil, in the southern hemisphere, ~70 km from the ocean. ~340 km to the east of São Paulo, Rio de Janeiro, Brazil its former capital, is located. Brasília, the capital of the country since 1960, is located ~870 km from São Paulo. The diameter of the metropolis is around 60 km at certain places. Grajaú is the southernmost district of the metropolis, at a distance of ~23 km from the city center.

Topography

São Paulo is located on a plateau called the Serra do Mar (translation: coastal range) at a height of ~800 m above sea level. Although the city is on this plateau, there are quite some height differences within the city, especially along the outskirts, like in Grajaú. From east to west (368m), the terrain of Parque Cocaía rises by 33 m, making for a slope of 8.9%.

Hydrography

The Tietê River runs through São Paulo toward the west, where it merges with the Paraná, which has its delta near Buenos Aires on the border between Argentina and Uruguay. The river has its source east of the city, at 22 km from the Atlantic Ocean, in the Serra do Mar.

On the south side of the city, two large water bodies are located, the Billings and Guarapiranga reservoir. They are used for energy generation, leisure, and to produce drinking water. Industry and inhabitation of the banks threaten the water quality though. Grajaú is located between the two reservoirs and Parque Cocaía is located 700 m from the Billings reservoir. The stream running in the valley on the east side of the site leads to the reservoir.

Green structures

To the southeast of São Paulo, the steep 70 km separating the city from the ocean is covered by the Mata Atlântica (translation: Atlantic Forest). This rainforest used to run along the entire east side of Brazil, though, 88% of the forest has been lost due to deforestation.

In São Paulo itself, only 1.5% of the area is covered by green space. In the city center, several large parks are located, but especially in the outskirts, public green, or in general public space, is scarce. The banks of the Billings reservoir boost some green, though, in most areas, there are no facilities for inhabitants to use this for leisure activities. In Cantinho do Céu, 2.5 km to the northeast of Parque Cocaía, a linear park has been constructed on the banks of the reservoir.

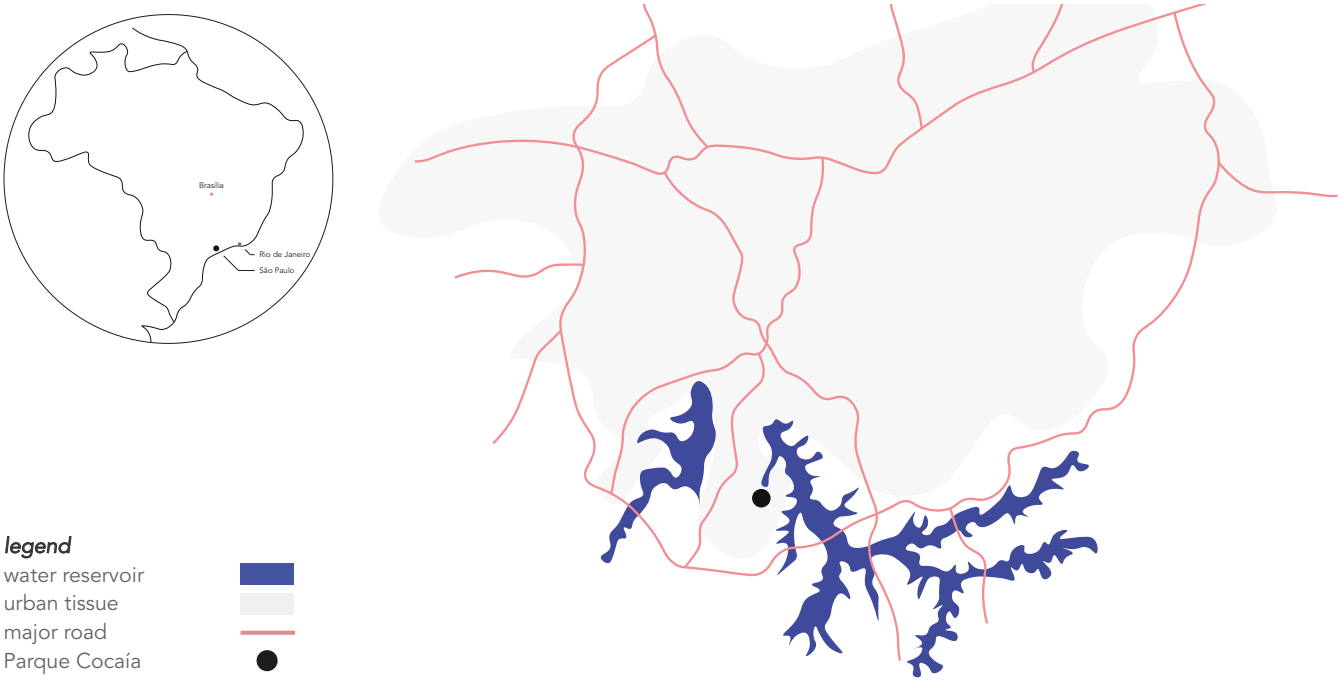


Figure 39. Map of São Paulo

Figure 40. Map of Grajaú

Figure 41. Section of the project site from west to east

CONNECTIVITY

Road structure

São Paulo is connected to Santos, a big city formed around the São Paulo harbor, by two highways and a train track with a funicular. ~340 km to the east of São Paulo, Rio de Janeiro, the second-biggest city in the country, is located. By bus, it takes six hours to get from one to the other by highway. Because of the enormous size of the country, most other cities are reached by plane, even though the major cities are interconnected by highways as well.

To get to the city center from Grajaú, it would take 1-2 hours by car, depending on the traffic, as the city is known for its frequent traffic jams. The Avenida Dona Belmira Marin 160 m south of Parque Cocaía has four lanes and leads to a highway that runs to the city center. At a width of 12 m, this road can also handle construction traffic, like trucks with trailers.

Public transport

No large train tracks run through Brazil. Instead, nearby cities are well-connected by bus. In São Paulo itself, there are several train lines, but most public transportation is by bus. Since the introduction of the 2014 master plan, more focus is put on improving public transport in the city (Prefeitura de São Paulo, 2014).

The area of influence of a bus station, meaning the distance people are willing to walk to get it, is defined as 300 m by the municipality. Parque Cocaía is 180 m away from the closest bus stop, which is on the Avenida Dona Belmira Marin in the south, and hence can be defined as well-connected. The closest train station, Grajaú station, is 2.5 km away. This does not fall in the range of influence of 600 m of a train station, but by bus, it only takes 5 minutes to get to the station from Parque Cocaía. This connection runs every 12 minutes. In total, it takes 80 minutes to get from the project site to the city center by public transport.

Bike lanes

São Paulo has very few bike lanes and facilities for cyclists. Due to the enormous size of the city, the hilly topography, and most importantly, the (perceived) safety levels, cycling is an unpopular method of transportation. Some cyclists can be found around the Avenida Paulista, but not a single was spotted in Grajaú during the field trip.

Pedestrians

As there is little public green present in the urban tissue of São Paulo and the distances traveled are large, pedestrian traffic mostly sticks to the neighborhood level. Sidewalks are common, yet

not standard. Officially, the 2014 master plan requires roads to have a sidewalk of at least 2 m wide.

Parking

In the new master plan, all parking norms in São Paulo were eliminated to reduce vehicular traffic (Prefeitura de São Paulo, 2014). Furthermore, it is officially not allowed to create parking spaces right in front of dwellings anymore and there are maxima put in place along transit corridors (Parking Reform Atlas, 2022). The results of the new parking norms can be seen in the precedents as well:

- Parque Novo Santo Amaro V boosts about 110 parking spots on-site. Along the roads around the perimeter, another 70 cars could be parked, though these are not official parking spots. As mentioned before, a large part of the ground floor of the building is being used as garage boxes, despite not being destined for this. At 201 housing units, this produces an average of 0.55 parking spots per dwelling, excluding the garages.
- In the Chácara do Conde, streets are set up wide to allow cars to park on both sides. An estimate of the number of parking spots would be 600 for the 1290 apartments, bringing the average number of spots to 0.47.
- With Gleba A, 41 parking spots can be found on Google Maps. For 537 dwelling units, this makes an average of 0.08 parking spots per unit. Probably, there are garages nearby though.

In 2020, one in every three Brazilian inhabitants owned a car (Global Feet, n.d.). Though, because of the large income inequality in the country, not every household owns one, especially not in the settlements.

Figure 42. Connectivity Parque Cocaía

URBAN TEXTURE

Settlement types

On the banks of the stream east of the project site, favelas have been constructed. Especially right on the banks of the stream, these dwellings are of poor quality. Furthermore, they threaten the water quality of the Billings reservoir. The dwellings on the other side of the streets of legal settlements, which are further away from the water, are typical informal settlements. They are autoconstructed and decently sized, yet lack a legal basis and faulty construction might cause dangerous situations.

Current use site

The site is currently mostly unoccupied, apart from the EMEF Padre José Pegoraro school on the south side. In the eastern part, some irregular dwellings and working spaces have been built. Most importantly, the site is surrounded by brick walls that have been placed at the back of the gardens of the incomplete building blocks on the west and north side. The school is surrounded by (lower) walls as well. With its protected status, the site forms a gap in the urban tissue. On the left part of the site, a walking path has been formed by pedestrians taking a shortcut to the other side of the plot. Although the site is not marked as publicly owned on GeoSampa, the construction of the school suggests it is.

Urban amenities

Shops, food, work, religion, leisure, etc.

In close vicinity of the project site, various small shops and canteens are present. Also, three churches are within walking distance from the site. The Avenida Dona Belmira Marin contains various facilities, such as a large supermarket, building materials shop, gas station, car repair shop, bars, and restaurants. The amount of public space around the area is limited and there are few sports facilities.

Demographics

In comparison to surroundings neighborhoods, Parque Cocaía has a relatively high IPVS standard, indicating high social vulnerability (Prefeitura do São Paulo, n.d.). The dwelling density is approximately 70 dw/ha and the inhabitant density lies between 160-290 habs/ha. The total population of Grajaú is 370.00 inhabitants. Just over 50% of the neighborhood its inhabitants has a health insurance and Basic Health Units (UBS), providing local medical care, are scarce. The average age is 32,9 years, with the average of the entire city being 36,7 years (Negócios SP, n.d.). The largest age group (9,2%) is 20-24 years old. The average income was B$ 2,445 in 2020, being 2.3 minimum wages at the time (Negócios SP, n.d.).

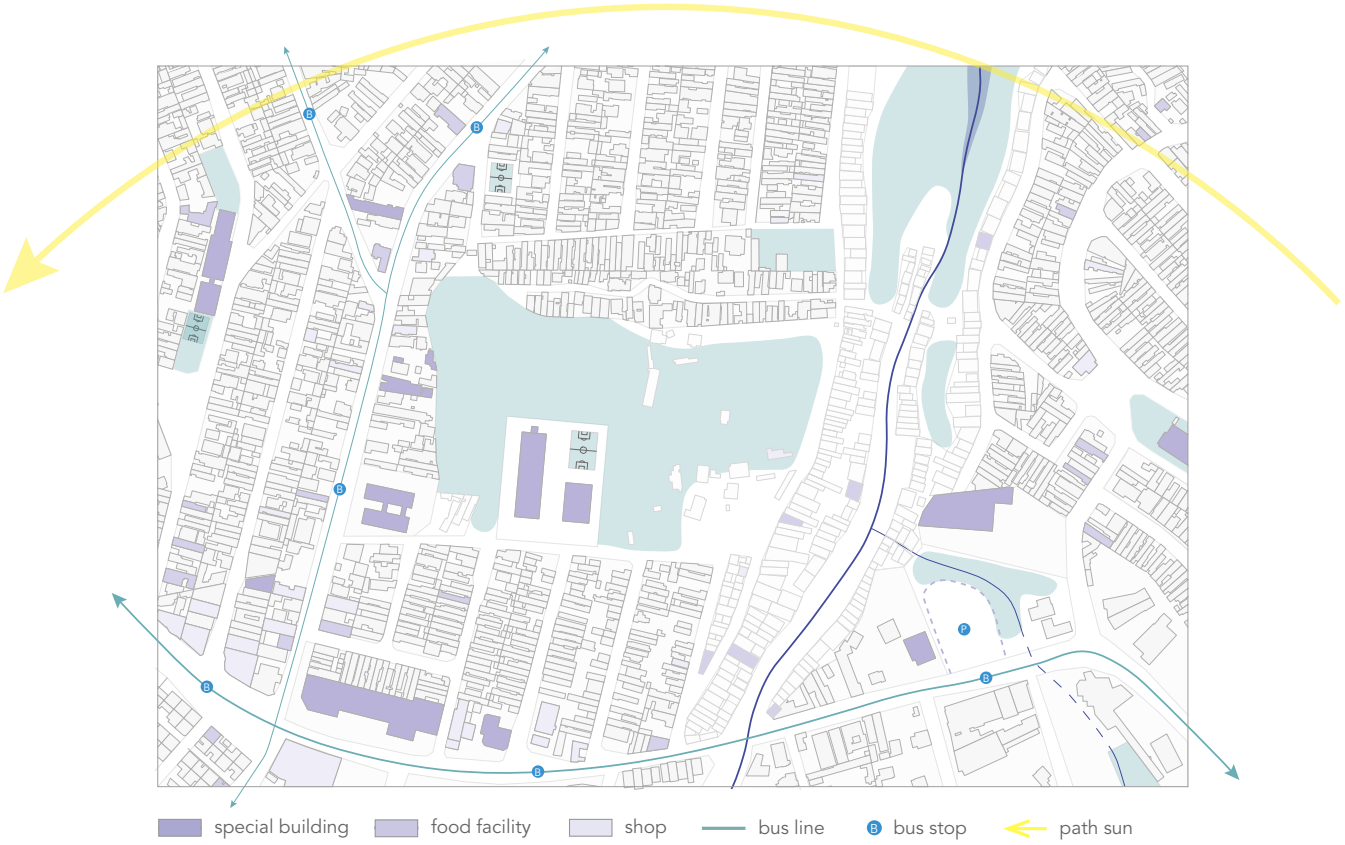


Figure 43. Urban amenities Parque Cocaía

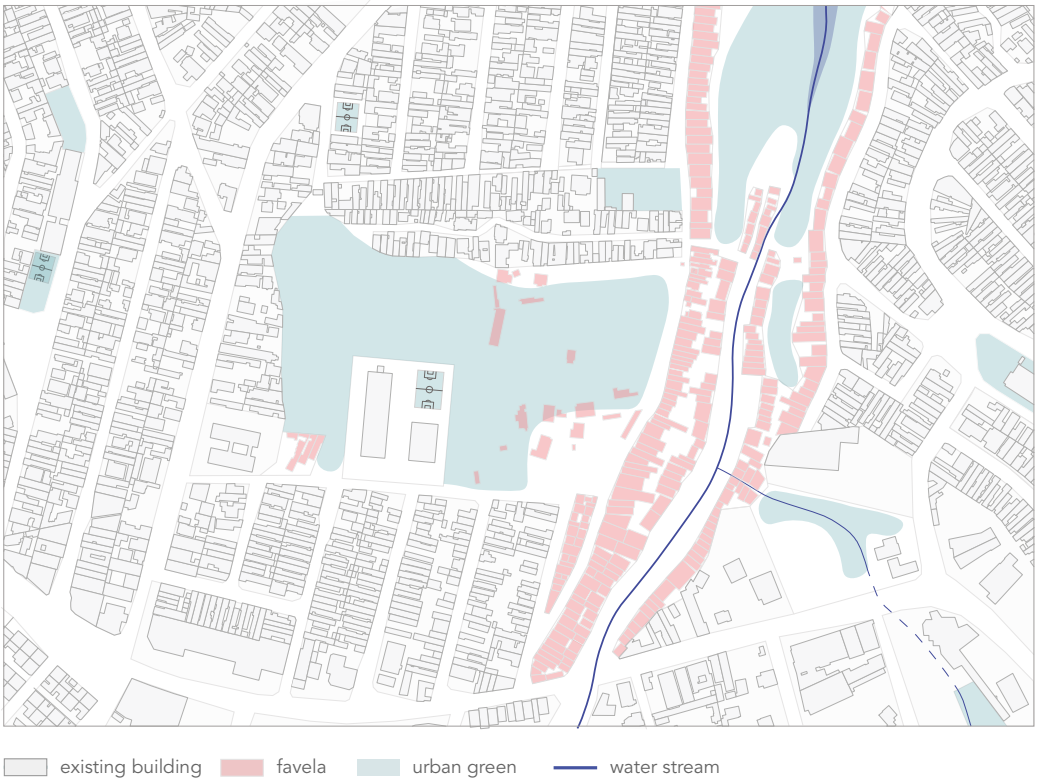
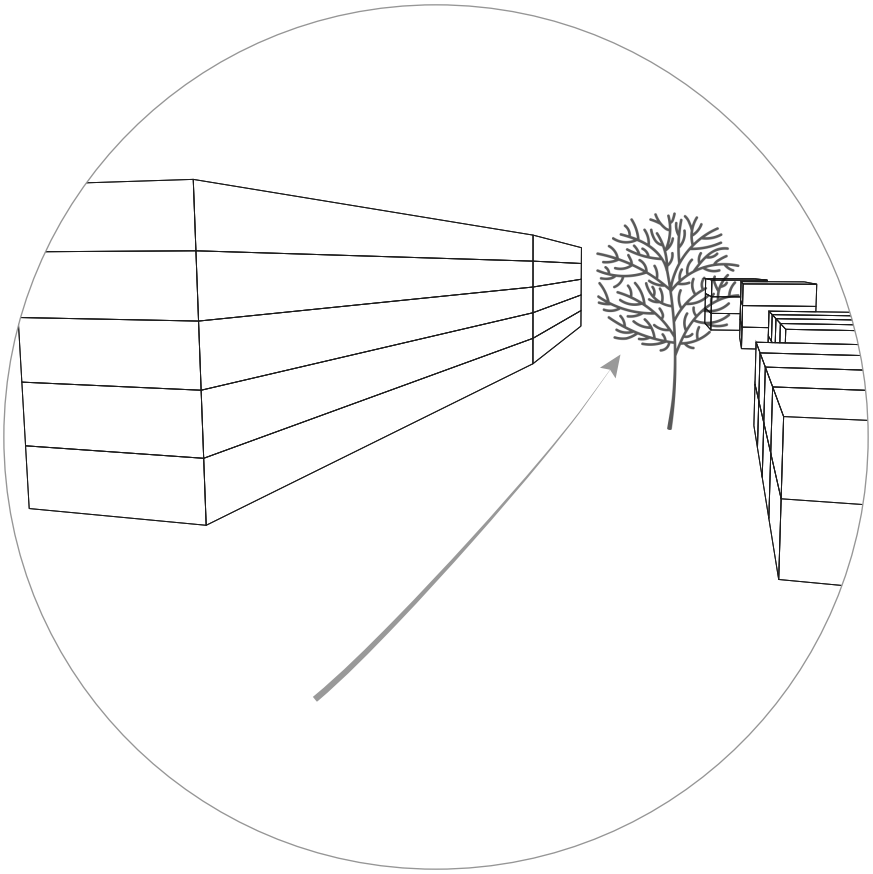


Figure 44. Urban amenities Parque Cocaía



DESIGN PARQUE COCAÍA

goals: (1) explore how architectural design can make the unsafest spaces of SP more safe and (2) design a new living area for the inhabitants of Grajaú

PROGRAM OF REQUIREMENTS

Design brief

In this thesis, a design is made for Parque Cocaía, a ZEIS 4 area in Grajaú, São Paulo. This is an area destined for social housing but with environmental restrictions. By design, it is tested how architecture influences safety in the periphery of São Paulo, hence helping to answer the research question of this thesis:

> *How can architectural design positively influence safety in the development of social housing in the periphery of São Paulo, taking into account socioeconomic segregation, local building practices, and social equity?*

In Brazil, 7.2 million people were affected by the housing shortage in 2013, of which 90% are part of the HIS 1 group (Lonardi et al., 2013). With this thesis, a blueprint is sought for the development of social housing for those living in precarity.

Zoning law

The most important laws that have to be taken into account during the design process are:

- The FSI should be smaller than 2, with 1 being the basic value (Santoro, 2015).
- At least 60% of the built volume should be destined for HIS 1 and at most, 20% can be destined for HMP dwellers (Santoro, 2015).
    - HIS 1 families have an income of 0-3 minimum wages, being B$0-3,906 (€0-704) at the time of writing (Yuca, 2022; Ministério da Economia, 2022).
    - HIS 2 families have an income of 3-6 minimum wages, being B$3,906-7,812.
    - HMP families have an income of 6-10 minimum wages, being B$7812-13020.
- At least 3% of the dwellings have to have high accessibility (Prefeitura de São Paulo, 2014).
- For buildings with more than five floors (GF+4), an elevator should be installed.
- There are no minimum parking spots to be taken into account (Prefeitura de São Paulo, 2014).

User groups

The group of future inhabitants of Parque Cocaía is extremely heterogeneous. It contains dwellers that are evicted to make way for the redevelopment of the area, evicted dwellers from other parts of the city, and dwellers looking for a place to settle legally. Furthermore, the users differ in income group, current dwelling situation, age, ethnicity, education level, and mobility. The design of Parque Cocaía should incorporate space for all, and even for future changes in the user groups.

Vision

In short, the goal of the development of Parque Cocaía is to design a neighborhood that is **Safe, fostering, affordable, and has an identity.**

More elaborately, the design strives to:

- Provide a permanent home that creates a foundation for evicted dwellers to escape poverty, tenure insecurity, and inequality,
- Be safe without adding to segregation,
- Foster community-building whilst securing existing relations,
- Add to the quality of life of inhabitants of the entirety of Grajaú,
- Be built with an eye for durability and sustainability,
- And can be replicated in other locations in the city.

