SUSTAINABLE SOCIAL HOUSING

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1. INTRODUCTION

1.1 **DESIGN BRIEF**

"Right to housing means to guaranty a place to shelter permanently to all, since the etymology of the verb "live" ("morar" in Portuguese), from the Latin "morari", means to take time, stay. The content of the right to housing does not means, only, the faculty of occupying the dwelling; The history of dwelling is connected to the social, economic and political development of humanity. It is essential that this dwelling have proper dimensions, hygiene conditions and comfort, in order to attend the saying in the Federal Constitution, which forecast the humanity dignity as a fundamental principle, just like the right to intimacy and privacy, and that the house is an inviolable refuge. If it is not like this, this right to housing would be poorly as a right, since consider housing a place that do not have adequacy and dignity to shelter a human being, is mortify a constitution norm."

(Canuto & Vlach, 2005)

Fig 1.01 - Fig. 1.01 – Picture taken on the project site; it shows the precarious condition in which the inhabitants have been living.

Fig 1.02 - Drawing by Filarete. Adam runs, searching for a shelter from rain. The shape made by his arms protecting the head anticipates the shape of the primitive hut (Ugo 2008).

1.2.1 THE RIGHT TO SHELTER

To live in a satisfactory housing condition is one of the biggest aims of one´s in life; housing is essential when considering people´s basic needs, such as shelter, and it is not only a matter of walls and roof; the house must offer a safe place where one can have privacy; personal space; where one is able to sleep and rest; and can raise a family, in a healthy environment. All of those elements can make of a house, a home.

The real state sector is growing in Brazil, and social housing units are being built in a large scale, with the aim to control the housing deficit; therefore this is the moment to introduce the sustainable concept in the social housing environment. The reduction of energy consumption is a crucial challenge and have to be considered together with the basic needs, comfort and life quality of the households.

Through an understanding of the Brazilian context, its needs and challenges, this project will bring a sustainable design for one housing complex in the city of Curitiba, located in the south of Brazil.

Fig 1.03 - From Laugier's Essai: allegory of the Architecture. The first and primal architecture: a shelter from nature, built in the nature, made with the nature. To be noted how the construction involves, perhaps unwittingly, a sustainable concept: the resources are preserved from depletion. The primitive hut is beared by the trees, rather than by the logs that could have been made with them.

Even though with time the comfort demands have been suffering changes, getting more demanding; since the begging of civilization men have been looking to protect their self from the harsh weather conditions; always looking for its welfare, health and life quality. Therefore one of the architecture functions is to offer men confortable climate conditions in the interior of the buildings, besides the climate conditions where it is located.

When understanding housing as a concept related to the habitat, it´s location must give easy access to infrastructure and basic hygiene services, like being close to schools, shopping areas, health centre, leisure and social equipment. Thinking about the heterogeneity of the demanding families and the guarantee of a satisfactory performance of the housing, the projects should differ on sizes; considering location, materials and labour quality. (Oliveira, Givisiez and Neto, 2009).

Thus the focus of this housing project will be making a sustainable design, based on the design demands for a comfortable indoor climate.

1.2.2 HOUSING DEFICIT

Brazil has the imminent need to build dwellings to solve specific social housing problems, a calculation of 7.2 million of lacking dwellings was published in 2004; the largest incidence of this shortage is urban, 76.4%. (BRASIL, 2004)

This situation shows the significant demand for new housing units, as well as repairing the existing units, which are in a precarious condition. (BRASIL, 2004)

In 2000, 88.2% of the Brazilian housing deficit corresponded to families with an income up to five minimum wages; the deficit has been getting larger to families with an income up to two minimum wages, in all the country, and represents about 4.2 million of the lacking housing units.

From the existing housing deficit, in 2010 it was analysed the condition of the houses and the households; 3 million of the housing units have families that are in cohabitation conditions - dividing a house or living in tenements; 2.3 million of the housing units have families that spend 30% or more of the family income with the rent - overcharge; 1.3 million of housing units are in precarious conditions; 500.000 housing units are overcrowded - the families are living in crowded conditions, with more than 3 persons per room. (Cidades, 2013)

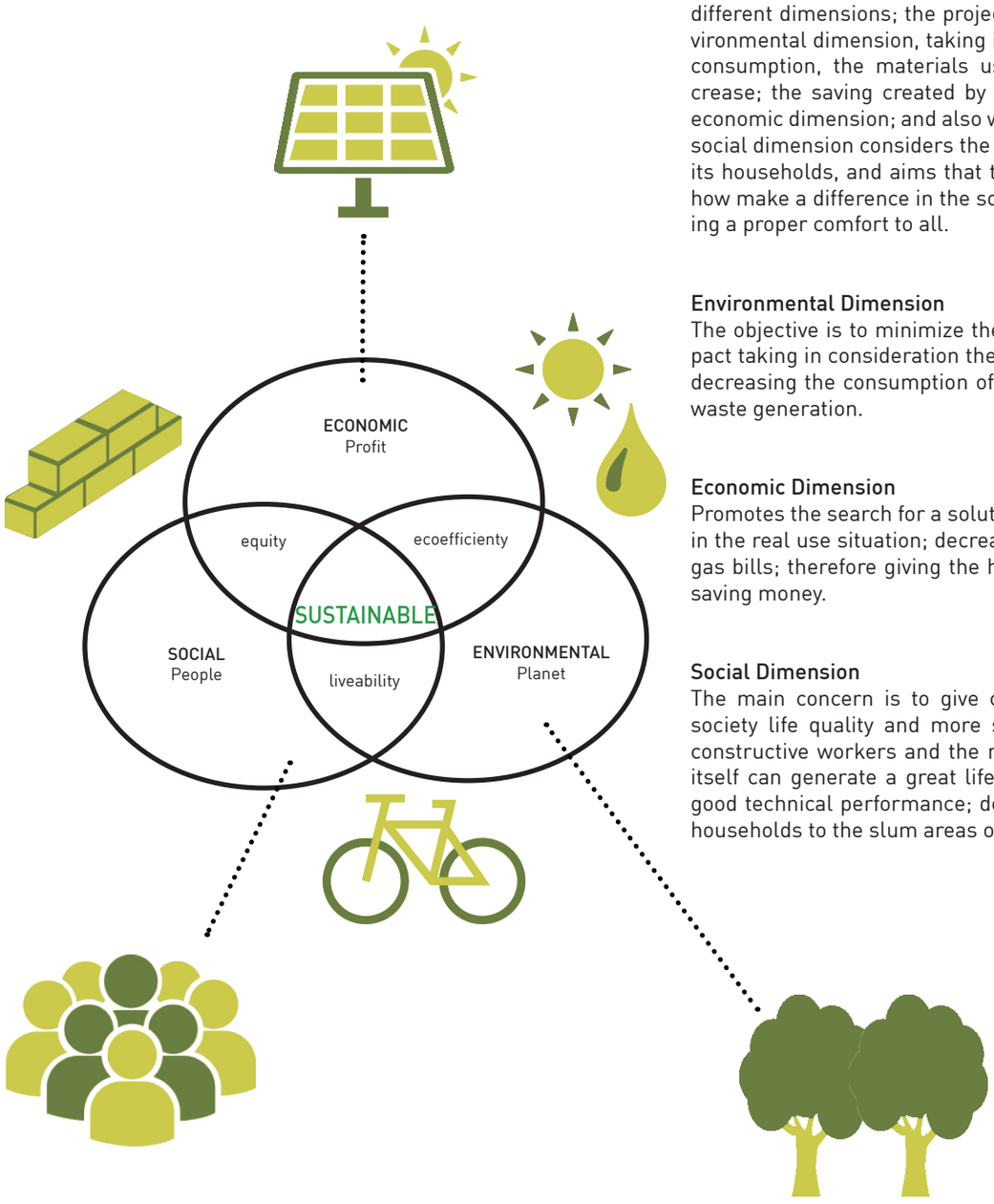
The quality of the existing housing units, that could low down the deficit number, is one more problem to face, since it is expressive the number of housing units with some kind of lack in the constructive standard, land issues, poor access to the urban equipment and services, in between other problems.

The project developed for this master thesis represents a design for an area where people have been living in precarious conditions; representing a possible solution for this existing question.

1.1.3 SUSTAINABLE THOUGHT

"Creating space which is energy efficient, healthy, comfortable, flexible in use and designed for long life. Sustainable design means doing the most with the least means. 'Less is more', is, in ecological terms, exactly the same as the proverbial injunction 'Waste not, want not'. It is about ideally using passive architectural means to save energy - rather than relying on wasteful mechanical services, which use up dwindling supplies of non-renewable fuel and produce pollution that contributes to global warming. But in the final analysis, sustainability is about good architecture. The better the quality of the architecture – and that includes the quality of thinking and ideas as much as the quality of the materials used - the longer the building will have a role, and in sustainability terms, longevity is a good thing. Obviously, if a building can be long-lasting and energy-efficient, that is even better".

Norman Foster [Edwards 2001]



Besides focusing on the deficit issue, the project has an sustainable approach, which have been considered in all different dimensions; the project main focus is on the Environmental dimension, taking in consideration the energy consumption, the materials used and the pollution decrease; the saving created by these solutions meets the economic dimension; and also with a great importance, the social dimension considers the impact that a house has on its households, and aims that the architecture can somehow make a difference in the social inequality, at least giving a proper comfort to all.

Environmental Dimension
The objective is to minimize the global environmental impact taking in consideration the global and local priorities; decreasing the consumption of natural resources and the waste generation.

Economic Dimension
Promotes the search for a solution that is economic viable, in the real use situation; decreasing the water, energy and gas bills; therefore giving the household the possibility of saving money.

Social Dimension
The main concern is to give comfort and maximize the society life quality and more specifically, the users, the constructive workers and the next by society. The house itself can generate a great life quality, if it counts with a good technical performance; decreasing the return of the households to the slum areas or tenement

Fig 1.04 – Sustainability Dimensions Diagram.

1.2 METHOD

There were many key issues that needed to be explored throughout this design process; in order to be able to think though the different dimensions of the project in a combined way, the integrated design process (IDP) was used.

The process consists of five phases: program, analysis, sketching, synthesis and presentation; and the process is divided into three design loops, which makes it possible to make iterations, always having the possibility of going back and forth on the loops in order to achieve the best result. (Hansen, Knudstrup, 2005)

Program Phase
In the program phase, where the brief, the basic requirement and knowledge were created, the concerned was mainly with the understanding of place and context.

Based on research on the government programs, visit to the site and own knowledge on the Brazilian context the explanation of the Brazilian context was developed. Focusing on how the social housing started and how are the programs and projects in this area are understood.

Analysis Phase
It is where all the analysis regarding the site, climate, structure, space program, expected qualities, case studies, indoor climate and energy consumption occurs; helping to create a clear vision for the project.

Sketching Phase
The sketching phase will look for solutions for the previous analysis, developing possible ideas for the project design; in this phase different methods were used, going from sketches and models to more precise drawings and to initial analysis on softwares like Bsim, which contributes with the technical solutions of the design.

Synthesis Phase
The solution found on the sketching phase is developed and detailed on this phase; taking the initial idea into a deeper architectural and technical level, with the help of drawings, model and calculations. The main concern of the synthesis phase on the project was to connect all the different scales of the project in a coherent way.

Presentation Phase
It is the presentation of what have been achieved from the whole design process, and it is presented in this report, technical drawings, models and visualizations.

