

# GRADUATION REPORT

## Revitalization of the 'Baixa de Maputo' through dense informal housing



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<i>Title</i>	<i>'Revitalization of the Baixa de Maputo through dense informal housing'</i>

## READER

This document comprises of four parts and an appendix, which together form a comprehensive report of my graduation project. Note this is *not* a formal thesis report. It *does* contain two research questions and quick answers in text and diagrams, but the final product is the design proposal in the shape of drawings and diagrams, and not a written thesis.

**PART 1**, called the thesis *plan*, as it sets out the direction of the research, contains an introduction to the situation in the Baixa de Maputo and should be read at least partly in order to understand the context. If one is already familiar with the context, it will suffice to read only the research questions. Some of the data, information and statements in this part follow from the analysis document, which was made in the spring of 2011, following the first visit to Maputo.

**PART 2** briefly explains possible answers to the questions, following the research which itself is more extensively explained in the reflection chapter (part 4). The themes of the two research questions form the basis of the design proposal.

**PART 3** is the architectural core of the project and can be seen as a summary of the final design proposal, without giving attention to the process. If only interested in the urban and architectural design, the reader should focus on this part of the document. To limit the length of this part, most of the final design drawings can be found in the appendices.

**PART 4** reflects on my personal design process and research in this project. A two page box diagram can give the reader a quick overview of the steps I have taken during the process. It concludes with recommendations and questions for the possible future of this project.

The APPENDECES contain all the final design drawings, sketches and technical data to support the design proposal as explained in part 3.

### READING GUIDE:

There are two types of markings to indicate summarizing or most important passages in the text.

A red mark such as to the left of this sentence, indicates an important passage of text, useful to read if one wants to quickly grasp topics which have had an influence on either the process or the design product itself.

**A bold text, such as this sentence, indicates a summary, either at the beginning or end of a chapter, and reading these is necessary to obtain a quick scan of the entire project.**

## INTRODUCTION TO THE PROJECT

This report explains the process and results of my graduation project, with the general theme *African contextual design*, and with the site: *Baixa de Maputo*, in Mozambique. It also marks the last project of my Master degree at the faculty of Architecture of the TU Delft.

Application for this master studio took place in Nov/Dec 2010. Not having done a project abroad in my previous years at the TU Delft, I was interested in doing a graduation project in a foreign country, especially with a very different culture as to experience something entirely new to me. Applying for the master studio in Maputo was a wild guess to be honest, not having been to Africa before and practically never having heard of Maputo before. However, over the past year I have come to learn quite a bit about the culture and way of life in Maputo, have very much enjoyed visiting the city twice and it has definitely broadened my horizons. The task of designing for a foreign culture was a big challenge, but a very interesting one, and I hope that my design proposal has eventually obtained a hint of local Maputo flavour!

Delft  
January 2012

This studio has been set up in the shape of a cooperation between the University of Pretoria (UP), the Universidade Eduardo Mondlane in Maputo (UEM) and the RMIT master studio of the Architecture faculty of the Technical University in Delft (TUD).

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# part 1 THESIS PLAN



*Photographs of the old and new in the Baixa. (MvB and EW)*

## 1.1 INTRODUCTION TO THE SUBJECT

The subject of this thesis is the *Baixa de Maputo*, which is both the old Portuguese colonial centre of town and the modern CBD of the current capital of Mozambique. In the 1990's Mozambique was one of the poorest nations in the world, following a civil war which had brought the country to a standstill. Mozambique had gained independence from Portugal in 1975, after political changes in both Portugal and Mozambique. However, with the colonial ruler swiftly leaving the country, together with a lot of Portuguese born knowledge and technological know-how, the country plunged into a long and devastating civil war between the FRELIMO (the so called "government") and the RENAMO (the "rebels"). One of the effects on the country, the city of Maputo and its centre was that there was hardly any maintenance done, let alone investment and development. Another effect was the extremely rapid urbanization which took place in Maputo during the entire civil war, as the rural population fled the battles in the countryside, looking for a safe haven and economic opportunities. As the city has expanded rapidly and informally at its edges, the Baixa, literally meaning 'low lying area', which it is, did not see a lot of maintenance or development. The little money that was available either went to civil war related causes or towards simple infrastructure in the quickly growing city boundary communities. However, since the end of the civil war in 1992, the country has seen a rapidly growing economy. Though still ranking among the poorest countries in the world, its GDP growth is extremely high, which is a very positive prospect for this developing nation.

The analysis of the Baixa shows that there is currently a lot of economic and social activity, primarily during daytime, but there are only few people living there. Furthermore, large scale property development in the eastern part of the Baixa seems to be in stark contrast with the small scale character of the Baixa. This does not necessarily imply that there is a problem. However, amongst other current development plans, the municipality of Maputo has issued the architecture and urban planning faculty of the local university (Universidade Eduardo Mondlane) the task to investigate possible interventions to "revitalize the Baixa de Maputo".



Figure 1.1: Mozambique is located on the south east coast of the African continent. Maputo is 70 km by road from the South African border.



Figure 1.2: a map of Lourenço Marques in 1925. Notice the landfill (white frame) east of the 'old Baixa' (red frame).

## 1.2 THE SITE

The Baixa is located on the southern edge of the city of Maputo, along the estuary of the Rio Tembe, which runs into the Delagoa Bay to the east. The Delagoa Bay / Maputo Bay opens up to the Indian Ocean north of Maputo, providing a natural barrier from the Indian Ocean. The old Baixa, located on an oblong piece of land slightly raised above the immediate surroundings, was the exact location on which the Portuguese first settled when an expedition led by Vasco da Gama arrived in the Delagoa Bay in 1498. Surrounding this little island, and cutting it off from the mainland, was about half a kilometre of swampy area. In a few stages, roughly between 1870 and 1920, this area was drained and it became a landfill. The connection to the mainland was made, and together with gold being found in the hinterland, the city of Lourenço Marques, as Maputo was called up till 1975, started expanding for the first time.

The boundaries of the contemporary Baixa are not fixed, but for my intervention project, I would like to concentrate on the oldest part of the Baixa (figure 1.4). Reason for this choice is that in my opinion the revitalization of the area needs to start in the core, where the Baixa (and the city) finds its origin. Because this oldest part of the Baixa has its own characteristics and identity, among others through its urban structure, the type of buildings and the functions, making plans and interventions for surrounding areas would not influence and bring about change inside the old Baixa as easily as when attempting to look at the heart of the area. Of course, the surrounding area will logically be related to what goes on in the 'old Baixa', or 'heart of the Baixa'.

Secondly, as explained in the next chapter, the 'old Baixa' seems to be the area most in need of attention.



Figure 1.3: framed in red is the so called 'greater Baixa', referring to the entire low lying area of the city.



Figure 1.4: framed in red is the 'heart of the Baixa' or 'old Baixa', corresponding with the first colonial settlement (orange frame).



Figure 1.5: the Baixa with pockets of: large scale property development (blue), transport hub (yellow) and high density of informal trading activities (green).

### 1.3 (HISTORICAL) VALUE STATEMENT

The Baixa has seen an peculiar and in some way sad historical development, starting off as the heart of a young colonial city, but at some moment in history (after independence in 1974 and the subsequent civil war) coming to a standstill in development, when the rest of the city continued growing. Only in the previous decade has the Baixa started developing again, visible nowadays in modern, high rise office buildings. But despite its staggered development, the Baixa has retained many of its valuable characteristics.

The following texts are (roughly) translated fragments from an essay written in 2011 (by EW) on the subject of cultural heritage development in Maputo, and explains the historical development of the Baixa and its former and previous values. The entire text, in Dutch, can be found in the appendix.

*"In terms of the predominant type of use of the Baixa, it has seen major changes over the past two centuries. What started as a small colonial tradepost evolved into a major port city at the time of the railway link to the mineral rich Transvaal in South Africa. After the railway link dried up due to political changes in both Mozambique and SA, the Baixa suddenly lost its main trade activity. Shady bars, related to the sea trade, remained, along with many empty warehouses and other buildings formerly linked to the trade."*

**The value of these changes is captured in the variety of buildings in the Baixa, each referring to a different period in time, along with a different architecture common at that time.**

*"However, the activities which have probably never really disappeared are the informal activities. Either fixed or walking around, these vendors add a liveliness to the streetscape, both in the current situation as in the past."*

**Inventive and "in your face", these informal tradesmen and -women reflect the ever developing and vibrant city centre of Maputo.**

*"What are the essential qualities of the Baixa? For one, the diversity of scales coming together in one small area. Diverse as in size of a building or its value, but also social scales, as in way of making a living, means of travel and one's daily tasks. The woman selling fish on the same pavement as the business man, the homeless carwasher, the student, the drunk and the prostitute. Only the building they go into, if at all, reveals their destination. And these buildings are either modern offices, shabby apartments, specialized stores or a building ruin. Again diverse!"*

**Diversity in the users of the Baixa is a positive value.**

*"The continual movement of people through the Baixa is both an essential (for many activities) and historical quality. The people are both the users of buildings and public space. They determine where and how a lively atmosphere is present. Because even though buildings are ill-maintained and run-down, their users create the comfortable atmosphere present throughout the Baixa. Take the people away, and the comfortable atmosphere disappears, such as in the evening / night." (figure 1.6)*

**Movement of people and their general presence create the comfortable Baixa atmosphere.**



Figure 1.6: these photographs show the difference in atmosphere during the day and night, where the empty streets invite illegal activities. (pictures EW and JC)

## 1.4 DEFINING THE 'PROBLEM' - *is there a problem?*

The problem defined in the description of the project is to revitalize a certain area (the *Baixa*) of the city Maputo. In other words, it can be described as *give life again* to a certain area, implying there is no life present at the moment. But what determines vitality in a sub-Saharan African city centre? In my opinion, it is untrue to call the *Baixa* 'not alive' at the moment, as there are shops and offices and to a certain extent people living there as well. Only a few buildings are proper homes, but many people live informally 'on the streets'.

*Then what is revitalization?* Possibly it refers to the growing number of empty plots, closed shops and vacant upper floors in the 'old *Baixa*', or 'heart of the *Baixa*' (figure 1.4), which is roughly the area where the original colonial settlement was built. The *Baixa* is formally (municipal offices) and informally (markets, small businesses, transport hubs) the centre of Maputo, though geographically not located in the centre of the city because the *Baixa* was built on the coast and the city expanded northwards. If the *Baixa* has the city centre qualities it claims to have (had), then one would expect every little nook and cranny to be used for economic exploitation, either on small or large scale.

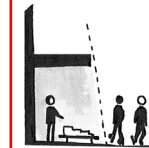
It would seem that this revitalization refers not to the entire *Baixa* (figure 1.3), but more specifically to the 'old *Baixa*' (figure 1.4). The entire *Baixa* has pockets where indeed every little space is used for a certain activity, pockets where large offices and supporting functions are located, and also areas which function as transport hubs (figure 1.5). However, of these three function types, none take place within the 'old *Baixa*'. This area is characterized by several old, tall, often government, offices, a surprisingly large number of hardware / building supplies stores and a few bars which generally attract little more than prostitutes during the evening. Many cars, linked to the offices and shop customers, fill the streetscape, thereby limiting the space and blocking views necessary for informal trade.

**Therefore, at this moment it seems important to act *now* to prevent the old *Baixa* from sliding into a very empty and degenerate old city core. An attempt should be made to attract the surrounding liveliness *into* the old *Baixa* and prevent a further drain of activities to the surrounding areas.**

## Most influential results from analysis

**INFORMAL VENDING**  
Referring to a very wide scale of activities taking place in the public domain, and seemingly lacking organization and legality.

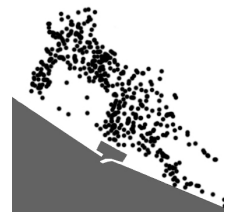
Determinants for informal vending: people passing by, shadow and preferably a blind wall.



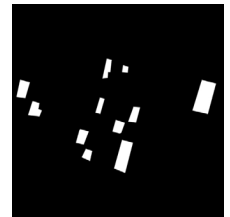
The city's building **DENSITY** decreases when moving away from the *Baixa*. Result: pressure on public transport and stretched or lacking infrastructure in periphery.



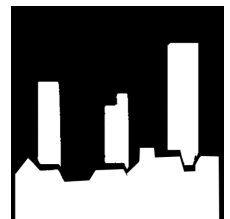
The old *Baixa* **LACKS INFORMAL VENDING**, though it appears around the edges in high concentrations. Result / cause: few potential clients as primary routes do not run through the old *Baixa* currently.



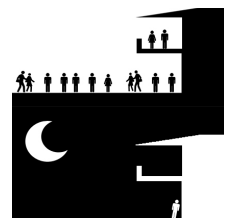
**VACANT PLOTS** and **UPPER FLOORS** in the *Baixa* creating pockets of in-activity and attracting unwanted users. Result: degeneration of the area but on the bright side also possibilities for small scale development.



The *Baixa* building volumes are primarily **LOW** with sporadic lean **HIGH TOWERS** sticking out. Result: relatively open streetscape, despite being the city centre.



In contrast to the daytime, *Baixa* roads are largely deserted during the evening and night. **FEW RESIDENTS**. Result: empty streets at night, contributing to an unsafe environment.



## 1.5 SOCIAL AND SCIENTIFIC RELEVANCE

This project is socially relevant because the Baixa is a meeting point for many people from different social backgrounds, all trying to make a living. The formally employed will get by easier than the informal traders, but they do influence each other. For example, the informal car guard will look after the bank employee's car, enabling the bank employee to travel comfortably to and from his work every day. The prostitutes on the streets at night depend on customers in the bars. Without bars, there will be less customers for the prostitutes, who probably live in rundown buildings in the Baixa anyway. These are just examples to illustrate the socially challenging context of the Baixa. The social structure, with many young prostitutes and young boys on the streets at night, when all the more well-off office employees have disappeared from the area, is hardly healthy. Therefore, including a social element in the design proposal would be very relevant.

Maputo's population has grown tremendously over the past decades (figure 1.7) and predictions for the next decades indicate a further increase of the percentage of the population living in urban areas. Also, the UN predicts the number of urban residents in the entire sub-Saharan Africa to grow from 330 million in 2005 to 730 million in 2030 (from: Jenkins, 2010).

The explosive growth of Maputo, which took off during the civil war, is visible in the informal settlements outside the city centre, built wherever there was enough space to build a little shelter. However, it now seems as if the Baixa's value as the centre of town is diminishing because the surrounding urban area it needs to service is too large. Scientifically developing a method in which a city could let informal development continue (it would be naïve to think this informal growth could be regulated) but at the same time prevent its traditional town centre being 'suffocated' by the vast informally urbanized area around it can also be of value for many other growing sub-Saharan cities.

On a smaller scale, an African city centre in which the vitality is threatened due to large scale property development, often financed from abroad, will need to find a way to prevent the traditional informal trade, which can be seen as a source of vitality, being taken over by big and shiny office buildings (figure 1.8). Research of this topic is necessary for finding a suitable solution.

### Quick introduction to Maputo daily life:

What is the living culture of the lower class inhabitants of Maputo, and specifically the Baixa? Though these following statements will definitely not apply to everyone, they are general values of living along which many inhabitants spend their days.

- > Daily routine consists of making money, this applies to nearly everyone! However, generally speaking, once enough money for that day has been made, it is time to relax.
- > Relaxing is to be done in the shade, ideally with companions, and if one can afford it, a drink and music from a car radio.
- > People spend a lot of their time outside, talking to friends or seemingly just hanging around.
- > IMAGE is everything! A car, nice clothes and a girlfriend rank high on youngsters' lists, only then followed by a job and a house. Making money is very obviously necessary!

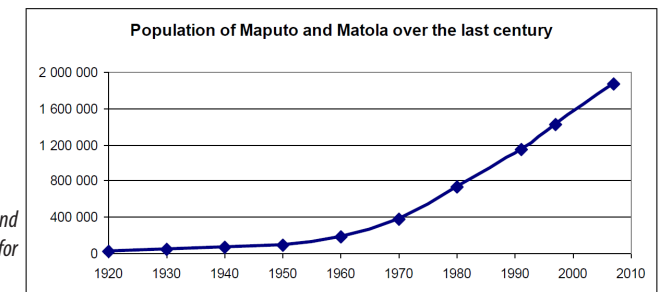


Figure 1.7: population growth in Maputo and Matola. Source: Hydroconseil water report for Maputo, 2008.



Figure 1.8: informal trade making way for formal high rise? Is this favourable for Maputo?

## 1.6 POSSIBLE RESEARCH THEMES

Before concentrating on the themes which I would like to investigate further, through literature and of course through designing, listed below are a number of themes which are relevant for the Baixa and therefore *could* be researched:

- Bringing new functions into the Baixa, such as a cruise terminal or a school;
- Extending or removing current functions, such as the office function, the night entertainment, the market function, the informal trade, the harbour function, the amount of housing, hotels, etc.;
- Introducing new buildings in the Baixa, either in similar style as- or in contrast to the existing built environment, at first regardless of the future use;
- Adapting existing buildings or ruins to a new function, such as turning the abundance of office buildings into something else or finding a way to use a building in ruin;
- Changing the traffic flows through and into the Baixa, because this is actually posing a very present-day problem, with the amount of cars steadily rising. Also the pedestrian traffic flow could be redesigned;
- Rebuilding an entire urban block in the Baixa, in other words if the Baixa needs rigorous interventions;
- Attracting more people / less people / a different target group to the Baixa. Many empty shops might well be caused by too few customers reaching the Baixa;
- Improving the social situation in the Baixa, including topics such as safety, shelter and waste management;
- "Lighting a spark" to encourage future unstructured, organic development. A very small scale design intervention could prove to have large social and/or economic effects in due time.



Figure 1.9: photograph of a frequently used basketball court inside an urban block in the 'old Baixa'. (SZ)

## 1.7 RESEARCH QUESTIONS

Attempting to “solve” the problem explained above, I will try to focus on two themes. These are combinations of the themes mentioned in the list above: 1) integrating currently vacant plots and empty buildings into the urban plan of the Baixa, and 2) providing shelter in local, informal, style in the dense urbanity of the Baixa. Obviously, these two topics can be linked, but by keeping them apart in the first stage, I hope to prevent tunnel vision and keep an open mind. In the design process however, these two topics will probably be linked quicker. As a subtheme of the second theme, I would like to add the level of self-sufficiency in terms of water use and waste management, as these are problem topics for the Baixa.

*The research questions I would like to investigate are:*

- 1.) **How to integrate currently vacant plots and upper floors into a revitalization strategy for the Baixa de Maputo?**
- 2.) **How to provide shelter / living space in the dense urbanity of the Baixa de Maputo, following a local, informal style?**

*AND, how to achieve this with minimal investment, as the target group (the semi homeless, see next page for explanation) is financially weak.*

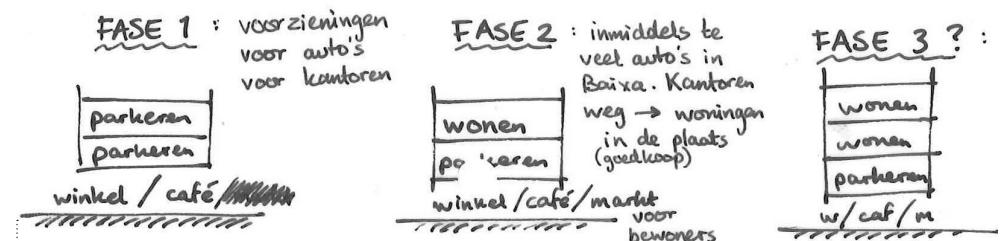


Figure 1.10: sketch of a possible phased adaptation of a, non specific, existing building in the old Baixa.

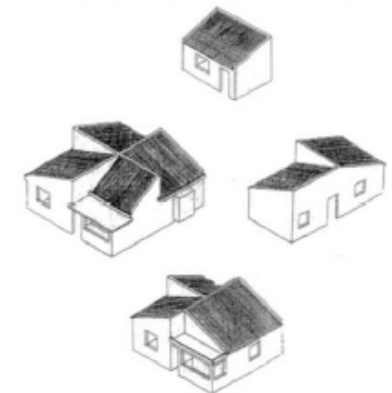


Figure 1.11: fan typology, or 'ventoinha' type, as described by Luis Lage in 'Lage, Carrilho et al, 2005'. Ventoinha translates literally into 'small wind'. Note: this typology is eventually not used in final design.

### 1.7.1 Q1: How to integrate currently vacant plots and upper floors into a revitalization strategy for the Baixa de Maputo?