To achieve this feat, the findings of the literature review, comparative analysis, and contextual analysis should be taken into account. As a result, the design includes the following components:

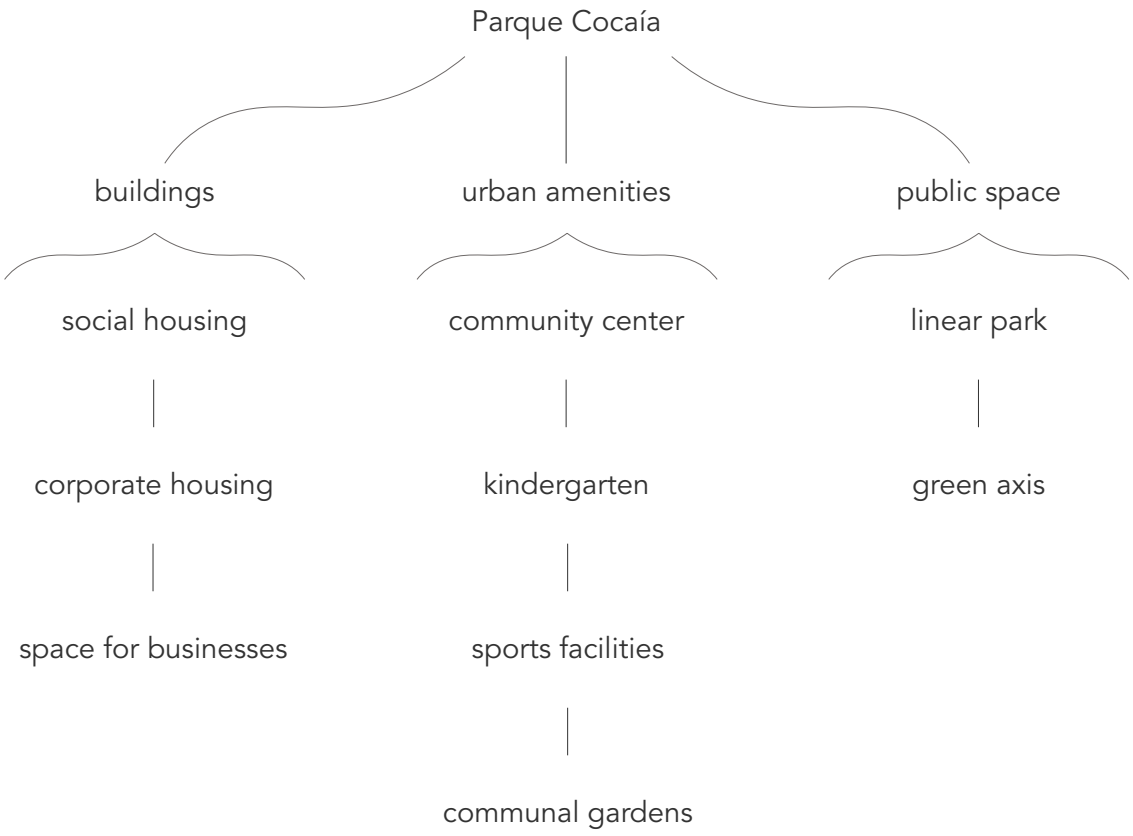


Figure 45. Building components included in the design of Parque Cocaía

Program

1. Housing
   a. Social housing
      >40,800m2 (FSI>1) and >408 dwellings (>100 dw/ha).
      Funded by public instances and developed by the SEHAB. Destined for HIS 1 dwellers. Partly used as emergency housing.
   b. Corporate housing
      <27,200m2 and <272 dwellings at a minimum amount of social housing.
      Funded and developed by corporate parties. The land is sold to them by the municipality with a set of bylaws describing the architectural and urban limitations of the buildings to be developed.
2. Urban amenities
   a. Community center
      A place for the residents of Parque Cocaía to connect, interact, and build a community.
   b. Kindergarten
      So that both parents can go to work without having to worry about their children. Also, it gives the children an opportunity to socialize with other children living in the area and to develop themselves under guidance.
   c. Sports facilities
      These contribute to community creation, safety, and public health. A skate park, football pitch, and outdoor gymnastics court would benefit Parque Cocaía and surrounding neighborhoods.
   d. Communal gardens
      A place for residents to come together and cut costs by producing their own food.
3. Public space
   a. Linear park
   b. Along the stream running towards the Billings reservoir, a linear park should give space to the water during high tide and heavy rainfall. Furthermore, it provides leisure possibilities for the inhabitants of Grajaú.
   c. Green axis
   d. The linear park is extended into Parque Cocaía using the green axis, which offers residents a safe and healthy strip of public space.

	Site scale	Block scale	Unit scale
Architectural (social and aesthetical)	• Give space to the Billings stream (>15 m on both sides). • Include urban green in the design for all inhabitants. • React to and enrich existing urban tissue. • Provide missing urban amenities. • Make use of the topography. • Create visual points of recognition in the design. • Create a feeling of belonging and identity.	• Avoid the use of fences and walls to protect public space. • Apply a building typology that fosters the creation of communities. • Create unity in the design of urban blocks but prevent mass repetition. • Mix functions and user groups.	• Design affordable yet decent housing. • Provide everything needed to build a stable, secure life. • Take into account the lifestyle of future inhabitants. • Provide private outdoor space with every dwelling.
Safety	• Incorporate mixed-use development on the ground floor level, activating the streets throughout the day. • Create safe and welcoming commute conditions for pedestrians. • Include greenery providing shading to facades without blocking the view. • Include adequate street lighting. • Design low-rise over high-rise.	• Limit the length of building blocks. • Prevent the creation of blind-eyed corners. • Create levels of openness within the design. • Create a unique design. • Clearly demarcate the transition between the public and private realms. • Use robust building shapes and materials requiring little maintenance.	• Juxtapose living spaces and the public realm. • Ensure high permeability of the facades while preventing overheating. • Allow for the appropriation of dwellings.
Technical	• Make design decisions to minimize material usage. • Prevent water streaming downhill during heavy rainfall. • Collect waste centrally.	• Ensure acoustic and thermal insulation between dwellings and the exterior. • Harvest rainwater for reuse in flushing, irrigation, and washing. • Take measures to cope with water outages. • Ensure every dwelling has two escape routes. • Think about future upgrading and repurposing of building blocks.	• Naturally ventilate the dwellings. • Prevent overheating. • Use materials that are: locally available, have a low environmental impact, can be applied by local contractors, require little/no heavy machinery, require little maintenance, are durable, and are affordable. • Take into account fireproofing, sun orientation, wind, shafts, piping distance, noise, and structural design.
Managerial (quantities, finances, and phasing)	• Offer safe and affordable dwellings to low-income groups (>60% HIS 1, <20% HMP). • Create an FSI of approximately 1.5 (max.: 2.0). • Include high-accessibility dwellings in the design (>3%). • Reduce the nuisance for the evicted dwellers (time and changes in their social network). • Pick supply routes that can be used throughout the construction and are able to deal with the traffic. • Store building materials on-site, in an easily accessible spot. • Ensure cost recovery. • Employ local contractors and workers in construction.	• Ensure new blocks are immediately connected to the urban infrastructure. • Reduce construction time by working on various floors simultaneously.	• Provide apartments based on payment schemes similar to other social housing. • Include options for those with (almost) no income.

Figure 46. Complete program of requirements for the design of Parque Cocaía

ARCHITECTURE

Introduction

The design of Parque Cocaía is used as a tool to answer the practical component of the research question. Whereas the items in the safety interventions catalog stay on a more abstract level, the design offers an opportunity to see how these interventions can be made on an actual site. With this implementation, the findings of the comparative analysis and contextual analysis are also taken into account. The explorations of the design process become an analytical tool by itself, further adding to the answer to the research question, 'How can architectural design positively influence safety in the development of social housing in the periphery of São Paulo, taking into account socioeconomic segregation, local building practices, and social equity?'

Given the size of Parque Cocaía, this design exploration on all scales could take years. Since this thesis spans two semesters only, it instead focuses on a couple of design components. For these specific components, an attempt is made to answer the research question in the given context. The components dealt with have been chosen based on their relevance to the overall safety of a neighborhood, as experienced during the field trip and noted during the comparative analysis. The design components that are dealt with in this research are:

- Building typology on an urban scale;
- The design of a safe streetscape that creates an identity for the neighborhood;
- The creation of a maximum healthy living density;
- The mixing of functions and user groups;
- And the design of floor plans that provide eyes on the street.

As this thesis marks the completion of the education for becoming an architect, the design for Parque Cocaía is completed beyond the minimum required to answer the research question. Below, the entire design is documented, yet special attention is given to components relevant to the research question.

Figure 47. Impression street and HIS 1 slab type

Site level

Design concepts

On the urban scale, the design aims to complete the existing urban tissue, improve the connectivity of the area, and add amenities. More concretely, the following design principles are applied:

1. Completion of the unfinished urban blocks along the site.
Along the west and north side of the site, the urban blocks have not been completed, leading to the creation of walls of buildings. These blind facades create an atmosphere of discomfort and not belonging. To counter this, a courtyard dwelling type, inspired by Gleba A, is placed next to these walls. Between the buildings and the walls, semi-public courtyards are formed.

2. The creation of a linear park along the stream on the east of the site plus the extension of this park into Parque Cocaía using a green axis.
As mentioned in the contextual analysis, little urban green is present in São Paulo and Grajaú. By adding urban green to the project site, inhabitants of Parque Cocaía and surrounding neighborhoods are offered space to socialize, relax, and perform sports. In future developments, the linear park may well be extended along the banks of the Billings reservoir to connect various neighborhoods and provide green to all inhabitants of Grajaú.

3. The creation of enclosed public spaces.
As a high density is pursued, private gardens cannot be provided to all users. Instead, enclosed public spaces are created for inhabitants of building blocks to share. These should provide a safe place for children to play, inhabitants to meet, and communal events to be held.

4. Placing the amenities along the green axis.
A kindergarten, community center, skate park, sports pitch, and communal gardens are placed along the green axis. From here, they can be accessed by all inhabitants of the neighborhood and lure people from their dwellings into the public realm.

5. The creation of a wall of buildings along the green axis.
A wall of duplex dwellings along the green axis guides visitors towards the linear park downhill. The green axis and wall interact: inhabitants watch over the public space, while visitors of the green axis come across the terrace of inhabitants and might start a conversation. Cars can cross the axis at three locations, with crosswalks integrated into the design to ensure the safety of pedestrians while also connecting the surroundings.

To cater to various user groups, four building types without various apartment types can be distinguished in the plan: a slab type, courtyard type, sobrado type, and tower type. The first two have HIS 1 and HIS 2 versions, whereas the final two are destined for HIS 2 only. The types are spread over the site based on the design principles listed above, with an eye for detail and aesthetics. The current master plan is a result of months of iteration and improvement.

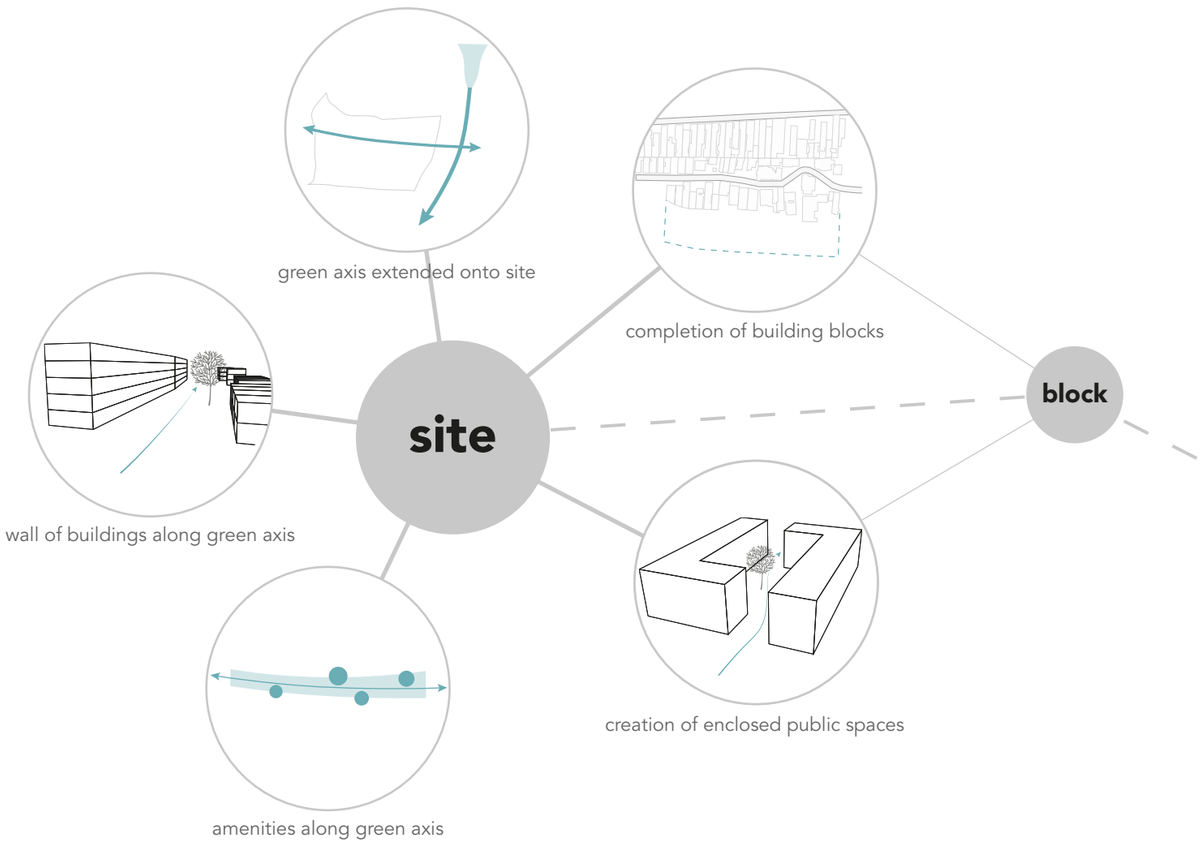


Figure 48. Urban design principles Parque Cocaía

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Density

In São Paulo, the number of households in favelas and irregular settlements was estimated at four hundred thousand each in 2017 (Prefeitura de São Paulo, 2017). To be able to provide these dwellers with a more permanent residence, large-scale investments in social housing by the municipality are needed. As the land in the city is scarce, maximum density without compromising on livability should be strived for in the design of social housing projects. Every extra dwelling offers another family a chance to raise themselves from insecurity, poverty, and inequality. Hence, an elaborate study was made on how this density could be acquired in Parque Cocaía.

The maximum density in Parque Cocaía was determined mostly by the requirements for cross-ventilation, as explained in the ***Building technology*** chapter. Yet, other factors that influenced the design are:

- A building can be five stories high without requiring an elevator;
- Buildings next to existing settlements should not intrude on the privacy of their neighbors;
- No buildings are allowed within 15m on both sides of the water stream;
- Sufficient space is reserved for the green axis, linear park, and other urban amenities;
- Space is reserved for roads and parking;
- The ratio between social and corporate housing.

Together, these led to a design with FSI=1.00 in which five-story buildings are the standard, with exceptions along the western and northern borders of the area (four stories) and along the stream (eight levels). With the former, four stories are used to reduce the transition in building heights between urban tissues and to prevent inhabitants from looking into the gardens of dwellings along the project site. With the latter, eight stories overlook the open terrain of the linear park around the stream.

The built areas around the project site have a density of approximately 70 dwellings per hectare, though there is little public space, as there is almost no vertical stacking of dwellings.

Project	Chácara do Conde	Santo Amaro V	Gleba A	Parque Cocaía
Plot area (ha)	10.4	2.19	4.32	6.80
Number of dwellings	1290	201	537	1361
Unit sizes (m2)	45-51	48-62	48-62	52-114
Density (dw/ha)	124	91.8	124	200
GSI	0.13	0.12	0.16	0.23
FSI	0.66	0.67	0.74	1.00

Figure 49. Comparison densities social housing projects in São Paulo

Mixing user groups and functions

In the new neighborhood, users of various backgrounds will come together. Of the 1361 new dwellings in Parque Cocaía, 80% is allocated to HIS 1 households and 20% to HIS 2 households. Furthermore, 400 of the HIS 1 dwellings will be filled by evicted inhabitants. These user groups have various preferences for their dwelling, but also their surroundings, lifestyle, and amenities. In the design, a careful balance should be struck between promoting interaction between the various user groups and leaving space for differences and retreat.

In the project, two blocks, the row of sobrado types, and the tower types along the stream are designated for HIS 2 users. The blocks are placed between HIS 1 blocks but have their own courtyards. The dwellings in these blocks are larger and suit the difference in lifestyle. For example, the HIS 2 blocks are larger and incorporate small private gardens, whereas the HIS 1 only boast a shared garden. Furthermore, the HIS 2 areas are placed centrally for the best connectivity and the number of parking spots per apartment is higher.

Apart from user groups being mixed in the design, functions are mixed in the plinth of the slab type. On the plinth level of this type, space is left for businesses, stores, canteens, and bars. Especially on corners of this type, where the streets meet the green axis, there should be a lot of traffic passing the businesses. The Santo Amaro V project shows how a monoculture within the plinth level can be detrimental to the perceived safety of the street, hence various functions are mixed in the plinth of Parque Cocaía. So, this level also boasts dwellings, which are suitable for wheelchair users as well.

Figure 50. HIS 1 blocks (purple) and HIS 2 blocks (pink) are interconnected but not forged.

Green axis

The green axis is the site its backbone; it connects various parts of the new neighborhood, provides amenities, and is a place to meet. The green axis therefore also aims to be the bridge between dwellers evicted from the river banks and those moving from other parts of the city or country. To do so, the design of the green axis aims to create an identity for all inhabitants of the neighborhood. This is done by proving space to meet and connect, but also through its materialization. The urban furniture of the green axis is built using the building materials of the dwellings along the river banks that are demolished. Timber beams create benches and shading, while bricks are used to construct pavement, walls, and little squares. Apart from the intrinsic value of this reuse, it also has sustainability benefits.

reuse roofing tiles in ceramics

reuse timber beams for pergola and urban furniture

Figure 51. Impression and material usage green axis

Block level

Design concepts

On the level of the urban block, the following design principles are applied in Parque Cocaía:

1. Completion of the unfinished urban blocks along the site (as explained on site level).

2. The creation of enclosed public spaces (as explained on site level).

3. Make use of the topography.

The design for Parque Cocaía deals with the steep slope of the site by having souterrain stories. As shown in the block floor plan and the section, the soil level of the courtyard and the street differ by one story. This story is provided daylight by small, wide windows just below the ceiling on the west side, alongside the windows in a normal facade on the east side. By integrating this height difference in the plinth, the courtyard, and street can be kept flat. In the Gleba A project, a height difference between the courtyard and the buildings creates a disconnection, which makes the space less used and safe.

4. Design a streetscape stimulating interaction between the public and private realms.

Interaction between the two realms improves actual and perceived safety, contributes to the community, and helps to create an identity for the neighborhood. The interaction is stimulated using transition zones, like slightly raised verandahs, front gardens, and balconies. Furthermore, the plinth level is clearly demarcated with an overhang, a larger story height, a different facade design, and mixed functions. Apart from the aesthetical separation of the ground level from the upper levels, this also suggests a different form of openness.

5. Having building types react to their surroundings, user group, solar orientation, and level of privacy.

The building blocks their allocation and orientation follow the design principles on site scale, but adapt to the micro conditions in their facade and floor plan. To name a few examples:

- The corner units of the slab type along the green axis are raised to indicate a change in scenery.
- The slab type dwellings their facades vary in setback in the streets towards the green axis to prevent the creation of a monotonous streetscape. Furthermore, this also provides extra shade.
- The back side of the slab type dwellings along the green axis reacts to the park.
- The facades of the HIS 2 dwellings are clad

- using earth plaster, whereas this can be applied later in the HIS 1 dwellings.
- The facades are set back on the north side, and even further on the east and west side, to prevent overheating during the summer.
- The balcony railing on the street side is higher than on the courtyard side of building blocks.
- The verandah and front garden on the street side are deeper than the balcony on the ground floor on the courtyard side to provide more distance between the public and private realm. At the same time, they are more open and stretch into the public realm from the building outline, thereby actively claiming a part of the sidewalk and creating territoriality.