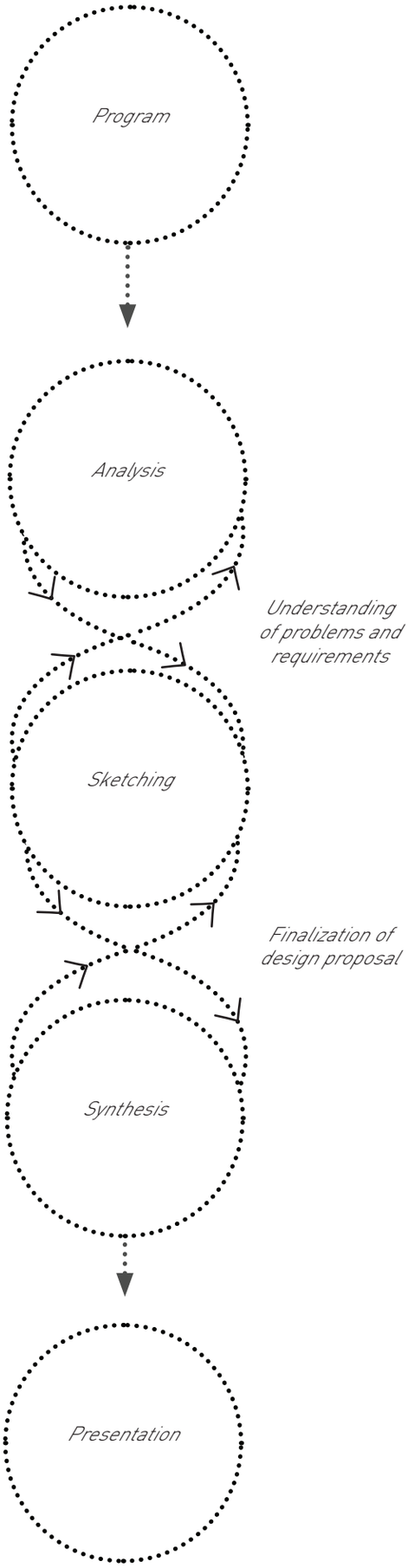


Fig 1.05 – Integrated Design Process Diagram.

2. CONTEXT

In order to be able to design a project in a specific place it is important to understand the way projects are thought, and why. In this context it will be presented the Social housing history and currently programs, as well as the sustainable practice in Brazil, from its beginning to the current situation, giving a special attention to the relation between the social housing and the sustainable features.

The cultural understanding also has a great importance, especially in housing projects; since the house reflects the society. Therefore in the context it will also be presented information regarding the Brazilian culture.

2.1 **THE HOUSE AS CULTURAL AND IDENTITY REFERENCE**

Fig. 2.02 – Illustration that shows the Brazilian miscegenation.

A house represents the most intimate core of the social familiarity, considering the way in which a family organizes themselves in the interior of a city or in the rural areas. Every culture has created their own ways of constructing a familiar shelter, individual or collective, creating different models that ended up assuming its own peculiarities.

Regarding the culture influence on the housing design, the utility can be seen as a cultural component; which distinctions are made concerning the value of comfort in each culture, such as of other basic needs. (Rapoport)

In Brazil, the housing formula went through determinate solutions, which directly influenced the evolution on the way of living, and the values that over the years defined the Brazilian society; which families, the essential feature of these housing units, are a product of the white, indigenous and African miscegenation.

In order to have a quick understanding of the formation of the currant "Brazilian house", the colonial society can be seen as a starting point. In order to give housing to the colonial society, after the Portuguese colonization, it was created a model in which many of the European lifestyles were being preserved; though deeply influenced by the seven centuries traditions of the Arabian presence in the Iberian Peninsula: houses with the ground floor being used as commercial area or as a warehouse, and the housing functions were developed in the second floor, where there was a social room in the front, living and visits room, and a second room in the back, dining and intimate living room. In between these two rooms, a long hallway in which it was distributed the alcoves, bedrooms without windows. This kind of house did not have many furniture or ornaments, it had thick walls, high ceilings and the floor, the lining, the doors and the window frames were made in wood. This housing solution, the Luso-Brazilian, spread through the country and it was the domestic base of a society jealous of itself and its values; extended from mid-16th century until the 19th century.

After the large transformations that the industrial revolution did around the world, it was only in mid-19th century that the eclecticism got enough strength to impose a new housing model in Brazil, a country that continued basically rural and enslaver. New world visions and different constructive options were the base of the architecture that broke with the colonial pattern and extended until half of the 20th century.

With the abolition of slavery, the residential environments became smaller and more compact, due to the lack of slaves to do the domestic work. The ground floor house with a high basement, surrounded by gardens, with balconies, and with glazed doors and windows became the new designing principles, where all the rooms should now receive sunlight. At the same time, the urbanization process accelerated, which implicated in a demographic intensification; increasing the difference between classes, which could be seen in the housing design; the tenement, the first slums and the working villages emerge to give shelter to the poor population of the cities. The houses that were built to this part of the population had to be cheap and only appropriate to their basic needs; many of them were simple houses and were still reproducing the colonial period plans.

The rationalism of the housing architecture from the 20th century passed quickly by the Art Deco and moved for the modernism, where new values and technological possibilities imposed renewing forms, especially for the apartment buildings, the truly housing machines of the 20th century.

In the 1920´s the ground floor residences, from the upper class, suffered some changes according to the plans from the beginning of the century, getting only one balcony and a small garden, which was a barrier from the public and the private areas.

Due to the precarious conditions of the big cities, in the 1970´s the property market started to invest in new housing programs, the closed condominiums, that include different facilities to the users, offering security, comfort, leisure and isolating them from the contact to the rest of the city. Nowadays, the Brazilian civil construction is really connected to the condominium regime, with apartments (multifamily) or houses (unfamiliar).

(Filho, 2013 & Silva, 2007)

Fig. 2.03 – Picture an example of colonial housing in Brazil.

Fig. 2.04 – Section and Plan from a house in Olinda, Recife from the first decades of the 17th century, one of the oldest houses with this characteristics.

Fig. 2.05 – Picture of apartment building in São Paulo, project by the architect Tadeu Giuzo, from the beginning of the 20th century.

Fig. 2.06 – Example of a housing closed condominium.

During the cultural and housing changes suffered over the years, the basic needs values, mentioned as part of the cultural particularities of the house by Amos Rapoport, also suffered large changes; and, unfortunately, these needs became different according to the social class which the house belonged, even though the society and the worries, safety for example, were the same.

According to a research made by Mariuzza Digiacomo, besides the monetary condition of the household, the Brazilian houses should be provided by some essential items, which are divided in seven main sections:

Habitability

It is mainly defined by the indoor environment comfort, considering between others, the air quality and the thermal, acoustic and visual comfort.

Security

It considers the structural security, such as being safe against fire and against intrusions.

Suitability space - function

It aims functional spaces that have the adequate dimensions.

Articulation

It considers that the housing spaces should allow the intercourse and the privacy of the users.

Personalization

The creation of spaces that allows the appropriation and the adaptation.

Aesthetics

It should be internal and external attractive, and it should be integrated to the surrounding.

Economy

To optimize the necessary resources to achieve the quality items.

2.2 SOCIAL HOUSING IN BRAZIL

2.2.1 HISTORY OF SOCIAL HOUSING

As mentioned in the previous text, the cities accelerate growth were responsible for the begging of the tenements, slum areas and other kind of social housing units. This excluding urbanization process made by the government along the 20th century, and resulted in irregular occupations, areas that are taken in an illegal way.

An irregular occupation, can be described as dwellings where the main characteristic is the lack of housing conditions, resulting, in most cases, in life and housing in subhuman conditions; the most common kind of occupations is the subnormal clusters, which are, according to the IBGE (2010), allotments of at least 51 housing units, which occupy others land (public or particular), in a dense and disordered lay out, that and lack the essential public services.

The capitalist market, the low salaries and the social difference that are included in the Brazilian population since its beginning, made it impossible for a large part of the population to have access to a house, especially in the last decades; leading to a process of peripherization, segregation, environmental destruction, poor quality life and violence in the cities.

Fig. 2.07 - Picture that shows two sides of the Brazilian occupations; a luxury building and a slum area (Paraisópolis Favela) separated only by protections walls.

The first recognized way of irregular occupations in the cities appeared in the 19th century, when the tenement (Image 2.09 and 2.10) starts to be seen as a poverty focus, a place propitious to violence, epidemics and addictions; when, in reality was the solution that the poor inhabitants found to live in the cities.

Figs. 2.08/2.09 - Images of two "slum" in the centre of Rio de Janeiro, it is possible to see the lack of infra-structure of these places.

After the European movement for the urban hygiene renovation, the Brazilian cities decided to start building large avenues and implement sanitation in order to attend the rich population interests. Since 1856, the government made it more difficult to popular housing to be built in the city centre, followed by the forbiddance to build, not long after closing the buildings and demolishing some of them.

During the renovation there was not enough social housing to shelter all the working class that used to live in the tenements; which made another kind of irregular occupation begin. It was the beginning of the peripherization and the creation of slum areas, the "favelas". The poor part of the population was being expelled by the government to the outskirts of the city.

Fig. 2.10 - Picture from the Favella hill, occupation that gave the origin to the name "Favela", used to describe slum areas in Brazil.

During the called Vargas Period in Brazil (1930-1945) the house starts to be considered as a basic condition to the reproduction of the working straight, aiming the country industrialization. So, with this aim, the president at the time, Getúlio Vargas, created the IAPs, Pensioner and Retired Institution, the first social housing initiative done by the government. There were many social housing projects being done in this period, not all were built, though; the most important project from this period was the Residential complex Mayor Mendes de Morais, known as Pedregulho, by the architect Alfonso Eduardo Reidy (fig2.11), an import icon of the Brazilian modern architecture. (Mackenzie, 2007)

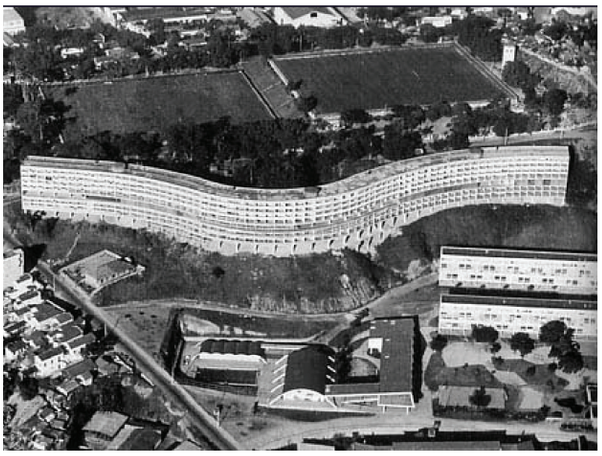


Fig. 2.11– Pedregulho Residential Complex.

With the industrial development, the urbanization process expends. During the period of 1940-60 the Brazilian population grew from 41 million to 70 million inhabitants, with the urbanization rate going from 31% to 45%; which made the irregular occupations suffer a large expansion.

It was also during this period that the first "working villages" were created next to the factories, especially in São Paulo, where the industrialisation was beginning, since the workers did not have transportation to the industrial areas.

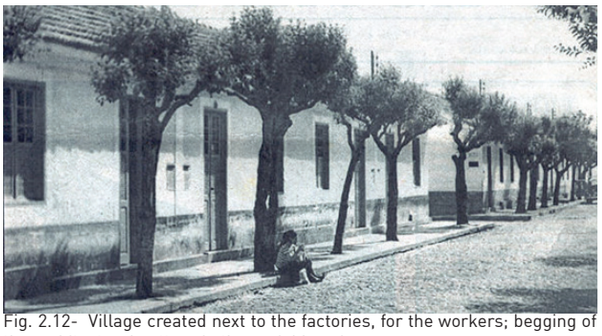


Fig. 2.12- Village created next to the factories, for the workers; begging of the architectural pattern in the social housing.