With a few exceptions, buildings in the heart of the Baixa are not maintained very well, and on more than one occasion are they left to crumble down (see pictures to the right). This lack of investment adds to the degrading value of the Baixa. Talking to shop owners on Rua Consiglieri Pedroso (central east-west orientated street in the 'old Baixa') revealed that formerly shop owners or tenants would live on the floor above the shop (confirmed by local, very influential architect Jose Forjaz), but over the past years they have moved out and upper floors are either left vacant or used as storage or little office. If nothing is going to happen for the next decade or so, it is my prediction that the existing vacant plots and vacant floors will slowly turn into a ruin and cause a domino effect whereby more and more plots will become empty. After all, who wants to run a shop next to a ruin used as toilet by homeless people? Or have your office underneath a badly maintained upper storey on the brink of collapsing?

A possible scenario: as the number of empty premises increases, the next step will be to rigorously tear down large parts of the Baixa to build large scale, modern high rise buildings as is currently happening in the eastern former landfill area. This would ruin the value of the old Baixa, which is in most cases not capsuled in the specific buildings but in the building volumes as a whole and the open space in between the volumes: the urban morphology.

**Therefore, in my opinion, it is imperative that a development is put in motion where little (local, acupunctural) interventions are done on currently vacant plots, to prevent the number of vacancies (plots, floors, and entire buildings) increasing. These small scale investments could be put to use for example to introduce a new function in the area or increase the accessibility of vacant areas.**



Figure 1.12: Vacant plots in the 'old Baixa' (MvB and EW)

### 1.7.2 Q2: How to provide shelter / living space in the dense urbanity of the *Baixa de Maputo*, following a local, informal style?

The inspiration for this specific theme follows from the rapid urbanization of Maputo the past decades. The people moving from rural areas into the city settled in the growing outskirts, where an urban typology of people building their own homes in an unregulated urban environment developed itself. Within this very general typology, there are several different possibilities. One of them is the 'fan typology', because the shelter 'fans' out over time (it grows), as shown in figure 1.11. Other typologies are also based on the home 'growing' over time, but less organized (figure 1.13). Many of the people living in such settlements are originally from rural areas, are used to living outside, literally near the ground which is used for subsistence farming, cooking and waste disposal, and can extend their homes as their wealth and family grows. Rent or housing costs are low, as little as 17% of an average monthly household income (source: Jenkins, 2000). However, many of the people living informally in the outskirts, make costs to travel daily to work (also informally) in the *Baixa*. For someone living in the periphery and working informally in the *Baixa*, this could be up to one third of a 1500 Mtn (€40) monthly personal income spent on public transport (source: on site interviews). It is a growing problem: the most recent arrivals to the city will settle on the furthest outskirts (cheapest and available area), but will probably also be the least well connected in the city and therefore start at the bottom of the employment ladder = informal services or -retail in the city center (*Baixa*). This means that the poorest in the city need to travel furthest between their home and work! Logically, there is a group who cannot afford this and who settle very informally in the *Baixa*. These I call the semi-homeless, because they live in makeshift shelters or in ruins of buildings (such as Predio Pott, on the intersection of Av. 25 de Setembro and Av. Samora Machel), without even the most basic amenities.

**If one could provide a low cost alternative for living on the city border or informally in the *Baixa*, it would save the people the cost of the *chapa* ride (*chapa*= taxi minivan, most common type of public transport) and allow them to spend more time engaged in their trade or in developing themselves (education). Thus not only leading to a revitalization of the *Baixa* but in the longer term adding to the social and economic growth of the city.**

To increase the feasibility of placing low income citizens on a site in the heart of town and to provide an example for a possible solution to the water and drainage problem in Maputo *as well*, my thought is to minimize the required infrastructural connections by making the building self-sufficient in terms of water use and waste management. In theory, the Portuguese influence in Maputo up to 1975 should have led to a sound utilities system. However, lack of maintenance and development of these systems has made them incapable of handling peaks and made them generally unreliable. This increases the necessity to think of (small scale) solutions. There are many aid projects for developing countries focusing on water management and sanitation. This means there are numerous proven technologies which could be implemented. However, many of these technologies are designed for rural locations without access to water- and drainage networks. The challenge is to adapt these technologies to fit a urban, very dense, environment.



Figure 1.13: typology of a living space for one or two families, living in the informal urban settlements in Maputo. The buildings grow over time as wealth and family size increase (top sketch is research sketch by EW).

Below, from literature a similar concept, from: Sollien, 2010.

# 1.8 TIME SCHEDULE

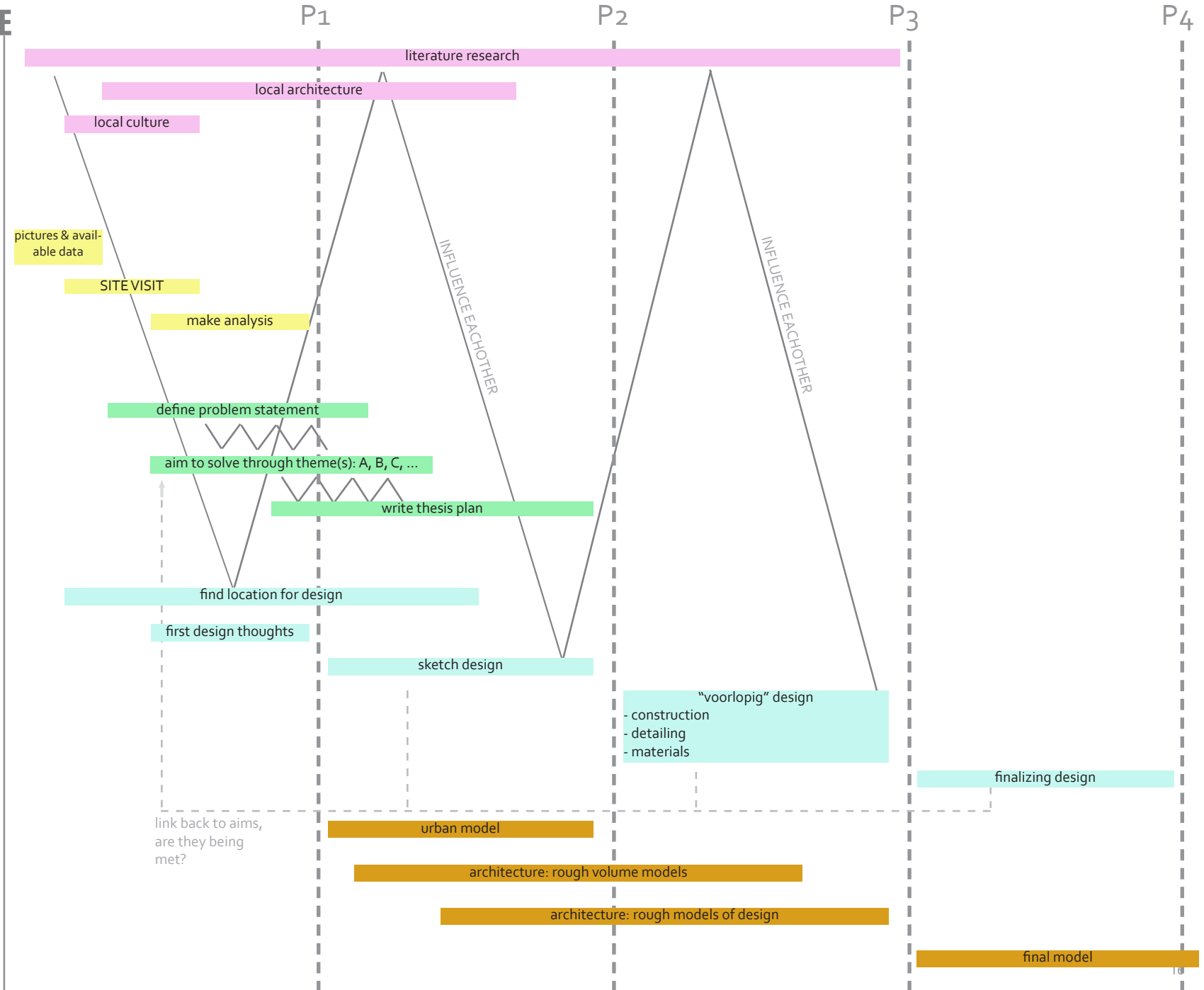
## RESEARCH

## ANALYSIS

## PROBLEM STATEMENT

## DESIGN

## MODELS



## 1.9 BIBLIOGRAPHY

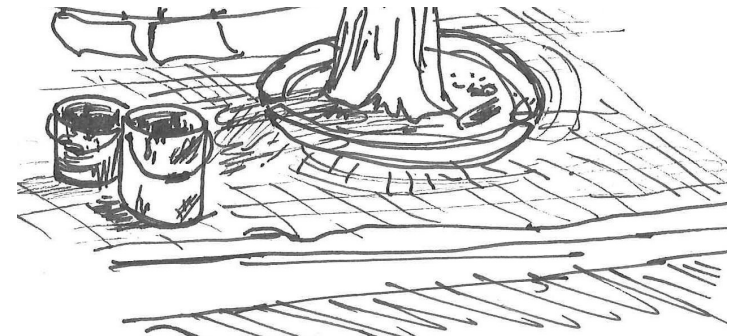
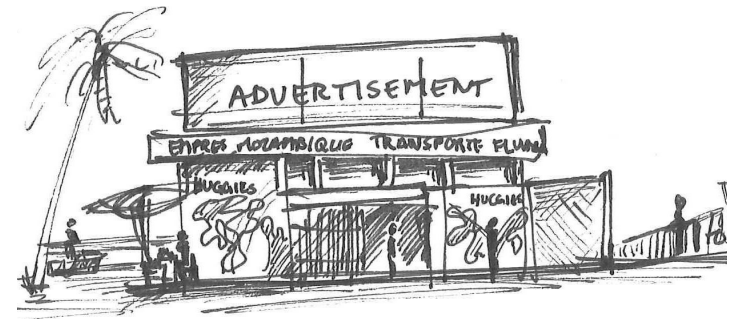
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# part 2 RESEARCH RESULTS



Research sketches at different moments in the design process.

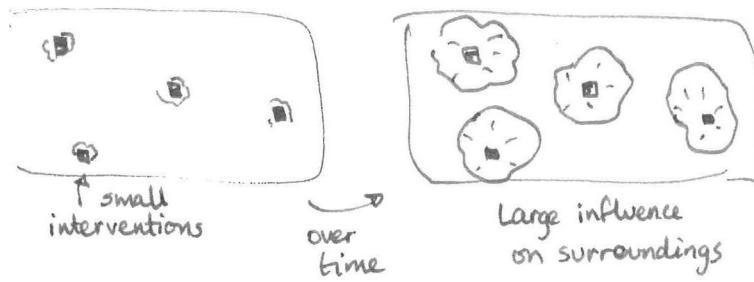
## 2.1 ANSWER RESEARCH Q 1

### How to integrate currently vacant plots and upper floors into a revitalization strategy for the Baixa de Maputo?

In answering this question, I have made the distinction between a generic method, which could be applied to every vacant plot in the Baixa, and a site specific solution for one particular site. On the map to the right (figure 2.1), all the vacant plots currently in the old Baixa are marked red. These plots are either unbuilt and in use as car park or car storage, open and in use as a sports facility, empty and unused or have ruins of a previous structure on them. They are numerous, spread evenly throughout the old Baixa and all of very different sizes.



Figure 2.1: marked in red all the currently vacant plots in the old Baixa.



**The essence of the solution I propose, is to set up small scale interventions on several sites, each intervention over time expanding its ring of influence.**

This method should, in theory, be financially and physically easy to implement, making it realistic in the short term, with long term effects. The small interventions should ideally be socially engaged to help diversify the functions in the Baixa and at the same time attract people to live in the Baixa.

research / observe



analyse

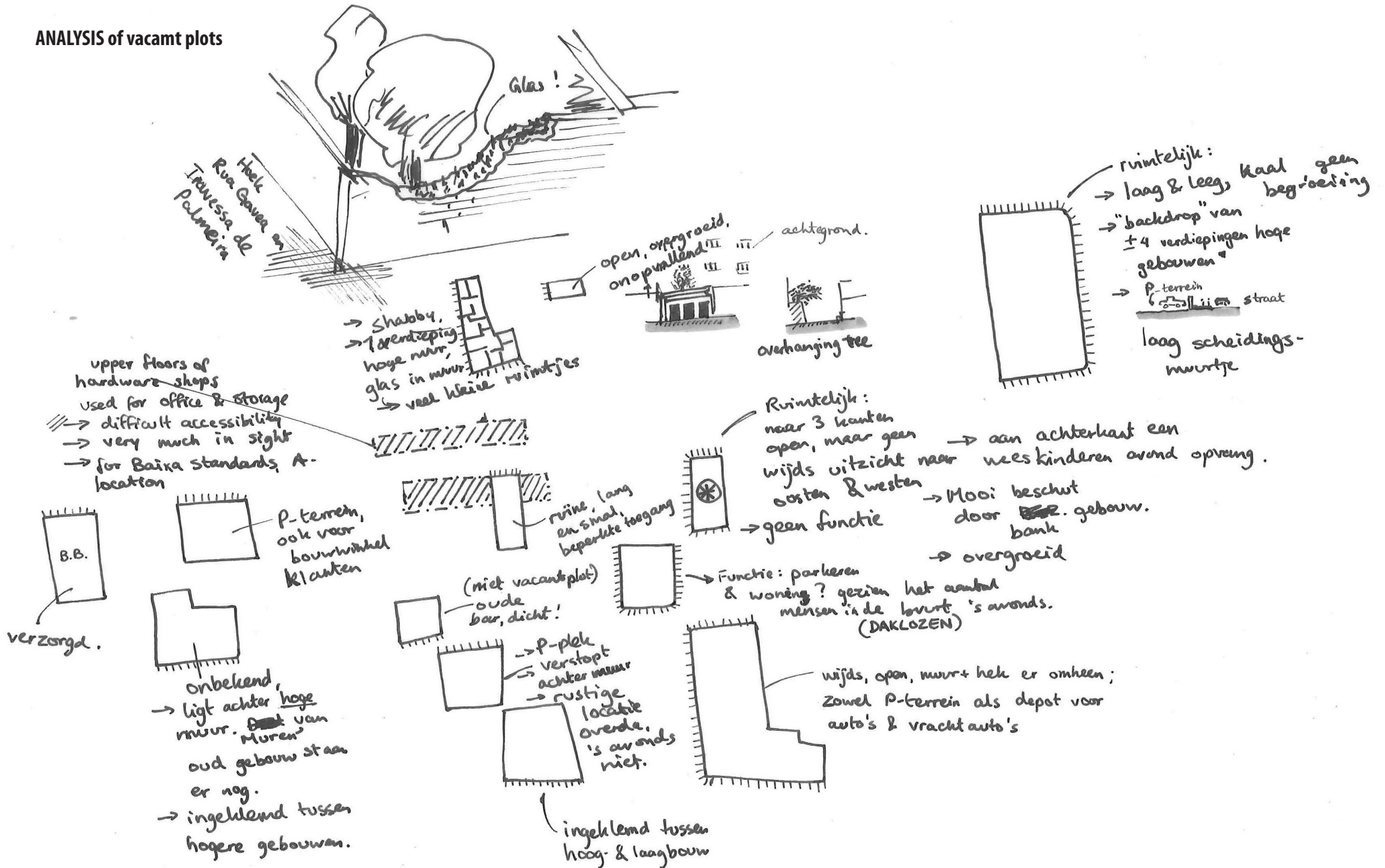


differentiate



integrate needs of the Baixa with possibilities offered by vacant plots

ANALYSIS of vacant plots



**Generic vs. site specific**

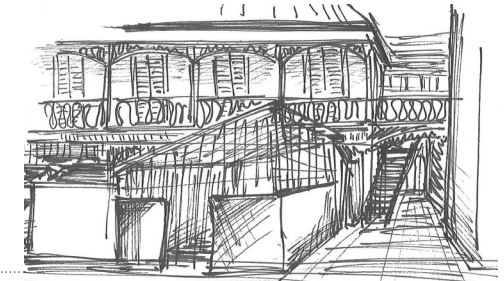
In answering this question, I have made the distinction between a generic method, which could be applied to every vacant plot in the Baixa, and a site specific method which applies to one particular site.

**GENERIC methods for approaching vacant plots in the Baixa:**

- Remove remaining ruins and possible walls along pavement;
- Small scale interventions, acupunctural, as to increase the rate at which a structure can be introduced and built;
- Catalytic interventions, as to lead to further urban upgrades in its immediate surroundings; it should radiate energy!
- Prevent long term use as car park, which further degrades the plot through unwanted activities and also further delays possible new functions;
- To make the plot accessible, link the new structure or function to the existing or future urban plan.

On a more controversial note: in my opinion the intervention, be it a new structure or a renovated old building, does not necessarily need to be a landmark. A functional building for the community can suffice. There is enough interesting architecture in the Baixa, but it seems to lack enough people to fully make use of the architecture. Therefore icons are not needed, but simple, cheap and socially functional structures are more valuable.

Figure 2.2: a vacant plot on Av. Martires de Inhaminga, with behind it colonial style buildings on Rua do Bagamoyo.

**SITE SPECIFIC methods for approaching one particular vacant plot, currently a ruin: (figure 2.3)**

- The intervention should be quick built and cheaply built;
- Among others, include a residential function, of which there is clearly little in the Baixa
- Allow easy accessible, shadowed, public space created on ground level; therefore the building can be seen as multifunctional (residential and public);
- A pedestrian passageway through the site "opens up" the relatively closed urban morphology of the old Baixa;
- Include a unique installations system for Maputo, which runs as a pilot project (regarding the sustainability in dense urban Maputo).

Figure 2.3: the particular vacant plot in the old Baixa, referred to in the site specific method. (EW)



**Example of a currently *successful* use of a vacant plot:**

On the corner of Av. 25 de Setembro and Av. Filipe Manuel Magaia, just outside the old Baixa, a vacant plot has been put to use as a market for boxes and other wrapping and transport materials. It is a vacant plot, with no structure on it, bordered on two sides by main roads and on two sides by buildings. Its function supports the surrounding market area and is similarly close to the main Baixa chapa and bus stands. Furthermore, as well as servicing main business such as the central market, it attracts smaller scale businesses and in a way acts as a catalyst for informal vending. It has developed to a well known corner in the Baixa. Why?

- simple but necessary product for sale;
- located along a main route;
- linked with activities taking place in its immediate surroundings.



Figure 2.4: framed in red the site of the 'box market'



Figure 2.5: the box market along Av. 25 de Setembro (EW)

**Example of a currently *unsuccessful* 'use' of a vacant plot:**

On the corner of Rua da Gavea and Travessa da Palmeira, in the heart of the Baixa, lies an abandoned and run down building which formerly was probably a collection of shops or something similar. Nowadays, all boarded up and largely roofless, it serves as a spot where prostitutes take their customers, according to an entrepreneur who owns a little office in a building bordering the vacant plot. For that reason, he has boarded up the few remaining entrances and has laid a ledge of broken glass along the top of the wall. The informal use of that vacant plot has not done the immediate surroundings any good. Why?

- dirty activities taking place;
- very closed off from the road;
- no positive relationship with surrounding activities.

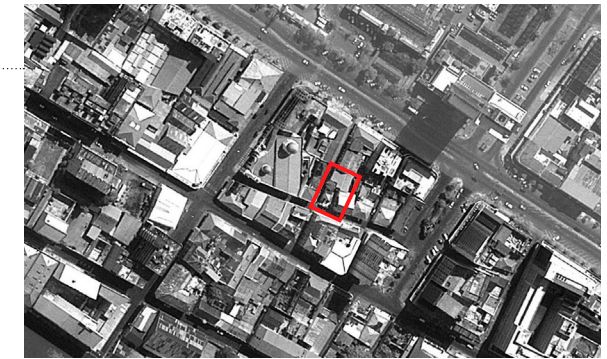


Figure 2.6: framed in red the corner with the ruin.

Figure 2.7: the vacant plot is not in use and has been further boarded up by neighbours. (EW)



## 2.2 ANSWER RESEARCH Q 2

**How to provide shelter / living space in the dense urbanity of the *Baixa de Maputo*, following a local, informal style?**

The path through which I found a possible answer to this question can be summarized as shown on the right. The actual proposed answer has the shape of an architectural design, not a written report, but these are the steps that have led to that design.

**The answer to the research question can be summarized as followed: take the size and shape found in the informal settlements on the outskirts, and bring many of these units together on one site with all necessary facilities while respecting the social structure.**

The found social structure provides the possibility to have people share facilities and live close together. The sketch below was made in the Mafalala neighbourhood and shows the way several homes are clustered around one 'courtyard', sharing facilities such as water supply, kitchen and toilet. It must be noted though that a lot more research can and should be done in respect to the social structure in the informal settlements. The data used for this design is entirely true, but may possibly be shortsighted because I made only a few cases studies.