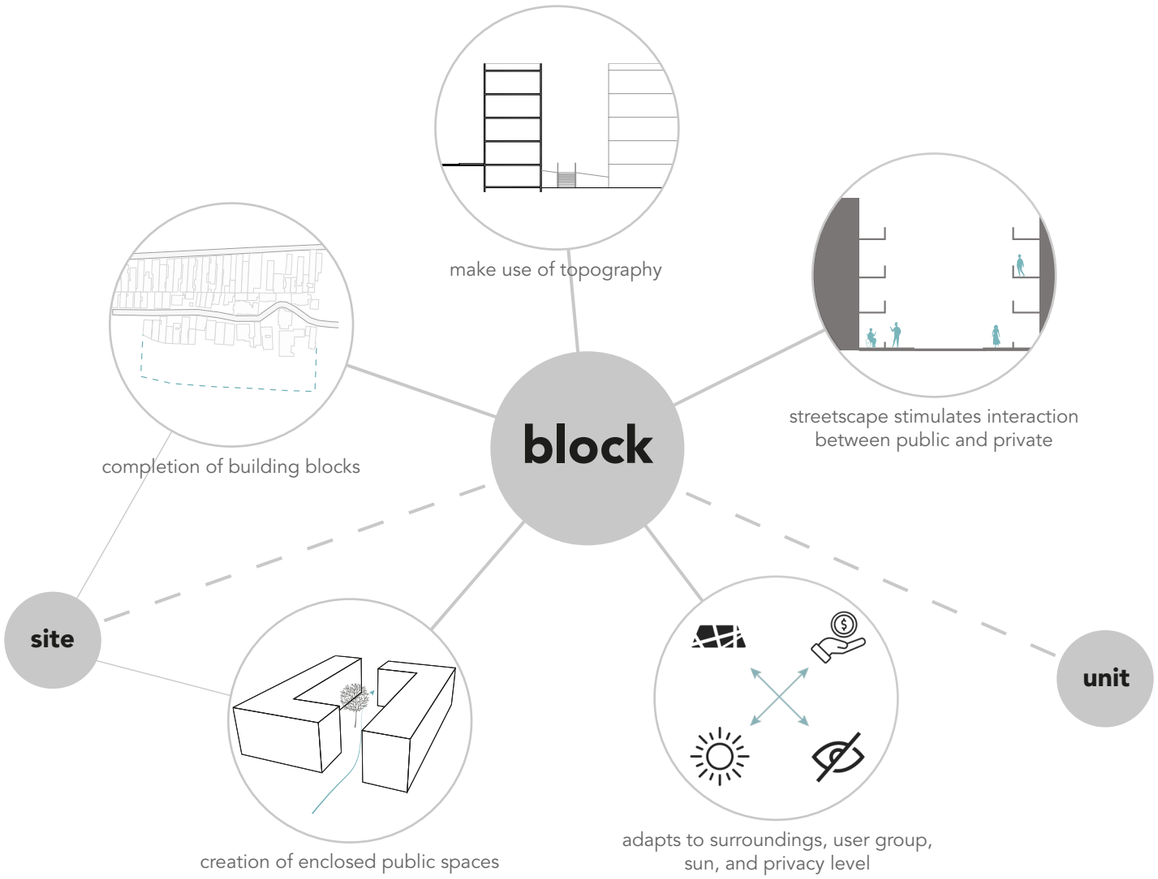


Figure 51. Block design principles Parque Cocaía

Figure 52. Floor block plan GF

Figure 53. Floor block plan 1F

Figure 54. Floor block plan 2F

Figure 55. Section existing settlements - courtyard - courtyard type

Figure 56. Section courtyard type - street - slab type

Figure 57. Impression courtyard type

Figure 58. Impression courtyard next to existing settlements

Figure 59. Impression view from balcony courtyard

Figure 60. Impression street and slab type

Figure 61. Impression safety measures pedestrians

Figure 62. Impression street with courtyard and slab type

Dwelling level

Design concepts

The following design principles are applied in the design of the unit types. Furthermore, inspiration is drawn from the comparative analysis and by looking at floor plans of brokers in São Paulo online.

1. Providing eyes on the street on both sides of the building.

The number of eyes on the street is an important factor influencing the safety of a neighborhood. In the floor plans of the various types, attention is given to providing opportunities to watch over the public space on both sides of the building. This is done by strategically placing large windows and balconies along much-used spaces like the living room and kitchen.

2. Ensuring cross-ventilation in all dwellings.

Given the climate in São Paulo, allowing cross-ventilation is important to deal with the hot Brazilian summers. This is dealt with in detail in the Building technology chapter. The cross-ventilation is ensured by always connecting the living room of a dwelling with both sides of the building and connecting to the outside using windows that can be opened up. Especially for the HIS 1 dwellings, this form of ventilation is an affordable solution to the heat.

3. Providing varying building types for various preferences.

To meet the demands of the various groups of inhabitants of Parque Cocaía, a range of dwelling types is provided in the newly-developed area. The dwellings differ in size, amenities, materialization, location, and payment scheme. They cater to different income groups and lifestyles. Furthermore, dwellings for wheelchair users and large families are included.

4. Individual appropriation of facades.

In many social housing projects in Brazil, monotonous landscapes of similar dwellings are created. Although these suit the purpose of providing housing to the country's poor, their durability can be questioned because of the mass repetition. No one wants to be treated as a number, especially not in a country where segregation and stigmatization are already so common. By providing appropriation possibilities for the facade, residents can make their homes unique and feel like their own. Furthermore, this appropriation also indirectly helps to build territoriality and therefore improves the safety of a neighborhood.

5. Combining wet spaces.

By placing wet spaces close to each other, the

piping distance is reduced. This makes for efficient use of space and reduces costs. Especially since two piping systems are installed, one for tap water and one for grey water.

Housing for HIS 1 and HIS 2 families has certain cultural standards that have been applied in the design. For example, the bedrooms are always located behind a living room or kitchen, HIS 1 dwellings often have a sink on their balcony for washing clothes, in HIS 2 dwellings, the master bedroom is equipped with its own bathroom, and the living room and kitchen are often one space.

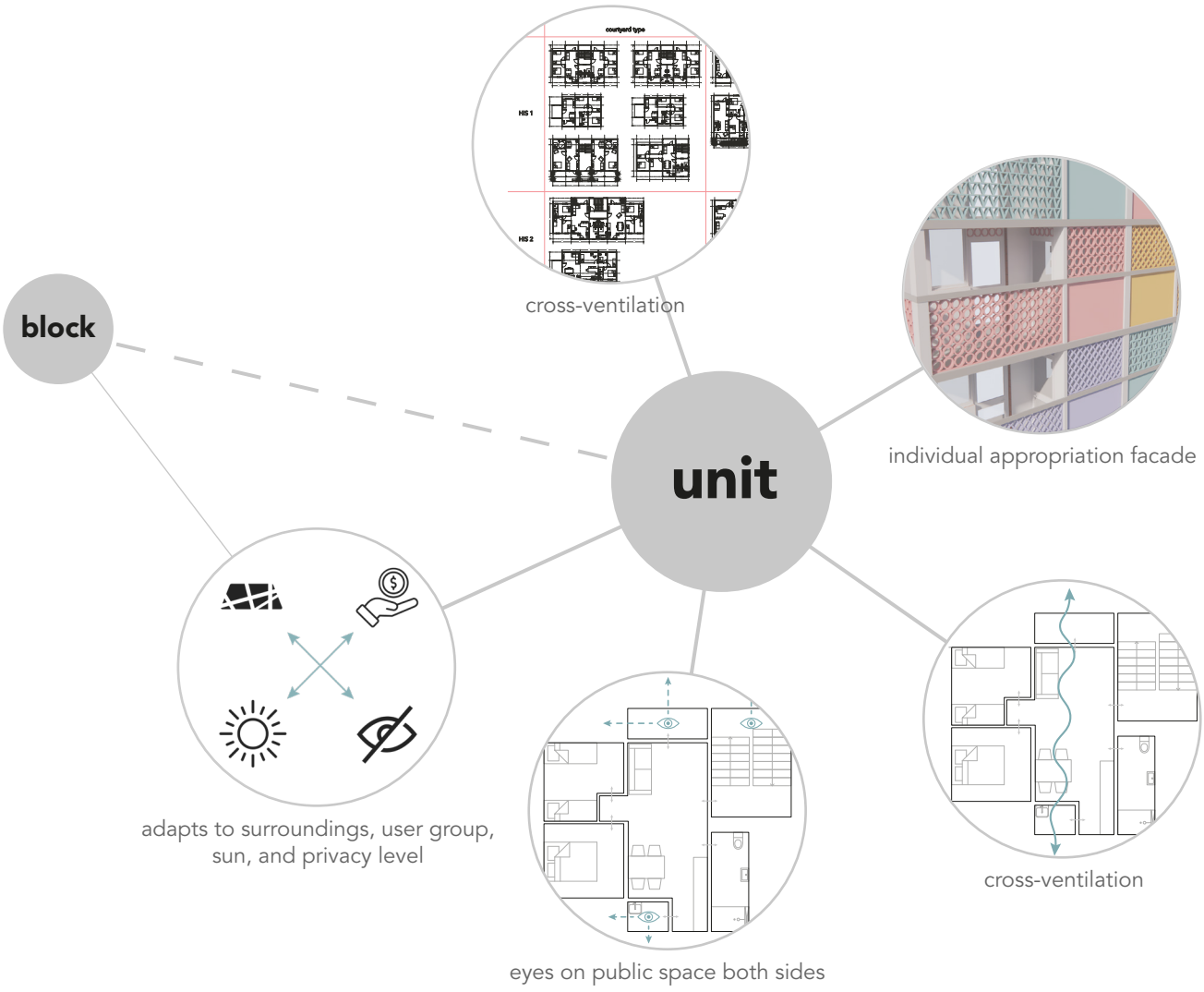


Figure 63. Dwelling design principles Parque Cocaía

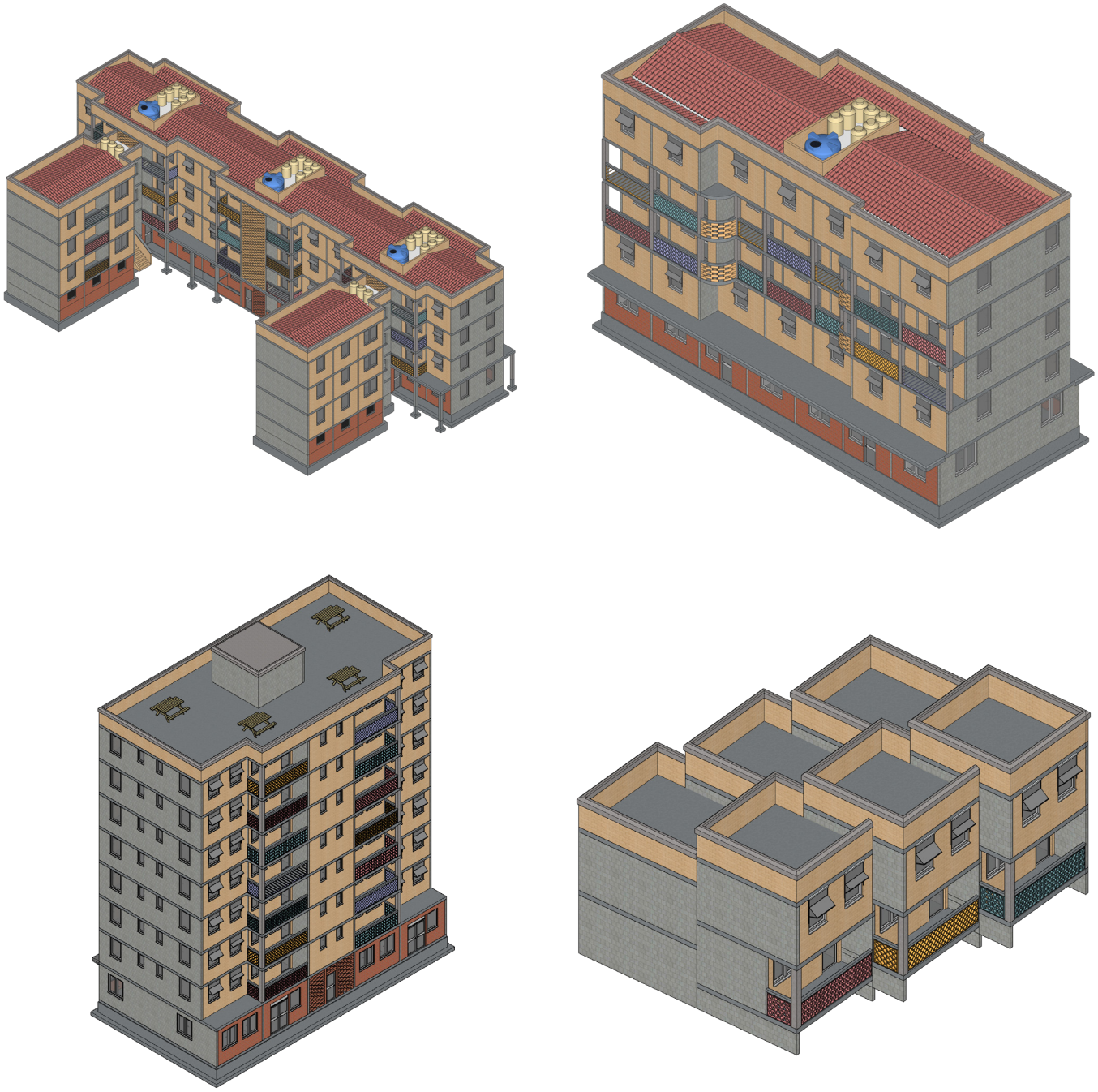
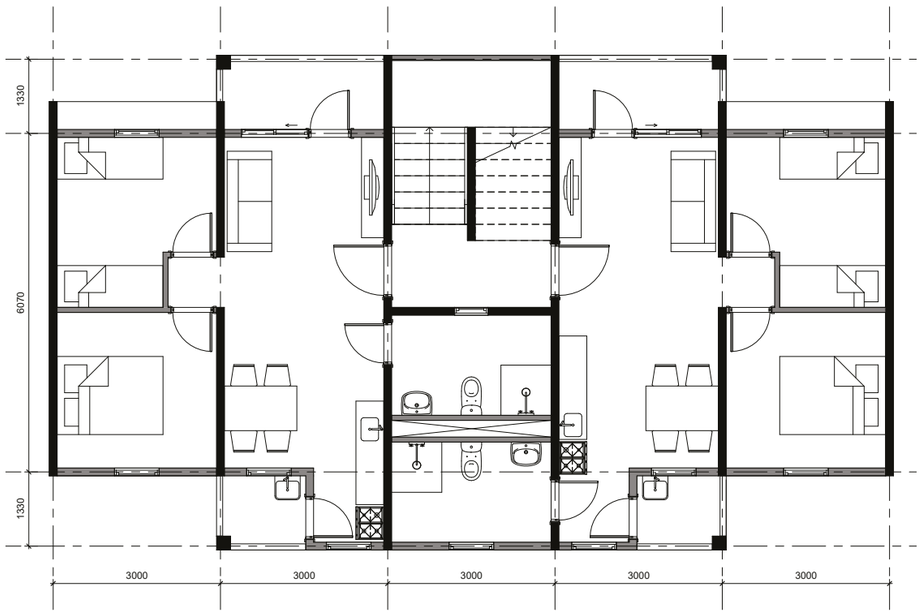
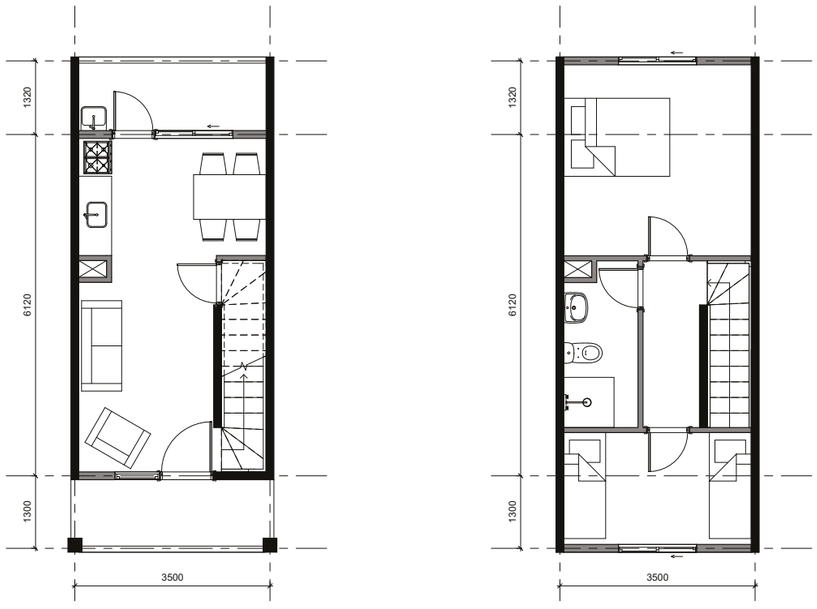


Figure 64. Building types Parque Cocaía - general impression, as the types adapt to their surroundings

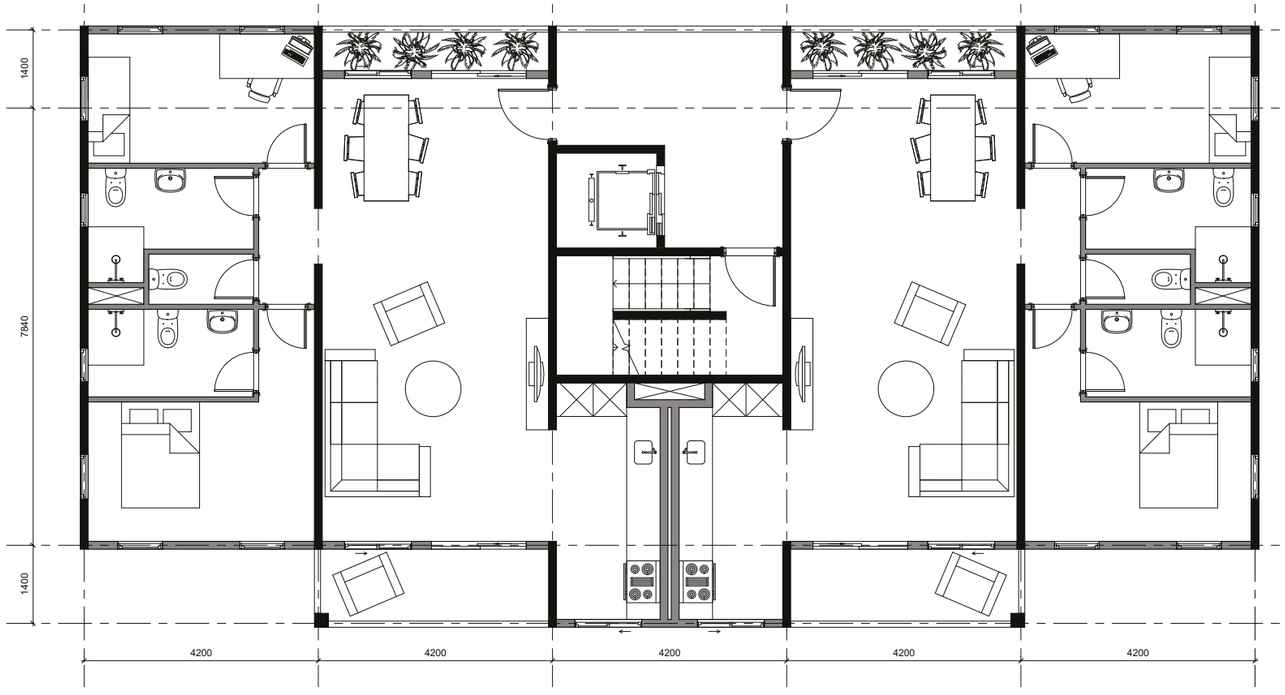


courtyard type, HIS 1 variant, 52 m²

sobrado type, HIS 2, 114 m²



slab type, HIS 1 variant, 54 m²



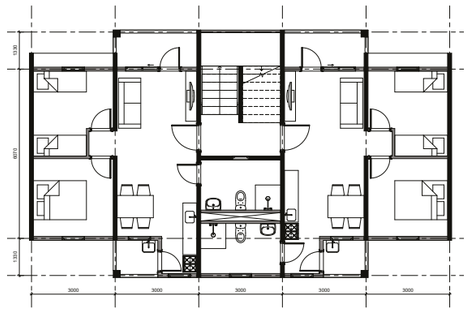
tower type, HIS 2, 100 m²

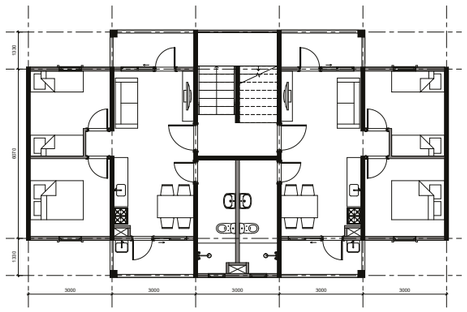
Figure 65. Most common dwelling type for every building type (1:100)