The first national housing policy was created in 1946, the "Social house foundation". This foundation did not succeed due to the lack of resources and the rules that were stabilised to finance houses; the program ended up helping only the class with a higher income (above eight minimum wage), instead of the lower class (below tree minimum wage), that was supposed to be the benefited.

With the military government in 1964, the prices started to be the main concern in the social housing projects, lowering the quality. The fig. 2.13 shows a project from this period, with the repetition of the same pattern, and no real architectural concerns.

Fig. 2.13 – Social housing from the military government.

In the year of 1988, Brazil got a new constitution, where it was stated the right to housing for the whole population. At this time different programs of the government were being created, with the intention of helping people to finance their own houses.

Even though the government had been working on programs to help the lower class to be able to afford their own land and house, nothing had been done in order to give good quality housing to this parcel of the population; thousands of houses were built with poor qualify and standard architectural design; creating a difference between the houses which had a good professional orientation and the ones with a defined pattern.

It was only in 2001 that the technical assistance becomes a device in the federal legislation. The "City Constitution" law, approved in 2001, forecast that the projects must be offered without any costs to the less favoured social groups. (cidades, habitação, 2007)

In 2003 the "Cities ministry" is created and gets responsible for the urban development and the housing policies. The new ministry created in 2004 the "National housing policy". It is possible to understand the chronology of the creation of the institutions and regulations, since the approval of the City Constitution in 2001, in the timeline below.

(Holz, Monteiro, 2008)

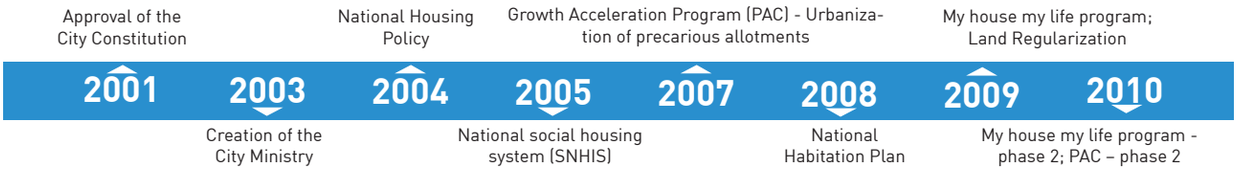


Fig. 2.14 – Timeline of the housing programs of Brazil.

Unfortunately, even with a progress from the government in the understanding of the need of dignify housing for all the population, and the creation of more and different programs and policies over the years, when comparing the architecture done by military during the dictatorship and the houses done by the current housing programs, it is not possible to see a large difference or a great improvement, especially when considering architectural quality, as shown in the fig 2.15.

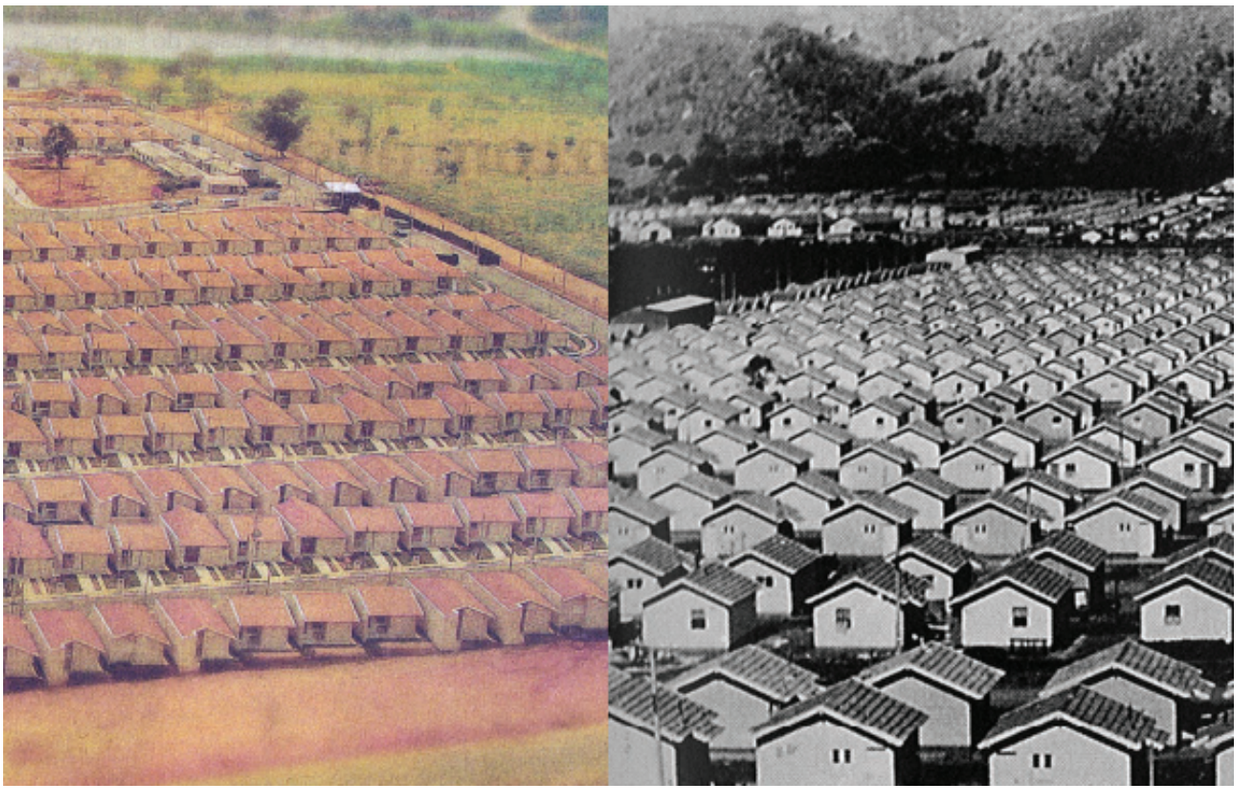


Fig. 2.15 – Comparison between a social housing complex from the 60ths decade, in the left, and a project done by the My life My house program, in the right.

2.2.2 CURRENT PROGRAMS FOCUSED ON THE SOCIAL HOUSING

National Housing Policy

The housing deficit problem in Brazil made the government create, in 2004, the National Housing Policy; which aims to develop the conditions of access to dignified housing to all parts of the population, focusing especially in the lower classes and contributing to the social inclusion. The main components of this policy are: the urban integration of precarious allotments; the land regularization; the housing provision; and the integration between the housing policy and the urban development policy.

In between many guidelines, which focuses on giving dignify dwellings to all, it is also part of the guidelines to implement actions focused in the sustainability of the construction environment, embracing the design and execution phase, having as objective the reduction of waste, the increase of the buildings duration and the use of the generated waste.

In order to the National Housing Policy to be put into action, credit programs are used to expand the low classes access to housing units. There are four different groups of beneficiaries, according to their payment capacity:

Group 1 - includes the ones in absolutely misery, which will have to participate in the programs that the houses are totally subsidized;

Group 2 - includes the ones with a very low buying power, they will only be able to afford a good housing if the government provides a finance support that allows them to pay only a small parcel of the housing price;

Group 3 - contemplate the families that the buying power can be equated by finance programs, with low costs;

Group 4 - include the families with finance standards compatible to the one asked by the financial market, to whom the program will help by enlarging the housing units and facilitating the financing.

The National Housing Policy has some instruments that were created in order to make it possible for the policy to be executed, in the different areas that are supposed to be. Some of them are the Land Regularization, The National Social Housing System and the Nation Housing Plan; all created to face the long term problem: access of the poor population to housing.

(Cidades, 2013)

Growth Acceleration Program – PAC

Created in 2007, the Growth Acceleration Program (PAC) developed the recovery of the planning and execution of large constructions in the social and urban infra-structure, logistic and energy areas in the whole country, contributing for its accelerated and sustainable growth.

It was thought as a strategic plan to rescue the planning and to recover the investments in the structural sectors of the country; contributing for the generation of funds and elevating the public and private investments to fundamental constructions. In the first four years the program helped Brazil to double the public investments (GDP went from 1,62% in 2006 to 3,27% in 2010), and to generate a record working volume – 8.2 million working positions were created in the period.

This program has several different programs that contemplate distinct areas, housing is one of the areas and in the whole country there are several different investments being done, especially in order to decrease the housing deficit and to regularize the irregular occupations. One of the programs that uses the funds from the PAC, is the My house My life program.

(PAC, n.d)

My house, my life program

The program was launched in 2009 and aim to recover the social problem related to the housing deficit existing and the estimated future demand until 2023. According to the program´s primer, the perspective is that in 10 years Brazil will reach a new level in the access to social housing.

It attends families with income up to ten minimum wages; having a scaling of subsidies, where the families with the income up to tree minimum wages have subsidies of almost 100%. Until the end of 2013, the program has permitted the contracting of about 2.8 million housing units, which almost half have already been delivered; with an investment of over R$ 160 billion and generating more than 920.000 direct or indirect employments per year.

The program so far was divided in two phases, the distribution of the housing units in the country was made according to approximated estimative of the housing deficit in each region, 39% for the southeast, 30% for the northeast, 12 % for the north, 11% for the south and 8% for the mid-west.

The estimation is that between 2013 and 2023, Brazil will have the need to produce an average of 1.520 million new housing units per year, giving the total of 23.8 million housing units. The program is really connected with the real estate developers and the constructors, the financial transactions are made by the bank Caixa Econômica Federal. However the government, and the municipalities need to be able to supervise the offered service and select the beneficiaries; there are four different programs for the urban areas and tree for the rural, in the urban programs the houses can be built by real estate developers or by the housing companies of each city, all the housing units have to follow the minimum technical specifications, and to have at least a living room, two bedrooms, a kitchen, a bathroom and a laundry room, and it need to be possible to adapt the use for families with disables members.

(Cidades, 2013)

2.2.3 RESPONSIBLE ORGANIZATIONS

Social Housing Company (COHAB)

The COHAB is the responsible company of social housing in Brazil, it is not a unique organ though; the company has separated units, from cities or regions. In Curitiba, city where the project will be developed, the existing company is the COHAB-CT.

The Social Housing Company of Curitiba (COHAB-CT) has as a mission to make it viable the access to social housing and it is the agency manager of the social housing segment and the responsible for driving the housing policy of Curitiba and metropolitan region. It is a mixt capital company and has as major shareholder the Municipality of Curitiba.

From the 1990´s the company started to manage the funds from the Municipal Housing Funds (which became Social Housing Municipal Funds in 2007); and have as main guideline the implementation of the Curitiba´s housing program.

According to the Company, in more than 40 years the register is of attending about 120.000 families, taking benefits for more than 450.000 people; focused on the poorest part of the population, the Cohab dedicates special attention to the village urbanization, resettlement of families living in risk or insalubrious areas and regularization of irregular occupations programs.

Besides the work in the occupations, the housing program also provides housing units to attend the Cohab registered demand; a list of families that are waiting for housing assistance and that are attended according to its position in the list.

(Apresentação,n.d)

2.3 BRAZILIAN ENERGETIC PANORAMA

Brazil is one of the countries with the lowest CO2 emission per kWh of generated electricity (fig.19); this happened because of the hydroelectric predominance for the electric energy generation. Over 80% of electricity is from hydraulic origins, the rest is divided in coal thermoelectric power plants, natural gas, fuel oil, diesel oil, nuclear power plant and some other natural materials that are used, as wood.

(SUSHI, 2010)

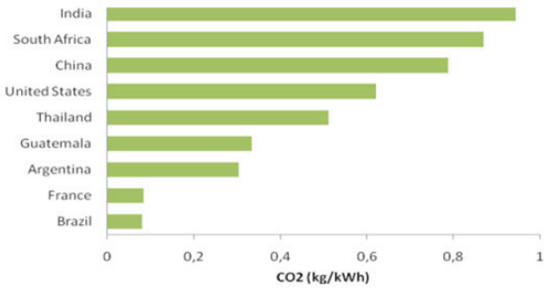


Fig. 2.20 – CO2 emission per kWh of generated electicity.