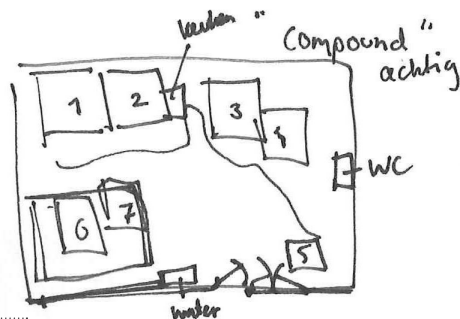
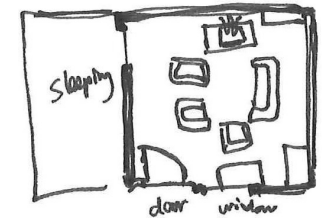
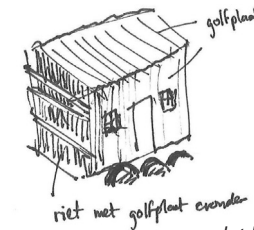


Figure 2.8: quick sketch of layout of small living units around a shared 'courtyard'.

research



east of Marracuene (EW)

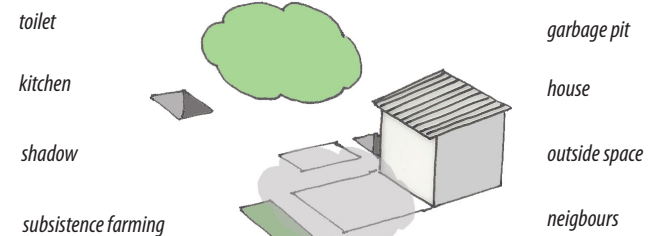


sketches made in Mafalala

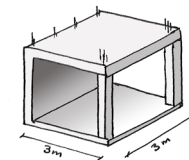
analyse



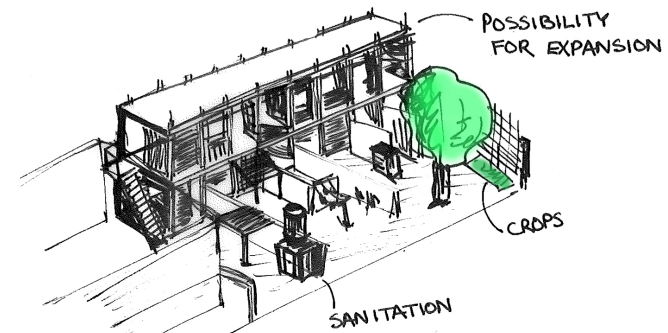
simplify



translate to urban situation



densify



## Research

The methodology of research will be fully explained in the *reflection* chapter. For now this text only serves as explanation of how I came to the answer of the research question. Essential for bringing a certain typology into the Baixa is to understand that typology. Trips made to these areas of informal settlement helped clarify data found beforehand in articles and reports. The actual way people live on a small plot and use the little space inside of their home can only be understood when seeing it with your own eyes. The little buildings, made of either concrete, reeds, corrugated sheets or a combination of the above, are extremely small and multilayered in their use. Living, eating and sleeping are often done in the same area, obviously not simultaneously. Sleeping in a private room or area is unheard of, and many people in one family sleep in the same, small room. The 'data' found through this research is partly *intangible*, as it refers to a culture and atmosphere which is difficult to give an actual appearance in an architectural design.

## Analyse

Besides the 'intangibles', there are several very clear characteristics of the living conditions in the informal settlements, which I have symbolized on the previous page. Shelter from the weather (both sun and rain!), basic sanitation, (running) water, a drain or garbage pit, possibility for small scale crops (urban subsistence farming) and an area for cooking are the basic needs I have distilled from the research.

## Simplify

This step was necessary for me to literally visualize what the relationship between the different elements is, and clarify all the elements which make up and informal living unit.

## Translate to urban situation

This step is a very important step for my design proposal. The sketch is a simplified version of what actually happens, as it refers only to the actual living unit, measuring 3 by 3 by 3 metres, roughly reflecting the size of the square rooms of which informal homes are built up of. That size in turn is defined by the maximum span that the most common roofing material, corrugated sheets (metal or plastic) can reach. Outside of this 3x3x3 living unit, other basic facilities are present, yet also efficiently stacked or placed close together.

## Densify

The final step is to take the urban living unit and multiply it as often as the site and building height will offer. The site measurements relate easily to the building footprint, but the building height is slightly more difficult to determine. A small height of only a few floors will not provide enough living units per square metre of footprint to make the entire project feasible, but an enormous height will possibly not function socially and require extensive vertical transport elements in the building, such as elevators and emergency staircases. The ideal height of the building can be an entirely new topic for study, but for the sake of time, the final design proposal will have a roughly estimated ideal height, also fitting well into the context.

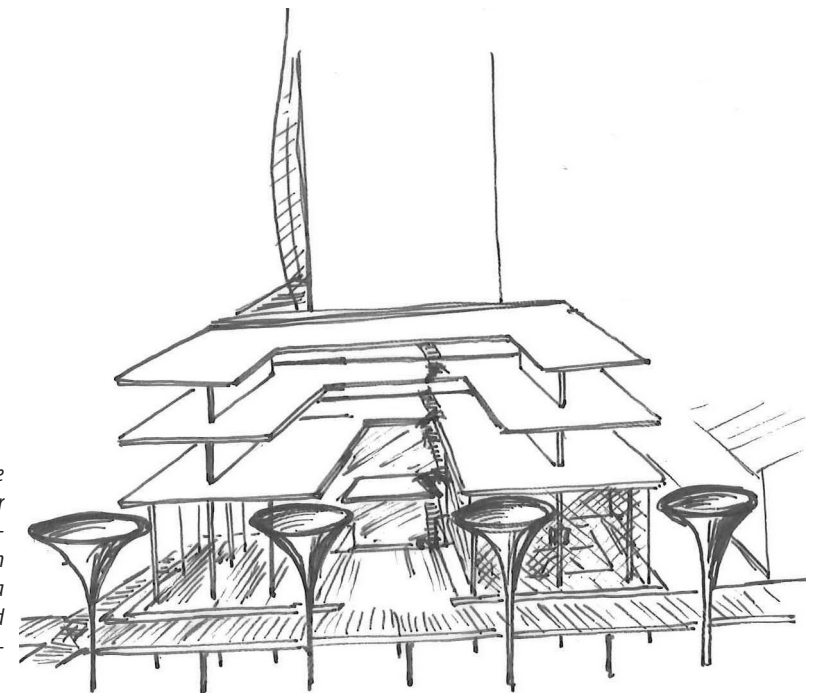
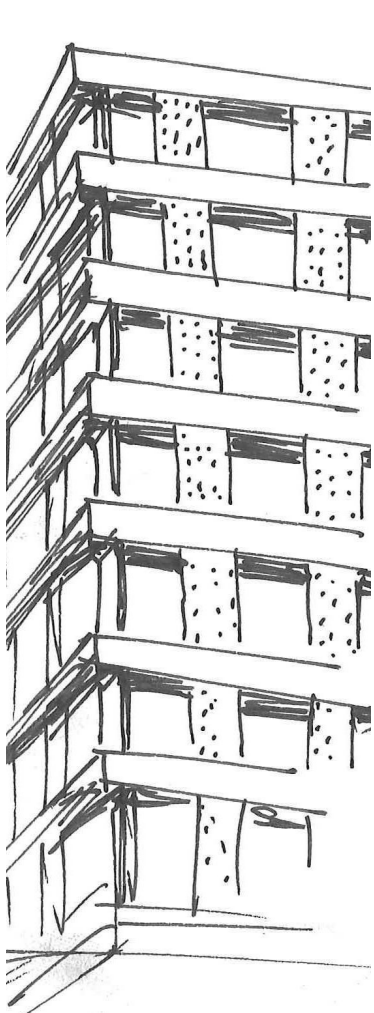


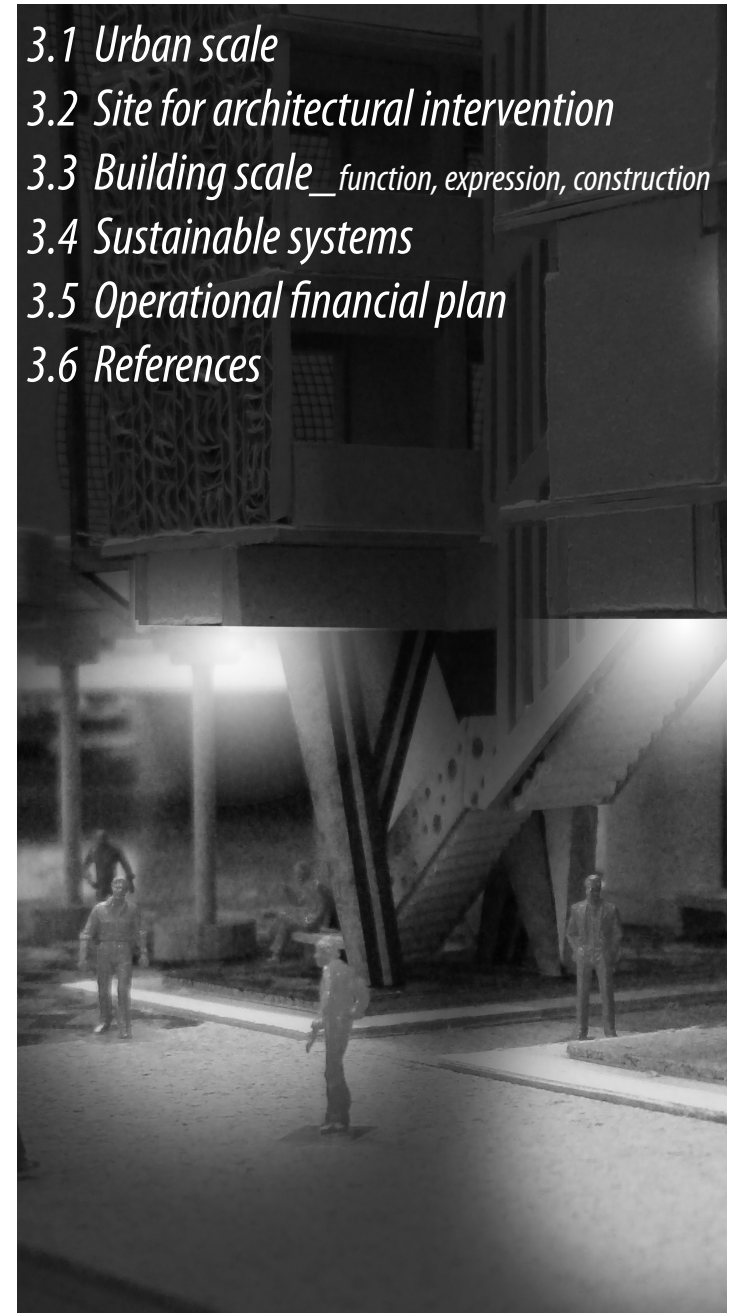
Figure 2.9: one of the first design sketches for an informal living building, with living units on the upper floors and a large and open ground floor for market and recreational functions.

## part 3 ARCHITECTURAL RESULTS



Research sketches made on site in the Baixa. Right: photograph: of a model.

- 3.1 *Urban scale*
- 3.2 *Site for architectural intervention*
- 3.3 *Building scale\_ function, expression, construction*
- 3.4 *Sustainable systems*
- 3.5 *Operational financial plan*
- 3.6 *References*



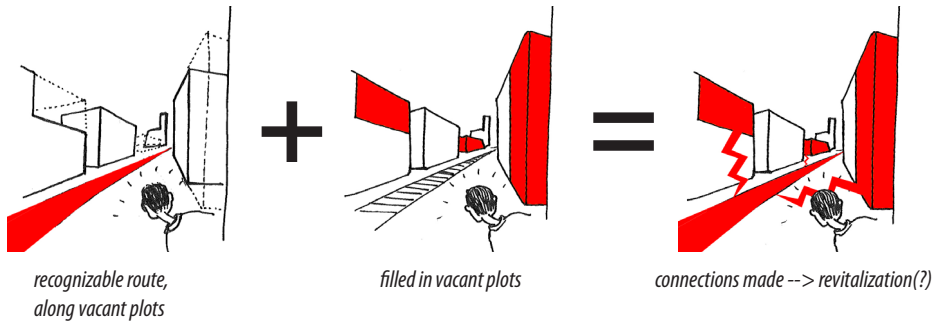
### 3.1 URBAN SCALE

The urban plan for the Baixa de Maputo is based on introducing a subtle but tangible urban element along certain routes through the old Baixa, with goal to:

- 1.) preserve and strengthen the old Baixa's identity;
- 2.) link the currently vacant plots.

Expected results are:

- a.) degredation of the old Baixa brought to a halt;
- b.) decreased number of vacant plots;
- c.) improved balance of functions in the area.



By introducing a repetitive element in the streetscape of only one specific area, say the "old Baixa", over time people will associate the presence of that certain element with the specific neighbourhood. It is to increase the awareness for the old Baixa, because its historical characteristics are currently receiving too little attention. For example, the large number of vacant plots not being used, but new structures being built less than a mile away (eastern Baixa development, see figure 1.5 in chapter 1.2). By in a way demarcating the old Baixa, the unique little heart of the city will be preserved, at least as a recognizable entity within Maputo, and not be swallowed up by large scale property development in its immediate surroundings.

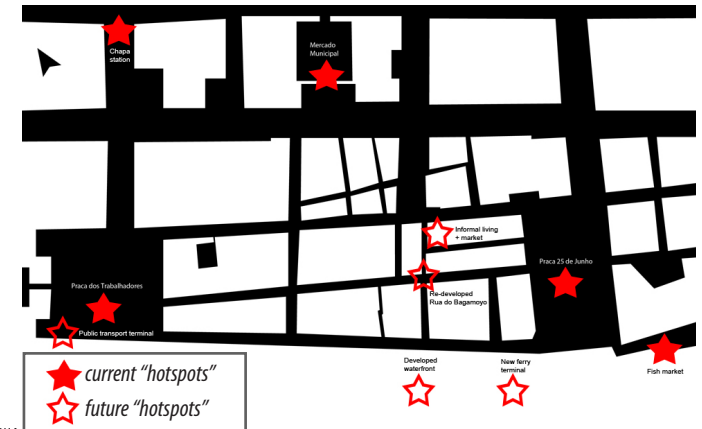


Figure 3.1: Nolli map of the 'old Baixa' and immediate surroundings, with existing hotspots, which attract masses of people, such as the chapa station (top left), and future potential hotspots, such as the to be developed waterfront.

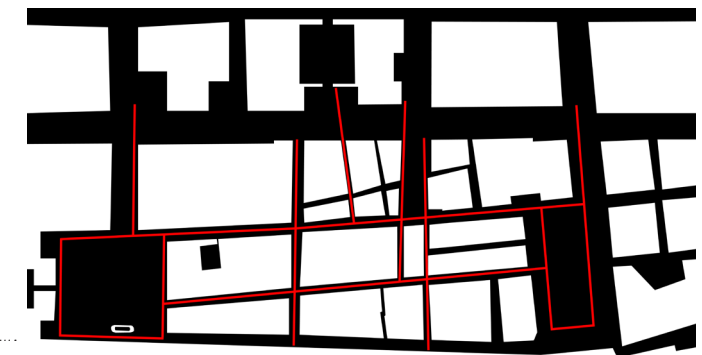


Figure 3.2: Nolli map of the 'old Baixa' and immediate surroundings, with the proposed urban route, made tangible by placing street furniture along the pavement, as on the following page.



Figure 3.3: Nolli map of the 'old Baixa' and immediate surroundings, with the proposed urban route and the currently vacant plots it connects to.

Secondly, by adding an extra, very tangible characteristic to the area, the attention of people passing through should be drawn to the area's unique (historical) characteristics, which correspond with the presence of the newly introduced urban element.

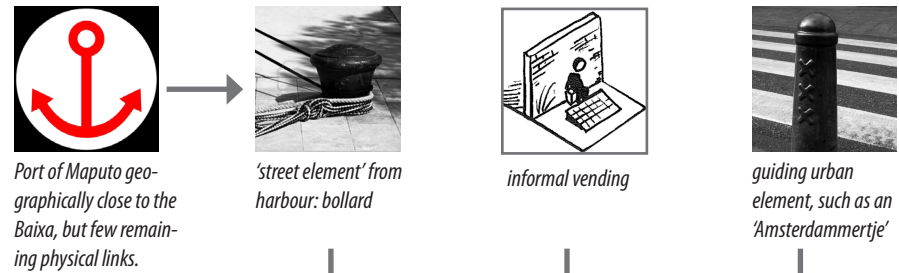
Besides influencing the minds of people passing through, which would over time hopefully lead to a thoughtful preservation of the character of the area, supported not only by historians but also by the population of Maputo, the urban element is to be placed along routes through the old Baixa, linking existing hotspots but also connecting to currently vacant plots and future hotspots (see figure 3.1), such as the to be developed waterfront, a possible new transport terminal and the informal living building on a vacant plot in the heart of the old Baixa. These vacant plots are to be filled in according to the method described in the answer to research question 1 (chapter 2.1, p. 19). By placing the urban element along certain existing and possible new routes, it is expected that people passing along that route, travelling from A to B, and informal activities taking place along that route, will create a two-way stimulation resulting in a generally more lively atmosphere in the streets of the old Baixa.

Thirdly, the urban element which can be placed at irregular intervals on the pavement along the routes, adds a flexibility to the use of the pavement for informal (vending) activities which take place on a large scale in areas surrounding the old Baixa, but seem to be lacking within the old Baixa. Furthermore, it forces cars to stay off the pavement, allowing easier flow of pedestrian traffic. Currently cars clog both the streets *and* the pavement (photographs top right).

Having extensively analysed the characteristics of informal vending in the 'larger Baixa', it can be said that there are several determinants for successful informal vending. These can be found in chapter 4, *Maputo 4D*, of the analysis document that has been made in the spring period of 2011 for this graduation project. The most important findings are the determinants: people passing by, shelter from sun and rain and some sort of object or ideally blind wall to create a direction in which the vendor will present his goods. The concept being aimed at informal activities means that as little guiding structure as possible is preferred, as structure will only increase formality.



MOTIVATION: cars on the pavement --> pedestrian un-friendly - (?) --> lack of informal vending.



Port of Maputo geographically close to the Baixa, but few remaining physical links.

'street element' from harbour: bollard

informal vending

guiding urban element, such as an 'Amsterdammertje'

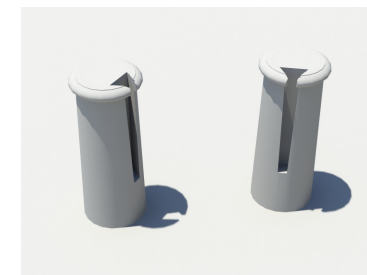


Figure 3.4 : diagram explaining the motivation and inspiration which led to the design of the 1 metre tall concrete column.

The urban street element I have designed is a short (1m), reinforced concrete column, with a diameter of 40 cm, and a triangular void along one side which can be used to support structures set up by informal vendors or carry urban furniture such as benches, trash cans or flower pots. It is inspired by both the traditional bollard shape, which refers to the port of Maputo being geographically close by but in reality hardly linked to the old Baixa, neither in terms of atmosphere nor activities, and the 'guiding' characteristics of the in Holland well known 'Amsterdammertjes', which limit car traffic to designated areas in the centre of Amsterdam.

The one metre tall concrete column is prefab mounted on a concrete slab (dimensions: 1m x 1m x 0,2m) which forms its foundation and can be buried underneath the Baixa cobblestone pavement. The concrete edges are rounded off to prevent quick wear and tear. The concrete is painted white at the time of placement, but can be appropriated by inhabitants, shop keepers or informal vendors and decorated in whatever colour or pattern they like. This way, a colourful and variable element is introduced, which could introduce some more pride of the area among the inhabitants and retailers.

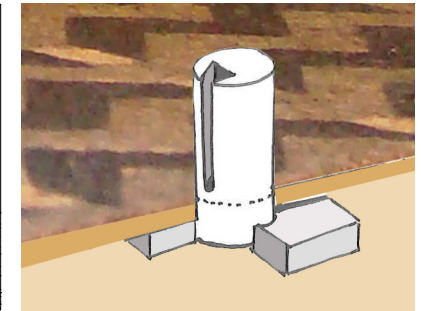
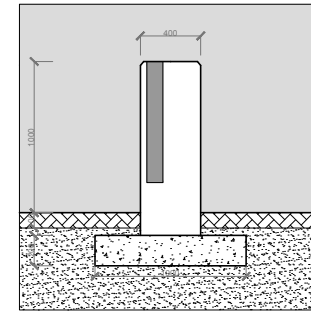


Figure 3.5: section (scale 1:50) and cut-away of the concrete column with foundation slab.