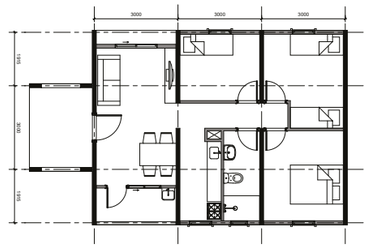
courtyard type

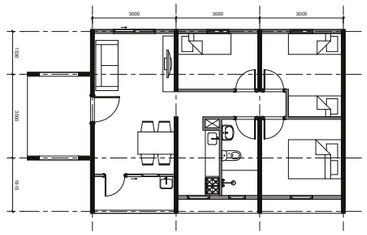
slab type

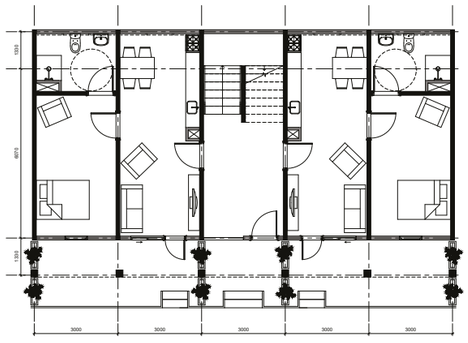
HIS 1

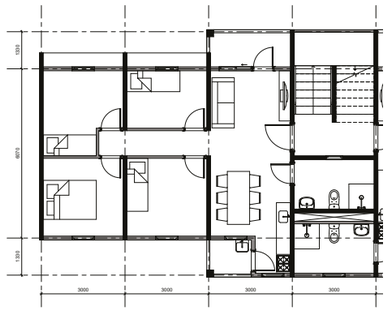


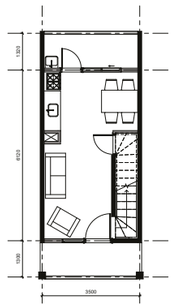


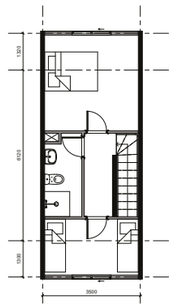


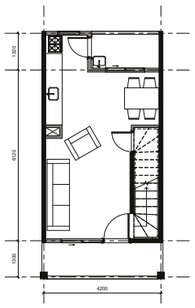


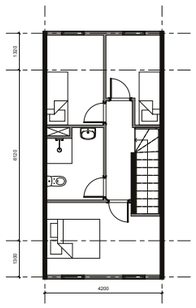


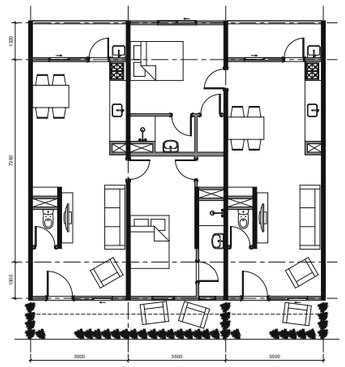




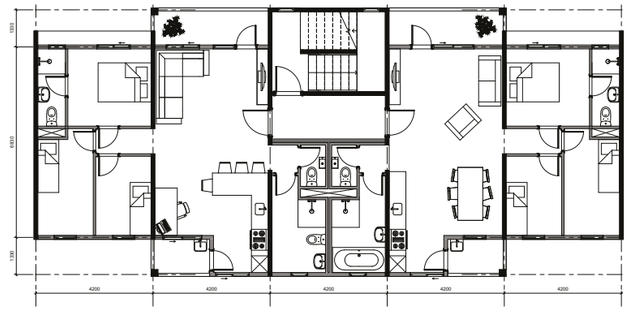


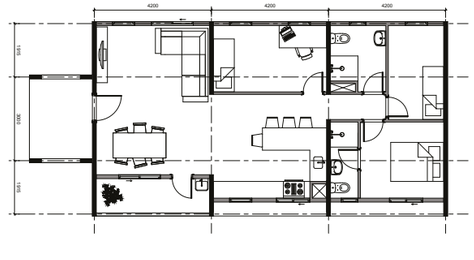


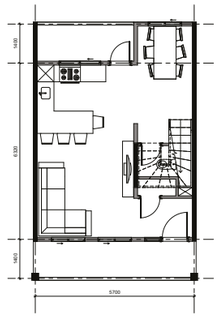




HIS 2







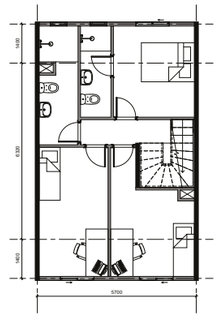
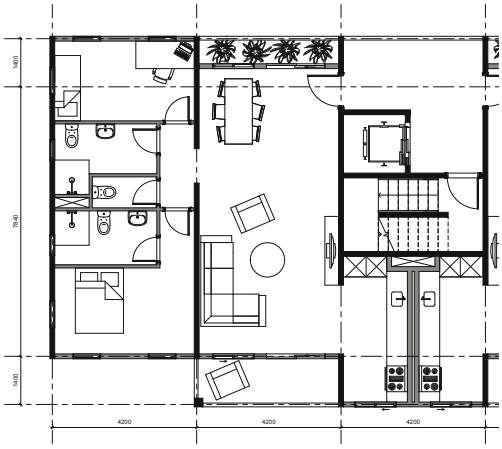


Figure 66. Overview of all dwelling types (1:200)

tower type

sobrado type



BUILDING TECHNOLOGY

Materialization

Construction cost is one of the key financial indicators in the development of Parque Cocaía, given the large component of social housing being constructed. The cheapest construction methods in Brazil are in-situ concrete, concrete masonry units, and structural masonry. The industry is focused on large-scale production of these materials and contractors on all levels know how to handle them. Though, these solutions are relatively unsustainable as well, with the production of the building materials leading to high emissions (CINARK, n.d.). In the design of Parque Cocaía, a balance is sought between the availability of materials, knowledge of local contractors, and sustainability, or in short, between affordability and sustainability.

Floors: EPS slabs and (recycled) concrete

For the construction of the floors of Parque Cocaía, in-situ concrete is poured on top of EPS slabs, similar to the Dutch broodjesvloer. This construction method is commonly used in Brazil and therefore affordable and executable by local contractors (Blocos e Lajes ITAI, n.d.). Also, a factory where the material is produced is located 8 km from the building site (Blocos e Lajes ITAIM, Estr. Ecoturística de Parelheiros 344), facilitating low transportation costs and emissions.

The carbon emissions of the project are reduced by pouring the concrete on top of EPS slabs, which also improves the sound and thermal insulation of the floor. Furthermore, the debris of the demolished settlements is reused in the production of new concrete. Using the reCO2ver technique by the Swiss Sika Group, up to 40% water and 25% cement can be reduced (Sika Group, n.d.). With the technique, concrete debris is treated with a mixture of chemicals that cause the cement to carbonate and thereby separate from the aggregate of the debris. The products of the treatment are secondary aggregates of high quality and a powdery material consisting of cement and sand. These materials can be used in the construction of the buildings and roads of Parque Cocaía respectively. The thickness of the concrete poured is calculated using the TU Delft rules of thumb (BK Faculty TU Delft, 2013).

Load-bearing walls: mollusks blocks

For the load-bearing walls of Parque Cocaía, blocos verdes (Portuguese for green blocks) are used. These building blocks are largely similar in appearance, production method, and material properties to the much-used concrete masonry units, yet their production process is more sustainable (Dallanhol, 2011). Therefore, the blocks can be used without requiring further educating

of the construction workers or irregular connections, resulting in low construction costs and the possibility of having the project executed by local contractors.

Blocos verdes are produced by Blocaus Pré-Fabricados in Santa Catarina, the state just south of São Paulo state. As explained by Dallanhol (2011), in Santa Catarina, the mariculture industry, the harvesting of oysters and shellfish, is booming. When the mollusks have been harvested, the fishermen are left with the shells of the animals, which are often dumped in the sea or at a landfill. Over time, the erosion of these can cause environmental risks to the subsoil. Bernadate B. Batista, from the Universidade do Sul de Santa Catarina, invented a solution for this, as the shells can also be crushed and afterward replace a part of the sand and concrete used in the production of concrete masonry units. By doing so, lightweight and sound-proof blocks, blocos verdes, are created with almost 50% less cement (Casa Ecologica, n.d.). In this way, an environmental hazard is turned into a sustainable, local construction alternative.

A single ton of shells can be used to produce 4000 building blocks, which is required for the construction of a house of 120 m2 floor area (Dallanhol, 2011). Considering the total floor area of Parque Cocaía (~55,000m2), ~460 tons of shells would be recycled. Fortunately, in Santa Catarina, ~12,000 tons of shells are retrieved per year.
For this thesis, detailed information on the production process and material properties was requested from producer Blocaus and inventor Bernadete Batalha Batista, but unfortunately, no answers were received. Though, the product did receive eighteen international prizes in the two years after its release (Trombini, 2014) and can be ordered online in Brazil at the time of writing (Construmarket, n.d.).

Non-load-bearing walls: compressed earth blocks and ceramic bricks

The non-loadbearing walls of Parque Cocaía are mostly constructed using compressed earth blocks (CEB), also known as ecological bricks or bloco de terra comprimida (BTC), that have been produced on-site from the excavated subsoil. The production process of these bricks requires educating local contractors. Though, when the bricks have been produced, these can be stacked like other construction methods common in Brazil. The non-loadbearing walls of the ground floor are constructed using ceramic bricks, as CEB is sen-

structural walls: blocos verdes

floors: recycled concrete + EPS

non-structural walls: ceramics + compressed earth blocks

porous facades: Cobogó

Figure 67. Main building materials Parque Cocaía

sitive to water, and to create a visual difference between the plinth level and apartment levels. Ceramic bricks are widely available, affordable, relatively sustainable, and have a well-known construction process (CINARK, n.d.).

The production technique of compressed earth was introduced in Brazil by the Portuguese in the sixteenth century, with African slaves being familiar with the building technique from their country of origin (Assunção Oliveira, 2012, p. 17). The technique remained popular until after the Second World War when baked bricks became a faster and cheaper alternative (p. 19). Though, some important Brazilian buildings have been constructed using the technique. In the 1990s, the material started to become used again for single-family dwellings (p. 20).

As explained by Minke (2006) in the elaborate book Building With Earth, earth structures are great at maintaining a comfortable and healthy indoor climate by buffering heat, purifying air, and regulating humidity levels (p. 15-18, 31). Special care should be given to the waterproofing of the material, as it erodes when exposed to water frequently (p. 14). When used correctly though, structures made of earth can survive for centuries and even thousands of years, as numerous examples have proven (p. 11).

With CEB, a composition of soil types is compressed in a mold drive manually or mechanically (Minke, 2006, p. 63-64). Its construction is cheap and fast, though the production process should be monitored constantly to assure the brick quality. Sometimes, cement is mixed with the soil types to improve the product its strength and stability or reduce the drying time (p. 64). Though, this increases the emissions of the construction process. During the construction of Parque Cocaía, bricks without cement are used, hence these walls are non-loadbearing.

The subsoil at Parque Cocaía mostly consists of tertiary sediment, but also mixed massif and alluvial plain subsoil are present (Prefeitura de São Paulo, n.d.). Although further analysis is needed to determine its suitability, sediment does contain the clay necessary for construction with compressed earth (Minke, 2006, p. 13).

Porous facades: Cobogó

To allow for cross-ventilation in the dwellings, porous facade elements are used. These elements are called Cobogó in Brazil, being named after three architects from Recife inventing the material in 1920 (Delaqua, 2017). Similar elements are known in other countries as brisesoleil. The elements offer a combination of privacy, ventilation, and sun-shading, thereby suiting the Brazilian climate and lifestyle. Cobogós are used in

Jardim Vicentina | Gleba A | Santo Amaro V | Parque Eduardo Guinle

Figure 68. Cobogó facades in the case studies

all types of projects, from upper-class housing to social housing and public buildings. Apart from their practical qualities, the elements also offer appropriation opportunities, as shown by Lucio Costa with the design of Parque Eduardo Guinle in Rio de Janeiro (The Architectural Review, 2020).

Viglieca uses various brick bonds in Gleba A, Parque Novo Santo Amaro V, and Jardim Vicentina to create porous facades with benefits similar to that of Cobogós. These are more affordable than prefabricated panels of ceramic, concrete, or fiber cement, like the ones used in Parque Eduardo Guinle.

Foundation: in-situ concrete

For Parque Cocaía, a line foundation supports the load-bearing and external walls, and a foundation is poured directly on the subsoil below the ground floor. This construction method is also used in the Chácara do Conde II and Santo Amaro V projects (ArchDaily, 2015; Arquitetos Urbanistas, 2016), which are built on the same subsoil types (Prefeitura de São Paulo, n.d.). The foundation of the floors and walls are poured separately to prevent cracking through settling. A more detailed analysis is needed to determine the exact depth and thickness of the foundation, but dimensions similar to that of the two aforementioned projects are assumed.

To pour the foundation, the soil has to be excavated until a terrace structure is created. This leftover soil, if suitable, is used to produce the compressed earth blocks or to raise the soil level on other spots on the site to create slopes. By doing so, a zero soil balance is strived for.

Facade cladding: earth plaster

As facade cladding in the HIS 2 dwellings, earth plaster (also known as clay plaster or earthen plaster) is applied. As explained by the British Institute of Historic Building Conversation (2021), the building material is making a comeback in the construction industry, after being applied in historic architecture before being taken over by stucco plasters. Earth plaster is made from clay, fine aggregates, and fiber. Its usage can be internal and external, although care for its waterproofing is required with the latter.

The use of earth plaster has various building physical treats that increase user comfort. They are porous, allowing the building to breathe, they regulate the moisture content of a room, are non-toxic, and provide a natural look. Like most natural materials, earth plaster does require careful detailing and maintenance though.

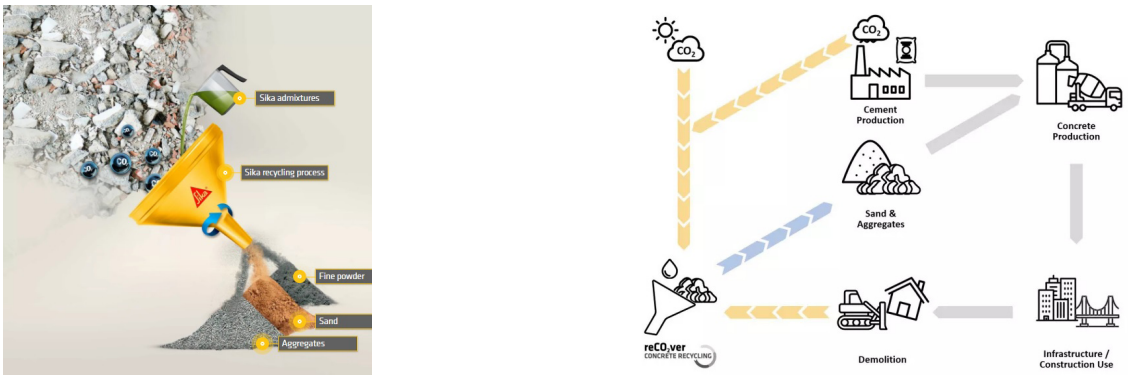


Figure 69. Concrete recycling process (Sika Group, n.d.)

Structural design

The loads in the dwellings of Parque Cocaía are carried by the blocos verdes and the in-situ concrete floors. The parallel walls are placed perpendicular to the long side of the buildings, every 3.0 to 5.7 meters, depending on the type. This technique is material efficient and does not require special knowledge or large machinery, hence it is suited to the type of project.

With this design, openings can be easily made in the facades facing the street or the courtyard. Especially when the openings span as high as the next floor slab, as no lintel is required to carry the non-loadbearing bricks above the opening then. This is done on the floors that only contain dwellings. Openings in the load-bearing walls require a lintel and sometimes a column to carry the loads.

Stability is provided by (parts of) walls perpendicular to load-bearing walls. These are made of blocos verdes as well. By placing these in the exterior walls, the building retains greater repurposing possibilities. For the tower type, stability is provided by the elevator shaft.

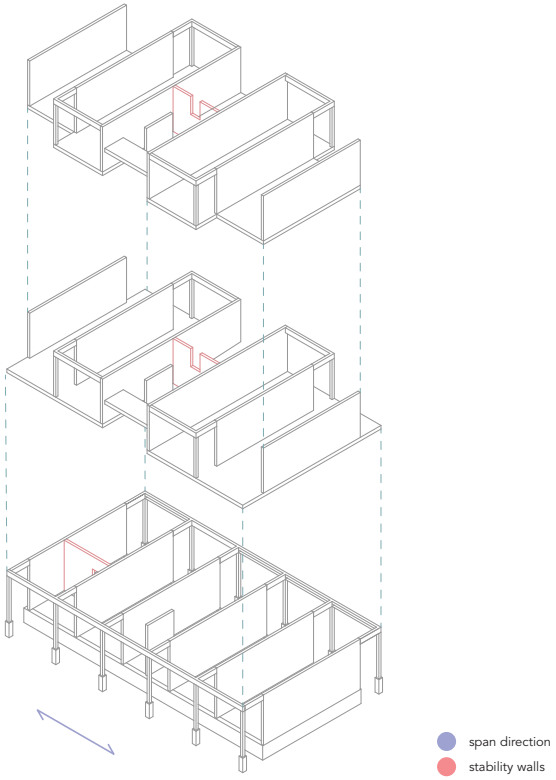


Figure 70. Structural design principles

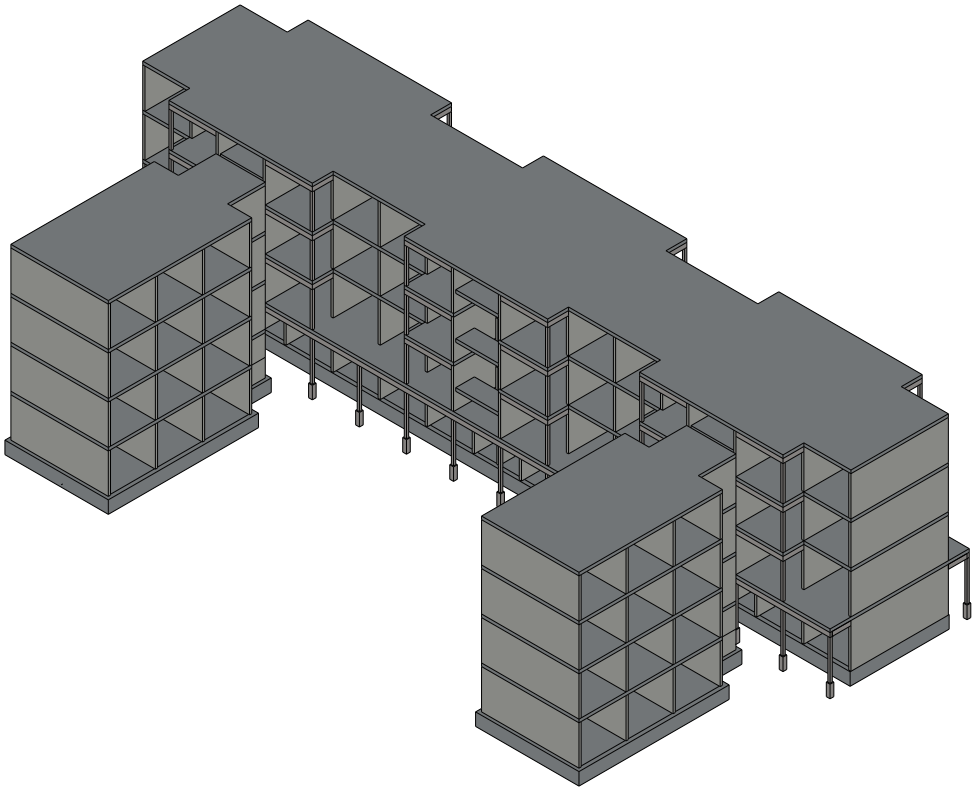


Figure 71. Total structural system courtyard type

Building physics

São Paulo is located in the southern hemisphere at 23^0 S 46^0 W at an altitude of ~800 m above sea level. Its climate is subtropical, with the winter (June-August) being relatively cool and dry, and the summer (November-March) hot and rainy (World Climate Guide, n.d.). The weather in the city is often variable, due to a large difference between the specifications of air masses from various directions passing the city.

Designing in this variable climate requires extra care, especially for social housing, as the inhabitants do not have the means to rely on expensive mechanical ventilation or heating systems to regulate the indoor climate. By looking at precedent cases, affordable alternatives can be determined though.

Insolation and shading

During the summer, the insolation values in São Paulo can be high, though, there are often clouds in the sky as well (Weather Spark, n.d.). Because of the high temperatures in the summer, sun shading is needed to prevent overheating of dwellings. The west facade is the most sensitive to overheating, followed by the east facade. Around noon, the sun is high up during summer, meaning the north facade does not get as hot as the others. During winter, when the sun is lower, dwellings are warmed up through the north facade.

In the settlements, most dwellings have balconies that take away direct sunlight from their facades. Also, most dwellings are deep and slim, with little windows. These dimensions were determined during the division of land, though they also contribute to a comfortable indoor climate. The downside of this design is that (a part of the) indoor spaces rely on artificial lighting.

In social housing projects, the dwelling units are less slim and deep than in the settlements, but they have smaller windows to compensate for it. When visiting Chácara do Conde on a hot, sunny day in late summer, the indoor temperature of the dwellings was comfortable despite the walls not being insulated, the spaces being small, and no sun shading being installed. In Gleba A, Santo Amaro V, and Jardim Vicentina porous facades allow daylight to enter without the spaces being exposed to direct sunlight, reducing the chances of overheating.

In Parque Cocaía, the buildings will be orientated in various directions, so also with facades exposed to the west. As the west side of the area is 33 m higher than the east side, the hill and

the buildings themselves will partially provide shading to each other. Though to further prevent overheating, porous facades are integrated into all dwellings in the design. Also, exterior shutters are applied to any exposed windows on the west, north, and east facade to keep out the heat during the summer, while letting through the sun during the winter. The same is done by the trees in the design, as during winter the leaves fall off and the sun can naturally heat the buildings. Exterior blockage of the sun is more effective at preventing overheating and vegetation reduces the local temperature even further by taking up the heat during evaporation of fluids (Yu & Hien, 2006). In the projects of the comparative analysis, sliding panels are often used to keep out the sun, though, these drastically reduce the illumination levels inside the building and turn facades into blind facades, thereby reducing safety in the area.

Temperature and insulation

The two lines in the graph show the average maximum and minimum temperature per day in São Paulo. The temperature is comfortable during the winter and high in the summer. Hence, thermal buffering during the day in the summer and at night during the winter is preferred.

In the settlements and social housing projects analyzed, no insulation material was used. As mentioned above, the number of facade openings is limited and all windows can be opened. Both the settlements and the social housing projects are made of either concrete masonry units or ceramic brick units in combination with concrete floors. These have a high thermal mass, thereby reducing the indoor temperature during the day and preventing cooling down too much at night (Bensalem, 1991).