Even though the hydraulic is a clean source, with less pollutants then from other energy sources and it does not produce toxic or radioactive waste, as in the nuclear power plants; the hydroelectric are responsible for the flooding of large areas and it can cause huge social-environmental impacts. (Conflicts, 2013)

On top of that, the data from the electric system operator (ONS) indicates that in the Southeast and Midwest the water tanks registered in March 2013, a water storage level of 48.71%, that is much below the 78.6% from one year before. In the same way, in the Northeast it got 42% against 82.7% from the previous year; with this information is impossible to deny that there is a growing risk to the lack of water storage, what is making the thermoelectric power work, polluting the environment in order to keep the water tanks out of the risk of getting too empty. (DASOL, 2013)

Brazil do not have any regulations about thermic and energetic performance; what it is already a reality in many other countries, Portugal was the last country in the European Economic Community to establish the use of a regulation to make the thermic and energetic performance of its building better, in 1990. The first North-American norm about it is from 1972 and became law is 1992. In Brazil the only thing that exists is a volunteer norm (ABNT NBR 15.220) approved in 2005. (Cidades & Energia, 2005)

2.3.1 DOMESTIC USE OF ENERGY

It is estimated that 48% of the electrical energy used in Brazil has its origin in the user's needs to create confortable indoor environments, to give artificial illumination and venting or conditioned ventilation, which are common to the industry, commercial areas and in the specific dwellings uses, like electrical appliances and water heating. The graph shows the percentage of the different electrical uses in the average Brazilian house. (Cidades, Energia, 2005)

Besides the appliances, which considers the television, refrigerator and so on, the water heating, illumination and indoor climate conditioning (air conditioner and heater) can be saved whit the design of the dwellings.

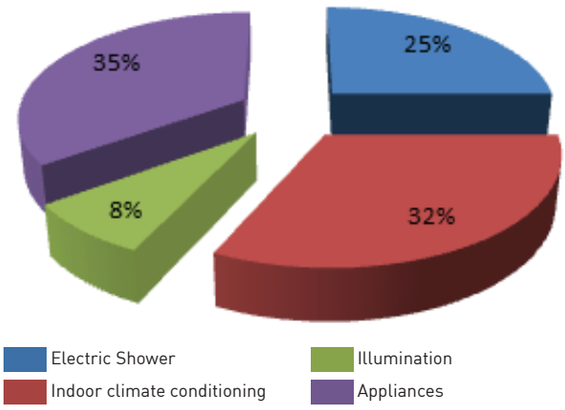


Fig. 2.21 – Electric uses in the average dwelling in the south region of Brazil.

2.3.2 THE USE OF ELECTRIC SHOWER

The electric shower is a Brazilian technology that was developed in the 1940´s, until the 1990 decade Brazil was the only producer in the world. This shower is a passing heater with a high power (more then 4,4kW) and low cost, it transforms electric energy in heat through the Joule effect; Heating of 10-15°C producing water in a temperature between 30-40°C. Because of its low cost, easiness of installation and low maintenance, the electric shower has become the mainly way of water heating in Brazil, being in about 85% of the Brazilian houses. (Pinheiro, 2012)

Taking in consideration that the medium residential consume is 140kWh/month and considering that 26% of the final use of the electrical consume is used to heat the water; if by hypothesis only 50% of the 7.2 million dwellings relative to the Brazilian habitation deficit, could have solar heating system, the total electrical consumption in these houses would be of 1.008GWh/month; where the water heating energy in 50% of the houses would be of 131GWh/month, in one year it would be saved 1.572GWh/month. This amount can be compared with the total annual consume of the Alagoas state, and it could be used to create new connections with the electrical net, benefiting communities that are not connected yet. (Cidades, Energia, 2005)

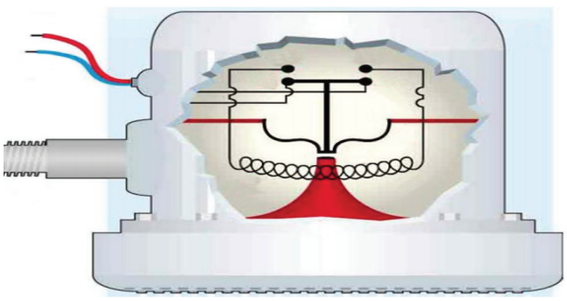
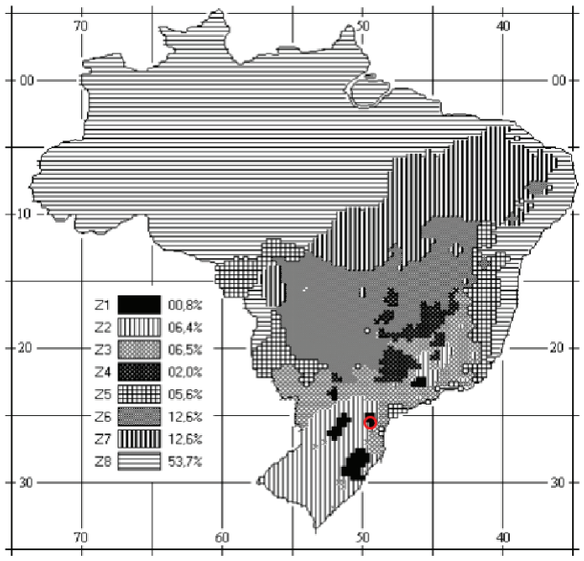


Fig. 2.22 – Illustrative image of how it functions the electric shower.

2.4 BRAZILIAN BIOCLIMATIC ZONING



The bioclimatic zoning of a country has the function of being an instrument that makes it easier to choose the architectural project strategies, which take advantage of the different climates to attend the comfort need of the households. (Cidades, Energia, 2005)

The Brazilian bioclimatic zoning is divided into eight different zones, according to the climate, the division was made considering a bioclimatic chart, adapt from the Givoni chart ("Comfort, climate analysis and building design guidelines"). (ABNT, 2003)

Fig 2.23 - Brazilian bioclimatic zoning, with Curitiba in red.

2.4.1 BIOCLIMATIC ZONE 1

Guidelines were created for each bioclimatic zone, in the form of a Technical Standard; the standards establish the size of the ventilation openings, the protection on the openings, the external sealing and passive thermic conditioning strategies.

Once these guidelines are followed, the social housing architectural projects should have a positive impact, since these guidelines were created in order to help the ones projecting to design according to the location and it climate, making it necessary the distinction in the projects solutions according to where its placed; though it is not mandatory.

The bioclimatic Zone 1 has 12 cities, including Curitiba, which was the chosen city to be studied in this thesis. The guidelines given by the 15220 Standard (ABNT, 2003) are stated on the tables below.

When relating the standards with the need to reduce energy, as explained on the previous text, the intention is to reduce the consumption with these guidelines; when considering a climate as the one from Curitiba (see 2. ..) it is not enough, though. More restrict guidelines will be followed in order to achieve a lower energy consumption and a comfort indoor climate.

Thermic performance – sealing			
	External walls	Internal walls	Roof
U Value (W/m2K)	⩽ 2.5	-	⩽ 2.3
Thermal Capacity (KJ/m².K)	⩾ 130	⩾ 130	-

Openings				
Ventilation			Illumination	Shading
Living Room	Bedrooms	Kitchen		
Opening A⩾10	Opening A⩾8%	Opening A⩾8%	Opening A⩾16%	It is mandatory protection in the bedrooms, with a control device that allows the sun radiation in winter.

Strategies
Passive solar heating: the building has to be placed with the best solar orientation, in order to guarantee the sun radiation in the long stay rooms (living room and bedrooms)
Heavy internal sealing (thermic inertia) – adoption of internal heavy walls can contribute to maintain the interior heated; the passive solutions might not be enough during the coldest periods of the year.

2.5 SUSTAINABLE MEASURES EXISTING IN BRAZIL

2.5.1 -SUSTAINABLE CONSTRUCTING PROGRAM – CAIXA ECONÔMICA FEDERAL

The CAIXA Econômica Federal is a Federal bank recognized as the housing bank, since it makes possible for many Brazilians to buy their own houses; only in 2009 the bank financed 71% of all the real state credit in Brazil, benefiting around 897.000 families.

The sustainable constructing program is based in the sustainable concept from the ventures, which integrates the financial-economic, physic, cultural and social-environmental aspects. Since 2008, the housing programs standards from CAIXA, started to incorporate the social-environmental features, even though is not mandatory to get the bank´s support, with these intentions: to minimize the constructive impacts in the environment; to use local natural sources; to save water and energy during the construction; to promote the moderate use of resources during the construction; to plant trees and stimulate the trees planting in the sites; to promote the collection and recycle of the solid waste; to adopt solutions to create better indoor climates and to promote the environmental education to the households.

The main action and results achieved by the Sustainable construction program are: the Legal Wood action, which aim to guarantee the sustainable exploration of wood in the Amazon forest; Solar Water Heating System in the My House My life program houses; Solar Brazil Project, an agreement with a German agency for the implementation of solar heating systems in the Brazilian houses; afforestation of developments, a standard that recommends the plantation of one tree for each housing unit built; environmental compensation program, in which the developments that create an environmental impact have to pay a determined value; environmental evaluation of sites with a contamination potential, in order to manage the risk of future developments; energetic efficiency in the social housing, program which gives to the families more efficient lamps and household appliances in order to save energy; and the Blue House Certification.

(Sustentável, n.d)

Blue House Certification: Social – environmental classification of housing developments projects

When creating the CAIXA Blue House Certification, the aim was to encourage the rational use of the natural sources in the development constructions, to reduce the building maintenance costs and the household's monthly expenses, such as to promote the awareness of the entrepreneur and the households of the sustainable construction benefits.

Considering that Brazil do not have any regulation regarding sustainability and energy consumption; this program is encouraging this way of designing.

The CAIXA Blue House Certification seeks to recognize the projects that demonstrate its contribution to the reduction of environmental impacts, evaluating from criteria that are connected to six different topics.

The certification can be given to all kind of housing projects presented to CAIXA to get a financing, no matter if it is a public company or a real state constructor; the adhesion is volunteer and when wanted have to be informed, to be evaluated.

The certification is divided into Gold, Silver and Bronze categories, to get the Bronze, all the mandatory items needs to be respected; the Silver it is necessary to have the entire mandatory items and chose 6 more; and the Gold there is the need of 12 more items. It is possible to see the table with all the items in the appendix.

(Caixa, 2010)

Fig. 2.24 – Gold, Silver and Bronze certifications images.

CATEGORY 1 – URBAN QUALITY

The expected result from the successful housing developments is the creation of communities adjusted to the households needs, today as well as in the future. One of the most common ways of describing sustainable communities is with the Egan Disc (fig.2.25), named after the main author from the Egan Review; made in 2003, with the aim to help the implementation of the visions and objectives of the Sustainable communities plan in England.

Fig. 2.25 – The Egan Disc

From the seven components of the disc, the Governance, the Economy and the Social and Cultural, are related to the social sustainability of the community and are indirectly connected to the interventions and integration between the designers, entrepreneur and building companies; these social interactions have influence in the economic and environmental spheres, especially in relation with the life quality.

The other four components, the Transport and connectivity, the Services, the Environmental, and the housing and the built environment, on the other hand, are directly connected to the planning and the production of new housing developments.

The sustainable community has to be designed in a way that the inhabitants value and appropriate the space; some of the criteria for that to happen are: to have basic infrastructure; easy access to public transport; commercial area in the radius of 1km; public school in the radius of 1.5km; health centre or hospital in the radius of 2.5km and leisure equipment in the radius of 2.5km. It is also important, and part of the certification mandatory items, that the site does not have any impact sources in the radius of 2.5km (airport, for example).