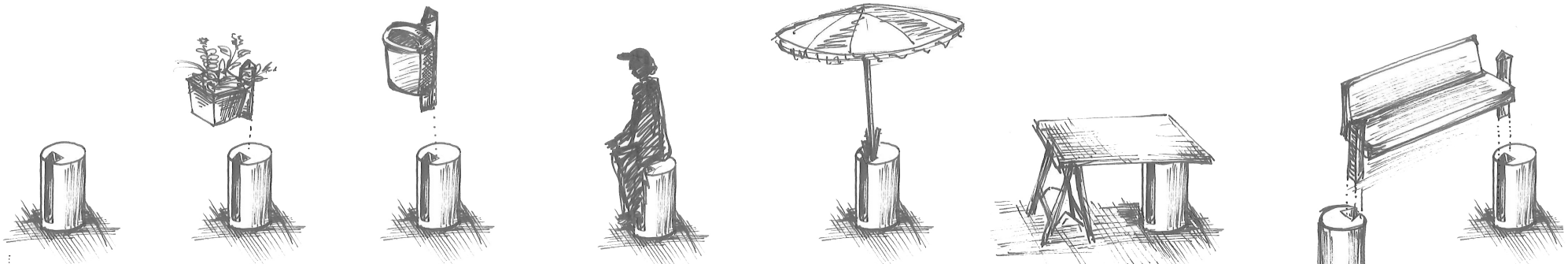


Figure 3.6: the characteristic column can have many different functions, both formal (trash can) and informal (table stand for informal vendor).

## 3.2 SITE FOR ARCHITECTURAL INTERVENTION

The site chosen for the architectural intervention is located in the centre of the 'old Baixa'. One could say that if the old Baixa is to be regarded as the old 'heart' of Maputo, then the chosen site lies in the very centre of Maputo (though not literally of course)!

The site is located along one of the two main east-west roads that run through the old Baixa, the *Rua Consiglieri Pedrosa*. Figure 3.8 shows the intensity of traffic flow (combined pedestrian and car) and the main intersections; the size of the circles corresponding with the amount of people currently passing by. The site, framed in grey, lies in between these two main roads. The dashed circled intersection I expect to grow in the next few years, as the waterfront is being developed, which will attract more north-south movement through the Baixa with people coming from the central market (to the north off the map) to the former harbour entrance, south of the dashed circle on the map. The site is expected to be both a catalyst for movement along the north-south route, as well as being able to come alive resulting from the passing traffic.

In its direct urban context, the design works together with another design proposal (design by Jaqui Casson, graduated at UP), to create a sequence of open spaces from the end of Av. Karl Marx southwards (figure 3.9 and 3.10, following page). Analysis through Nolli maps shows that the urban blocks in old Baixa are all very closed and provide few open spaces such as the two squares bordering the area to the east and west (as shown in figure 3.1), which are commonly used by locals to relax, meet people or informally sell all types of goods. The open space on the ground floor of the proposed design for the vacant plot is to offer similar possibilities as the larger squares, but then on a smaller, more intimate scale, and in the centre of the old Baixa instead of on its borders.



Figure 3.7 : the site for the architectural intervention, on a vacant plot, is located in the centre of the old Baixa.

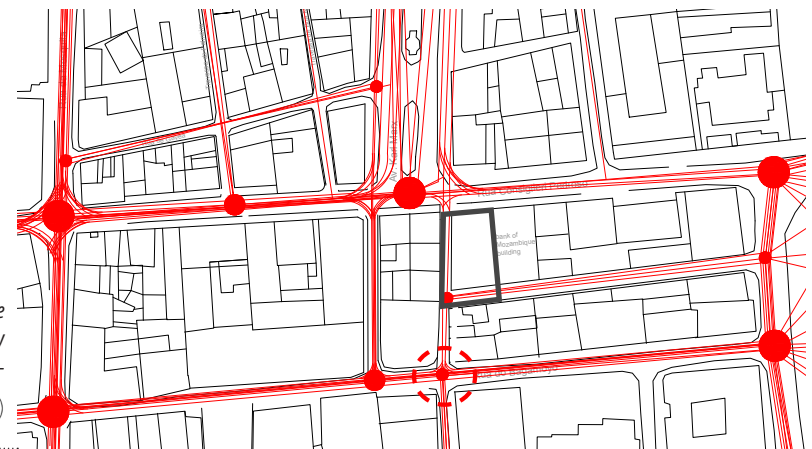


Figure 3.8: map of the old Baixa with intensity of traffic flow and intersections.

Figure 3.9: Nolli-map of the direct context, showing the before and after situation, which, together with the design by J.C. on Rua do Bagamoyo, will lead to a series of open spaces.

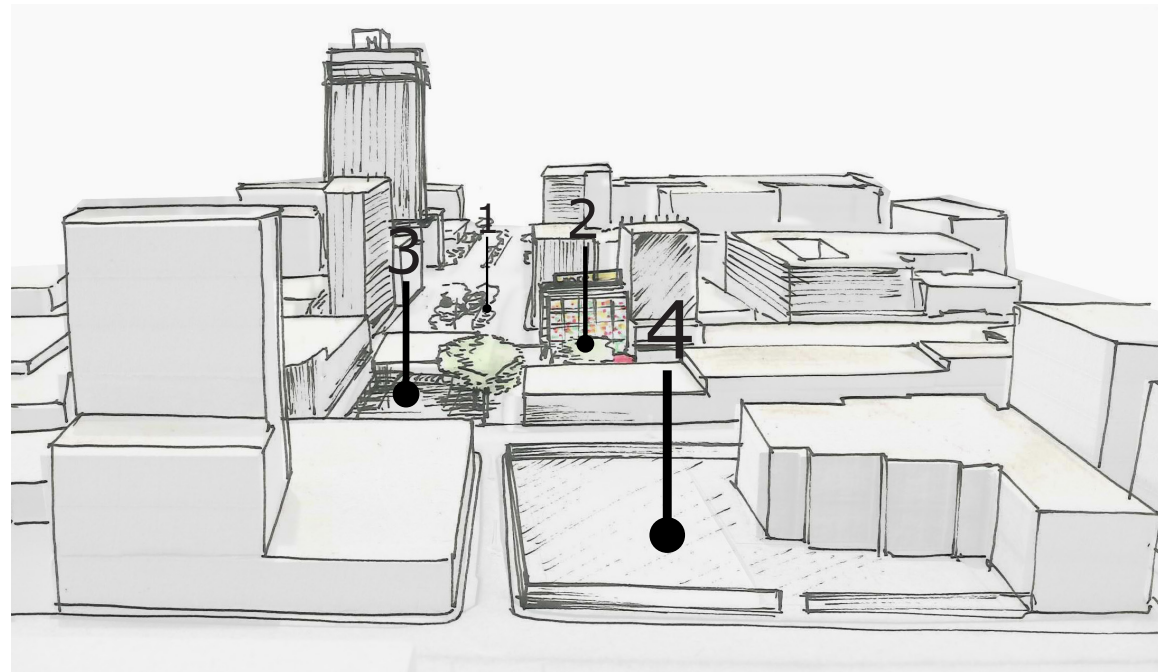
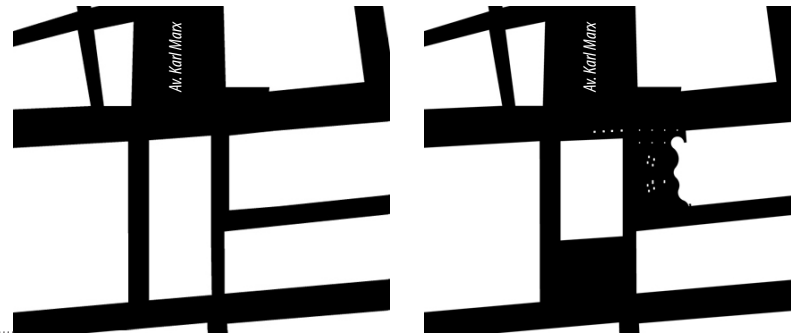


Figure 3.10: sketch of the site in its context, seen from the southwest, with the proposed sequence of open spaces. Nr 2 is the site for the intervention.

The site is bordered by the Rua Consiglieri Pedroso to the north-east, and the two small alleys *Rua da Catembe* to the north-west and the *Travessa Tenente Valadim* to the south-west. To the south-east, the site is bordered by a recently built 13 storey office building, occupied by the national bank, the *Banco de Mozambique*. The facade facing the site is entirely closed and painted white.

The site itself is currently covered by a one story, roofless ruin and a narrow, boarded up former store, or so it seems. The site has obviously been derelict for quite some time as there are several trees growing inside the walls. All openings have been filled up with bricks and concrete, but the size of the openings in the front facade indicate a possible previous use as a store or something similar.

Though the site currently has no formal function, it is regularly used by homeless people, such as Angelo (see chapter 4.2.3 for photo's and more information), who scale the wall and sleep inside the ruin. The homeless sleeping within the walls reflects itself on the outside through the stench of urine and excrement in the bordering streets.

Building on the explanation in chapter 1.7.1, it is my opinion that the lack of anyone feeling responsible for a street, alley or facade, due to the fact that no one lives there or does business there, will negatively influence the immediate surroundings through smell, trash and people hanging around. I find that this site proves my point.

**The current value of the site can be summarized as follows:**

- **it has no formal use, other than a shelter for homeless people;**
- **the roofless ruin is run down and has no value as a building;**
- **the current state has a negative influence on its immediate surroundings.**



Figure 3.11: view from above onto the site for the design proposal. Currently a ruin. (EW)



Figure 3.12: view of the rear of the site. All openings in the wall are closed. (JC)



Figure 3.13: view along the side wall of the ruin, looking towards Rua do Bagamoyo. This is also the road along which the new urban route will lead. Notice the trees in the background, creating a dark alley. (JC)

### 3.3 BUILDING SCALE - *function, expression & construction*

The answer to research question 2 (chapter 2.2) introduces a unit, based on informal living in a less dense area, which could in theory be stacked and if sufficiently facilitated form a multi storey living building. However, it is a generic approach, not specified to a certain site. Combining the 'living unit method' with a concept for the chosen site and three themes to enrich it, create the basis for the design proposal.

#### CONCEPT

The three sketches on the right illustrate the basic concept, which is aimed to be a cheap and simple basic structure which is in fact only 2/3 of a proper dwelling. The final 1/3 is to be provided by the inhabitants, thereby letting them appropriate the space by having them set up their own facade boundaries, conform the informal living typology, which is barely regulated. A certain level of regulation is necessary when building in a dense area, such as the heart of the old Baixa, but the idea of this concept is to keep it to a minimum.

The three themes which add on to the primary concept are:

**a.) offer the target group (see below) an affordable place to sleep, work and recreate;**



**b.) growing building typology, as explained in chapter 1.7.2;**



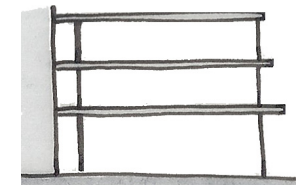
**c.) sustainability and self-sufficiency with regards to water and waste;**



The target group consists of homeless people, living on the streets in the Baixa, the semi homeless who frequently live on the streets, and people who spend too much of their income traveling to a small home on the outskirts of the city, whilst working informally in the Baixa.



1. Take down the current ruin.



2. Build a simple, cheap concrete structure with outlines for the basic living unit, AND a public domain on the ground floor!



3. Allow inhabitants to fill it in.

CONTEXT

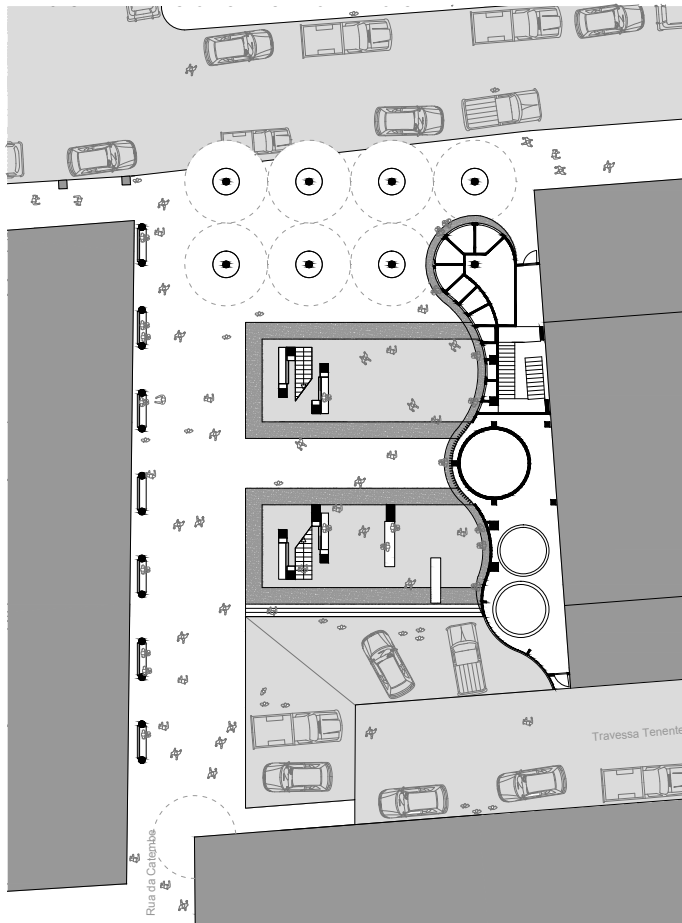


Figure 3.15: the ground floor set in the immediate context. The area will be for pedestrians only, though cars have easy access to the site at the front and rear.

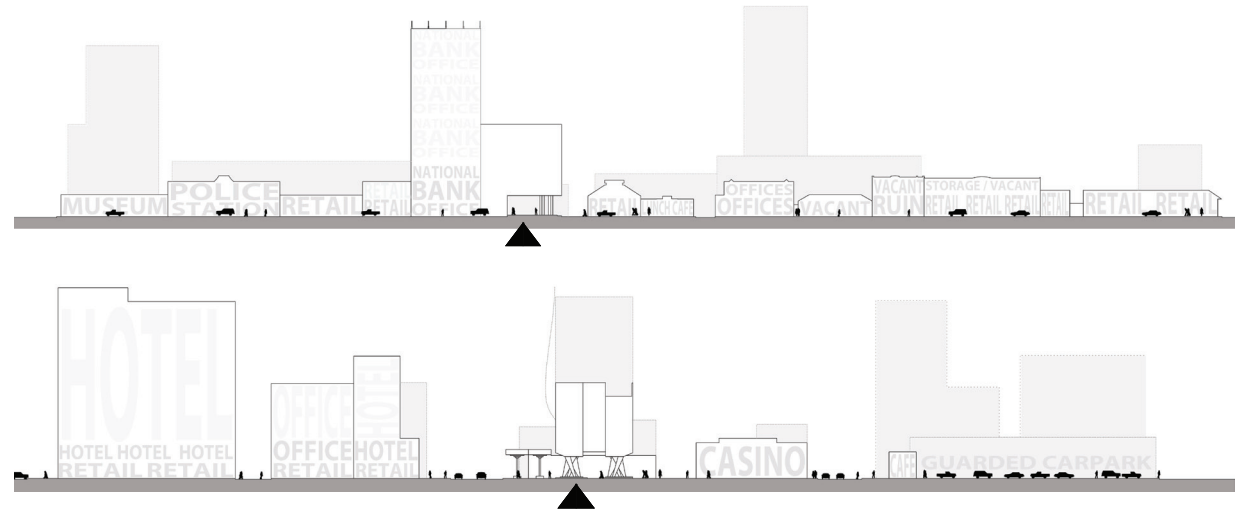


Figure 3.15: these two urban sections, across Rua Consiglieri Pedroso (top) and Av. Karl Marx and Rua da Catembe (below) show the volumes and functions in the surrounding area.



Figure 3.17: sketch of the buildings on the end of Av. Karl Marx, opposite the site. Note the different textures in the facades and the different building heights.

## FUNCTION

The ground floor of the design is left largely open to the public. It provides shade and places to sit, which could be used for example by informal retailers, business men in their lunch break, people meeting each other or simply for locals to relax before, after or during work! The curved wall, which springs from the umbrella columns in front of the building, shields installations and provides little lockable stalls for small scale market retailers or informal vendors needing an overnight storage place for their goods. The area underneath the building has potential to become an informal, small scale market, selling goods to the inhabitants, very well possible *by* the inhabitants too.

The area behind the building, on the southwest side, is characterized by the large tree, which currently grows on the site. Underneath, at the newly created end to the existing road, cars can be washed by local boys or inhabitants can relax in the shade or even play some basketball against the back facade of the new casino, which will border the site to the southwest.

The building itself is made up of two main volumes, housing the living units, and linked on each floor by a communal kitchen area, in between the two staircases, and by a "sanitation" area, housing water tanks, a large wash basin and shower stalls. The wide staircases (each 1,5m wide) wrapped around the communal kitchens, stimulate interaction between floors to create one large living community spanning several floors.

NOTE: the drawings on these and following pages are reduced in size to fit on the page. Larger drawings can be found in the appendix number ... or in 1:100 scale on the presentation posters.

Figure 3.18: plan of the ground floor public area with the characteristic curved wall

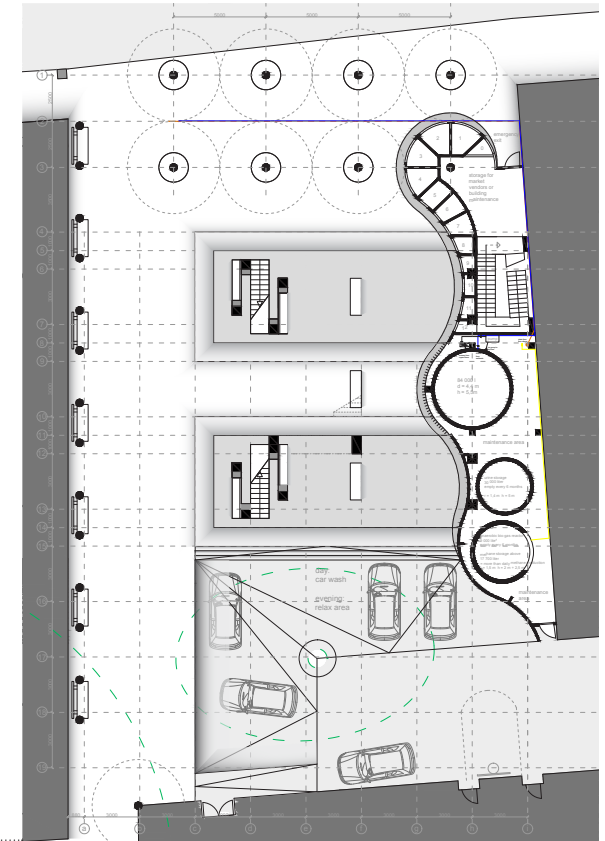


Figure 3.19: plan of the upper floors (all the same). Also shown are the installations in different colours.

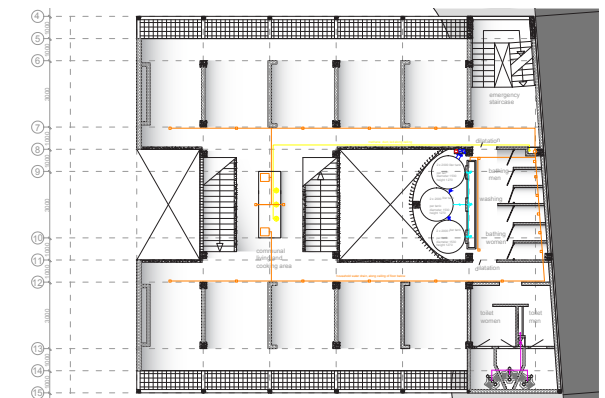




Figure 3.20 overview photograph of the scale 1:50 model.

## EXPRESSION

The urban context of the Baixa and the rest of Maputo offers a variety of options regarding the general expression of the design proposal. The frivolous and creative textures and shapes which characterize many of the concrete structures built halfway through the twentieth century are inspiring and rich in expression. Where concrete buildings built in the western world tend to be very sparsely decorated, the use of concrete seems to have been reinvented in Maputo to build detailed concrete textures.

The colonial style introduced by several European colonial powers adds to the general variety of the Baixa. This is also a style with a relatively high degree of detail, but on a smaller scale than the twentieth century concrete. Add to this the indigenous style made with reeds and wood, together with the creative shapes, volumes and curves of many structures in Maputo, and it can be said that Maputo offers an extreme variety of styles to link with. These many different styles, often side by side, imply another characteristic: the heterogeneity of the built environment in Maputo.

As the design proposal for the urban informal living structure has no need to dissociate itself from the context, it not having the pretence to be a revolutionary icon of architecture in Maputo, it follows the expression of heterogeneity and links into several different styles, though primarily the use of concrete in frivolous shapes and detailed textures.



Figure 3.21: what started as a rough design sketch ended up being cast in actual concrete in the 1:50 scale model.