In 2009, market analysis by IAL Consultants showed that only 4% of construction projects in Brazil included any form of thermal insulation (Messe Düsseldorf, n.d.). For the years that followed, an annual growth of 6% was forecast. Though, it should be kept in mind that the temperature in the southern states is lower than in São Paulo, so the low percentage could be explained by insulation material only gaining popularity in these states.

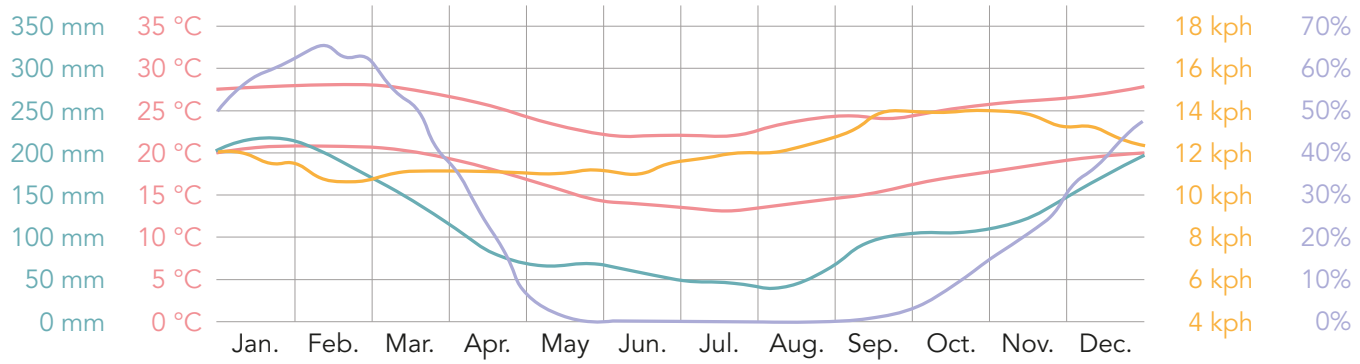


Figure 72. The climate conditions in São Paulo (Weather Spark, n.d.).

Brazilian building law NBR 15.575 states the following requirements for dwellings constructed in São Paulo:

- The thermal conductivity (U) of walls should be $U \leq 3.7$ W/m^2.K
- The thermal capacity (CT) of walls should be $CT \geq 130$ kJ/m^2.K
- The thermal conductivity (U) of roofs should be $U \leq 2.3$ W/m^2.K

A wall consisting of 2 mm plaster, 140 mm CMU, and 25 mm mortar (inside to outside), which is seen in a lot of social housing projects and settlements, has a thermal conductivity of 2.86 W/m^2.K and a CT of 222 and thereby suffices this requirement (Nudel, n.d.). Given that the blocos verdes have similar physical properties to CMUs, these should suffice this requirement. Compressed earth blocks, which make up most of the exterior facade, have a thermal conductivity of about 1.1 W/m^2.K, depending on the soil composition, and the ceramic bricks that are used on the ground floor have a thermal conductivity of 1.74 W/m^2.K when combined with plaster and mortar (Mansour et al., 2016; Nudel, n.d.). Hence, both more than suffice these requirements. For the roof, a sloped roof on top of a 100 mm concrete slab suffice with a U-value of 2.06 W/m^2.K. Though, since the insolation is the highest on the roof, 50 mm EPS is added on top of the roof slabs of Parque Cocaía, bringing the U-value to ~0.50 W/m^2.K. Insulation of the ground floor slabs is not needed, as the subsoil temperature in São Paulo is about 23 ^{0}C (Zaparolli, 2022).

So, in Parque Cocaía, the heavy building materials are used as a thermal buffer without insulation material being needed. This makes the dwellings more affordable and reduces the emissions of the project that insulation material or stucco would have caused. An exception is made on the roof, where an extra insulation layer greatly reduces the heat gain of the top floor during the summer.

Ventilation

Although the summers in São Paulo are hot with a maximum average of 28 ^{0}C, the temperature on average drops 7 ^{0}C at night. Sufficient ventilation options allow for this temperature drop to be used to cool down buildings, a principle called night ventilation (Bensalem, 1991). This ventilation can be achieved naturally or mechanically, with the latter being more effective yet expensive. With natural ventilation, special care is to be given to the design of the floor plans and the urban composition of the dwellings.

Given the user groups of Parque Cocaía, the dwellings of the project are designed to allow for cross-ventilation to deal with the Brazilian heat. During the day, inhabitants can have the windows closed to keep out the heat, which is reinforced by the thermal buffering of the compressed earth bricks, and at night, windows on both sides of the building can be opened up to let the air flow through the building. Research by Prof. Lamberts (2014) of the University of Florianópolis shows that in São Paulo state the best indoor temperatures are achieved when the windows are kept open 14.3% of the time every year, but 45.2% of the time during summer, being at night.

To achieve cross-ventilation in dwelling units, several requirements are to be met, which are listed below. A more elaborate overview of factors influencing the effectiveness of wind-driven ventilation was taken from Bensalem (1991).

- The apartments need sufficient facade openings on two sides of the building.
- Of these openings, a large enough part should be able to let through the air.

- Inside the apartments, the airflow should be not interrupted by walls, doors, or other barriers.
- The surroundings of the building should allow for the (partially) unobstructed entrance of fresh air.

This last requirement is hard to quantify since it can only be calculated using details computer models or wind tunnels. Factors influencing the effectiveness may be topography, nearby buildings, trees, and any other large objects close to the apartment. Furthermore, the effectiveness may vary greatly with different wind directions and speeds. For the Parque Cocaía project, the ratio between the building heights (H) and courtyard dimensions (W) is the determining factor. As a rule of thumb, Guyer (2013) recommends this ratio to be W<1.5H. For five floors of 2.7m, this would mean the courtyard would have to be at least 20.25m. In the design of Parque Cocaía, these four requirements are taken into account, as can be seen from the floor plans and urban plan. The Cobogós allow for ventilation even without opening a window directly onto the street, meaning the spaces can also be ventilated when it rains and without having to worry about break-ins or privacy.

Apart from regulating the temperature, ventilation also contributes to health, thermal comfort, preservation of the dwelling, and smoke control, as illustrated in the diagram by Bensalem (1991).

Sound insulation

As noise complaints are frequent in Brazilian condos, Brazilian building law NBR 15,575 states that apartment floors must have some sort of sound insulation installed. A 5 mm layer of expanded polyethylene (EPE) between the finishing floor and concrete floor can already reduce the sound level of neighbors by 25 dB (Acusterm, n.d.). This technique is applied in Parque Cocaía as well.

Sound transmission between apartments through walls is less than through floors, as there often is no direct contact between the source and wall. Also, as the floors are insulated, sound transmission to adjacent apartments will be limited. Still, noise can cause a nuisance and hence a layer of insulation material is installed onto the walls separating apartments as well.

Fireproofing

According to the aforementioned Brazilian building law, walls and roofs separating apartments or separating a space where gas is used from a living space must be at least 30 minutes fire-resistant (Garcia, 2015). Although the information on whether blocos verdes suffice to this norm cannot be found online, it is assumed that they do, given that their physical properties and composition are similar to that of CMUs.

Furthermore, from every apartment, at least two routes should lead to safety in case of fire. An exception is made for walk-up apartments and towers when the staircase has its fire compartment. For the duplex dwellings though, the elevated walkways have at least two escape routes.

Water management

With human action inducing global warming to dangerous levels, the management of water has become more important than ever. Water is becoming scarcer, yet, climate change increases the frequency of hazardous weather conditions. Most vulnerable to these are low-income groups. To create a safer living environment for the low-income groups of Parque Cocaía, the design is taking into account 1) water security, 2) flood prevention, and 3) rainwater harvesting.

Water security

On the roof of (almost) every settlement dwelling in the periphery of São Paulo and Rio de Janeiro, a water cistern is found. Their blue appearance creates an image stereotypical of the living environment, yet, as found out during the field trip, the cisterns form a crucial part of the dwelling. The city of São Paulo, and probably other Brazilian cities as well, have trouble with providing a steady water output to all its inhabitants. Occasionally, parts of the cities have to deal with a water outage that may last up to a day. Hence, every dwelling boasts a cistern filled with potable water for approximately one-day usage. The cisterns require cleaning a couple of times per year, which can be done by the owner.

The average water consumption of Brazilian households is reported to be 70-120 L per person per day by the NGO Collaborative Labeling and Appliance Standards Program (CLASP) in 2021. The average household size in Brazil is 3.0, though favela households are assumed to have a higher average despite accurate data lacking (Butler et al., 2020). An estimate would be that a tank of 500L could provide an average Brazilian household with enough water during an outage.

In the design for Parque Cocaía, every dwelling unit is equipped with an individual cistern on top of the building. Although a shared cistern could possibly reduce costs, it would also make families dependent on each other during outages. The cisterns can be accessed through a hatch from the shared staircases for maintenance.

Flood prevention

Low-income groups are vulnerable to flooding, as they are more often living in flood-prone locations, their dwellings are of lesser quality, and they have fewer cash reserves to overcome or outlast floods. In São Paulo, the inhabitants are familiar with floods as well. Last winter, the coastal areas of São Paulo state were left devastated by floods, with 48 inhabitants losing their lives because of the water and subsequent landslides (The Guardian, 2023). In response, the state declared a

180-day "state of calamity" during the Carnival holiday (CNN, 2023).

Gated communities have also proved to be adding to the flood-proneness of poorer neighborhoods, with walls channeling rainwater into the neighborhoods around gated communities in Buenos Aires and causing severe flooding (Reed, 2016). In São Paulo, similar urban conditions exist, which might increase the vulnerability of certain neighborhoods.

The project site is located on the slope of a hill, close to the Billings reservoir. Because of the steep slope and the relatively high altitude compared to the rest of the city, the site is not endangered by a rising water level. However, its position on the slope of the hill will make that water will stream from the hill during heavy rainfall. To counter this and to stimulate subsoil penetration of the rainwater, rainwater ditches perpendicular to the slope of the hill are spread over the site. A welcoming future, considering the high levels of precipitation throughout the year in São Paulo, the urban heat island effect, and the conservation of underground water reservoirs.

Rainwater harvesting

Considering climate change and the expansion of São Paulo, it is a matter of time before the Brazilian megapolis has to deal with water shortages. Rainwater harvesting can reduce tap water

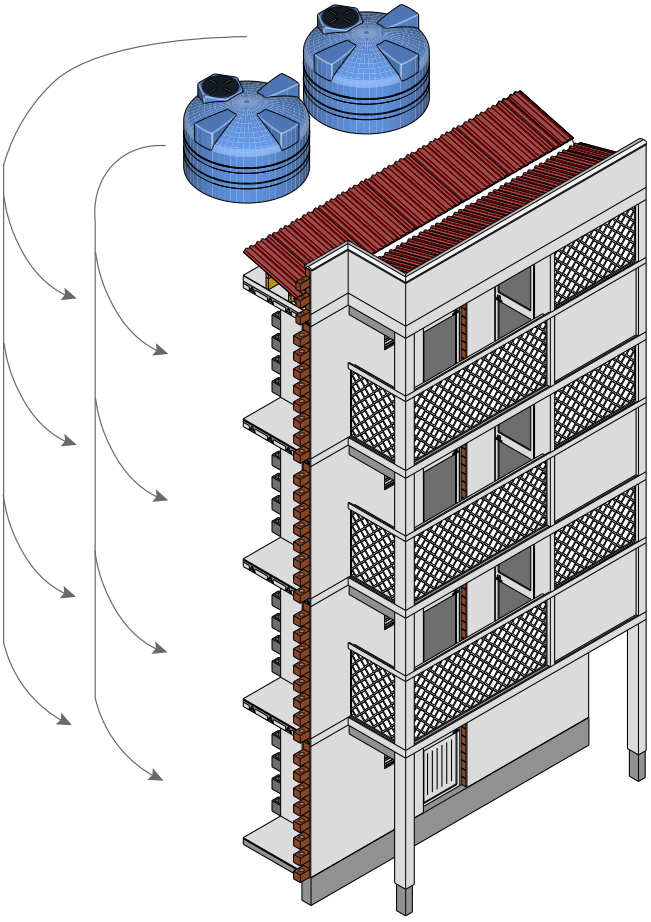


Figure 74. Water system principles

Figure 73. Rainwater ditch

Figure 75. Floods in São Paulo

usage by up to 50% in Brazilian households, and thereby counter this shortage (Inson, 2022). The collected water can be used to water gardens and plants, for washing, and toilet flushing. With the first two applications, the chances of subsoil penetration are increased as well, reducing the pressure on the sewerage system and contributing to a healthier subsoil (Souza, 2020). Since 2007 already, built surfaces of more than 500 m2 are obliged to collect rainwater by São Paulo state law to reduce flooding risks (Acqualimp, 2021).

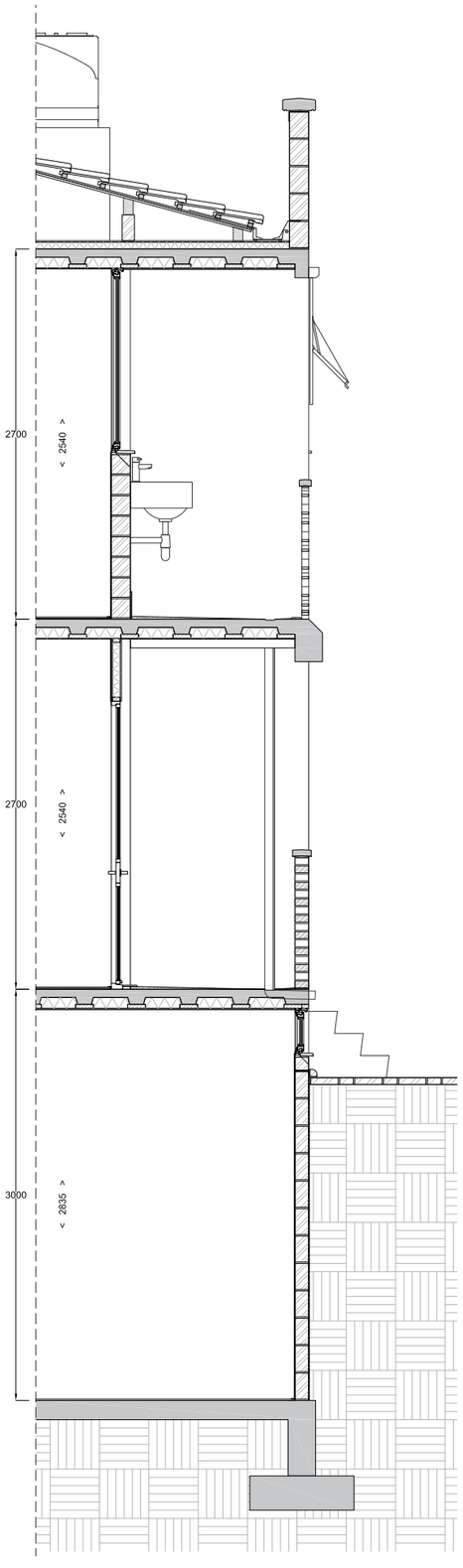
Rainwater can be collected on top of buildings, inside buildings, or underground, in cisterns made of various materials, like masonry, fiberglass, plastic, and cement (Inson, 2022). Cisterns located at ground level or below ground have a smaller chance of microorganisms growing inside, yet, these solutions are also more expensive, and with the latter maintenance is harder.

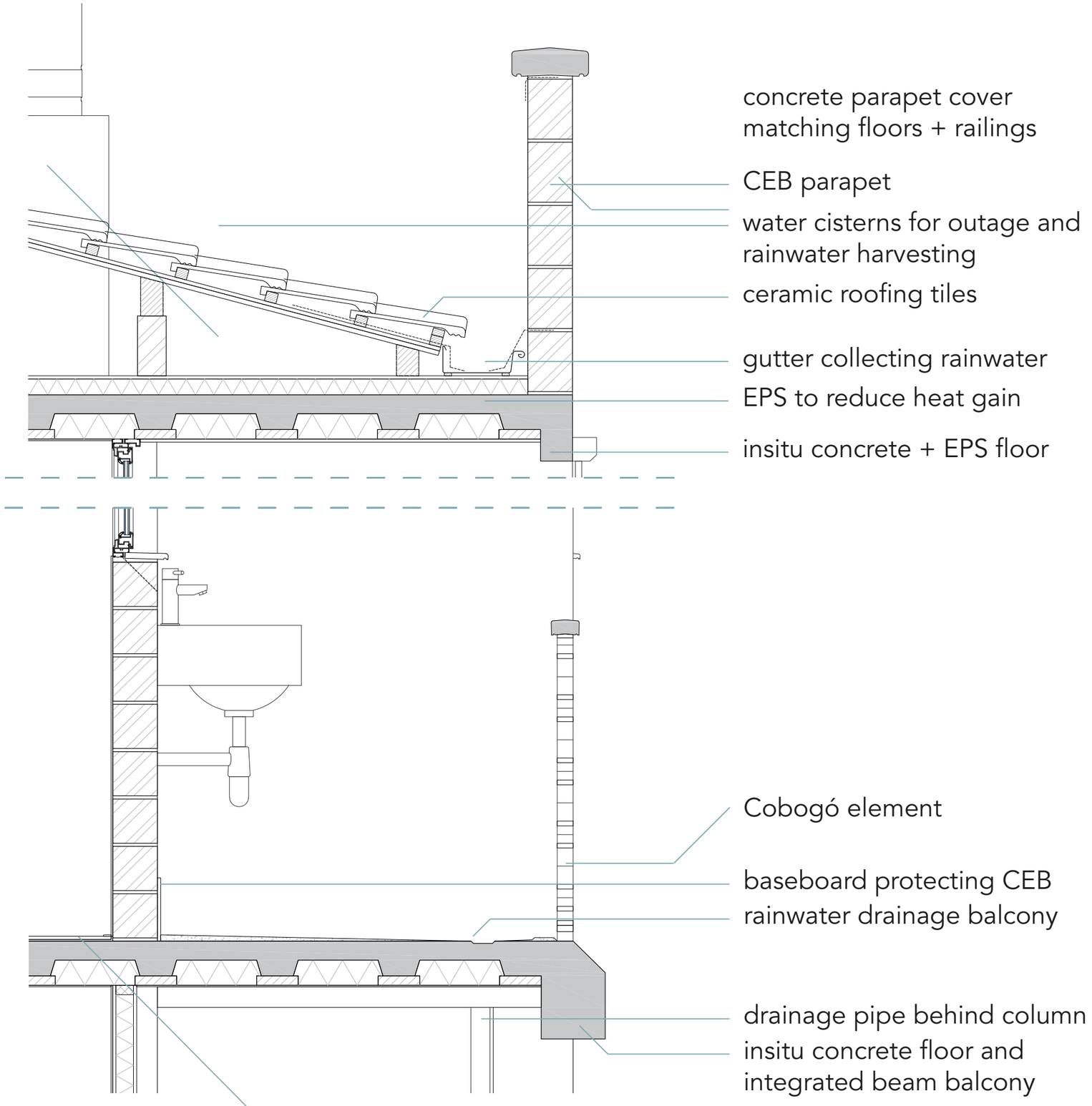
In the design for Parque Cocaía, the large roof surfaces are equipped with plastic cisterns to store harvested rainwater. The water is collected from the roofing tiles using gutters. By placing the cisterns next to the cisterns for water shortage, the infrastructure for the tap water and rainwater can be installed next to each other. In contrast to the tap water cisterns, a single, large cistern is used for the rainwater, as there is no need to separate rainwater for individual apartments. The harvested rainwater is supplied to the toilets in the buildings and to the sink on the balcony, to be used for washing and watering plants and gardens. A sign next to the sink indicates that the water is non-potable.

Construction process

An overview of the construction process can be found in the appendices.