The main focus on this category for the project design is the recovery of degraded areas, since the site can be seen as an area that needs intervention.

CATEGORY 2 – PROJECT AND COMFORT

This category concerns about planning and project conception, especially considering climatic conditions, physic characteristics and local geography. The Brazilian bioclimatic zoning have to be considered in order to create this comfortable indoor environments.

Besides the insolation, ventilation and the other passive solutions that have to be used, the flexibility should also be considered in this category; giving the opportunity to the households to adapt their houses according to their needs, and also considering, in housing complexes, the different families that will live there.

When considering sustainability in the projects, the social spaces have a great importance, in order to elevate the social conviviality between the inhabitants; this can be made with leisure, social or sports equipment.

CATEGORY 3 – ENERGETIC EFFICIENCY

As explained in the previous category, the use of passive/bioclimatic strategies in the project phase is fundamental for a good thermic performance; at the same time, effective solutions should be used to reduce the energy consumption, like electric appliances, water heating and artificial illumination.

The objective of this category is the reduction of the consumption and the optimization of the quantity of energy in the described uses; making it possible also the reduction in the households expenses.

CATEGORY 4 – CONSERVATION OF MATERIAL RESOURCES

The residues are a serious environmental problem which follows the whole life cycle of it. Nowadays this cycle is opened, with most of the waste ending in the landfill; with a closed cycle the wastes could become the future raw material.

On the construction field the quantity of material that is produced and that end it up wasted is huge; this category has the aim of conserving the existing resources and controlling the waste, with a good choice of the materials, façade solutions, reutilization of what it is possible and controlling the construction and demolition wastes.

CATEGORY 5 – WATER CONTROL

The water needs to be seen as a finite source; it is an economic valuable asset, indispensable to guarantee public health and the life maintenance and therefore needs to be maintained in quantity and in quality to extend the attendance to the user´s needs.

The management of the water in the buildings is necessary to have a more sustainable use of it; therefore the water control category deals with mainly the supply of clean water, the management of the rain water and the sanitary sewage.

It is also part of this category the worry with the permeable areas in the site, which has as objective to maintain the water cycle, and to prevent the inundation risk.

CATEGORY 6 – SOCIAL PRACTICES

This category seeks to promote the development sustainability through actions that includes different agents involved in the project elaboration, construction and occupation. These actions have the aim of creating an environmental sense and reducing the social differences.

Some of the items that these interventions have to consider are: social inclusion; appreciation of the community productive potential; the respect with the environment; integrated design and integrate the technical teams, the architectural/engineer and the social; include the future households in the project development; actions aimed to the sustainability.

Since all the actions from this category would occur after the project construction, there are not any specific focuses taken in consideration during the project development.

(Caixa, 2010)

2.6 LOCATION

2.6.1 THE CITY OF CURITIBA

The project is located in the city of Curitiba, which is the Capital of the Paraná State, one of the three States situated in the South region of Brazil.

The city was founded in 1693; in the end of the 19th century the arrival of a large number of European immigrants has changed in many aspects the everyday life of the city.

In the 1970´s the city went through an accelarated urbanization process, caused mainly because of the migration from the rural areas; contributing to the formation of irregular occupation, since then the city has been facing this problem.

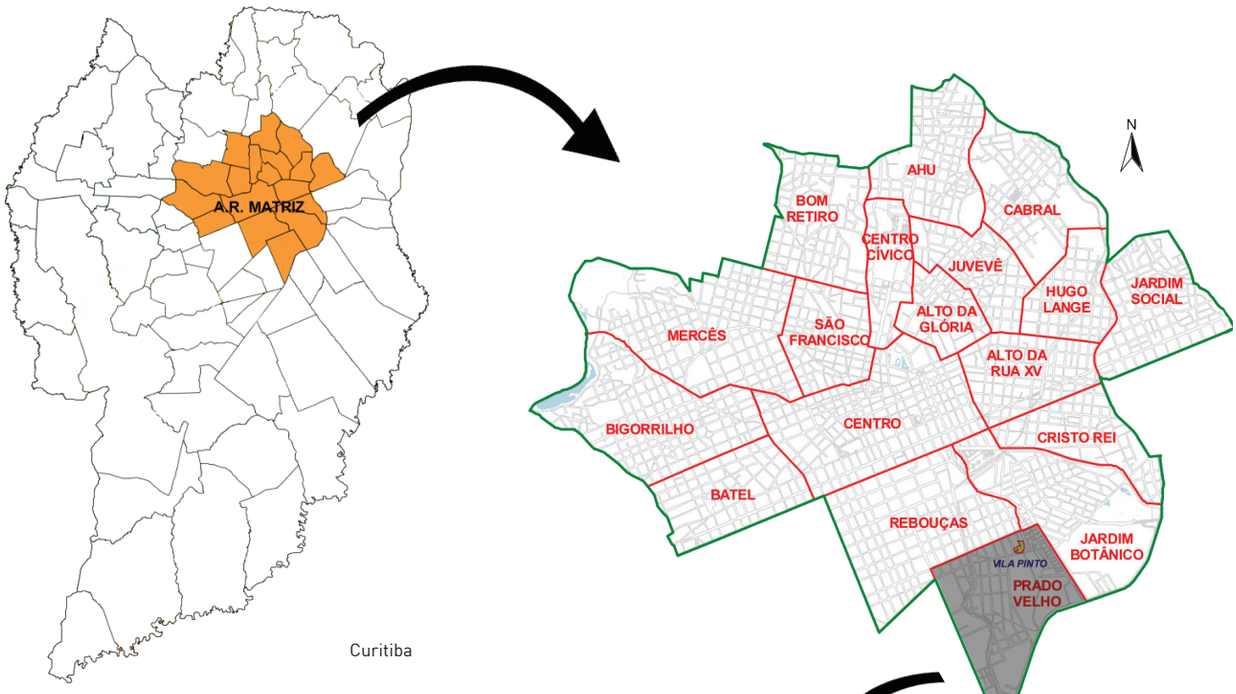
Altitude	945 m
Area	434,967 km²
Green area per inhabitant	51 m²
Climate	Subtropical
Latitude	25°25'48'' South
Longitude	49°16'15'' West
Rainfall	1500 mm/year
Population	1.751.907 Inhabitantes
Relief	Slightly wavy
Average temperature in summer	21 °C
Maximum temperature (average)	33 °C
Average temperature in winter	13 °C
Minimum temperature (average)	0 °C
Distance from São Paulo	408 Km

(Curitiba, n.d)

Fig. 2.26 – Picture from the city of Curitiba.

Fig. 2.27 – Location of the city of Curitiba.

2.6.2 **VILA PRADO**



Inside the city of Curitiba, the project site is located in the Prado Velho Neighbourhood, and it is part of the Torres Village.

The Torres Village have around 9.000 inhabitants and 2.300 families in an area of approximately 300.000sqm. It is located only 3.5km from the city centre and therefore it is surrounded by good infrastructure, as shopping areas, schools, health centre, day-care, police station, and other equipment from the municipality.

Between 1950 and 1970, the Torres Village was the largest irregular occupation in Curitiba, with about 3.000 inhabitants, that corresponded to 30% of the poor population of the city. From 1976 and 1977 the Housing Company (Cohab-CT) made an intervention in the area and distributed the families on neighbourhoods in the outskirts of the city, a small part of the occupation did not leave, due to the distance of the new housing complexes.

Since 1980´s the area got urbanized, having basic sanitation, electrical energy, schools, and other primary infrastructure. Nowadays, the only remaining irregular occupation in the area, is the Prado Village, which is in the process of getting regularized by the Social Housing Company – Cohab-CT.

(Vila, n.d)

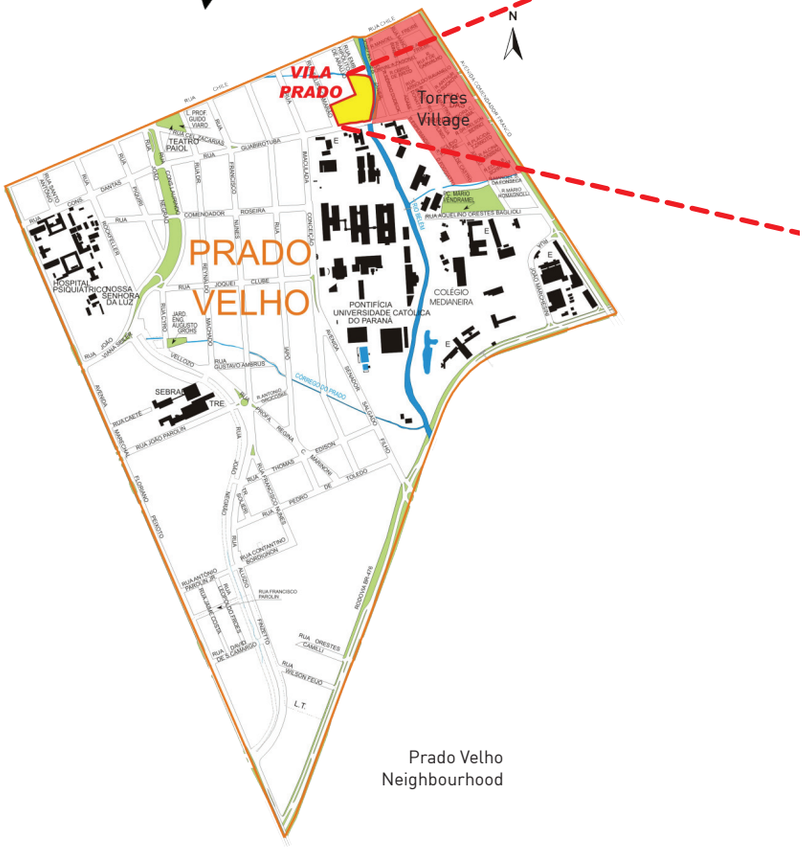


Fig. 2.28 – Location of Prado Village.

Fig. 2.29– Aerial image of the site.

2.7 CLIMATIC CHARACTERISTICS

As it was mentioned in the Bioclimatic Zoning; according to the Brazilian Technical Association, the city is in the Zone 1, which means that the city is among the coldest cities of the country in the winter. (ABNT, 2003)

There are different elements that interfere in the climatic characteristics of the city of Curitiba; its location in relation to the Capricorn Tropic, the city´s average altitude of 934,6m above the sea level, and the natural geographic barrier from the mountain range located between the city and the sea side.

From the Koeppen classification, the city of Curitiba is located in a Cfb climatic region, with humid mild climate (or subtropical), without a dry season, with fresh summers and winters with frequent frost and occasionally snow precipitations. (Simepar, n.d)

According to the analysis made by the Curitiba Weather Station (Simepar, n.d), taking the data from January 1998 and December 2001, Curitiba has the climatic characteristics as explained below.

Temperature – The maximum temperatures in this period were registered between 23.7 (June/1998) and 32.5°C (December/1998) and the minimum from -1.3 (August/1999) to 15.9°C (February/2001), the general average was of 17.488°C

Solar Radiation – The average solar radiation of this period was of 158.02W/m², where the largest solar radiation incidence of the monthly average was of 234.5W/m² in January of 2001 and the smallest in June 2001 of 85.0W/m². As for the maximum solar radiation of the period, the larger incidence was in November 1999 with 1.047W/m² and the smallest com 523W/m² in June 2001.

Precipitation – The average precipitation during this period was of 130.94mm and the year average was of 1.385.00mm in the year 2000, with 144 rainy days and 1.625.20mm in 2001, with 170 rainy days. As for the rainy season, it occurs always during summer, and the larger month incidence was in January 1999 with 27 days of precipitation.