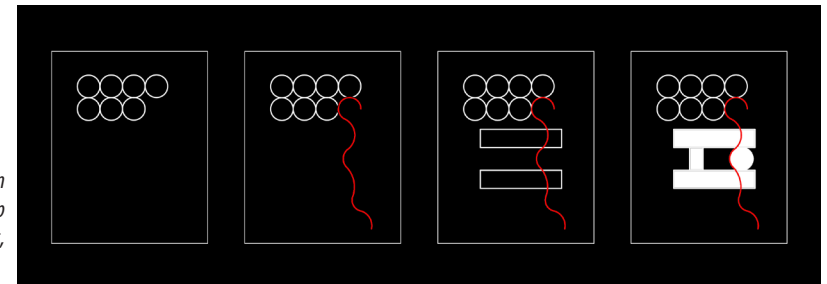


Figure 3.22: diagram showing the build up of shapes and volumes, and their connection.



Figure 3.23: different shapes, volumes and textures come together in a very heterogenic design.



*Figure 3.24: the texture on the northwestern facades creates a characteristic image, relating to the frivolous textures seen elsewhere in Maputo, but also stands in contrast with the informal and less structured other two facades of the building, which are to be "coloured in" by the inhabitants.*

## CONSTRUCTION

The load bearing structure is made entirely of reinforced, in situ cast concrete. Consideration for this choice have been primarily that concrete is the common construction material for multi storey buildings in Maputo. Also, concrete being relatively cheap has been reason for this choice. Joints between the column structure and the beams are fixed. Concrete floors, also cast in situ, span between the beams. The height of the floor works together with the height of the beam to provide a combined sufficient height to span between two columns. The communal kitchen floors and the staircases, spanning between the two volumes with living units, has a separate column structure but its load is eventually brought down to the main support structure. The semi round floors with the watertanks on them however, are entirely stand alone and even have a separate foundation because of the enormous weight of the water tanks when full.

The section on the following page illustrates the beams running along the length of the floors, and the floors themselves spanning over the top, cantelevered on both sides.

The walls separating the living units are made of locally produced concrete blocks. This is a very common building material used in informal settlements, as it is relatively cheap, widely available because of its simple manufacturing process and easy to build with. The same blocks stacked on their side create the texture of the entire northwest facade.

All plans, sections and technical details are collected in appenix b, together with a spreadsheet with all the dimensions of the foundation, columns, beams and floors, as well as the loads on them.

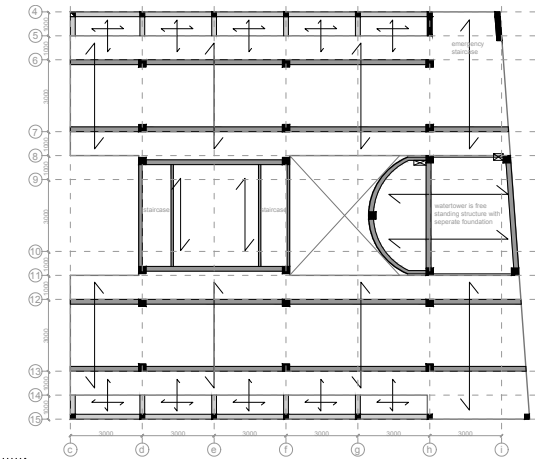


Figure 3.25: the thick grey lines indicate beams, the columns are filled black and the arrows show the span of the floors on the beams.

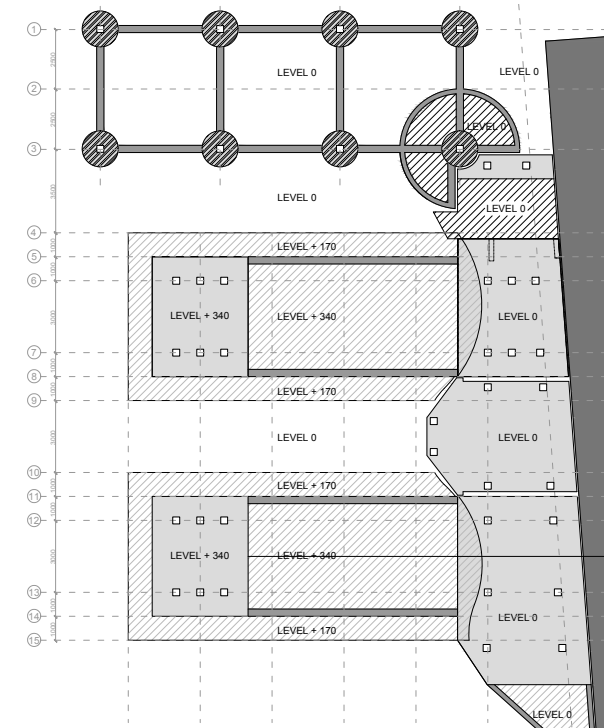


Figure 3.26: the foundation for the structure is made up of different sections, not necessarily connected. The "water tower" in the centre and the umbrella columns in front of the building have their own foundation.

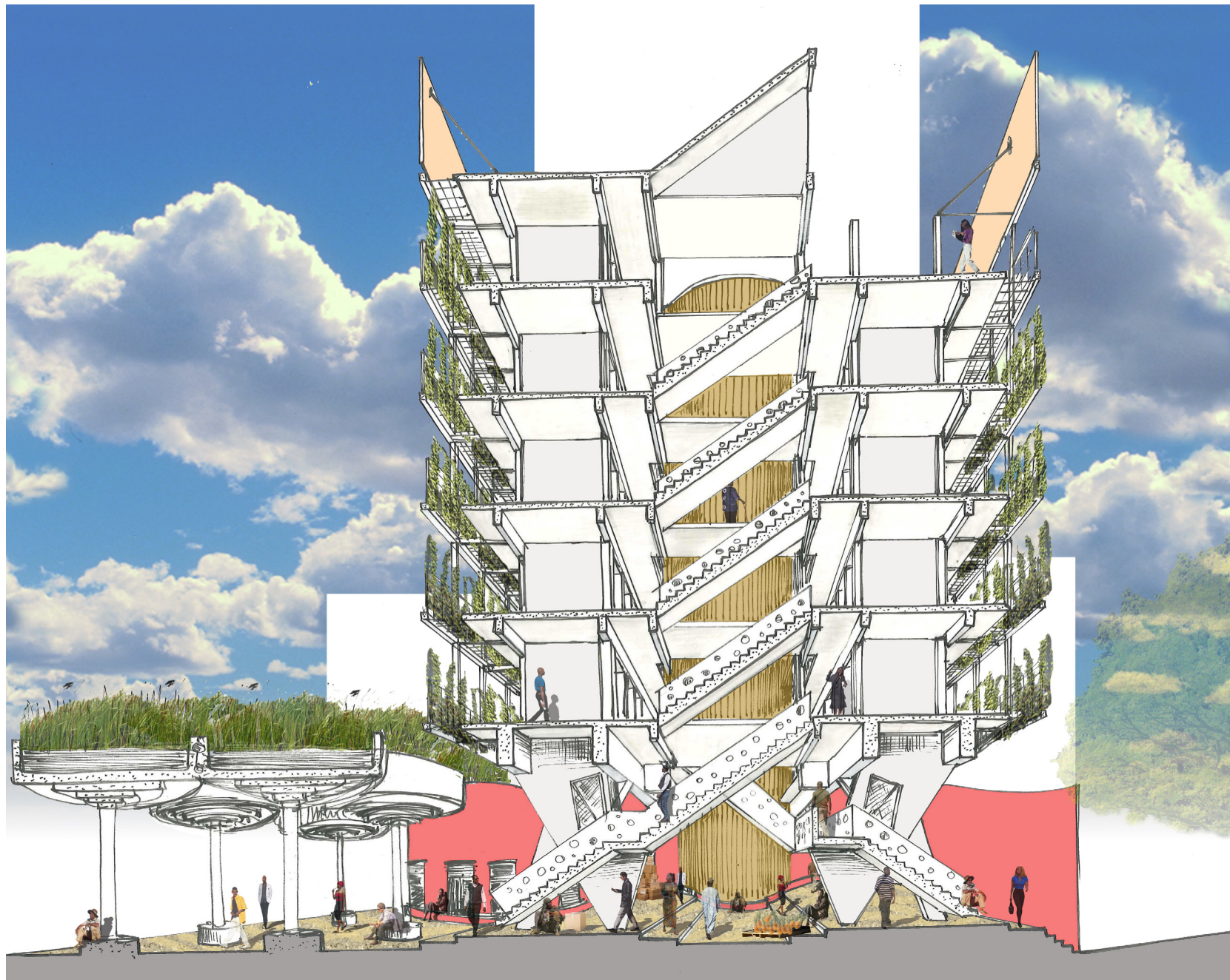
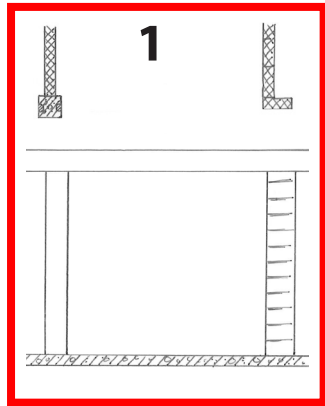
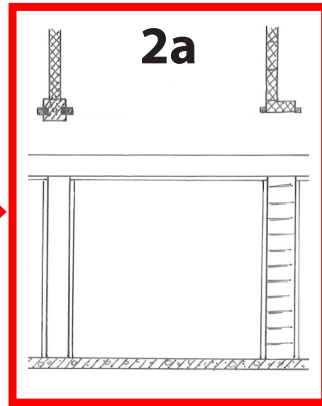


Figure 3.27: section, across the outer staircase, clearly shows the simple structural system of the two main living volumes, and the stairs connecting them.

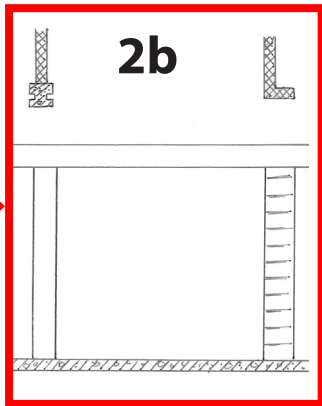
**Possible system for improvised "informal facade"**



Wooden beams are cast into concrete columns in the construction phase.

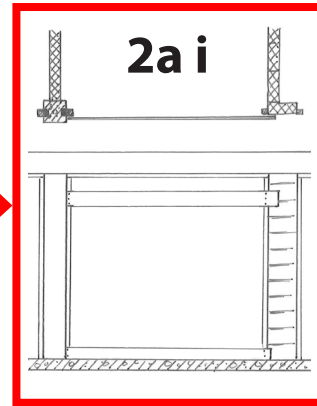


A second wooden beam is attached to the first, to provide a ledge.

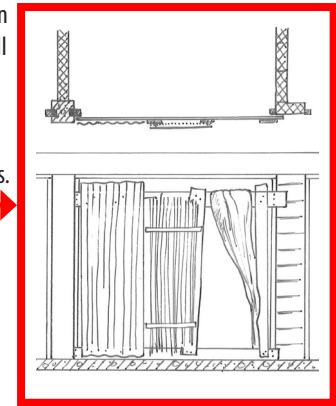


Over time, with lack of maintenance, the wooden beams could well disappear from or rot out of the concrete columns.

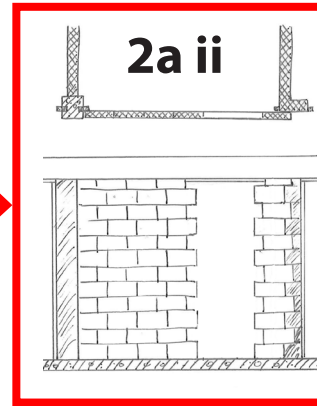
A wooden frame, made of scrap wood, can be fixed to the primary wooden beams.



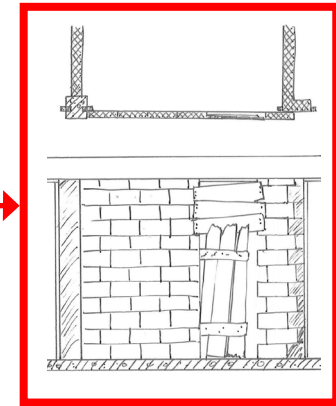
The wooden frame can be made to support all kinds of facade covers and sheeting, such as reeds or corrugated plastic or metal sheets.



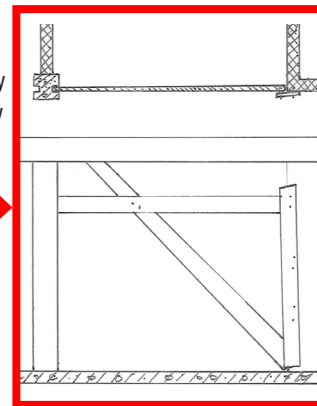
A wall of concrete blocks is built against the ledges provided by the beams.



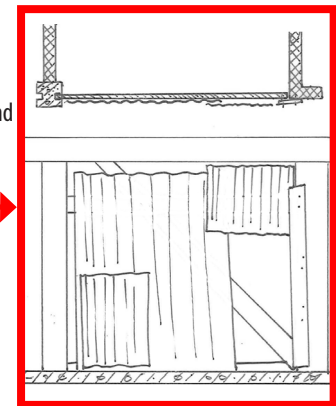
The concrete block wall can include a wooden door or window, and/or a ventilation opening.



*No problem though!*  
The void left in the concrete can be filled by improvisation with new fixing materials.



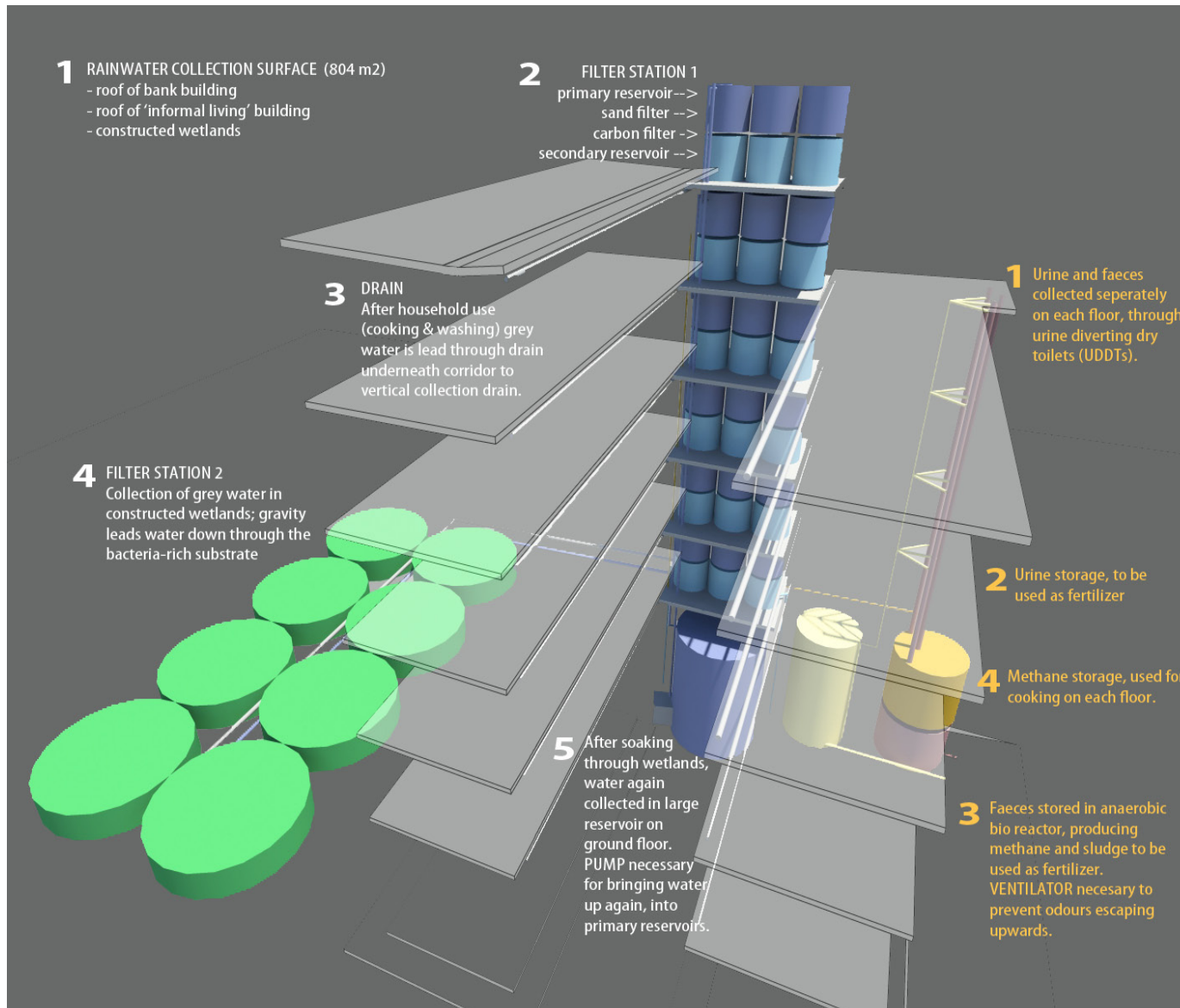
Once a base facade construction is in place, it can again be covered with any found materials.



### 3.4 SUSTAINABLE SYSTEMS

#### WATER SYSTEM

- collection (1)
- treatment (2)
- distribution
- use
- collection (3)
- treatment (4)
- collection
- distribution (5)

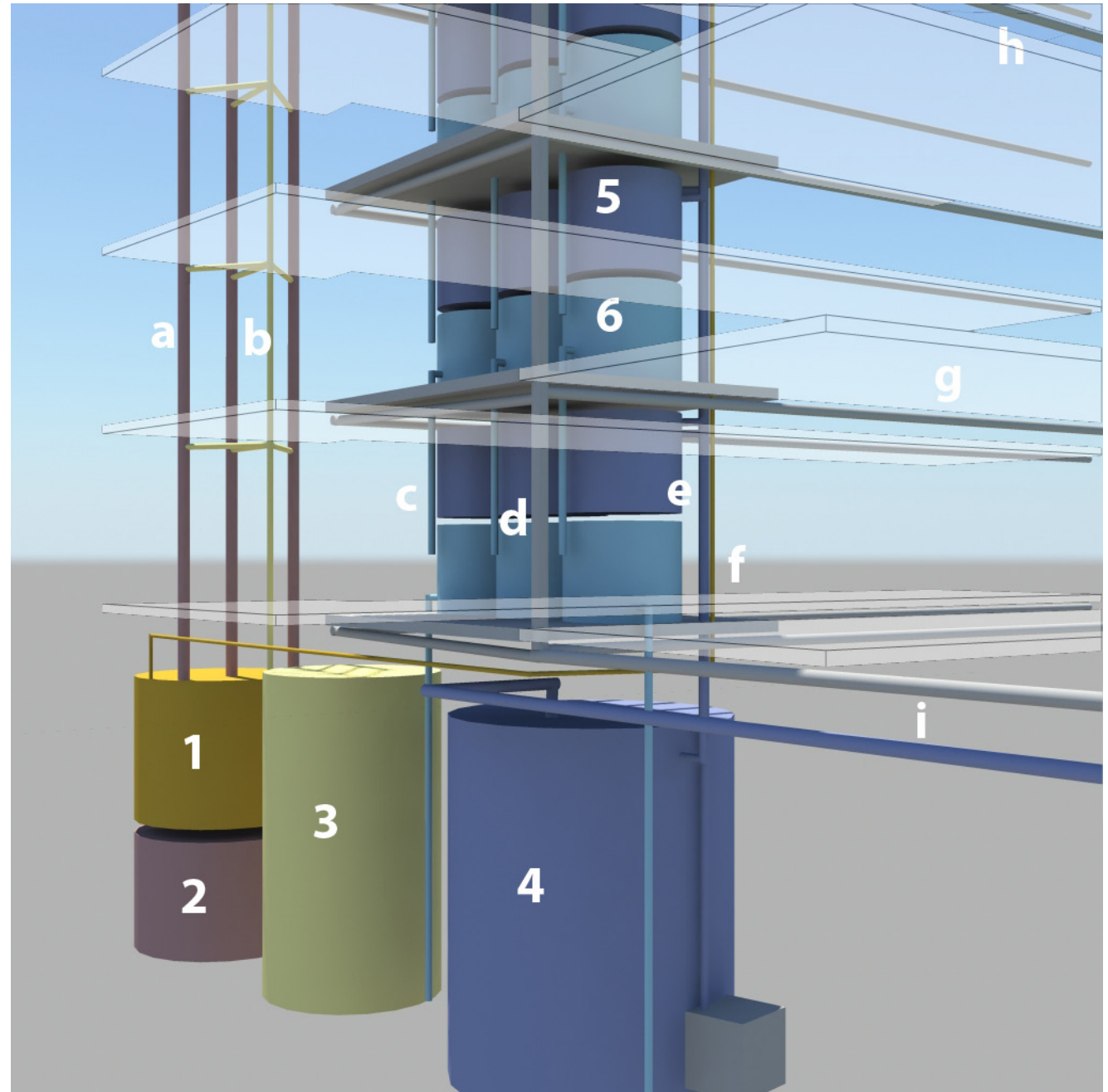


#### WASTE SYSTEM

- toilet use (UDDT)
- collection
- storage fluid (2)
- storage faeces (3)
- methane production (3)
- methane storage and distribution (4)
- fertilizer selling

## Installations system

Note: this view of the installations is not realistic, as this would be the view looking through the blind facade of the bank.