Figure 76. Detailed section and elevation courtyard type





concrete parapet cover
matching floors + railings

CEB parapet

water cisterns for outage and
rainwater harvesting

ceramic roofing tiles

gutter collecting rainwater

EPS to reduce heat gain

insitu concrete + EPS floor

Cobogó element

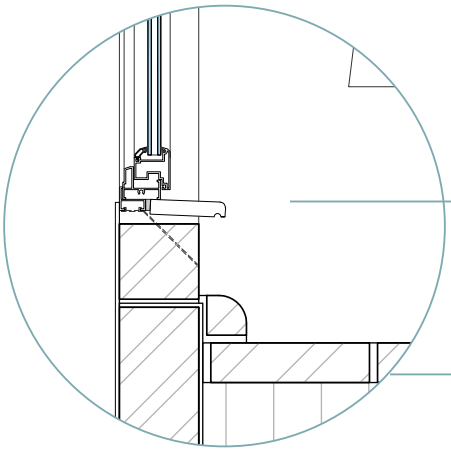
baseboard protecting CEB

rainwater drainage balcony

drainage pipe behind column

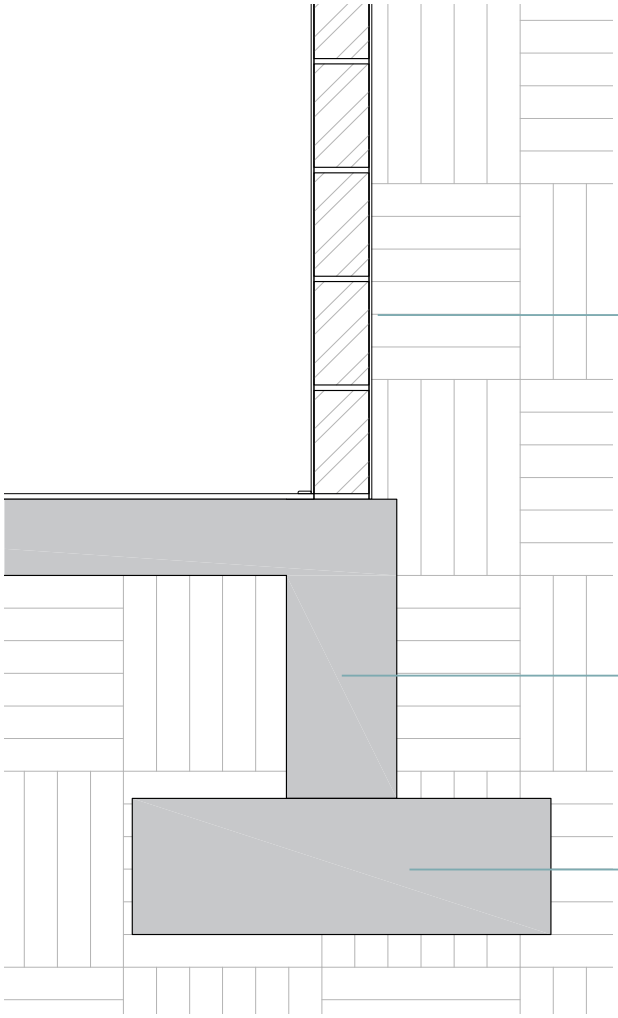
insitu concrete floor and
integrated beam balcony

insulation layer to prevent
sound transmission



PVC window frame souterrain

pavement courtyard



waterproof layer

concrete foundation 33% thicker than CEB wall

foundation on sandy subsoil

MANAGERIAL STRATEGY

In the previous chapters, the architectural design has been elaborated on. For this design to be constructed, a managerial plan is thought of as well. This chapter covers the stakeholders involved, the phasing of the project, and the financial strategy.

Stakeholders

Given the size and importance of the project, a large variety of stakeholders is involved. First, an overview is shown of all the stakeholders, after which the most important stakeholders are elaborately discussed. The stakeholders in the table are sorted on interest in the completion of the project. Power indicates to what extent a party is able to influence the outcome of the project.

Formicki (2019) argues that although favela upgrading is meant to reduce the influence of parallel powers, the group whose power levels are most affected is favela dwellers. In the large-scale social housing projects, their opinion is one of many and they are forced to accept a new dwelling without being able to influence the dwelling its size, layout, location, neighbors, and even the rules that come with it. Hence, the process of favela upgrading leads to increasing the power asymmetry in the São Paulo periphery. Hopefully, however, the new dwellings can provide a base from where a more stable life can be built, with more (financial) freedom in the future.

Inhabitants

The user group of the project, the future inhabitants of Parque Cocaía, is represented by a management council (conselho gestor), being: "a type of local council which is made up of dwellers and landowners of an area to be upgraded, as well as public officials and NGOs that work inside or with the area" (Formicki, 2019). This council is to communicate with the developers about involvement in the design process, updates on the progress, and payment schemes. Forming the council will be challenging, given the size of the project and the various backgrounds of future users. Of the 1082 HIS 1 dwellings that will be constructed, approximately 400 will be housed by evicted dwellers from the area.

When the inhabitants enter the new dwellings, homeowner associations are founded. These are responsible for the maintenance of the buildings, the processing of complaints, and for spreading information received from the municipality. The associations are divided per courtyard, as their users share the buildings and facilities among them.

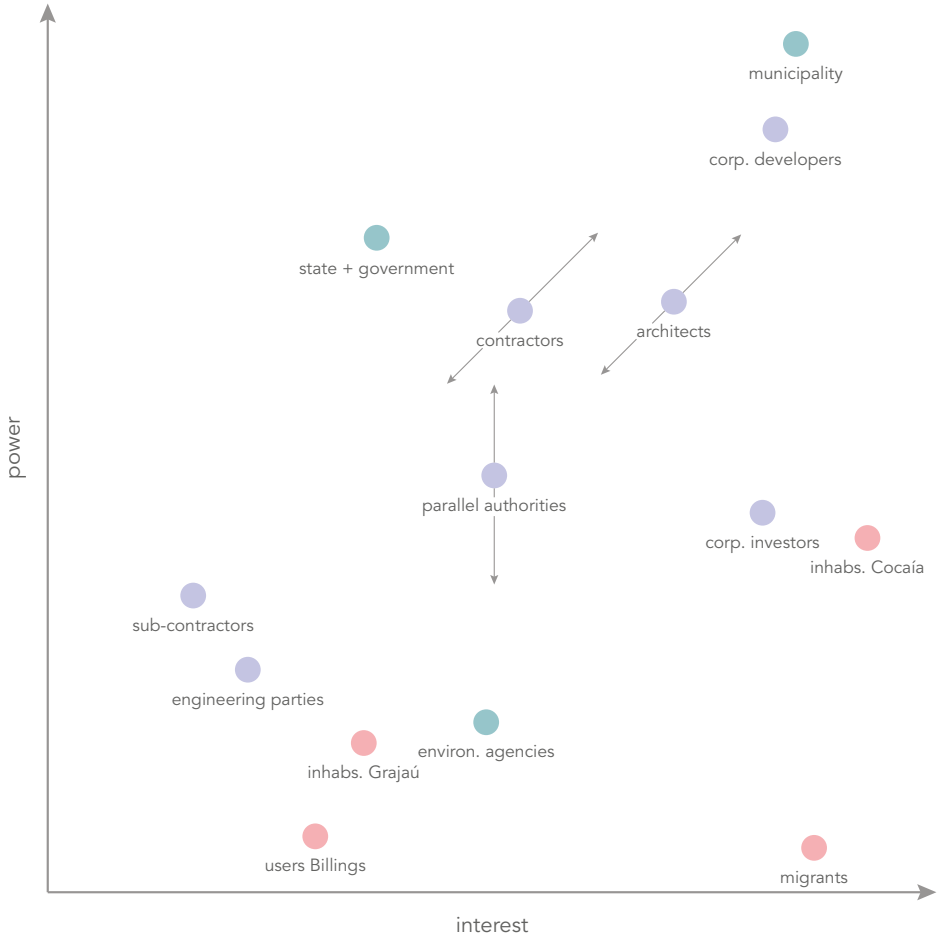


Figure 77. Stakeholder matrix

Figure 78. Stakeholder relations diagram

Developers (SEHAB and corporate parties)

Given that the project mostly contains housing for the poorest inhabitants of São Paulo, it is up to the municipality to fulfill the role of developer, investor, and landlord for the social housing component of the project. Similar developments are being made in other parts of the periphery of São Paulo as part of the Mananciais Project, a project sponsored by the World Bank aiming to "contribute to the protection of metropolitan headwaters, and, in parallel, to introduce territorial ordering and to seek to improve the quality of life of the low-income population living in the headwaters area" (Government of the state of São Paulo, 2007). The Chácara do Conde is one of these projects, offering housing to dwellers evicted from Cantinho do Ceú. The SEHAB is the board of the municipality responsible for the investment and development of social housing.

Of the dwellings on the project site, 20% is allocated to HIS 2 inhabitants. The construction and sale of these dwellings are left to private developers and investors. By selling these rights up front, money is gained to cross-subsidize the social housing and make the project more feasible. The design and location of the dwellings have already been determined, to prevent disconnection between HIS 1 and HIS 2 dwellings in the area.

The HIS 1 dwellers slowly gain ownership of their homes over the years. After approximately twenty years, when they have fully repaid their depth with the municipality, the home becomes theirs. The land and urban amenities stay municipal property. It is their responsibility to do maintenance on this.

Normally, the developers (SEHAB and corporate parties) determine the program of requirements for the architects. Based on site analysis, they envision a certain density, types of dwellings, and amenities, which they communicate to the architects. They are also to stay in touch with other stakeholders about the development process. For example, they inform evicted inhabitants, open up a website where the apartments are sold, and organize stakeholder meetings. In the case of Parque Cocaía, the design has already been made.

Architects

As various parts of the project site are developed by various parties, the architects have an important role in matching the design and construction process. The architect of the social housing is the catalyst of the development of Parque Cocaía. Its role is to keep in touch with the parties involved in the development and construction of the project. May any changes or delays occur in the process, the architect is to take the lead in tackling these.

Important benchmarks for the architect to look out for are the quality of the project for the future inhabitants, costs, durability, sustainability, and its influence on other inhabitants of São Paulo.

Contractors

The project requires multiple contractors to execute the construction. Preferably, local contractors are chosen, given their experience with the area's conditions, the local communities, and their connections with local suppliers. The contractors receive instructions from the architects and report back any deviations from the plan or trouble they run into.

Large contractors would offer economies of scale for the construction of certain building components. For example, a lot of concrete needs to

Stakeholder	Role	Interest	Power	Expectations
Evicted inhabitants Parque Cocaía (conselho gestor)	Future inhabitants + evicted from current home	Very high	Medium/low	• Move to a more robust dwelling. • Gain ownership over a dwelling. • Receive access to more urban amenities. • Maintain (and expand) social ties.
People looking to move to Parque Cocaía (migrants)	Future inhabitants	Very high	Very low	• Find a place to live in São Paulo. " "
Municipality (SEHAB)	Developer + investor	High	Very high	• Create social housing. • Reduce the housing deficit. • Improve the life of the inhabitants of São Paulo.
Corporate developers	Developer (+ investor)	High	High	• Make profit. • (when also investing: expand portfolio)
Corporate investors	Investor	High	Medium	• Make profit. • Expand portfolio.
Architects	Designer	High	High/medium	• Make profit. • Expand portfolio. • Fulfill corporate social responsibility.
Contractors	Constructor	Medium	High/medium	• Make profit. • Fulfill corporate social responsibility.
Parallel authorities (e.g., the PCC) [1]	Objector	Medium	Medium/low	• Maintain power in Grajaú. • Find new methods to make money in Parque Cocaía.
Environmental agencies	Objector	Medium	Low	• Ensure environmental protection of the subsoil, Billings reservoir, air quality, flora, and fauna. • Seeing the urban green being expanded.
State (CDHU) [2]	Investor	Medium/low	High	• Create social housing. • Reduce the housing deficit.
Government [2]	Investor	Medium/low	High	• Create social housing. • Reduce the housing deficit.
Inhabitants Grajaú	Objector	Low	Low	• Receive access to new urban amenities. • Receive job opportunities during construction and after.
All users of the Billings reservoir	Objector	Low	Very low	• Ensure protection/improvement of the water quality.
Engineering parties	Designer	Low	Low	• Make profit.
Sub-contractors	Constructor	Low	Low	• Make profit.

[1] *The presence, size, and influence of parallel authorities are uncertain. Their influence would be indirect.*
[2] *Although the state and government have a high interest in new social housing being constructed, their numerous involvements in projects lead to lower interest in individual projects.*

Figure 79. Overview of all stakeholders

be poured at the site. It is cost-efficient to do so in one go. Other building components, like the walls made of concrete masonry units, could also be constructed per block, by various smaller contractors.

A bid can be held to determine the contractors. Though, in this bid, social factors and experience are to be taken into account as well. Hence, one can also opt to invite several local contractors to make a bid and choose from these only.

A labor-intensive construction is chosen, which offers job opportunities for inhabitants of Grajaú. Future inhabitants or citizens living nearby could be employed to earn money and to create a connection with the newly-built neighborhood. For the poorest evicted inhabitants, this could also provide an opportunity to earn money to pay the rent.

Investors

The main investor of the project will be the municipality. They are largely responsible for funding the social housing of the project. The housing developed by corporate parties is funded by these parties themselves or by corporate investors. The investors influence the design via the developers. They can for example ask for more dwellings to be built per hectare or for different dwelling types to be incorporated into the design.

Phasing

Below, the phasing of the project is elaborated on. For a detailed overview of the construction process of a single building, the Building technology chapter is referred to.

1. Finish the master plan and bylaws for corporate development. The master plan contains allotment plans and the bylaws address maximum building dimensions, number of dwellings, architectural style, etc.
   a. The first investments are made by the municipality, and/or government.
2. Sell the plots of land that are developed by corporate parties. Finish the design of the social housing that is developed by the municipality.
3. Open a bid for contractors. Preferably hire local contractors and personnel, unless economies of scale greatly reduce the costs.
   a. Inform inhabitants and the school of building plans, eviction, and possibilities of participating in the design process.
4. Demolish the dump site just west of the project site to make way for construction traffic.
5. Lay down iron plates for construction traffic to drive on.
6. Set up a temporary base for the construction crew and set up a place to store building materials, protected from the rain.
7. Start excavating subsoil on the western part of the project site. Start the production of compressed earth blocks as soon as the right soil types are retrieved. This process is continued throughout the excavations.
   a. Excavators can enter the site from the west, where the dump site has been demolished, and from the south.
   b. Soil is split based on composition. Soil that can be used for the compressed earth blocks

is separated from soil types that can be used for leveling. The soil and bricks are stored in a dry place.

8. Pouring the foundation of the western blocks in concrete. The excavation crew moves on to excavate the ditches all over the project site to prevent the building pits from filling up with water.
   a. Concrete trucks can be driven onto the site or small mixers can be used, based on availability with the contractors. Given the size of the project, economies of scale can probably be utilized.
   b. The first load of blocos verdes can be transferred to the site as well. To prevent having to build an enormous storage location for these, it's better to transfer them in phases.
   c. The future green axis can be used for transportation.
9. The construction of the first blocks on the west side of the project area can start. These contain solely HIS 1 housing to relocate evicted dwellers (approximately 400 families) from the banks of the stream.
10. The construction of the other blocks can start when the first phases of the first blocks (e.g., floors have been poured so the concrete mixer can move on) have been completed or simultaneously when there is sufficient room on the site and the contractors have enough personnel.
    a. Preferably, the evicted dwellers would move to their new homes over a period of a couple of months to maintain social bonds but prevent traffic disturbance.
    b. Contractors can divide the work per building block since it is beneficial for installing urban infrastructure to have the two buildings of a courtyard block finished at the same time.
11. When the first blocks are finished, the roads leading up to the dwellings and the parking are paved. Construction of the next phases continues.
12. The evicted inhabitants move in based on: (1) the risk levels of their current dwelling, (2) construction traffic routes, and (3) traffic disturbance.
    a. The dwellings closest to the water have the highest risk levels, certain dwellings have to be removed to make way for construction routes, and when having the dwellers closest to the new buildings move first, they do not have to experience nuisance from people moving who live 'behind' them.
13. When the evicted dwellers have moved to their new homes, new access points can be constructed on the southeast and northern sides.
14. The settlements are demolished. The debris from these is used in the construction of the new blocks.
15. When the blocks on the western side have been finished, the green axis is closed for construction traffic. The first urban amenities are added: a walking path, vegetation, and a skate park. Vegetation and urban furniture are added to the finished blocks as well.
16. Construction of the blocks continues. When the walls of the block next to the public square are finished, the square is paved and connected to the green axis.
    a. Construction traffic enters the site from the south. The roads over here are paved once the rest of the project is finished.
    b. The linear park is constructed before the final entry points are closed off.
17. Once blocks are finished and the road leading up to them has been paved, new inhabitants can move in.
18. Completion of the project.

Finances

By looking at other social housing projects, the various cash flows involved in the development of Parque Cocaía can be estimated. Based on this, a proposal for a payment scheme can be derived and the investment costs be determined. Below, the various cash flows are elaborated on.

Investors

Given that Parque Cocaía is a ZEIS area and hence mostly consists of social housing, large investments will be needed by public instances to make the project feasible. Though, corporate investment is attracted by selling the rights to develop HIS 2 housing and in-kind help is attracted to reduce the design costs.

Municipality (SEHAB)

The municipality of São Paulo invests heavily in social housing to tackle the housing shortage in the metropolis, as can be read on the website of the SEHAB (Prefeitura da Cidade de São Paulo, n.d.). Funding for ZEIS 4 projects is provided by the municipality as part of the Programa Mananciais, which translates to Springs Program.

"The Program involves actions of: (1) urbanization of precarious settlements; (2) land regularization and (3) housing assistance (temporary and definitive) for families resettled from risk areas or areas under construction" (Prefeitura da Cidade de São Paulo, 2022).

Chácara do Conde, Santo Amaro V, and Gleba A were all developed by the SEHAB, with the former two being part of the Mananciais program since they offer housing to inhabitants evicted from areas close to the city's reservoirs.

State (CDHU)

The Chácara do Conde project was funded by both the SEHAB and CDHU (Governo do Estado de São Paulo, 2022). This was not the case for the Santo Amaro V and Gleba V projects, which is probably due to their smaller scale at 1290 units compared to 201 and 537 respectively (Vieglieca & Associados, n.d.-a; Vieglieca & Associados, n.d.-b). Given the size of the development in Parque Cocaía at approximately 1300 units, funding by the state could well be acquired once more. Though, the state is already investing in another 3000 housing units in Jardim Itajaí, about 2 km south of Parque Cocaía, in the next two years (Governo do Estado de São Paulo, 2022). This indicates the need for housing in Grajaú is high, but it might also affect the funding possibilities for the development of Parque Cocaía.

Government

The Brazilian government has been actively investing in the development of social housing

under the administrations of President Lula from 2003-2011 and once again since his reelection in late 2022 (Mello, 2023). The investments are made as part of the Minha Casa, Minha Vida (MCMV) program, which offers subsidies and below-market interest rates for low-income groups not owning any property yet (Ministério das Cidades, 2023). Half of the MCMV budget is allocated to families with an income of less than R$ 2640 per month (the HIS 1 group consists of families earning up to R$ 3906 per month), allowing for dwellings to be subsidized by 85-95% (Mello, 2023). The program has as a goal to contribute to the construction of two million homes by 2023 (Ministério das Cidades, 2023). With the Ministério das Cidades (2023), translated to Ministry of Cities, reporting a housing deficit of 5.9 million and 24.8 million dwellings of sub-par quality, this investment is more than needed.

Cities Alliance

The United Nations' Cities Alliance provides in-kind support to the development of social housing in the global south.

"The Cities Alliance is a global coalition of cities and their development partners committed to scaling up successful approaches to urban poverty reduction. […] Citywide and nationwide slum upgrading in accordance with the Alliance's Cities Without Slums action plan (MDG Target 11), including promoting secure tenure, access to shelter finance, and policies to help cities prevent

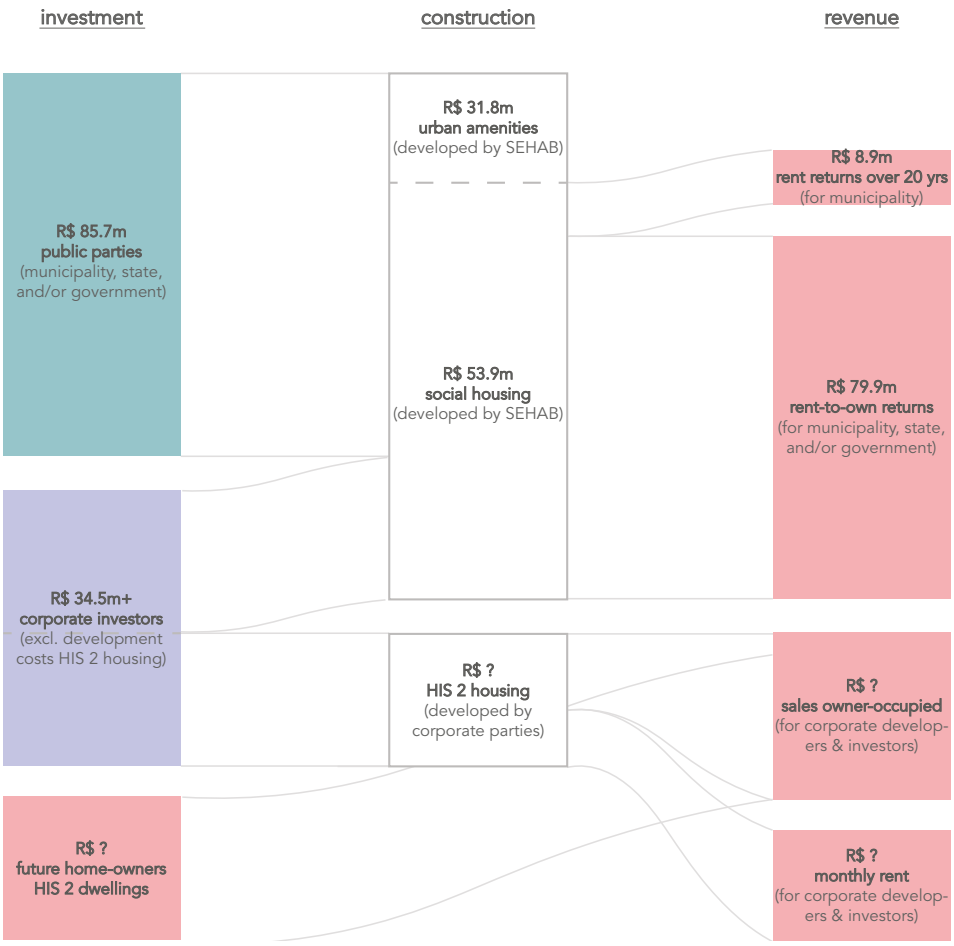


Figure 80. Cash flow chart

the growth of new slums." (Cities Alliance, n.d.-a) Between 2001 and 2004, the program provided technical support ($300,000 in labor) for the Bairro Legal program in São Paulo (Cities Alliances, n.d.-b). The program was focused on land tenure regularization and improving the living conditions of excluded areas of the city. Given that approximately 210 households are about to be evicted in Parque Cocaía, the Cities Alliance could be asked to assist in the eviction strategy and process. For this, they could use their expertise from the Bairro Legal program and build a standard for future evictions in Grajaú.