Relative Humidity – Because of the influence from the anticyclones Artic Polar and Atlantic Tropical, Curitiba presented during this same period a relative humidity average of 78.87%, with minimum occurrence of 10.1% in July of 2000 and maximum in October 2000, with 98.5%

Wind speed and direction – When analyzing the month direction of the wind the predominance was the East direction, with 29.15% with a speed of 13.86m/s.

In order to illustrate these climatic characteristics, and to give some more updated data, the table (Fig. 2.30) shows the precipitation, temperatures, relative humidity and wind speed and direction, from the year 2007.

According to the annual average daily sun exposition, Curitiba has from 5 to 6 hours, with an average radiation of 4700 to 4900 Wh/m² per day, as the image 3.06 shows.

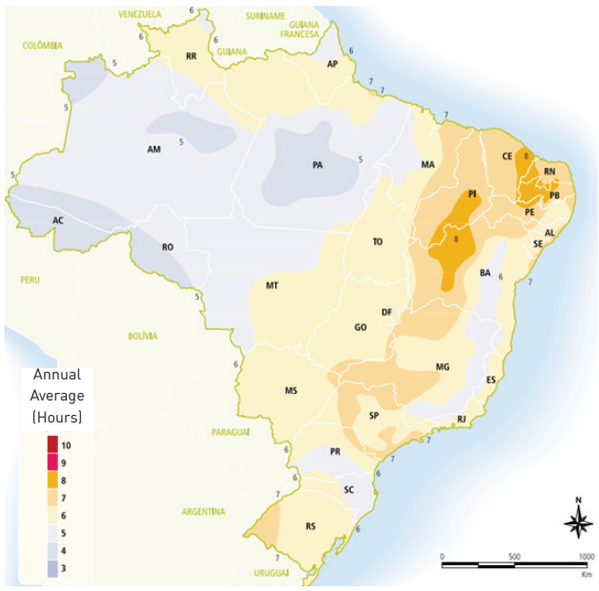
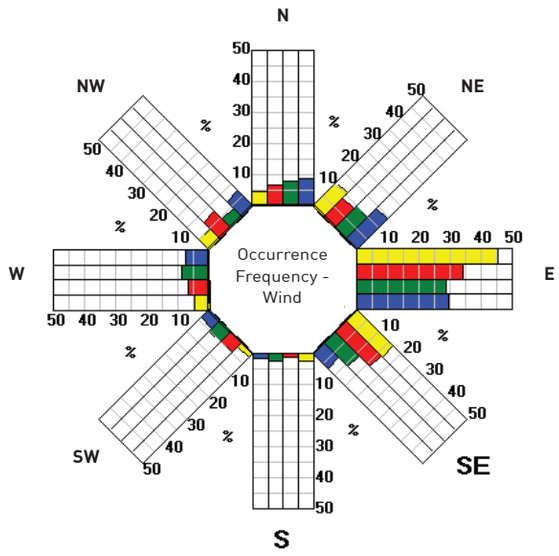


Fig. 2.31– Daily Insolation.

Month	Precipitation	Temperature (°C)			Relative Humidity (%)			Wind Speed (m/s)		Wind Direction
	Month	Maximum	Minimum	Average						Most frequent
	(mm)	Absolute	Absolute	Month	Minimum	Maximum	Average	Maximum	Average	
January	96	31,1	14,3	21,4	28,7	100	83,9	7,5	2,0	East
February	134,8	31,6	15,1	21,8	36,4	100	81,2	7,8	2,0	East
March	131,3	33,2	15,8	22,8	28,2	100	76,7	7,0	1,6	East
April	95,4	30,5	9,6	19,7	38,9	100	83,8	7,0	1,7	East
May	187,3	27,3	0,1	15,3	39	100	83	9,0	1,9	East
June	2,0	26,6	3,2	16,4	23,3	100	73	10,1	2,0	Northwest
July	100	26,7	1,2	13,7	21,3	100	76,2	9,8	2,1	Northeast
August	8,6	29,5	6,0	15,6	28,2	100	76,6	11,1	2,1	East
September	86,4	32	4,5	18,2	29	100	76,9	7,6	2,1	East
October	119,4	31,8	10,8	18,8	30,7	100	82,1	7,9	2,1	East
November	116,8	31,5	11,1	18,9	25,6	100	79,2	10,1	2,4	East
December	360,3	32	12,6	20,9	33,2	100	79,7	8,6	5,1	East

Fig. 2.30 – Table of Curitiba´s climate characteristics.



Some of the conclusions given are that the temperatures may not be so low, but the conditions in which the city is located makes the temperature sensation goes down, for example the humidity rate that is really high during all the year; the frequent wind direction give the orientation of the windows in order to have a good natural ventilation; with the insolation data, the use of the sun in the project can be analyzed it is possible to see that in Curitiba it is worth using the sun as a source.

It is important to highlight the climate data already mentioned, to use and control the weather conditions in order to create a good indoor climate; one other resource to use on the indoor environment design is the chart below (fig. 2.33), which was made by the Architectural Bioclimatic Classification Software, and it is showing the bioclimatic area in which the city climate fits during the year, the illustrations are showing the percentage on the year that each solution needs to be used.

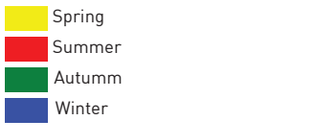
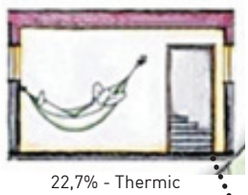
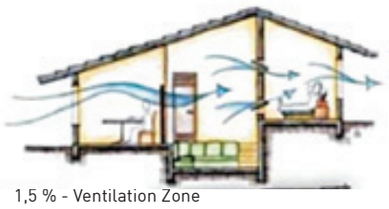


Fig. 2.32 – Wind Rose.



22,7% - Thermic
Comfort Zone



1,5 % - Ventilation Zone

42,4% - Passive
Solar Heating Zone

28.2% - Thermal Inertia
Heating Zone

5, 2% - Artificial
Heating Zone

Fig. 2.33 – Bioclimatic Chart of Curitiba.

3. ANALYSIS

The analysis will be presented showing the Vila Prado reality, in comparison to the city. From the social-economic profile, to the site analysis.

3.1 SOCIAL-ECONOMIC PROFILE

3.1.1 HOUSING CONDITIONS

Curitiba has 635.631 particular and collective housing units (IBGE, 2010); from this 90.8% are occupied, 1.8% have occasional use and 7.4% are vacant. These housing units are divided in different types of houses, from subnormal clusters to richer houses in gated communities.

In the city of Curitiba, according to the Census 2010, the largest part of the housing units has access to the basic infra-structure requirements, such as water supply, sewer connection, electricity and as well as access to public transportation.

It is important to understand the housing context in which the project is situated; its current situation and the municipality solutions for it.

Subnormal clusters

The current situation of the project site, is of subnormal clusters, which as explained before, are allotments with at least 51 housing units, which occupy others land (public or particular), it has a dense disordered lay out, and lack the essential public services.

Since 1991, the number of units in these allotments is reducing in most of the neighbourhoods in the city, at the same time the number of neighbourhoods with more than 1.000 units has increased, from 1991 to 2010, from seven to twelve neighbourhoods.

But besides the location, when evaluating the percentage of the subnormal clusters in the city, from 1991 to 2010 the percentage is the same, 7.8%; the absolute number has gone from 28.239 units in 1991 to 49.706 in 2010, according to the Brazilian Census.

Social Housing Complexes

With the aim to end with the housing deficit and to decrease the number of housing units in subnormal clusters, a large number of social housings have been being built; in 2008 the number of housing complexes built, by the Housing Company of Curitiba, Cohab-CT, was 412, while the total number of housing units were of 94.903, distributed in form of lots (50,79%), houses (24,82%) and apartment buildings (24,39%). (IBGE)

Fig. 3.02 – Apartment buildings and Houses made by the Social Housing Company of Curtiba, Cohab-CT.

Fig. 3.01 – Small house of a Subnormal cluster, without a good basic structure to have someone living on it.

Existing Project

Fig. 3.03 – Master Plan of the project, from the Housing Company, which is being built on the Prado Village.

The actual housing project to the site area was not provided by the Cohab-CT, but it was possible to have access to another project from the company, with very similiar characteristics.

The project has a gross area of 37m² contemplating two bedrooms, a living room integrated with a kitchen, one bathroom and an external laundry room.

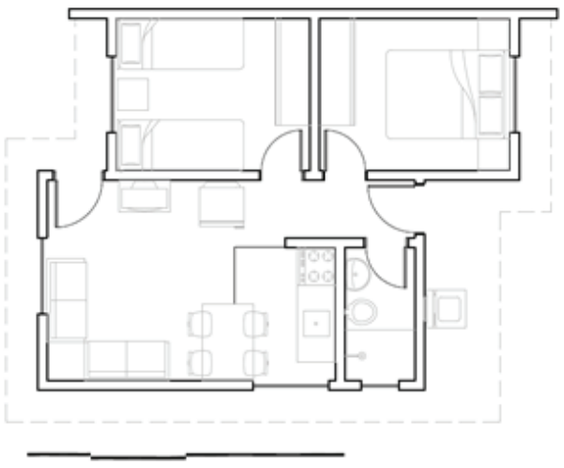


Fig. 3.04 - Plan of a social housing unit.

The Materials used in the house are:

WALLS: Ceramic Block and Plaster (U-value = 2,43)
ROOF: Clay Tile and PVC Ceiling (U-value = 1,75)
FLOOR: 10cm Concrete Slab (with Ceramic Floor on wet areas)
WINDOWS: Simple Glass and Metal Framing

Indoor Climate Analysis

Having the housing project and its materials, it was possible to run a simulation in the BSim software and get a deeper understanding on the indoor climate of these houses. In this particular project the orientation had the rooms facing East and West, but it is possible to have the same project facing North and South, which would have a different result, where the difference between temperatures would be higher.

All the rooms in the analysed house have more than 1.000 hours with the temperatures above 27°C during the year; the temperatures below 20°C are and around 3.500 hours during the year. Brazil does not have a regulation about indoor climate, using the Danish regulation as a standard this hours should be reduced to 25 hours above 27°C, considering that 100 hours can be above 26°C.

The graphs below are representing the warmest and the coldest months of the year (February and July of 2013); the temperatures between the rooms do not differ much, and are following the outdoor temperatures, having a variation of approximately 18°C during February and of 22°C during July. When analysing only one day instead of the whole year it is easier to understand the difference between the rooms (fig. 3.07).

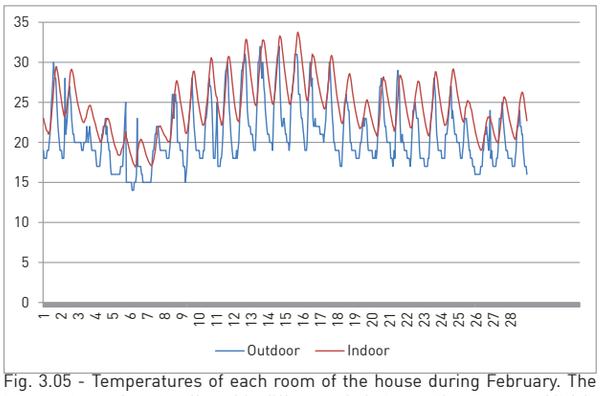


Fig. 3.05 - Temperatures of each room of the house during February. The temperatures do not suffer a big difference in between the rooms and it follows the outdoor temperatures; February is the warmest month of the year and the temperatures are varying between around 17 and 35°C.