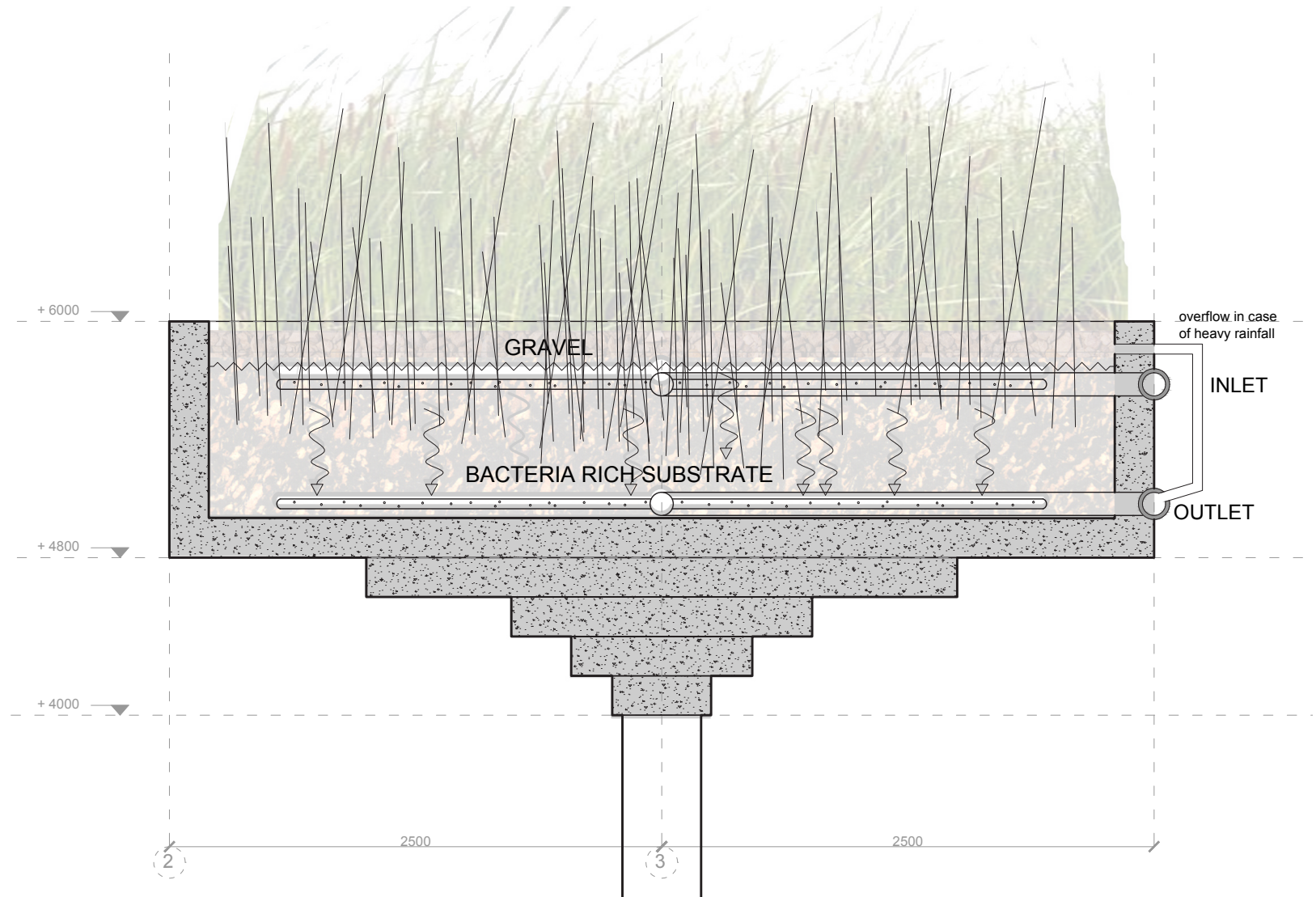


<b>water drainage and supply</b>		inside diameter
h	rainwater drain along top corridor	150 mm
-	standpipe drain rain water	150 mm
g	household water drain along other corridors	69 mm
d	standpipe drain household water	150 mm
i	pipes to and from wetlands	150 mm
e	pipe for pumping water from large reservoir to top floor	45 mm
-	overflow pipes from floor to floor	125 mm
-	emergency overflow from roof to ground floor reservoir	150 mm
c	tap water supply, from reservoir on each floor	15 mm
<b>toilet drainage</b>		
a	faeces vertical drop	110 mm
-	urine drain per toilet	50 mm
b	standpipe urine drain	110 mm
<b>Methane gas</b>		
f	standpipe, supplying all floors,	27,2 mm
-	horizontal pipe, per floor	12,5 mm
<b>storage tanks</b>		capacity
1	rigid, inflatable methane storage	17700 liter
2	anaerobic biogas reactor (remove sludge every 6 months)	9000 liter
3	urine storage (empty every 6 months)	30000 liter
4	large water reservoir	84000 liter
5	primary reservoir, with sand filter & carbon filter	2000 liter
6	secondary reservoir (drinking water)	2000 liter

### Section of constructed wetlands (*helofyten filter*) on umbrella column

Grey household water (no toilet water!) is led into the wetlands at the 'inlet' level, evenly spread over the surface of the filter. Through gravity, water flows to the outlet level. Along the way, the bacteria in the substrate, fed oxygen through the reeds growing from it, react with the organic pollutants in the dirty water, purifying it.

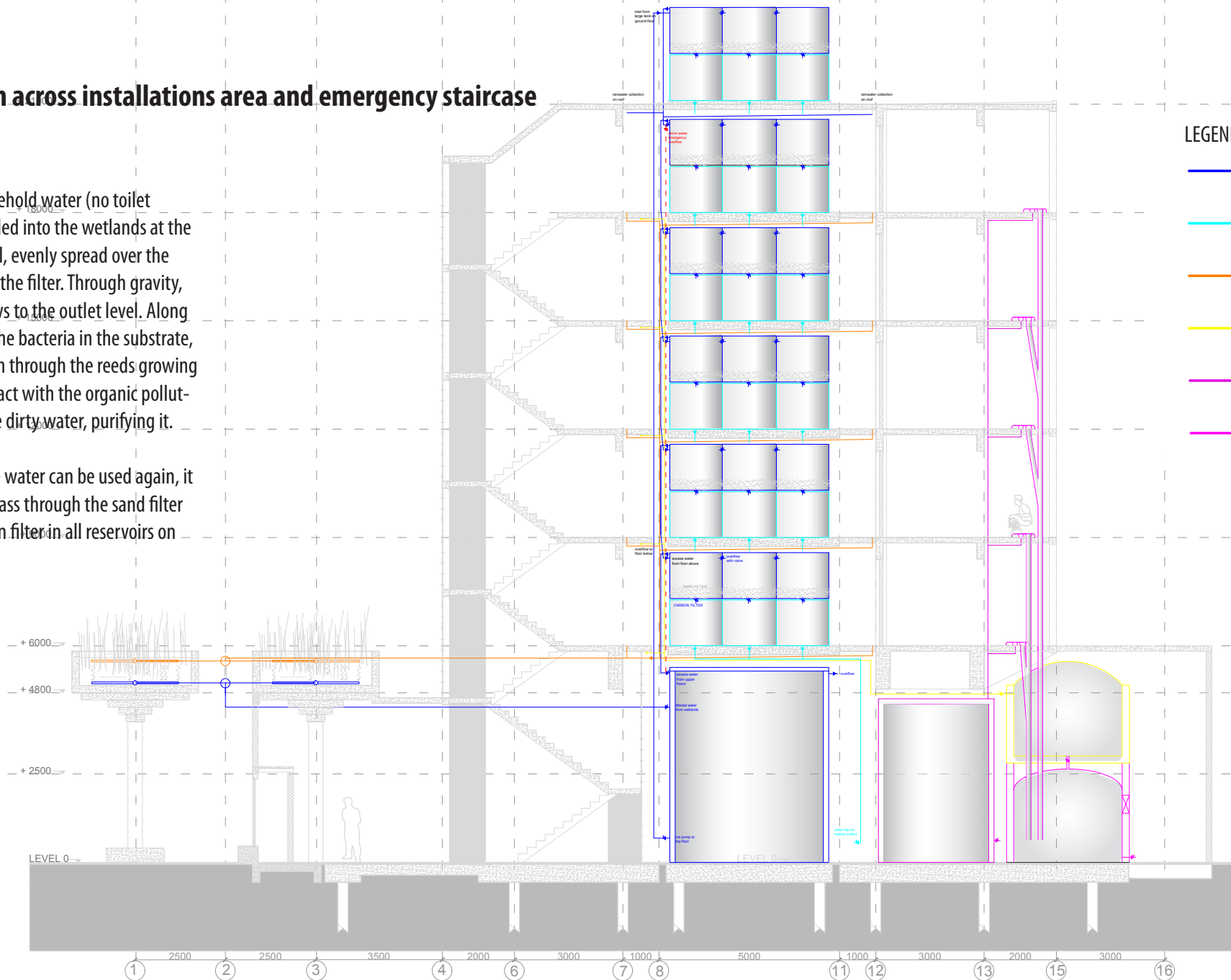
Before the water can be used again, it will also pass through the sand filter and carbon filter in all reservoirs on each floor.



### Section across installations area and emergency staircase

Grey household water (no toilet water!) is led into the wetlands at the 'inlet' level, evenly spread over the surface of the filter. Through gravity, water flows to the outlet level. Along the way, the bacteria in the substrate, fed oxygen through the reeds growing from it, react with the organic pollutants in the dirty water, purifying it.

Before the water can be used again, it will also pass through the sand filter and carbon filter in all reservoirs on each floor.



**LEGEND**

- unfiltered rainwater
- filtered water
- household drain water
- methane gas ducts
- toilet - urine
- toilet - faeces

## 3.5 OPERATIONAL FINANCIAL PLAN

### INITIAL COSTS

#### Building costs determinants:

surface area of one floor (m2)	270
total gross floor area (GFA) (m2)	1215
cost of structure per m2 GFA	400

building costs structure	€ 486.000
building costs water & waste installations	€ 50.000
cost of plot	n.a.

<b>Total investment necessary</b>	<b>€ 536.000</b>
-----------------------------------	------------------

### EXPLOITATION COSTS (per year)

interest (4% of investment)	€ 21.440
maintenance of building (1% building costs)	€ 4.860
maintenance of installations	€ 2.500
Electricity common rooms	€ 5.000
Concierge / caretaker	€ 3.000
Profit for investor	€ 25.000
Debt amortization	€ 23.000

<b>Total exploitation costs (per year)</b>	<b>€ 84.800</b>
--	-----------------

<b>Debt paid off in # years</b>	<b>23</b>
---------------------------------	-----------

### REVENUES

rent per living unit / month	€ 50	
# living units	45	
		€ 2.250
rent per inhabitant / month	€ 10	
# inhabitants	70	
		€ 700
rent per stall / month	€ 50	
# stalls	12	
		€ 600
informal vending facilities pp / month	€ 10	
# informal vendors	20	
		€ 200

<b>Total rent revenue (per month)</b>	<b>€ 3.750</b>
---------------------------------------	----------------

<b>Total rent revenue (per year)</b>	<b>€ 45.000</b>
--------------------------------------	-----------------

sale fertilizer	average price / tonne	€ 400	
	solid fertilizer (ton/yr)	12,4	
			€ 4.960
	average price / tonne	€ 200	
	urine (ton / yr)	50,4	
			€ 10.080

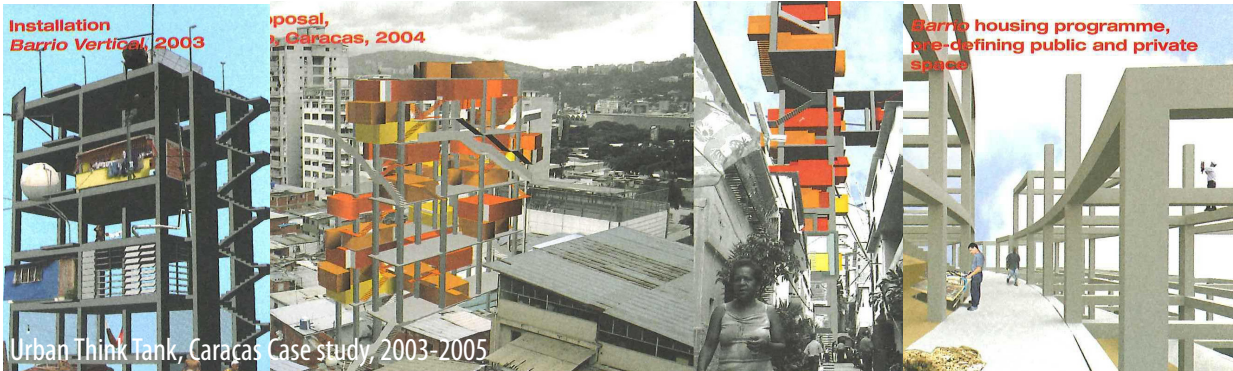
Billboards above facade		
front (north-west)	€ 15.000	
rear (south-east)	€ 10.000	

<b>Total revenue (per year)</b>	<b>€ 85.040</b>
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#### QUICK CONCLUSION:

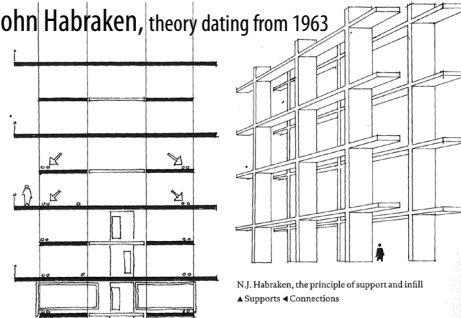
With a "soft loan" 4% interest and a steady level of income, the investment could be covered in 23 years, with the investor even making a yearly extra profit on top of the interest!

### 3.6 REFERENCES

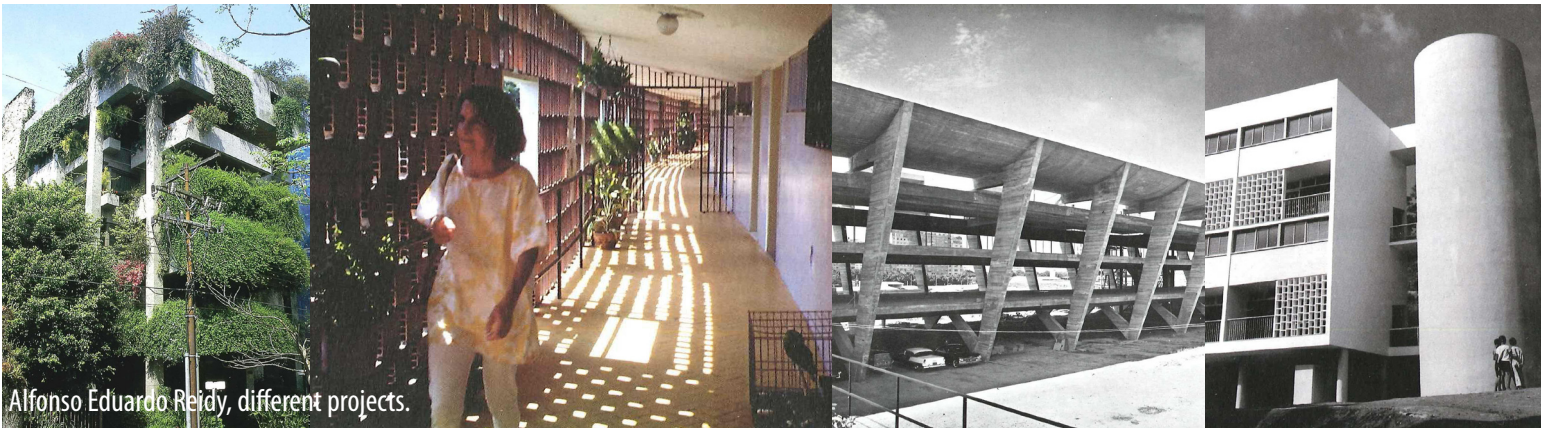


Costa, LeCorbusier, Niemeyer, Rio de Janeiro, 1936

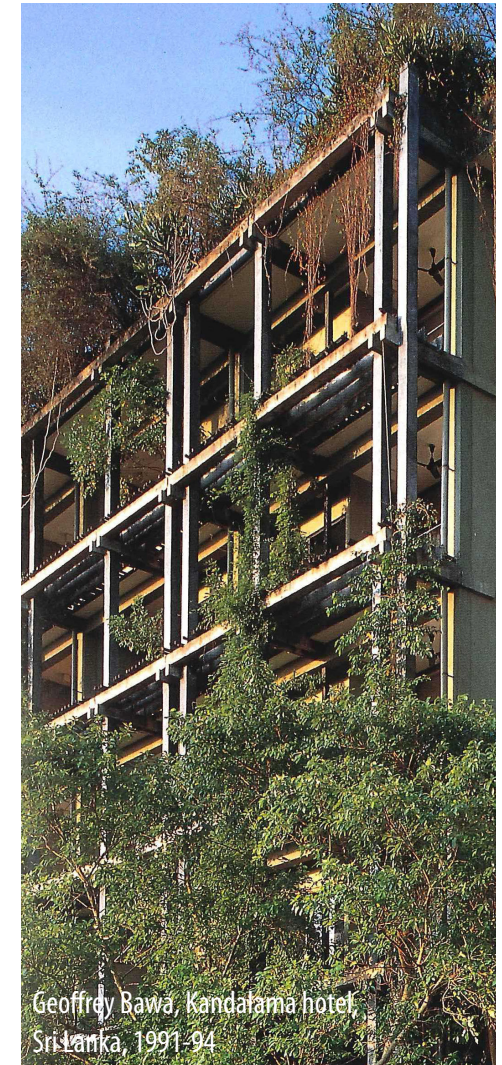
John Habraken, theory dating from 1963



N.J. Habraken, the principle of support and infill  
▲ Supports ◀ Connections



Alfonso Eduardo Reidy, different projects.