Corporate developers/investors

As corporate parties are looking to make a profit on their executed projects, they are probably not interested in getting involved with the development of social housing in Parque Cocaía. Though, corporate parties are offered the chance to develop HIS 2 housing on a part of the site. The funds retrieved from this are used to cross-subsidize the development of social housing.

Research has also been done on whether public-private partnerships (PPP projects) could offer opportunities to expand the limited public budget by incentivizing private investors with tax benefits, but these structures seem highly complex (Amorim & Faria, 2021).

Construction cost

In February 2023, the official average construction costs were R$1,781.56/m2 for São Paulo state, as reported by the Instituto Brasileiro de Geografia e Estatística (IBGE), Portuguese for Brazilian Institute of Geography and Statistics, which is a federal instance analyzing data (IBGE, n.d.). Though, this number varies depending on factors like location, type of dwelling, materials used, and the chosen contractor. The Custo Unitário Básico de Construção (CUB), Portuguese for Basic Unit Cost of Construction, provides average per dwelling type. For a low-standard housing unit that is part of a social interest project (PIS type), the average was R$ 1181.39/m2 in January 2022 in São Paulo state (Câmara Brasileira da Indústria da Construção, n.d.).

The Chácara do Conde project cost R$ 156.4m for 1290 housing units (Governo do Estado de São Paulo, 2022). Considering the total floor area of the project (68,500 m2), the costs per square meter of floor area were R$ 2283 (ref.: €83 in April 2023). This is higher than average, especially considering the basic material usage, greenfield location, inflation of building material prices, and repetition in design, but this can be explained due to the large-scale urban interventions included in the project – next to social housing, an urban park of 120,400 m2 was constructed on site (Governo do Estado de São Paulo, 2022). Considering the average construction price halfway through the construction, in the summer of 2020, was ~R$ 896/m2 (Câmara Brasileira da Indústria da Construção, n.d.), it can be estimated that ~R$ 61.4m was spent on the construction of the dwellings and ~R$ 95.022.4/7m on the construction of public space, consisting of the park and the space between the apartment buildings. With the project containing ~22.4 ha of public space (Arquitetura JAA, n.d.), the price for the construction of this public space was ~R$ 424/m2.

To make an estimate for the construction costs of Parque Cocaía, the CUB for social interest projects and the cost of development of public space for Chácara do Conde are used. Firstly, considering that the floor area of social housing in the project is 41,542 m2 and the inflation was 9.9% over the last year (IBGE, n.d.), the construction of housing will cost ~R$ 53.9m. Secondly, for the public

space, IBGE reports price inflation of ~43% from 2020 to 2023 (IBGE, n.d.). If we apply this to the price of the construction of public space for the Chácara do Conde project, the price to construct public space would now be ~R$ 606/m2. With a total of 5.25 ha of public space incorporated in the design of Parque Cocaía, its construction would cost ~R$ 31.8m. This makes for a total construction cost of ~R$ 85.7m. This does not include costs for the pre-construction phase and the construction of the HIS 2 housing.

Revenues

Sale land corporate development

In March 2023, the average land price for residential property in São Paulo was R$ 10,304/m2, according to the Fundação Instituto de Pesquisas Econômicas (FIPE), translating to Economic Research Institute Foundation. This NGO collects and analyzes economic data and is closely related to São Paulo University. Considering this price, the 3,349 m2 of land reserved for corporate development in Parque Cocaía could produce a revenue of R$ 34.5m. Though, this revenue might even be bigger considering the number of floors that are allowed to be built in certain locations and as the land does not include square meters for gardens yet.

Selling the land also means that no money will be retrieved by public instances for rent or sales of the HIS 2 dwellings. On the other hand, selling the land upfront makes the investment smaller and reduces the financial risks of the project.

Rent social housing

The social housing that is going to be constructed in Parque Cocaía is mostly meant to become the property of their inhabitants. Given the low income of the target group, the homes are supplied on a rent-to-own scheme, with the inhabitants of the dwellings paying approximately 10-15% of their income as rent to gain ownership over the dwelling in 15-25 years according to Guerreiro et al. (2021). Salcedo and Silva (2020) report HIS 1 families committing 20-25% of their monthly income to rent, and therefore an average commitment of 17.5% is assumed in the payment schemes of Parque Cocaía.

A home provides the stability needed to allow dwellers to start raising themselves from precarity. Inhabitants of Brazilian settlements strive their entire lives to reach a status of ownership/ holding title deeds, as experienced during the field trip and mentioned by São Paulo state governor Rodrigo Garcia during the opening ceremony of Chácara do Conde: 'Owning a home is the biggest dream of families and today we are here to make some of those dreams come true. We're not just handing over a key, but a home, where your family's future will be written' (Guerreiro et al., 2021).

Though, 10% of the social housing is made available on a rental scheme as well. This offers flexible housing for dwellers that only wish to live in the neighborhood for a short duration as part of a temporary job or as an emergency solution. In these, evicted dwellers from other areas of the city could also temporarily stay until new social housing projects have been constructed.

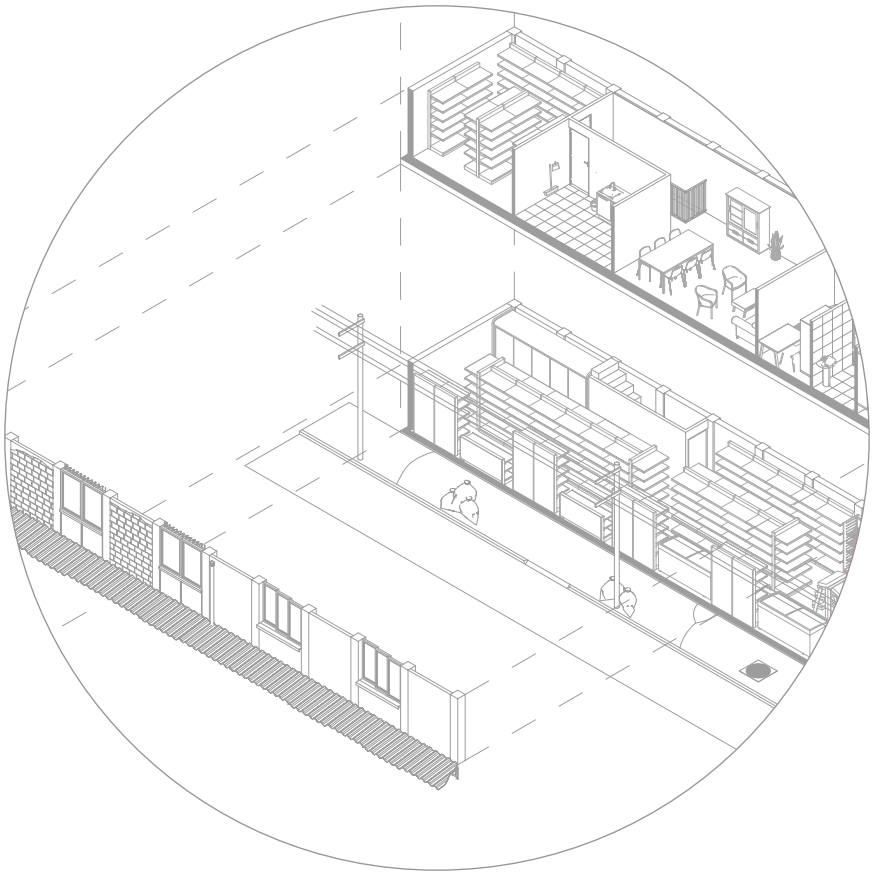
The HIS 1 group, which will occupy 80% of the dwellings of the future neighborhood, consists of families with an income between 0 to 3 minimum wages (Yuca, 2022). In 2023, the minimum wage was determined to be R$ 1302 per month (ref.: €250 in March 2023) (Ministério da Economia, 2022). Considering inhabitants pay 17.5% of this as rent, the average monthly payment would be ~R$ 342. Summing up this rent for 1082 HIS 1

rent-to-own households of Parque Cocaía, a revenue of ~R$ 370k per month and ~R$ 4.4m per year is to be expected. In twenty years, this adds up to ~R$ 88.8m being paid back by the inhabitants of Parque Cocaía. In twenty years' time, 10% of this, being ~R$ 8.88m, is collected with the rental units on the site.

Feasibility

The diagram summarizes the cash flows of the development of Parque Cocaía. Considering the construction costs of the social housing and public space (~R$ 85.7m) are lower than the revenues (R$ 34.5m + 88.8m= ~123m), the project can be considered feasible. Though, the revenue from the social housing will be spread over the next twenty years, meaning the public investors will have to wait for their investments to be repaid. Furthermore, a clear policy should be made on how to deal with (1) inhabitants not paying the rent, (2) inhabitants moving out, (3) maintenance of the neighborhood, and (4) inflation. To set up this policy, the Cities Alliance could be requested for assistance. Also, it is important to consider that the public instances investing in the project do not necessarily strive to make a profit from this type of project.

In the Chácara do Conde project, rent-to-own contracts are transferred when people move out and in. This process is arranged by the dwellers themselves and overseen by the homeowners association. The transfer needs to be approved by the SEHAB, as they receive the rent from the inhabitants. When making this approval, the SEHAB has to check if the family moving in complies with the user group for the specific apartment, to prevent social housing being lived in by families with too much income to live in social housing. For Parque Cocaía, the terms of these transfers are to be included in the dwelling contracts.



SYNTHESIS

goal: answer the research question and reflect on the work done

CONCLUSION

This thesis explored how architectural design can positively influence safety in the periphery of São Paulo, taking into account socioeconomic segregation, local building practices, and social equity. This was done using a literature review, comparative analysis, contextual analysis, and research by design. The results of the thesis contain of a catalog of design interventions positively influencing safety, an overview of case studies and how they deal with safety, a summary of the context of Grajaú, and a design for the development of Parque Cocaía. The goal of this thesis was to contribute to the collective knowledge of the relationship between architectural design and safety. A relationship that is of great importance to Grajaú, São Paulo, and other metropolises dealing with similar problems. Solving the housing crisis and improving urban safety in São Paulo are long-term processes, in which projects like Chácara do Conde set an example for future developments. Hopefully, these transformation projects can illustrate a future in which enclaves are not required to offer a safe living environment. A future in which various parties collaborate to take one billion slum dwellers from urban precarity, to hand them safer and more reliable homes.

Figure 81. Impression street and slab type

REFLECTION

Process

Spending ten months on a single project is a lot, yet this also brings forth the danger of dwelling on minor details and losing sight of the bigger picture. Especially since the thesis deviates from other projects of the master track in the way that it requires a research and design component. Creating a symbiotic relationship, where one reinforces the other, between these is one of the major challenges of this thesis. In this chapter, a reflection is drawn up on the development of my thesis and myself as a future architect. As this thesis marks the end of my study career, reflecting on my learnings might be equally as important as the results of the project itself. Furthermore, I look ahead to the P5, the future development of Parque Cocaía, and my career.

Explorative phase

On Monday, September 5, 2022, the graduation studio officially took off with the first lecture on the research plan. I got back from two months in Southeast Asia five days before and the first weeks I mostly spend wrapping up my board year at the Netherlands-Asia Honours Summer School (NAHSS) I did the year before. We had five weeks to do explorative reading and come up with a preliminary research plan before going to Brazil to visit reference projects and the project sites. Despite trying to come up with a feasible concept to be able to do interviews already, my ideas changed once I set foot in Brazil. Being able to experience the context firsthand is of immense value and my own feelings during the field trip directly brought forth my research topic, safety, as explained in the Prologue.

Upon returning to the Netherlands, I started making elaborating my research plan based on my experiences. In this process, a forced myself to make many variations and alternatives, even when these ideas may sound less feasible at first. This forced out-of-the-box thinking is something I have taught myself throughout this master, as by nature, I am prone to stick to logical reasoning and in doing so sometimes limit my design process. This might be due to following the structural design track during the first two years of my bachelor before switching to urban design for the final year. Now that I am aware of this behavior, I counter it by dedicating time to design exploration sessions during which I let go of my boundaries of logic. At the same time, I use this behavior as a strength when writing down my design narrative and ensuring the project its viability.

Design hypothesis

Having determined my direction for the thesis, safety, most of my time after the field trip was spent on the case studies of Santo Amaro V and Chácara do Conde. These analyses were highly valuable, as they gave me a sense of the lifestyles, ways of living, and use of spaces. In my current design, the influences of these are still visible. In the meantime, I also spend time on the literature review and making a first design for the area for the P2. Looking back, I think I should have spent more time on the literature review and comparative analysis at first, as the first designs were made without much knowledge of the subject and were therefore not valuable to the design process. What did help me out was figuring out how I would answer the research question, with a literature review, comparative analysis, and contextual analysis. It was only later that I started using my design as an analysis tool rather than an application of the results of the other three components, but that did not hamper the process.

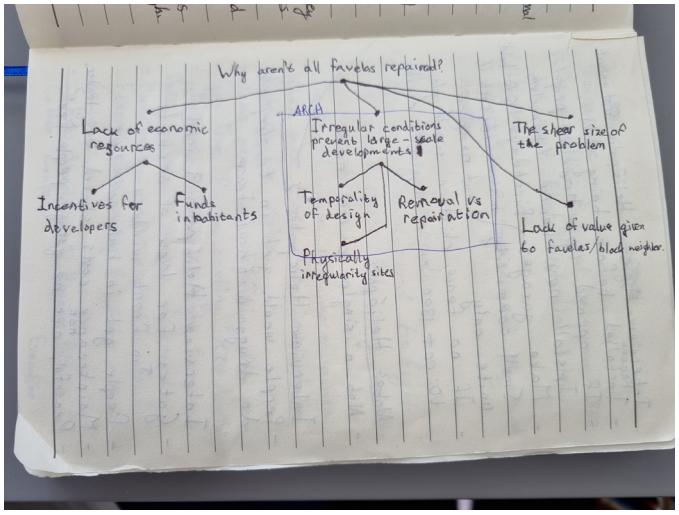


Figure 82. Problem-solving experiment performed with the students of the University of São Paulo during the field trip

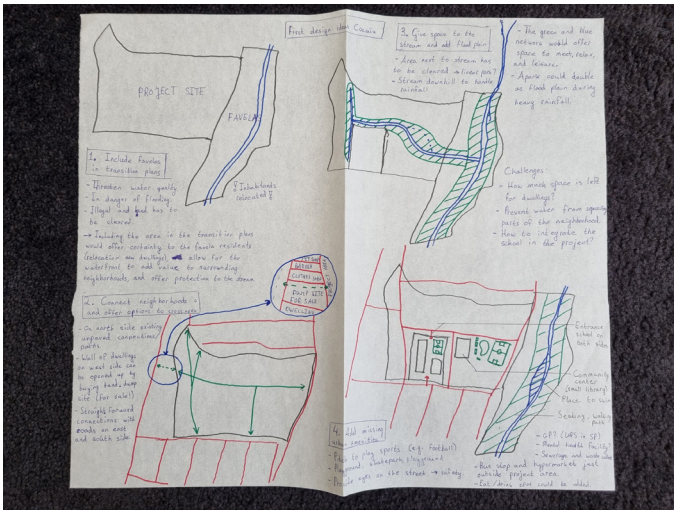


Figure 83. First sketches contextual analysis

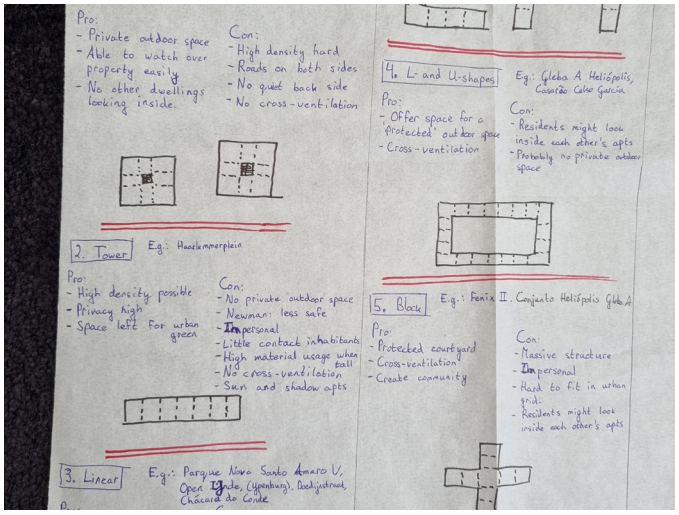


Figure 84. Design exploration of building block types

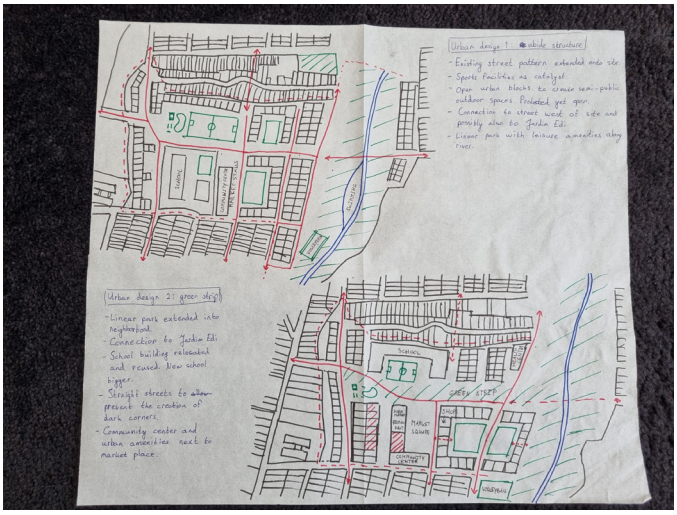
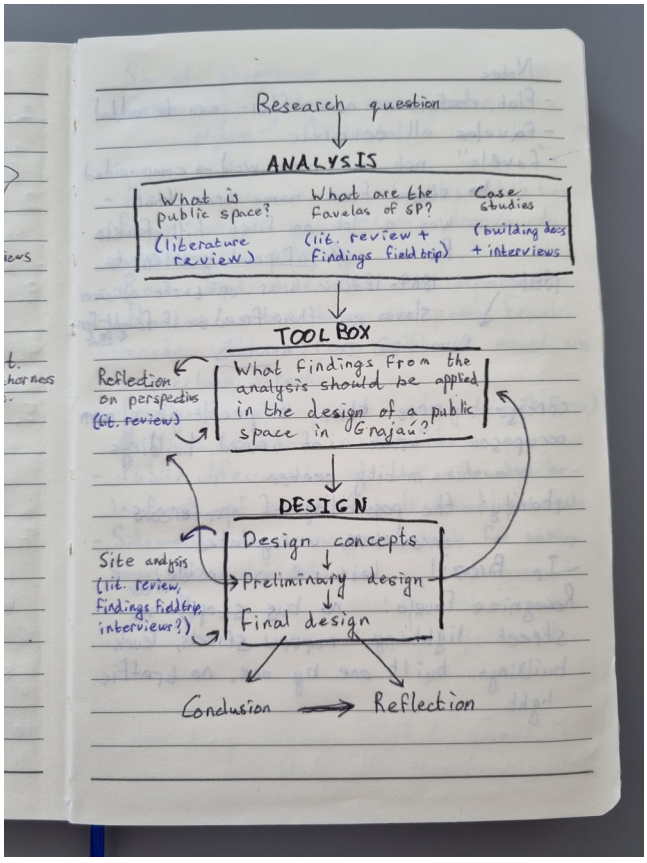