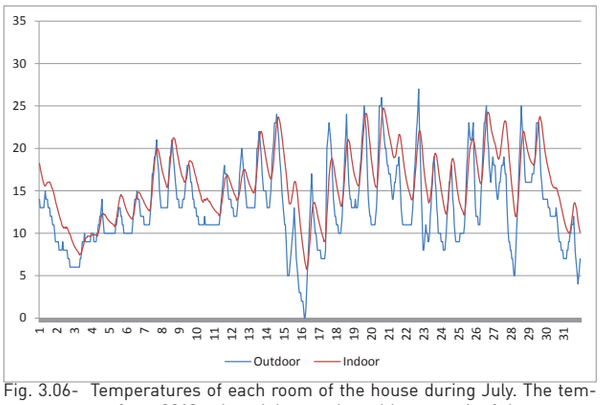


Fig. 3.06- Temperatures of each room of the house during July. The temperatures are from 2013, when July was the coldest month of the year; as in the previous graph the temperatures suffer a large difference during the month, going from 5 until 27°C approximately.

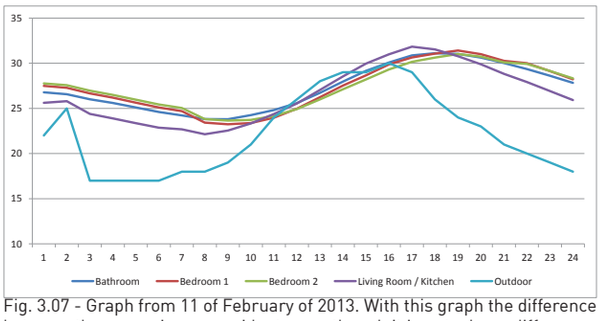


Fig. 3.07 - Graph from 11 of February of 2013. With this graph the difference between the rooms is more evident, even though it is not a huge difference. It is also possible to see that is not only during a month that the temperatures suffer such large differences, in this particular day it goes from approximately 22 until 32°C, inside the house, what it cannot be considered a comfortable indoor environment.

The conclusion that can be taken by the temperatures analysis, is that the indoor environment is not comfortable during all year long, whit a more evident lack of comfort during summer and winter. The main reason for this reality in the social housings is the lack of quality in the materials, which do not protect the inside of the houses from the temperature changes from the outside, and also the lack of protection on the windows, that do not block the sun heat in the summer period.

House x Family size

From the data of the social-economic characterization document made by the Social Housing Company (COHAB-CT), a profile was made with 97.2% of the families that were living in the area in December of 2007.

The larger percentage living on the area was of families with four persons, there were houses with one to twenty six households, thought. With the chart (fig. 3.13) it is possible to understand the distribution of persons on the houses, the percentage of above eleven households includes two families with 11 persons; one with 12 person; one with 13persons; one with 15 persons; and one with 26 persons.

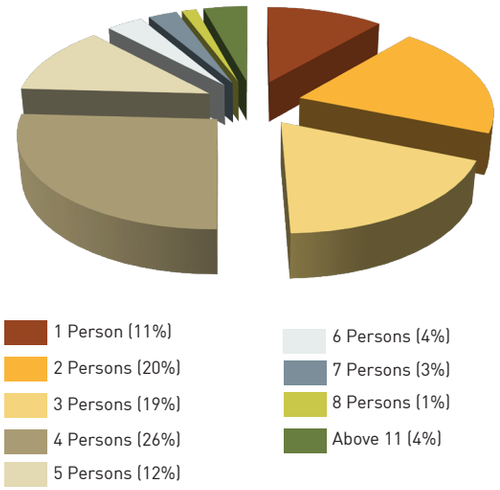


Fig. 3.08– Chart showing the distribution of the persons in the family.

The analysis data also shown that many of these families have been living in crowded conditions; dividing the rooms and dormitories in more persons than it really supports.

The existing project for the area meets only with the average number of households, having two bedrooms for all the different size of families.

3.1.2 ECONOMIC PROFILE

At the same time that the city of Curitiba is an example of developments, inside Brazil, in different areas, such as public transportation and selective waste collection; it has the 6th worst income distribution in the whole Latin America.

The process for this inequality started with the migration from the rural areas to the capital; this population ended up occupying the peripheral area of the city, never getting the chance to be inserted in the urban area, where all the development is. (Curitiba, 2012)

Due to this high inequality, when comparing the Prado Village with the whole city, it is visible the difficult economic situation in which the households live in.

The economic analysis, in Brazil, is made using the minimum wage as a determining factor. Nowadays the minimum wage corresponds to R$724,00 (around 240,00 Euro); with this amount one should be able to have all the basic needs contemplated, as housing, food, education, hygiene, transportation. According to a research, in order to live with all the basic needs been really contemplated, the minimum wage should be four higher, though. (Viver, 2009)

In 2000, 49.1% of the permanent particular houses households had an income below 5 minimum wages in Curitiba, 5.9% did not have an income and 45% had in income above 5 minimum wages. In 2010 there is an expressive grown in the percentage of households which the income goes until 5 minimum wages, 66.3%; the percentage of households without an income also showed a growth, of 9.6%. There is in the other hand a large drop in the percentage of households with an income above 5 minimum wages, going from 45% in 2000, to 24.1% in 2010. (IPPUC, 2010)

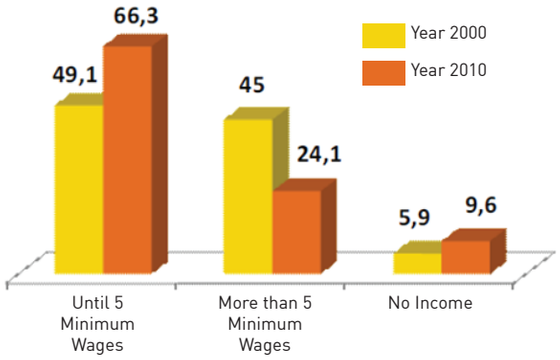
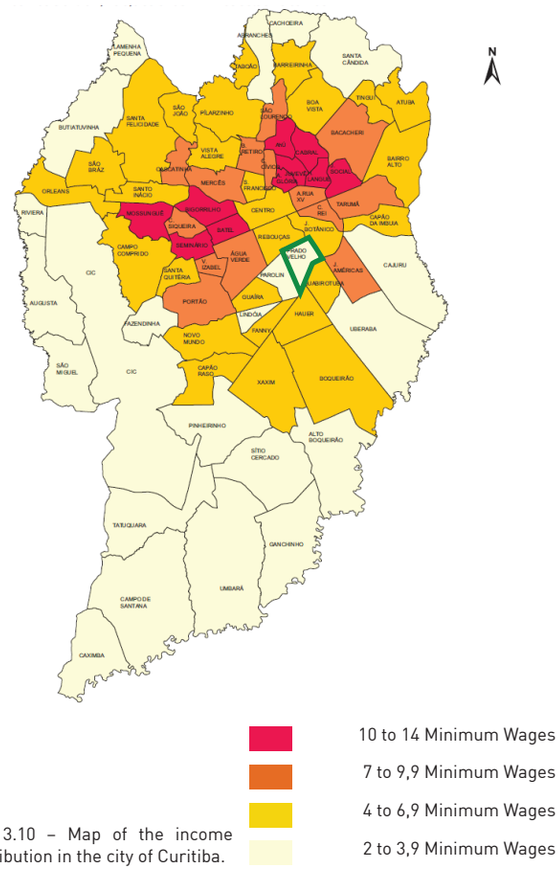


Fig. 3.09 – Income from the permanent particular house responsible household, in 2000 and 2010.

The map (fig.3.10) exemplify the income distribution on the city; being possible to see that Prado Velho is between the neighbourhoods with the lowest income rate.



10 to 14 Minimum Wages
7 to 9,9 Minimum Wages
4 to 6,9 Minimum Wages
2 to 3,9 Minimum Wages

Fig. 3.10 – Map of the income distribution in the city of Curitiba.

Regarding the Prado Village, according to the Social-Economic characterization document from the Cohab-CT, the overall income situation of the area can be understood with the chart (fig.3.19), in 2007, the larger majority did not reached R$1.050,00, less than 3 minimum wage, which was R$380 at the time.

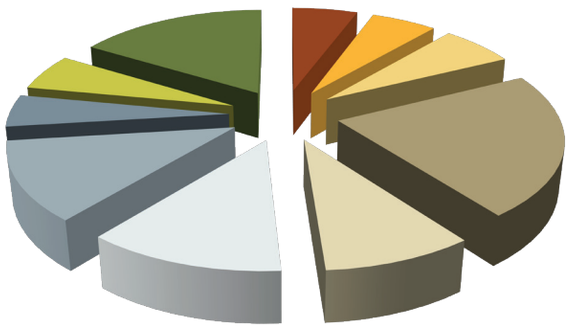


Fig. 3.11– Chart of the income of the Padro Village households.

No income (6%)
Income Until R$ 200,00 (6%)
Income R$ 200,00 to 300,00 (6%)
Income R$ 300,00 to 400,00 (22%)
Income R$ 400,00 to 500,00 (9%)
Income R$ 500,00 to 700,00 (12%)
Income R$ 700,00 to 800,00 (12%)
Income R$ 800,00 to 900,00 (5%)
Income R$ 900,00 to 1.050,00 (6%)
Income Above R$ 1.500,00 (16%)

3.1.3 SOCIAL PROFILE

The greater problem of the inequality, previous explained, is that it comes together with discrimination and violence.

In the Torres Village, the difficult to create a local identity starts with the place´s title, since the area used to be an irregular occupation it is still treated as a slum area by the city population. The inhabitants of the area have a daily fight, not only trying to live in good conditions, but also trying to integrate with the city.

The prejudice from the Curitiba´s population with the area comes by the violence history of the Village; even though it is only a small part of the inhabitants that are not acting right, the city end it up seeing the area as a criminal den, forgetting about the families that also lives there, and that are trying to have a pleasant life, besides the violence.

The social difficulty for the inhabitants go beyond the lack of security or identity; this discrimination can even make it more difficulty for them to get into jobs and other difficult that are created for them just because of the place they live. (Bem Paraná)

Fig. 3.12 – Picture from a family that lives in the area, with the new houses from the Social Housing Company .

Security

As it was said, inequality is directly connected to violence; insecurity is a problem faced in all the cities in Brazil; Curitiba is in between the cities with the highest violence rates, in 2008 the city was the 7th city in the country with the higher absolute number of homicides, and this number has been growing, together with the inequality rate.

The biggest problem of the Prado Village is the drug traffic, which has more than one representative and constant conflicts. In an interview made with the Prado Village Households, in the February 24th of 2014, the larger problem related by the interviewers was the lack of security in the area.

"They are not afraid to kill" - Report about the violent people that live in the area, from one household who have been living in the Village for 40 years; she has been living with a constant insecurity for the last few years. This insecurity is cause by a "war" between the two sides of the Torres Village, which is divided by the Guabirutuba Street.

One other reality that was pointed by almost all the interviewed households, was the difficult to access the health centre of the region, since is located in one side and this "side´s command" do not allow for all the population to use the health centre, intimidating the inhabitants. One elderly household reported that was already asked to leave the centre by one of the drug dealers holding a gun.

The lack of security is also felt by the population that do not live in the area; in order to realize the interviews I had to go two times to the site, in the first time I did not even had the possibility to go out of the car, because the place was field with drugged people and many intimating men around. The second time I went to the site the environment was better, so I could explore the site and I could talk to some of the households; but I did not feel comfortable even to take pictures, due to the reaction of some of the people that were around.

Fig. 3.13 – Picture of a police intervention in the area, that is not so present to create a secure place to the inhabitants, but when the situation gets out of control they try to control, also with the use of violence.

Fig. 3.14– Picture of the Peace Bridge of the Torres Village, the inhabitants painted this bridge with the word PAZ written on it, which means Peace in Portuguese.