Geoffrey Bawa, Kandarama hotel, Sri Lanka, 1991-94

# part 4 REFLECTION



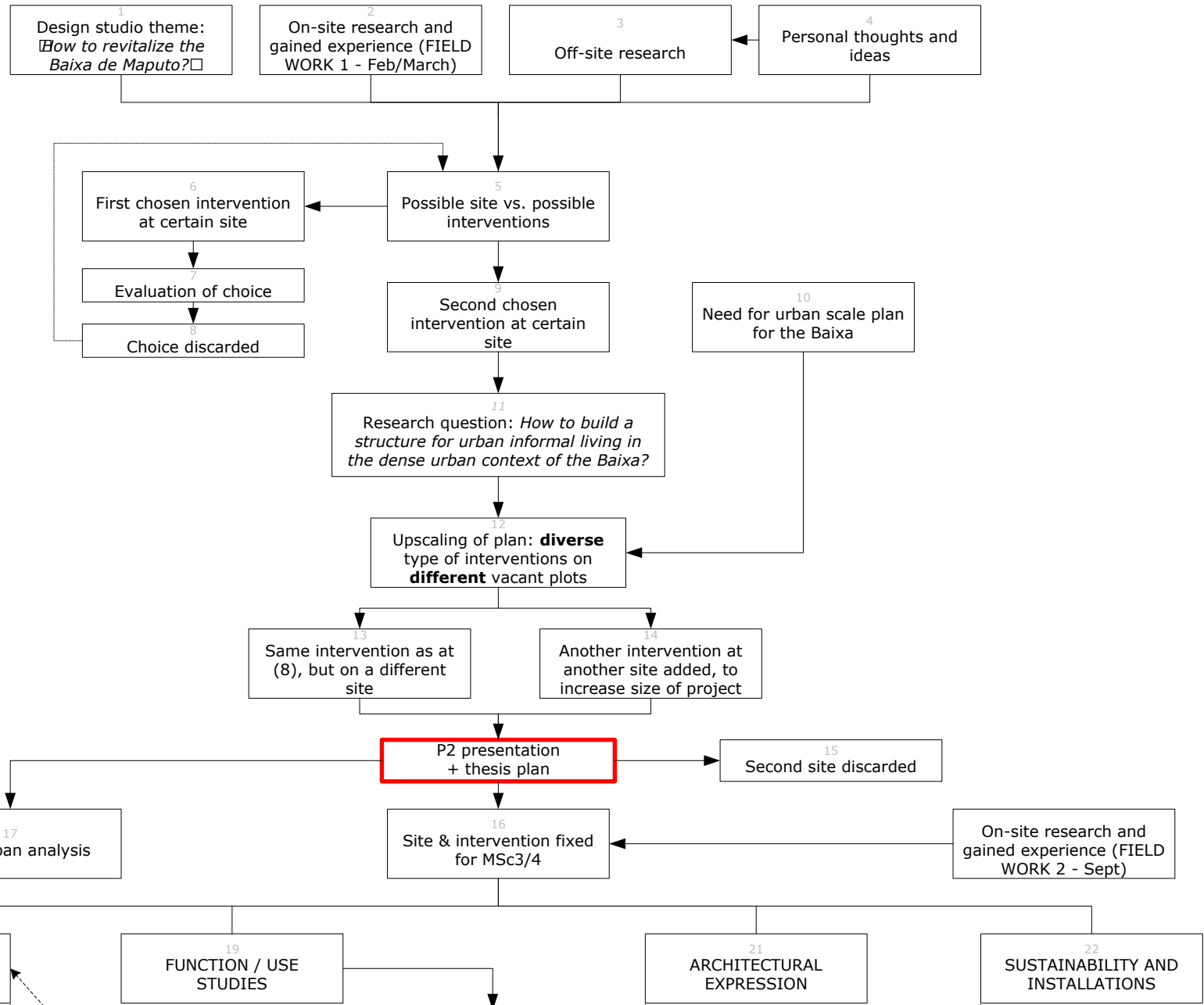
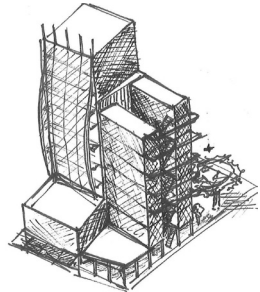
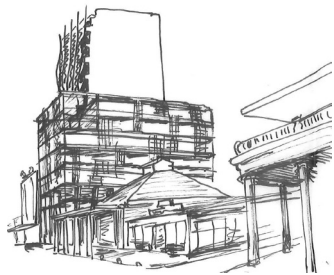
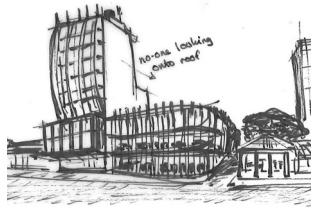
Photographs taken during Mafala site visit (MvB)



- 4.1 *Design process*
- 4.2 *Conducted research*
- 4.3 *Reflections on research*
- 4.4 *Recommendations / questions for the future*



# 4.1 DESIGN PROCESS





## Explanation of steps in the design process

1. What is 'revitalization'? What is the Baixa de Maputo? What scale of design is expected? What is the context? This theme could be split into three parts: the revitalization aspect, as in what does it literally mean (and also linked to one of the RMIT core themes), the Baixa de Maputo aspect, which I studied through maps and photographs, and thirdly the idea of something being 'wrong' with it, for there to be such question put forward by the city's municipality. In retrospect, I didn't give much attention to the first aspect at first.

4. Own interest led to the idea of providing a multifunctional building, as intuitively I expected such a structure to provide interesting design options and offer more than one solution to the local problem. At this moment in the design process however, the necessity for what type of intervention and at what location was still very open, leading to many different possibilities for a design, such as the sketches in figure 4.1.

5. First design thoughts that came to mind were either not very much related to the context or either very flexible in use and generally economically driven, as if to strengthen the already market driven atmosphere in the Baixa. The first shortlist of ideas was put down to make a quick start in the design process. None of the four ideas were very much bound to one location. However, simultaneously, several locations were spotted which had little or no current function (i.e. 'vacant plots').

6 / 8. See figure 4.3. The design proposal was too little context bound. It responded poorly to the rest of the Baixa, though it did try to follow the existing of building volumes. Moreover, its scale was very large, which was not justifiable enough (at the time). A valuable and bold first design proposal though.

9. The chose intervention at this stage formed the basis of the eventual design proposal as presented in my final presentation. The reaction to the physical and social context are more clear and the first signs of the project going to be a social one started to appear.

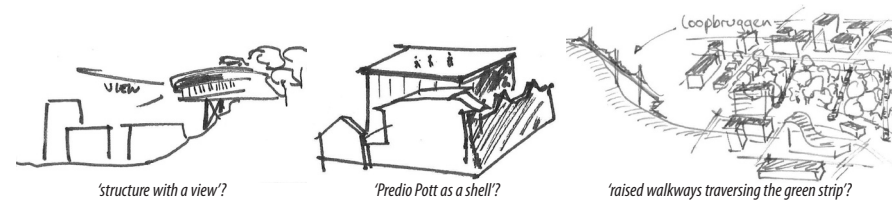


Figure 4.1: first sketches of thoughts for a design intervention in the Baixa.

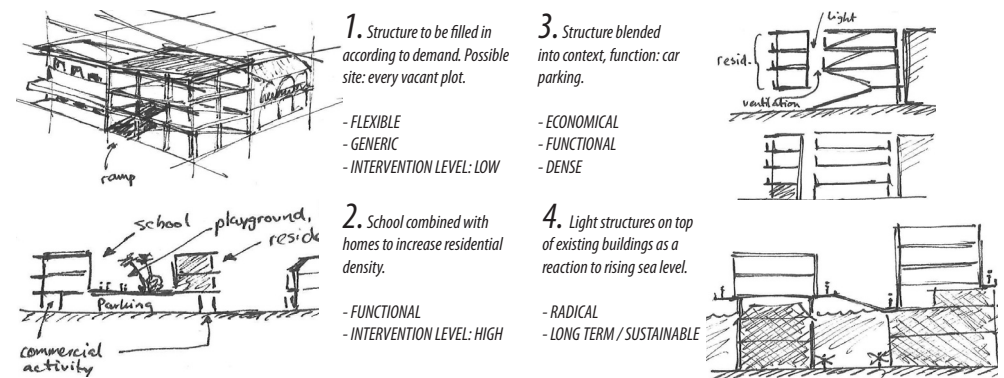


Figure 4.2: early shortlist of four possible interventions for the Baixa.

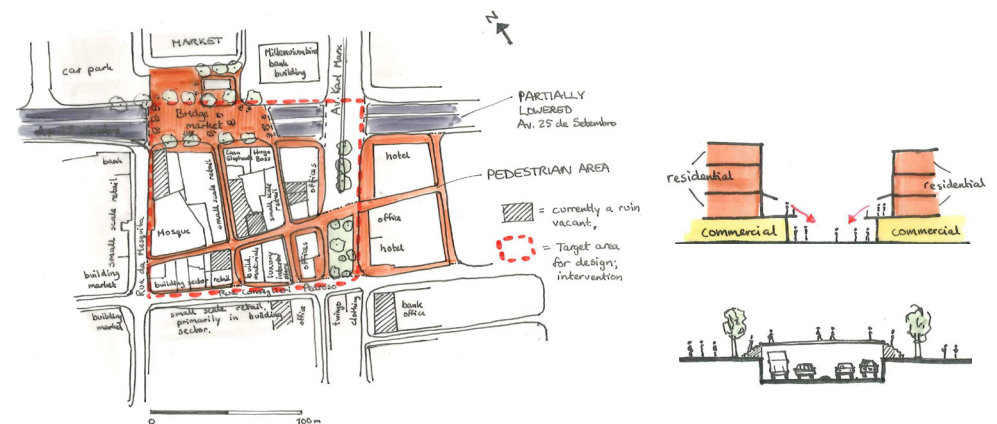


Figure 4.3: first extensive design proposal for an entire Baixa block to be redesigned, adding functions and crossing over the Av. 25 Sept.

11. The very poor standards of living for homeless and the poorest social class in the Baixa led to me wanting to look into the possibilities of using the currently vacant plots to house the homeless in the most simple and temporary construction possible. The challenge being both the technical aspect and also the social and physical context of the Baixa. Because would neighbouring offices and shops accept a type of semi-organised informal housing to be set up next to their plot? And what is the best way to combine multi-storey office blocks with a low, concrete structure? (figure 2.?)

12. Due to the design on a single site needing to be linked to a larger scale plan to make the concept of a small intervention with expanding effects work, the concept was translated to several vacant plots close together (figure 4.4). The plots were to be physically linked by a system of walkways. These walkways were to offer a number of different possibilities: allowing car-free pavement, areas for informal vending and extra storm drainage. However, the interventions were to numerous and I went from many interventions to only two on two different sites.

16. After the P2 presentation, it turned out that the fear for the project becoming too small, which had led to me increasing its sphere of influence earlier in the process, was not necessary, and it was decided to continue working on a single intervention on a single site, merely linked to a larger urban scale plan. The intervention was still to have a social taste, but all functions were not fixed yet (figure 4.5). NOTE: the self-sufficient waste and water system were already introduced at this stage.

17. Extra urban analysis led to the following sketch of the 'Baixa built volume development'. This helped find a suitable building volume for my design proposal, relating well to the context. (figure 4.6)

18. I spent a lot of time deciding on the type and size of volume which would fit well into the context. Scale models helped clarify what sizes would definitely not fit well, but the Baixa building morphology and the type of use of the building eventually had the largest impact on the volume.



Figure 4.4: urban plan for different functions on each vacant plot, linked by (raised) walkways with facilities, shown below.

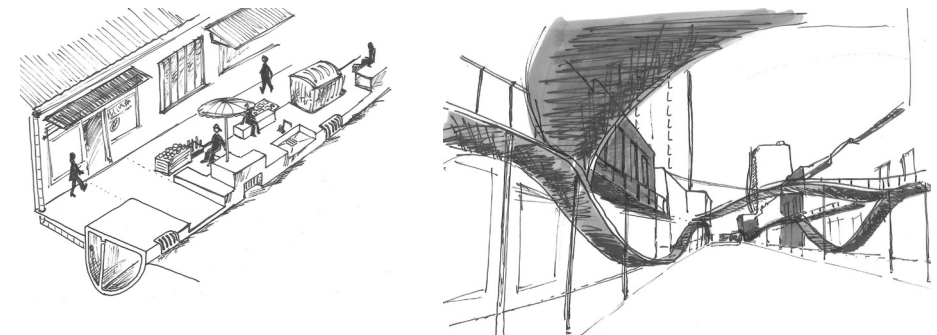


Figure 4.5: architectural intervention focused on one single vacant plot.



19. Research into 'intangibles' was very important for finding the needs of possible inhabitants (B3). The local way of living differs immensely from what I have experienced living in western countries. The expected way the target group will use such a building is based on examples of living found in the Baixa and elsewhere in Maputo.

22. The sustainability subject was woven through the design from an early stage, but has changed substantially throughout the design process. Talking to a sustainability expert at the faculty led to a separation into two flow systems not influencing each other. A lot of research into reference projects helped assure me that it in fact is a realistic plan.

24/25. As the concept of the building became fixed, it was important to look at the technical feasibility of the plan. Concrete structure calculations and installations calculations brought the design from entirely conceptual to something which could actually be built without falling down. Specific tutoring on the technical aspects helped both to signal problems and offer solutions.

26. Following the P3 presentation, it was decided to discard the designing for a future function change (such as figure 4.7). Reason being that a future, economically possibly more interesting function would invalidate the very social plan of cheap, informal housing in the heart of the Baixa. Instead of redesigning the building to fit an office or large apartments, it was decided to focus on a simple yet realistic financial operational plan.

27. Though a financial operational plan is not a requirement for an Architecture RMIT graduation design, it does add a realistic note to a slightly utopian plan.

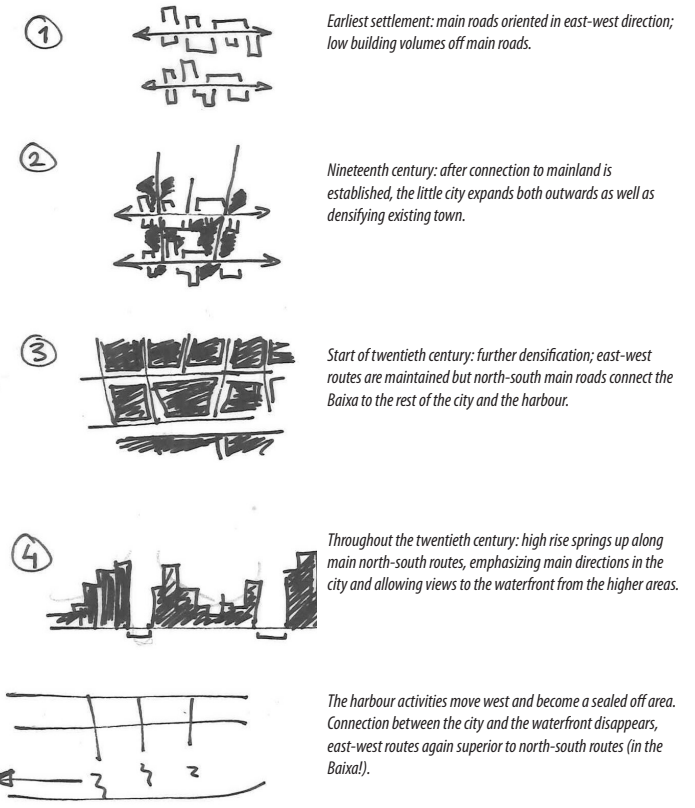


Figure 4.6: Baixa building volumes historic analysis, helping to develop volume of design proposal.

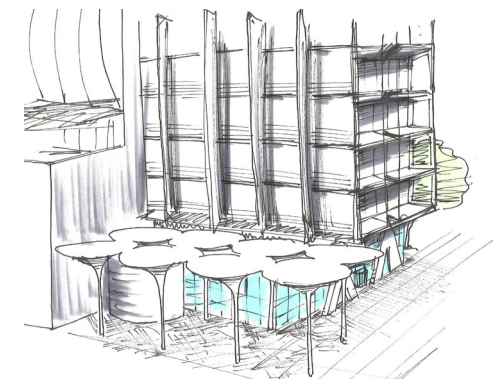


Figure 4.7: a possible future function and appearance change of the original design. Designing for a future function change was later discarded and replaced by developing a financial operation plan.

## 4.2 CONDUCTED RESEARCH

### 4.2.1 What type of research did I do and why?

Preliminary research prior to first visit to Maputo, finding out about the historical background, the type of built environment to expect and local culture. Reason being to gain as much understanding of the city and country as possible before travelling there.

On site research, answering questions such as: how do people make a living? What are the living conditions of people with low income? Where do they live? What is a common building material? What is daily routine? Where do people buy their daily needs? How do markets work?

Literature research, answering questions such as: how has Maputo developed historically? What are current problems in Maputo? How are similar problems addressed elsewhere? What are practical water & waste systems in a subtropical environment?

### 4.2.2 How did I do my research?

Research in Maputo consisted primarily of visiting specific sites and locations which had been determined beforehand. Visiting consisted of extensive walking around, if possible making sketches and photographs of interesting elements or views, and talking to people living or working at each location. The interaction with these people was essential to understand their way of living. By only taking photographs it is extremely difficult to later understand in what way elements and items on the photograph are to be used. Example: (figure 4.8) photograph of an apparent toilet hut, used by two families, however with two words on each of the doors of which the definition is not even known by the UEM students! Does it refer to a different type of toilet use or to a man/woman differentiation or maybe even a division between the two families? I do not know. However, at that specific location we spoke to the inhabitants about other characteristics of their way of living, which have proven to be valuable for my design. Example are the water and electricity meters, which allow families with only little income to be very economical with their water and electricity use (figure 4.9).



Figure 4.8 toilet facilities shared by three families, Mafalala neighbourhood, Maputo. (EW)



Figure 4.9: water supply with meter, shared by three families, Mafalala neighbourhood, Maputo. (EW)

### 4.2.3 Different scales of on-site research

The on-site research can be divided into three subcategories, each of a different scale and with a different goal: 1.) research around my building site: 2.) research within the Baixa and 3.) research on the outskirts of the concrete city.

The first, smallest scale research was aimed at answering questions such as: *what goes on there during the day? In the evening? What happens in the immediate surroundings? What is the atmosphere like (intangible!)? What are the dimensions to use in a design proposal?* It consisted of spending a lot of time hanging around the site, trying to register movements through and around my site (for example: tally of vehicles passing by in a certain time), mapping as much as possible what functions currently surround the site, and talking to people actually living(!) in the ruin which currently marks the area which I have identified as ideal for an intervention. I spoke to Angelo (figure 4.10), a homeless orphan, 20 years old, who sometimes sleeps within the few walls that remain standing on my site. He earns an income washing cars and moving goods around the central market. He is well-fed and well-dressed, but lacks a roof above his head. The building I am designing would suit him very well, as he could share a few living units with his homeless friends and continue the little already existing community within an actual building. This would offer Angelo and his companions, who he introduced to me and are both men and women, of different ages, an opportunity to spend more of their time making a living and not having to bother about finding shelter every evening.



Figure 4.10: a young man named Angelo, who frequently sleeps inside the ruin. (EW)

The research within the Baixa, but on a larger scale than only my site, was based on getting to know about the local building technological characteristics and the way people use the Baixa. *What is the level of detail in facades? What is the building height of every single building? What is the function of every building? Are there many vacancies?* This was done by again extensive walking, observation from a fixed location and by doing both surveys and counting on the streets, with the help of UEM students. These last two methods of research were well prepared and structured, necessary when working together with several people, but the observation was done very randomly and instinctively. Also the walking around was reasonably random and not planned beforehand. Downside is that this way the results of the “research” cannot be easily predicted, but on the other hand results might pop up which had not been anticipated or expected! And especially in a foreign city, with an entirely different culture from what I’m used to, I find it important to ‘experience’ the city to a certain extent, with less of a prepared plan. Fortunately, walking around in the Baixa is a very pleasant experience, with numerous places to rest shortly, make a sketch, make small talk with local kids hanging around, buy a bottle of coke or a beer sold on the street and attempt to experience the Baixa as the inhabitants do.

Research further outside of the Baixa, even outside the Maputo city borders was aimed at answering questions such as: *how does the dense built environment disperse as travelling further away from the Baixa? Do homes look different? Are these communities within a large city linked together? What are the means of existence people have here? What are the different types of informal living, and where are they found?* The research on the outskirts of the city was partially planned beforehand, but also in the hands of the drivers who drove me around (I made two day trips with two different drivers). The limitation of this method is the dependency on the drivers, logically. However, I visited different types of urban settlements within and just beyond the Maputo city boundary, which stood in stark contrast with the Baixa I had grown to know so well. Questions leading me at the time were: Again the method of recording this experience was largely done by sketches (such as the rough sketches in chapter 2.2, page 22), photographs, and little notes. These apparently random notes and remarks come together when reliving the field trip afterwards (*post production*). Only at that moment, do the experiences gained in the streets turn into valuable research results.

**4.2.1 Research example - "Predio Pott"**

As an example, and which has helped me in my design, I would like to shortly focus on the Predio Pott, which, though never designed as such, is a building which in use approaches my design. It is located on the border of the "old Baixa", and on the corner of one of the most important intersections in the entire Baixa. What characterises this burned down ruin, are (architecturally) the historical facades, still standing, and (in my opinion more important), the social function: homeless people inhabit the little rooms on what is left of the upper floor, and the ground floor is used as garbage dump, with homeless people scurrying around. (Note: the photograph above right was taken on a Sunday, when there is little activity in the Baixa.) Also, little stores are nestled into the façade, with informal vendors around them. The run-down and dirty area along the long façade leads to there being less informal vendors and social activity than on the other side. Much of the ground floor is closed off, therefore not tempting visitors further inside than a quick look at the façade. In the quick sketch below, a section of Predio Pott shows the closed-open build up while my proposed design is the other way around, to make more use of the ground floor and to provide more sheltered living above.



Figure 4.12: long facade of Predio Pott, on a Sunday. (MvB)

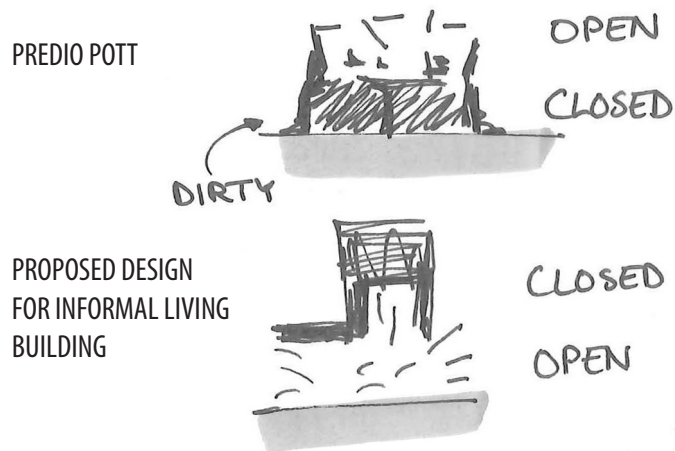


Figure 4.11: proposed design intervention to be the inverse of Predio Pott, though with similar function.