Figure 85. First versions urban design



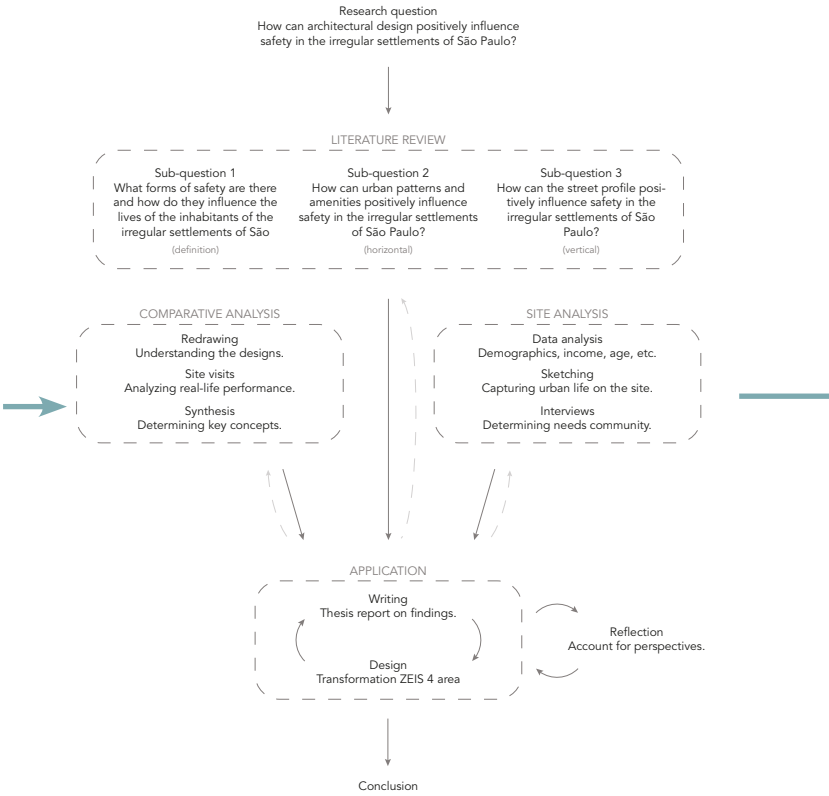
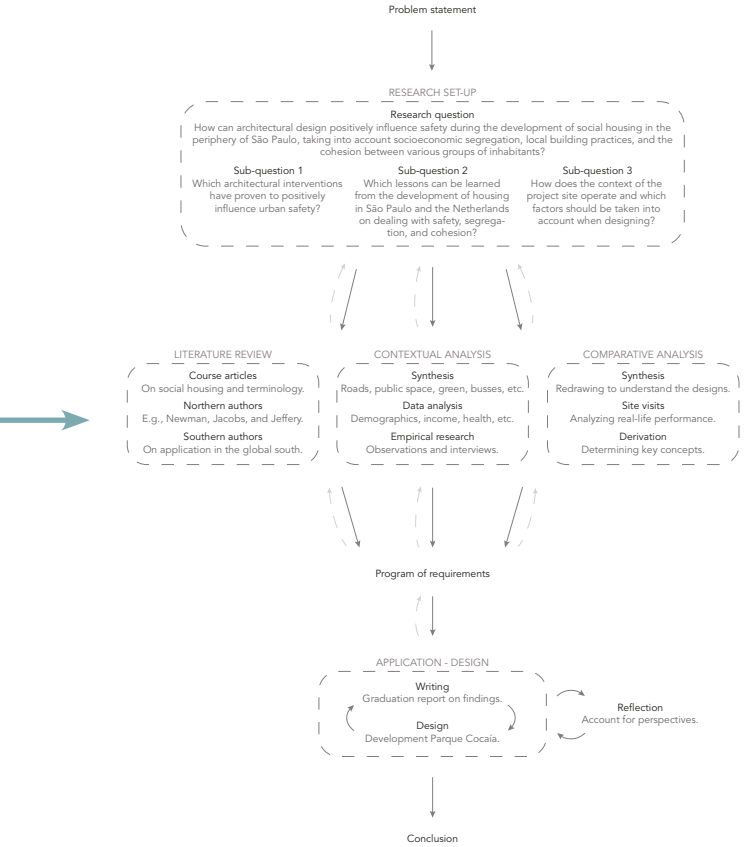
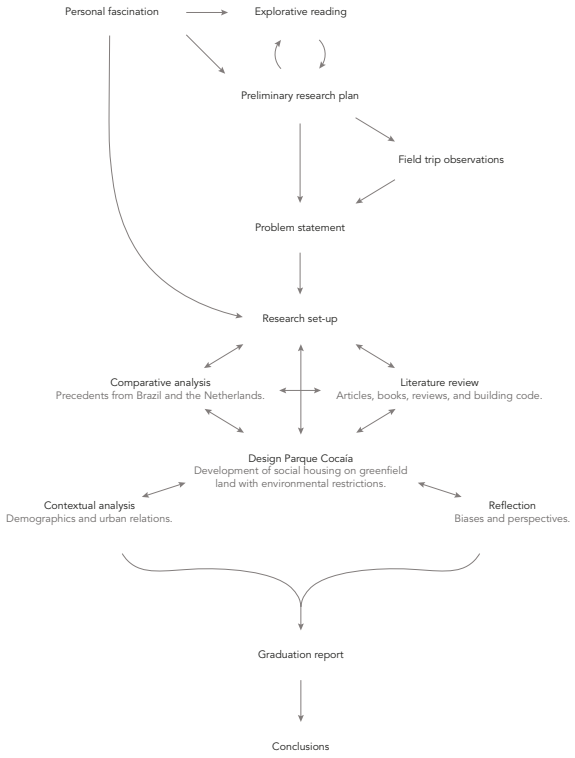


Figure 86. Development of the research plan over time


Problem statement
RESEARCH SET-UP
Research question
How can architectural design positively influence safety during the development of social housing in the periphery of São Paulo, taking into account socioeconomic segregation, local building practices, and the cohesion between various groups of inhabitants?
Sub-question 1
Which architectural interventions have proven to positively influence urban safety?
Sub-question 2
Which lessons can be learned from the development of housing in São Paulo and the Netherlands on dealing with safety, segregation, and cohesion?
Sub-question 3
How does the context of the project site operate and which factors should be taken into account when designing?
LITERATURE REVIEW
Course articles
On social housing and terminology.
Northern authors
E.g., Newman, Jacobs, and Jeffery.
Southern authors
On application in the global south.
CONTEXTUAL ANALYSIS
Synthesis
Roads, public space, green, busses, etc.
Data analysis
Demographics, income, health, etc.
Empirical research
Observations and interviews.
COMPARATIVE ANALYSIS
Synthesis
Redrawing to understand the designs.
Site visits
Analyzing real-life performance.
Derivation
Determining key concepts.
Program of requirements
APPLICATION - DESIGN
Writing
Graduation report on findings.
Design
Development Parque Cocaia.
Reflection
Account for perspectives.
Conclusion


Personal fascination
Explorative reading
Preliminary research plan
Field trip observations
Problem statement
Research set-up
Comparative analysis
Precedents from Brazil and the Netherlands.
Literature review
Articles, books, reviews, and building code.
Design Parque Cocaia
Development of social housing on greenfield land with environmental restrictions.
Contextual analysis
Demographics and urban relations.
Reflection
Biases and perspectives.
Graduation report
Conclusions

Preliminary designs

Between P2 and P3, attention was put on the technical and managerial side of the project. I chose to aim for maximum viability of my design by allowing it to be built with little heavy machinery, by small contractors, using local building methods, and for a low price. Innovation was brought in by using mollusk blocks, compressed earth blocks, and recycled concrete, three techniques that proved to be suited to the Brazilian context. By choosing nighttime cross-ventilation, Bahama shutters, and some thermal massing, I went for affordable and reliable strategies to ensure a comfortable indoor climate. Looking back, I could have used this thesis to be more innovative and explorative in the project its climate design. In a future project in a different climate, I wish to further explore the concepts of solar chimneys and Trombe walls.

At the same time, I worked on the architectural elaboration of the project. Despite investing in the comparative analysis and literature review, one of the challenges for me was integrating the outcomes of these analyses into the design. For this, the sessions with the faculty were very valuable, as my tutors pushed me into figuring out how to do this. What I appreciated in this was that they did not tell me what to do, but rather what to explore, which made the process of figuring this out more valuable to my development. Furthermore, I set up a feedback session with some of the other students in the studio every couple of weeks, from which I drew inspiration and gained feedback on my design and process. Because of our different personalities and backgrounds, we all focused on different aspects of the design, which helped me zoom out and go back to the basics of my project. Concrete lessons learned from the tutoring sessions and feedback sessions with my peers were:

- A neighborhood with a lot of corners and blind spots is not safe, but neither is one with large open spaces or long streets. The challenge lies in finding a balance between these two.
- Designing a safe neighborhood should be done on all scales and in 3D. Not only the master plan and urban block layout but also the design of units, the plinth level, the street section, and urban furniture are of importance.
- Designing new public space in the dense urban tissue of São Paulo is valuable, yet it also takes up space that could be used to build much-needed social housing. The design should strike a balance between the two.
- How to narrow down a research question to a point where it becomes relevant, defined, and manageable.

Apart from these, of course, many smaller points of feedback were integrated into the design. Sometimes, not at once, because I misunderstood the feedback or because other parts of the project needed attention first.

Another lesson learned for future projects is that I should involve my design sketches more often during tutors (or client meetings). During the thesis, I sometimes was reluctant to show sketches of concepts that had not been thought through completely yet, but this also takes away the opportunity for tutors to stimulate advancing with certain design explorations.

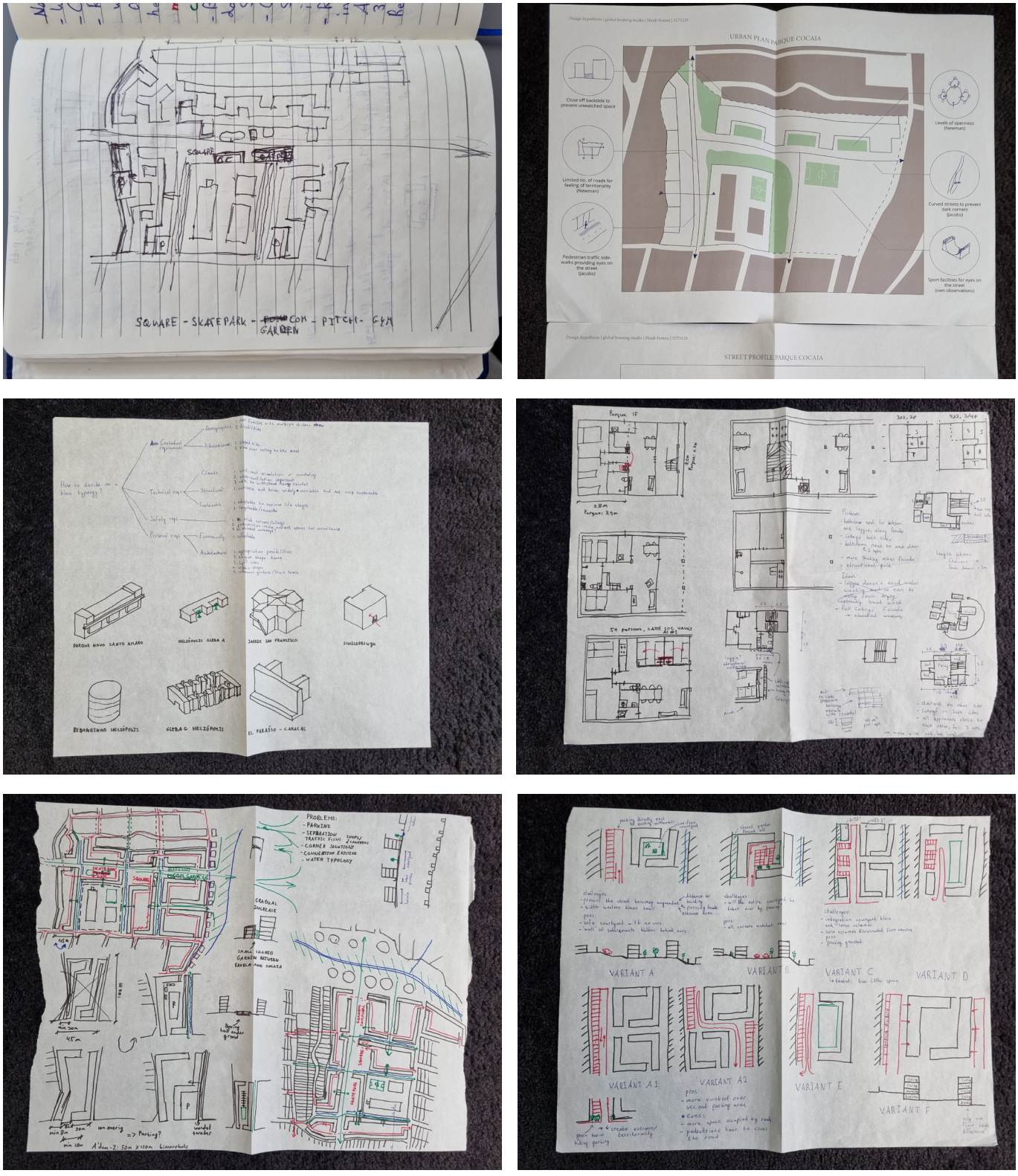


Figure 87. Pictures of various design variants and explorations

Final design

At the P3, the literature review, comparative analysis, and contextual analysis were close to being done. Because I had spent time finishing these, the design presented was lagging a bit. From the analyses, I had drawn inspiration and learned about how architectural design influences safety, but I had yet to integrate these mostly at block level. After the P3, I first processed the feedback on site level, but at the same time did not make time to illustrate the design at block level. During the last feedback session before the P4 (ref.: 1,5 weeks ago at the time of writing), I did not manage to finish all the drawings of the block yet, making it hard to receive feedback on this. On the other hand, I spent too much time figuring out the details of every part of the master plan, while these would change still later on. In a future project, I would keep the master plan more schematic at first and instead visualize an entire block in 3D with a detailed floor plan. This is what is presented in this version of the report, with the detailed master plan still being finalized after the most recent feedback sessions.

Furthermore, this final phase between the P3 and the P4 taught me more about drawings techniques. Through tutoring, by looking at my peers their work, and by looking at my own work, I improved myself at:

- Determining the level of detail shown in a drawing. Too much detail can harm a drawing because it draws the reader's attention away from the main message and it might insinuate that everything is shown on the drawing.
- The balance between text and images in a presentation. Especially during weekly tutoring sessions, it's tempting to put in a lot of text to discuss, yet it distracts from the drawings.
- Illustrating the human scale. Show how a space is perceived, what dimensions it has, and how it is appropriated by its inhabitants.

Final phase

Over the course of the next six weeks, the research and design are to be completed. The design concepts are mostly set, but they need further elaboration on a detailed level. Also, the research question is answered and the literature review, comparative analysis, and contextual analysis have been completed, although the results might need still be processed to a final presentation level. During the next weeks, most of my attention will go to producing atmospheric impressions of the public spaces in the project, working out the details on site level, building models, and finalizing the slides and report. The site is massive and hence months could be spent on figuring out every square meter, yet, of most importance for this thesis and my development as a future architect are the processes leading up to the design and the lessons learned during this process.

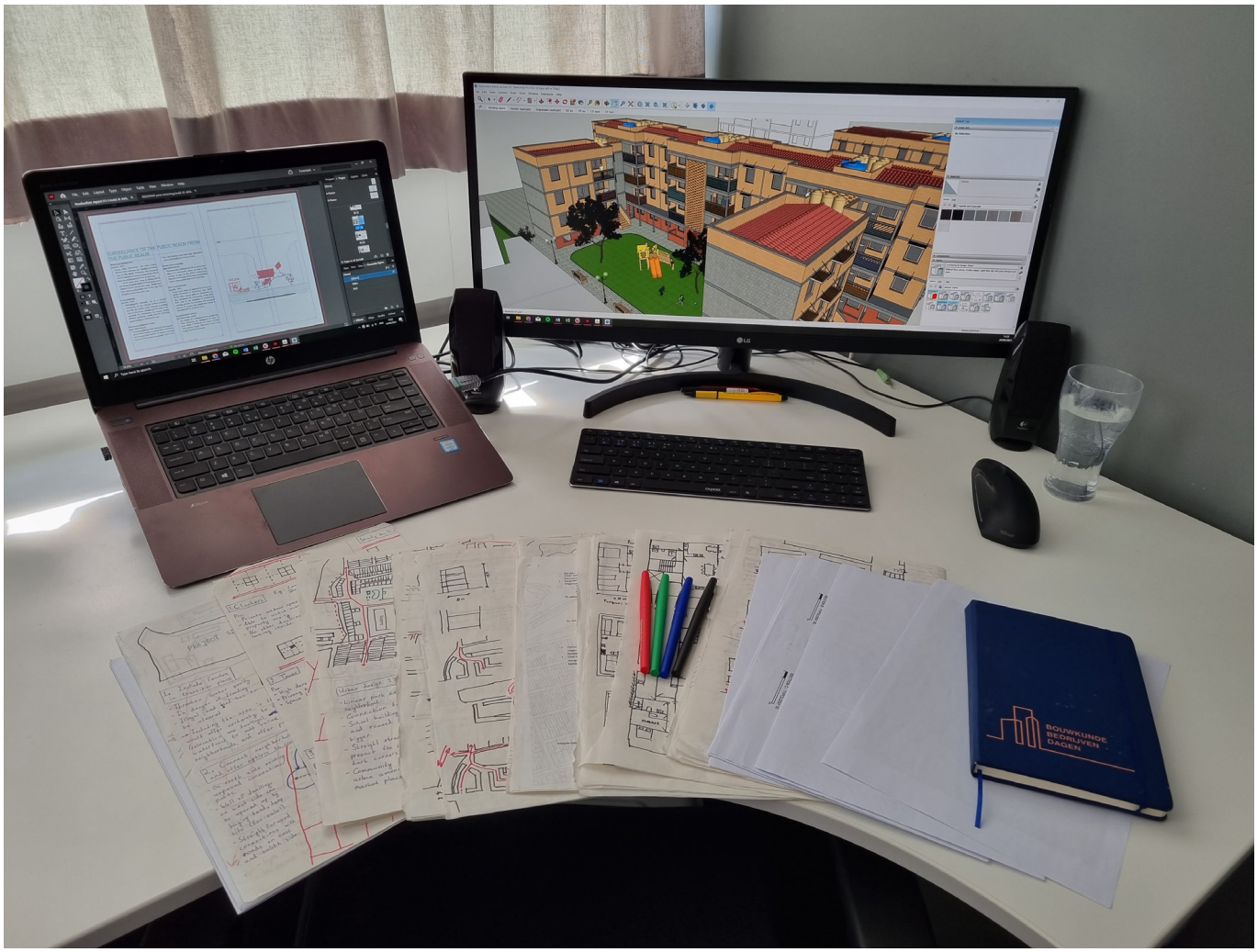


Figure 88. Order and chaos on my desk

Looking back

Relevance to the MSc Architecture

In 2020, the UN (United Nations) estimated the number of slum dwellers worldwide at one billion, and this number is still rising. Housing is one of the key human rights, though, creating housing for everybody is one of the major challenges of our generation. It is up to current and future architects to solve this challenge and thereby this thesis, in which a design is made for social housing in São Paulo, fits right in with the education towards becoming an architect.

Relevance to my career

I chose the Global Housing study because of the sheer urgency of the global housing crisis. Personally, I feel like more focus should be put on solving this crisis during the MSc Architecture. Witnessing the harrowing living conditions of some in São Paulo has further sparked my interest in a career in this working field. Although I am not certain yet about what role I could play in solving the global housing crisis, the graduation studio has further sparked my interest in contributing to finding solutions. After completing the thesis, I hope to travel to Latin America once more to further explore the cities, societies, and challenges it has to offer. Throughout my master's, I have been studying Spanish as well, which will help me out in doing so.

Mutual influence research and design

In the first months of the master thesis, my idea was that I would do research on safety and afterward integrate this into a design. Halfway through the project, however, I realized that the two were also related in the opposite direction. Challenges in design pushed me to dive into papers and cases to find a solution. For example, when designing the courtyards, I did research on what dimensions, functions, and characteristics determine whether a courtyard is perceived as safe or welcoming. The case studies also made me reformulate the research question a couple of times to narrow it down and make it more manageable.

Working method

As stated above, I figured out my analysis tools early on in the project. This helped me to structure the development of my project. Having these four different chapters to work on, I could also change activities halfway through the day, to not lose focus. The four analyses differ in how they progress, as the literature review was more linear whereas the comparative analysis and design of Parque Cocaía were more iterative. The challenge was having all four components influence each other, of which the results are hopefully visible in this report.

Academic and societal value

This thesis contains a set of concrete design interventions improving safety, a description of the architectural context of peripheral neighborhoods in São Paulo, lessons learned from other social housing projects, and a design for Parque Cocaía showing how a safe, fostering, and affordable living environment can be created in São Paulo. Hopefully, these contribute to the collective knowledge of architecture and safety, a topic whose importance can immediately be felt once arriving in São Paulo and cities dealing with similar problems. Although the research is performed from a northern point of view (as explained in the chapter Perspectives), an effort has been made to set aside bias and prejudice, with the efforts of the field trip playing a big part in this. At the same time, this different point of view might have produced solutions that would not have been thought of by southern designers.

Transferability value

The design of Parque Cocaía can be used as inspiration for future developments in the area. It offers an alternative to the enclavement strategy applied in Chácara do Conde, Gleba A, and Santo Amaro V, thereby preventing further segregation. The types and urban concepts, used in the design of Parque Cocaía can be replicated in other neighborhoods alike. For example, in other greenfield sites next to long blind facades or walls, the courtyard type can be constructed to create a safe, affordable, and fostering community. The strip, sobrado, and tower types can be transferred as well, as long as care is given to the design of the public space in between the types. For this, the design concepts used in the design of the public space of Parque Cocaía can be used as a source of inspiration too. If applied with care, this consolidation will also contribute to improving the lives of inhabitants living in neighborhoods nearby.

Design versus reality

The fences around the courtyard of the case studies initiated the search for an alternative design where no fences are needed. It sounds like the best way forward for these communities, though in reality, it might not be. With the Santo Amaro V project, a similar dream was chased, which resulted in an award-winning design that in theory should be able to do so. Though, a couple of years after the neighborhood was constructed, fences were installed regardless. It could lead to wondering if chasing this dream of a fenceless neighborhood is worth the effort at all and if it is not a dream which only exists in the heads of people that have not been raised in such an environment. Personally, I think it still is a dream worth chasing, but it also requires societal changes that are not influenced by architecture for the dream to become a reality. Brazil is still in political unrest, the inflation rate is high, and a considerable percentage of the country its population does not have a job or decent education. Addressing these issues has a higher priority than whether social housing projects have fences or not. At the same time, I feel this should not discourage efforts to design safer neighborhoods and more importantly, do research on what the future of Brazilian cities should look like.

Architecture & Safety
Safe social housing for the inhabitants of the periphery of São Paulo
Huub Fenten (5273129)

Master thesis MSc Architecture, Delft University of Technology
Global Housing studio '22/23: São Paulo, repair and consolidate (AR3AD105)
Main mentor: Harald Mooij
Second mentor: Frank Schnater
Third mentor: Nelson Mota

Delft, the Netherlands, 06-07-2023