Figure 4.13: little improvised living unit on the upper floor of Predio Pott. (MvB)

## 4.3 REFLECTION ON RESEARCH

### *Research by design - 'sketch research'?*

When flipping through sketches and pictures of little models made the last 10 months, it becomes clear that much of the research into finding the ideal solution for the problem to be responded to by this design studio, follows from making many different variants, all in some way or another offering a (part of a) solution. The main problem ('how to revitalize the Baixa de Maputo') is divided into many different issues, all to be looked at separately, without disregarding the other issues. Throughout the past graduation period, I have looked at many of these issues, trying to treat them all. Naturally, they cannot all be treated equally, and a selection is made as the project develops and certain aspects turn out to be more important than others. The issues that have had the most attention, such as the building volume for example, have seen many different answers. Many of these 'answers' can be disregarded short after they have been produced, but to my mind, they give structure to the way the design is developing. Shortly put, it becomes clear what is *certainly not* the answer. As this number of false answers grows, the more 'correct' answers will start becoming clear. This method I applied for a number of different scales, such as the urban scale, building scale and detail scale. Many of the low-tech detailing solutions incorporated into my design often follow from a series of developing sketches!

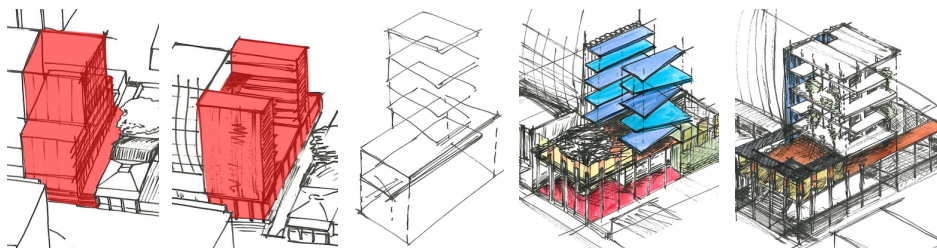


Figure 4.14: development of the building volume. Throughout the process volumes made way for floors and facades.

It must be very clear to the reader of this reflection that making series of sketches has helped me tremendously in reaching the final design. Only the pressure of time or my own opinion of having reached a satisfactory design solution to a certain problem determined if and when I would choose for a certain option, from a set of different options. This would not necessarily be the last sketch in a series, as that would usually be a too far-fetched solution. Also, comments from tutors influenced the moment when a part of the design was considered to be satisfactory, for the moment at least! Finally, in my opinion, I do not find it very hard to make decisions when it is necessary. Decisions need to be made in order to continue the design process. I understand that and therefore will not dwell unnecessarily long on elements in my design.

It would be unwise to pretend all research has come through design or field experience. The more technical aspects of my building are often partially based on information gathered from books and articles. Also, the internet offers many low tech and up to date solutions for, for example human waste disposal systems which I have added to my design proposal. This information comes directly out of regions in developing countries where these systems have been implemented, making it very valuable first-hand knowledge. Furthermore, it would be naïve to expect such information to be formally published and bound within the near future. The internet is the developing country's library!

Having made extensive use of sketches for researching elements in my design, both in preliminary stages and in the end phase, the type of research could be referred to as "*sketch research*".

### *Has research influenced the final design?*

The relationship between research and my design is very strong as much of my design results from the method of 'research by design'. Many of the issues that have been separately looked into (researched) have found a place in my final design. Therefore it can be said that the research has had a very large influence on my design. What made an issue important enough to be looked into? On one hand personal interest fuelled many of these little "missions". Wanting to put my model into an wind tunnel at the Aerospace Engineering faculty didn't work out in the end, as it would have probably torn my model to pieces, but other interests, such as the sustainable and affordable water system, have become quite a substantial part of the project. On the other hand,

necessary issues, such as the way such a building I was proposing was expected to be run, or the concrete structure, needed to be looked into anyway.

Reflecting on the elements which make up my design, I think many of them have been inspired by “research” done in this graduation period. Many social features follow from the informal but also laid back way of life experienced in Maputo, architectural features follow from impressions from Maputo and books on subtropical architecture and the construction of the designed building follows from the possibilities given by the local building techniques.

It is a difficult question to pose oneself if the project one has been working on the past 10 months has a relationship with the theme of the studio. This should be the case, to a certain extent, but a narrow-mindedness could have moved the design project away from the main theme without one noticing it. Luckily for me, the theme of the studio is very general and can be looked at from many different directions. The theme: ‘Revitalizing the Baixa’ offers a range of opportunities, although at first it seems to be primarily on an urban scale. Once going past the urban scale, though using it, it becomes clear that a single, well placed intervention could influence an entire area. My design in the end is a very small scale building on a little urban plot, stuck in between existing buildings, but still I feel as if it does answer to a large scale question, though maybe not in the first instance. In theory, my design should influence the immediate surroundings, through which a larger part of the Baixa should be reached.

Right from the start, I have been debating with myself (through sketches) whether to make a design for the Baixa which would stick out from the context (reaction!), such as the sketches in figure 4.15, or which would fit well into the context through similar volume and texture (interaction!), seen in the sketches in figure 4.16. Making my design link to the urban typology found elsewhere in Maputo, seemed to me to be in line with the aim of the studio, which is to look at urban African contextual design, not only the Baixa of Maputo. Focusing on just the Baixa alone would not be reason to set up this studio. This way, a small scale intervention can answer a question which seems to be of a larger scale. My final design links to the urban typology of Maputo through its public / market function of the ground floor, its height of roughly 7 stories, its predominant use of concrete and its frivolous shapes and facade textures. See chapter 3.2 for a comprehensive explanation of the final design proposal (figure 4.17).



Figure 4.15: very preliminary sketches with ‘reactionary’ designs, which do little to interact with the context.

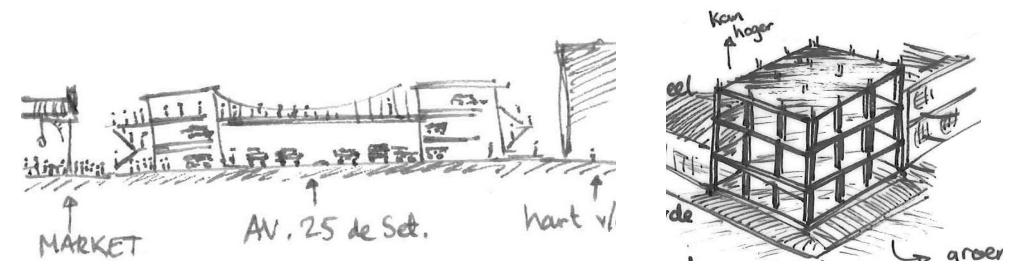
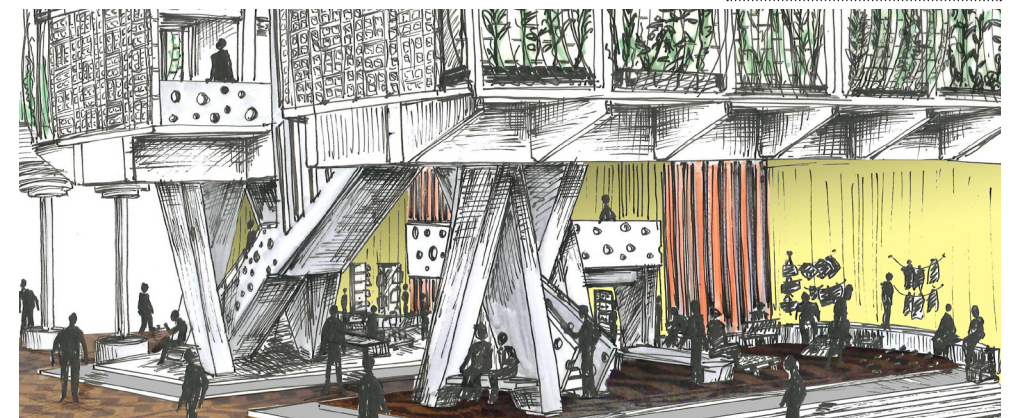


Figure 4.16: relatively preliminary sketches with ‘interactionary’ designs, linked to the context.

Figure 4.17: sketch of ground floor in use with social and retail activities.



When trying to compare my own method of dealing with this project to the 'methodical line of approach of the studio', I find myself wondering what to compare it to. Building on experience gained over the past years at this faculty, my method seemed to come naturally. Deadlines are moments to assess if the method works. If deadline requirements are met and the project seems to be developing (i.e. intensifying and separate elements coming together), then it could be said that the method works well.

Through the analysis, it has been attempted to grasp the social context of this studio. What type of city is Maputo, what do people need, what do people want, where do people want to go? These questions are difficult to answer for a Dutch city, let alone a foreign and African city. However, I have tried my best to respond to in my design a possible desire which the inhabitants of Maputo could have. And moreover, a solution which I believe could work! My design is 100% socially engaged, and linked very strongly to the local social context!

#### *Two trips to Maputo and three collaborating schools of architecture*

The three schools of architecture from Maputo, Pretoria and Delft each have their own approach to and time span for a graduation project, but have attempted to work together. However, due to the only sporadic moments of actual face to face contact, and not being at the same level in the design process at those moments, there has been only little influence from the other universities. The most valuable were the patient answers from the Maputo students to my numerous questions. Having 'local' comments on my project at several moments has definitely influenced my design, for example regarding the development of informal homes and the feasibility of having people from the lowest social class live in the heart of the Baixa.

Also very valuable was the second, initially not planned, visit to Maputo in September 2011. Having decided on a site and a type of intervention made it possible for research to be more focused and better planned beforehand. Such as the measuring of the site, talking to more people in the Baixa, and the trips to the outskirts of Maputo.

*Figure 4.18: sketch made in September 2011, showing living units above a public and open ground floor.*



### 4.3.1 Different function in future? Maybe not...

Possibly a seemingly misplaced paragraph of this reflection chapter, I would like to shortly explain a part of my design which has been dropped from the final product. As explained in the design process paragraph (4.1), I looked into and designed for a possible future function change of my building.

The reason for thinking of a future different function was based on the fact that the value of the land would possibly rise in the future (though data on the current value has not been researched) resulting in the cheap, informal living offering a very low return on investment, when compared to, for example, an office function or middle- and upper class apartments. However, these latter functions would not suit the revitalization of the Baixa in its current condition. Therefore a combination would seem to be the ideal solution. Start off with cheap, informal living, and adapt the same structure to another function in due time.

This reasoning turned out not to be entirely valid, because why would an investor interested in making the highest return on investment even consider building a structure which would not be very profitable in the first (how many?) years, but only later on?

And secondly, what would happen to the inhabitants when that time would have come? Back on to the streets? What would have been the reason for starting the whole project in the first place if it were not even expected to be sustainable?

Therefore, through discussions with my tutors, the drawings made for a possible future function change were discarded from the final product. They are shown on the right. In retrospect, I think I have made the correct decision. The different future functions would have weakened my argument that the design proposal in its primary phase is financially feasible. The financial operation plan (chapter 3.5), which has replaced these drawings, offers a realistic touch to an optimistic plan.

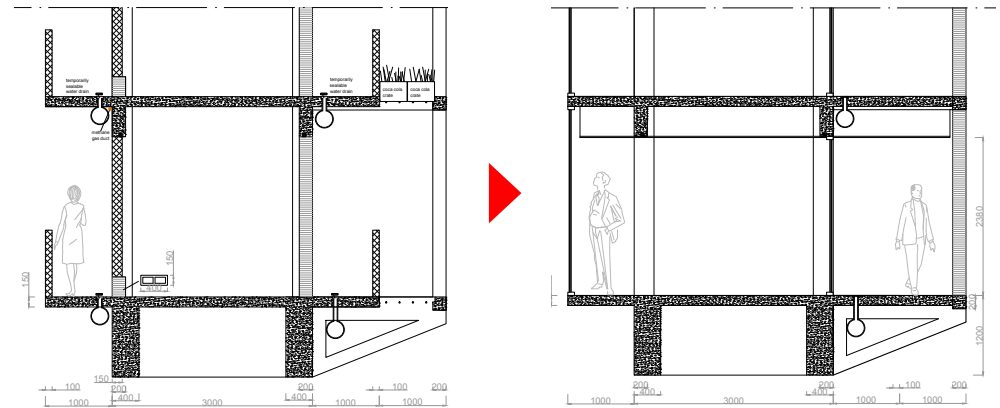


Figure 4.19: the section on the left shows the primary design (informal living). The section on the right is the same building if it would have undergone a function change. NOTE: THIS HAS BEEN REMOVED FROM FINAL DESIGN PRODUCT

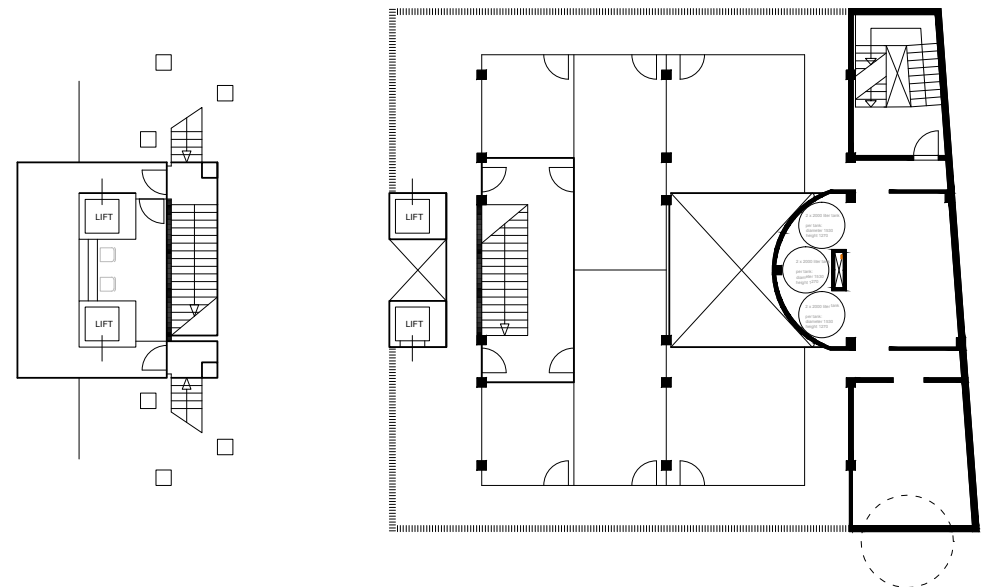


Figure 4.20: these drawings show a possible different use of the original informal living building. In this case: an office function, where one of the staircases has been removed. NOTE: THIS HAS BEEN REMOVED FROM FINAL DESIGN PRODUCT

## 4.4 Recommendations / questions for the future

The initial research and the design proposal which followed *from* that, have only brought what started as a concept a few steps in the right direction (hopefully). Although I have attempted to make a complete design, there are of course still an extremely large amount of factors which have been insufficiently looked into, or not at all. **Therefore, at this moment, at the end of this graduation project, I am left with quite some questions which I have not had the time to answer.** Such as:

Will the void left by the homeless in the Baixa, who live in the newly built structure, be filled by new arrivals? Thereby only solving one of the problems temporarily?

How will the demography of Maputo develop itself? Will the amount people moving from rural areas to the city grow?

What will happen to the prostitution on Rua do Bagamoyo as the vacant plots in the Baixa are filled in and the area becomes more lively all through the day and evening?

What is the feasibility of the water system? Will it require maintenance often? Will inhabitants of the building respect it and care for it? Will they recognize its sustainable value?

Will the large open space underneath the building, designed as a space where inhabitants and the public can interact, for example in a market, work?

I have started looking at ventilation schemes (figure 4.21), but have unfortunately not had the time nor incentive to continue looking at it further.

The research into the way of life of the social low class at which this project is targeted, can be extended much further, and more differentiation made between different types of informal living typologies, depending on income and location.

What is the feasibility of the plants grown in the façade area? Will these plants provide crops for living or also for selling? To what degree will inhabitants close off the “balcony” intermediate area and extend their home, instead of using the shadow and room for crops?

More research can be done into the type of people who will inhabit the building, in terms of their family structure, the materials they are capable of working with, their adaptability to a new type of living, and much more. What is the timespan of people living in the building? Will inhabitants tear down their own, improvised facades when leaving?

The sustainable waste system needs more looking into. Will the human waste sell as fertilizer? What is the acceptance of the inhabitants for such a sanitation system? Will they use it with respect?

Will this concept of cheap, informal living above a public function be possible to translate to another site? The design as it has been made for this particular site is definitely location based and cannot be picked up and simply placed elsewhere. However, how many adjustments have to be made to make it more generic?

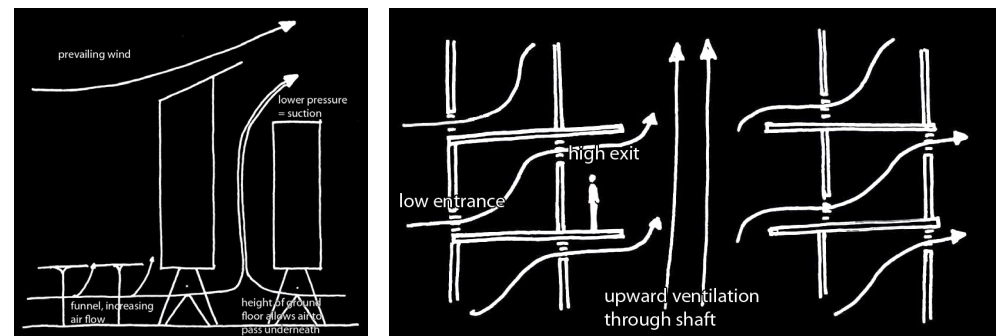
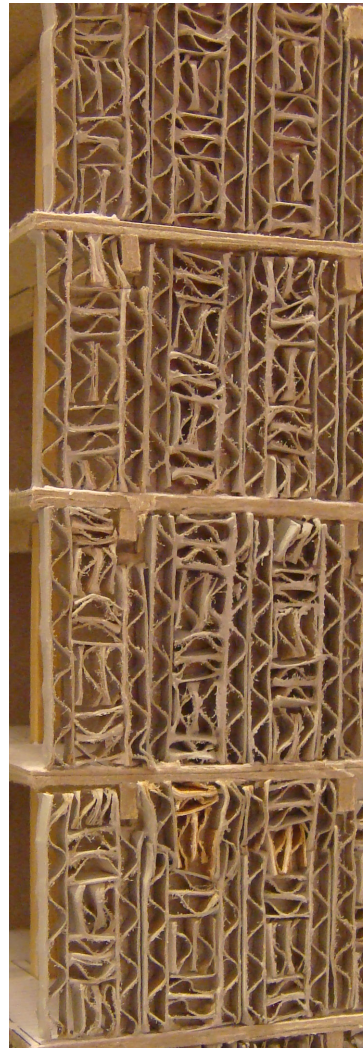
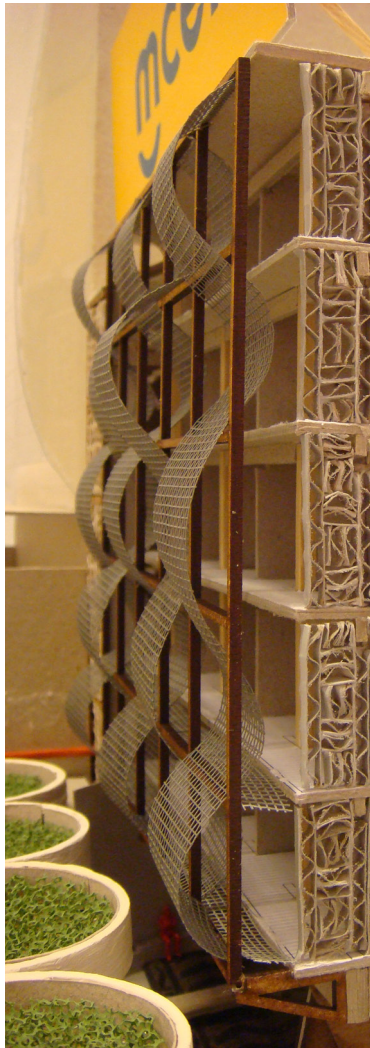


Figure 4.21: simple sketch of ventilation schemes, which unfortunately have not been investigated further.

# part 5 APPENDECES



Photographs of the 1:100 scale model for P4.

- a. Architectural drawings & diagrams*
- b. Construction dimensions & loads*
- c. Installations dimensions*
- d. Essay on cultural heritage in Maputo*