Schooling

The households who live in this area did not have much access to education. In 2007, the collected data showed that from the inhabitants who were not studying, 28 persons above 18 years declared themselves as illiterate (8,21%); between the ones who did studied, 63 persons (18,47%) stopped studying before the 4th grade, 70 persons stopped studying between the 5th and the 8th grade and only 26 (7,62%) concluded the primary school. At the same time, 37,43% of the researched households were studying at the moment, most of them were children going to regular school

Occupation

Regarding the occupation of the households older than 18 years, in 2007 7.9% were retired (26 persons); 111 persons (33.74%) were working as registered workers; 70 persons were workers without any registration or worked as autonomous; and 94 persons (28.57%) did not work.

In the Torres Village a common occupation is the collection of recyclable waste ; in 2007 the Prado Village area had 14 families working with it, 11 of these families had one collector, 2 families had 2 collectors and 1 had 3. Five of these families did the material separation at home, while the rest of the families did at a deposit in the village.

Fig. 3.15 – Picture of a collector of recyclable material.

3.2 USER GROUPS

As part of the social-economic reflections, and together with the performed interviews, the user groups were defined, and divided in three major groups, according to the users' age. The family's sizes might change, maintaining the main characteristics.

This definition is taking into consideration the needs, wishes, everyday practices and income of the current Village households.

Fig. 3.16 – Family from one of the new houses.

1 – Family / Single Mother with Children:

NEEDS

Bedrooms
Bathroom
Kitchen
Living Room
Laundry Room
Garage
Outdoor Area

WISHES

Play / Activity area for the children
Safe Environment
Economic House
Good Indoor climate
A more spacious house
Possibility to extend the house
Leisure Area

EVERY DAY PRACTICES

Children go to school during the morning or afternoon and stay at home the rest of the day

and

Parents usually work during all the day

$ INCOME $

Until 3 Minimum Wages

2 – Senior Couple

NEEDS

Easy access
One floor House
Bedrooms
Bigger Bathroom
Kitchen
Living Room
Laundry Room
Outdoor Area

WISHES

Safe Environment
Economic House
Good Indoor climate
Space – Possibility of having the family around
Possibility to extend the house
Space to work at home
Leisure Area

EVERY DAY PRACTICES

Spend almost all day at home

$ INCOME $

Until 3 Minimum Wages From Retirement or small services income

3 – Senior Couple / Mother with older brood

NEEDS

Easy access
One floor House
Bedrooms
Bigger Bathroom
Kitchen
Living Room
Laundry Room
Outdoor Area

WISHES

Safe Environment
Economic House
Good Indoor climate
Space – Possibility of having the family around
Possibility to extend the house
Space to work at home
Leisure Area

EVERY DAY PRACTICES

Brood usually work or study during the day

and

Parents usually stay at home

$ INCOME $

Until 3 Minimum Wages From Retirement or brood income

3.3 SITE ANALYSIS

3.3.1 METHODOLOGY

The methodology used on the site analysis aims to get the maximum information to the project development.

After a brief from the current situation of the site and the zoning characteristics in which the area is inserted,; a Kevin Lynch analysis was performed, mapping the Paths, Nodes, Districts, Edges and Landmarks of the area.

The analysis aim to understand the relation between environmental images and urban life based on urban design principles. The understanding of the site got on this process helped on the design development to get the main features into the project.

3.3.2 PRADO VILLAGE

The area of the Prado Village Housing project used to be occupied by 145 families, who lived in a compact way at an irregular occupation, taking the borders of the Belém River. An intervention on the area was started in 2011, when 55 families were transferred to new houses in the Sítio Cercado IV housing, in Bairro Novo Neighbourhood, on the outskirts of the city.

The project is being done with funds from the Growth Acceleration Program (PAC), a Federal Government project. All the remaining 90 families will receive new houses, with two rooms each, in the area. The moving is being done as soon as the houses are getting ready, but, unfortunately, the constructions have stop due to the lack of funds.

The current situation of the village, is that around twenty houses were built, in which the families already moved in; several houses were turned down, and the households has to go to provisory houses; and some of the families keep living on the old houses. The construction have stop when around five houses were half built; creating a problem to the area, since people are occupying this constructions, in part to use drugs.

Fig. 3.17 – Picture of the expropriation process.

Fig.3.18 – Situation Plan

The situation plan shows the existing condition of the Prado Village before the intervention from the Social Housing Company. The plan is showing the houses from which the families will continue living in the area; from these families, some of the existing conditions were pointed out, the houses with elderly people living in (9 families); houses with physical disable households (5 families); and the houses where there were recyclable material collectors living (7 families). All these perceptions about the existing allotment are really important in order to create a project that takes in consideration the households conditions and needs. The map also shows the houses that used to have commerce with the house, and the location of the recyclable material deposit.

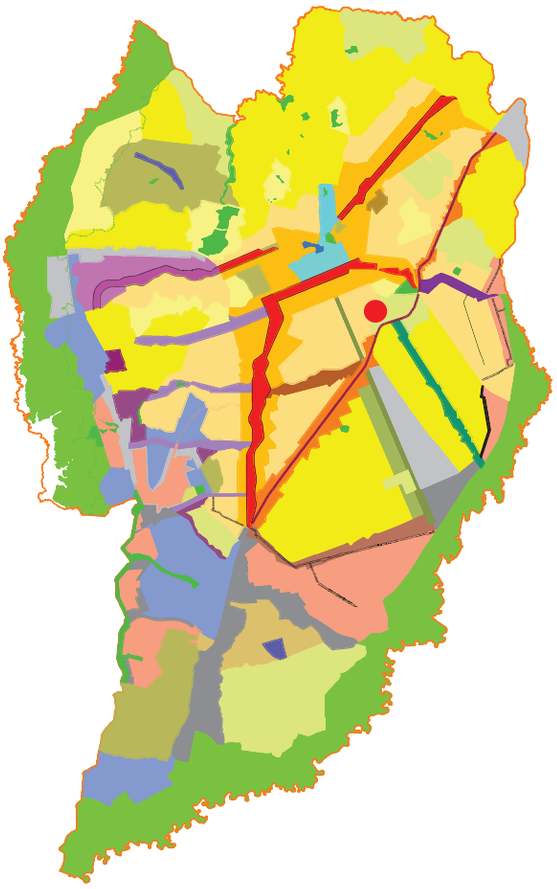


Fig. 3.19 – Zoning map of Curitiba.

The city of Curitiba is divided in 30 zones; for each zone, building parameters, related to the use and site occupation, are defined, having to be followed in order to get the project approved.

The project is located in the Residential Zone 3 of Curitiba (ZR3 zone. The city of Curitiba is divided into 30 different zones; for each zone, building parameters, related to the use and site occupation, are defined. Such parameters have to be followed in order to get projects approved.

The mainly constructive parameters of this zone are:
- It is permitted to build Single-family Houses,; Series of Single-family houses, and Collective Housing;
- Utilization Coefficient: 1 (meaning that it is permitted to build the maximum area of 1 time the area of the site);
- Occupancy rate: 50% (meaning that the building can only occupy 50% of the side);
- Permeability rate: 25% (meaning that at least 25% of the site has to be permeable);
- Maximum high: 3 floors.

The area gives the chance to buy constructive potential and have the Utilization Coefficient 2.5, instead of 1 and the maximum high of 8 floors instead of 3.

3.3.3 MAPPING – PATHS / NODES

Fig.3.20 – Paths/ Nodes Map

- Site
- Connection between Area – Centre Avenues
- Important connection streets
- Streets with a commercial character
- Belém River
- Nodes – conflict points

The site is located between important roads that are important connections from the city centre to the southeast of the city, the airport and other cities, like the sea side of Paraná state and São Paulo city (fig.3.29); the most important road to these connections is the Torres Avenue.

The Guabirotuba street also have a great importance, since it is the street that gives access to the University it has a large movement during the day; besides that, recently the Guabirotuba together with the Chile Street became a binary system also aiming the connection between the southeast of the city and the central area. (Fig. 3.30)

Being a connection area of the city with important streets surrounding the site, makes the "slum" area a problem for the region; that is the main reason why the Prado Village is being regularized and for the many interventions that the municipality did in the Torres Village.

Since the Belém river is visible in all this area, all the connections between the river and the main streets creates nodes, a conflict points; when analysing this node next to the site, there is one more important characteristic, the fact that the bridge is the starting point to the Torres Village and therefore it has to be treated differently. The other nodes are just pointing out the connection of busy roads, which creates traffic conflicts.

Fig. 3.21 – Map that shows the connections arising from the roads that are surround the site. It shows the site marked in read, the central area of the city that is in orange and the two connection streets that are passing next to the site. The grey area is the central regional of the city, the reason why this connecting roads have such a large importance.

Fig. 3.22– Image showing the Guabirotuba/ Chile binary system.

Fig. 3.23 – Belém River, inside the Torres Village Area.

Fig. 3.24 – Torres Avenue.

3.3.4 MAPPING – DISTRICTS

Fig. 3.25 – Districts map

- Site
- Educational Area
- Torres Village
- Residential Area
- Residential Complex
- Culture / Leisure
- Commerce / Service
- Institutional

With the districts map it is possible to understand the context in which the site is inserted; it is connected to the Torres Village, at the same time that is surrounded from one side by educational areas and on the other side by residential areas.

The Torres Village and the University are the main Edges for the site; they are barriers, visually and considering the changes on the area´s urban outline.

When considering the residential areas, the pictures allow for the understandinf of the difference, especially in the infrastructure, between the "proper" residential areas (fig.3.28) and the Torres Village (fig.3.26) area, which used to be an irregular occupation. Also in the residential field, the region has a working village (fig.3.27), which is a residential complex where in the ground floor the families can work, while they live in the second floor; the region is formed basically by houses, because of the residential zone that is insert, which only allow the construction of buildings if the builder buy the constructive potential, what happened in a residential complex (fig. 3.29) from the area. One other characteristic of this area is the houses do not have a high acquisition level and all the houses are direct on the street, there are not any closed condominiums.

One other characteristic of this area is the houses do not have a high acquisition level and all the houses are directed on the street, there are not any closed condominiums.

The education characteristic of the area is marked specially by the university, one of the biggest private universities of the city – PUC; there is also a very well-known private-school and other smaller public schools and kindergartens.

The other uses, commercial, services and institutional, follow the streets hierarch, and are mainly connected to the larger streets. In that sense, the area is well served when considering the user´s needs.

Fig. 3.27 – Working Village.

Fig. 3.28 – Residential Area.

Fig. 3.26 – Torres Village.

Fig. 3.29 – Buildings Complex.

3.5.5 MAPPING –LANDMARKS

Fig. 3.30 – Landmarks map

In this map the main points of interest in the region were explored; instead of showing all the activities the map has the most important points, divided into cultural, institutional and educational. The small commerce is spread in all the area, having two streets that concentrate more stores, one inside the Torres village, where the commerce is directed to the village inhabitants.

Having 800m as a radius the area is well served, with education, health and food supply; the radius was considered taking into consideration the demands from the Blue House Certification regarding the urban quality, since the site have all the services that would be needed in the 800m – 1.500m distance group inside the 800m radius.

Fig. 3.33 – Health Center.

Fig. 3.31 – Durival Britto e Silva, Vila Capanema Stadium.

Fig. 3.34 – Public School.

Fig. 3.32 - Paiol Theater.

Fig. 3.35 - PUC University.

3.5.6 **SITE DEFINITION**

Fig. 3.36 - Site Conditions

- Prado Village
- Housing Area
- Empty Area
- Church
- Recycle Deposit

The original site, the Prado Village, was defined by the municipality as being the area that was occupied irregularly. The rest of the area had a proper division of the lots, and the constructions are not high quality, as it is possible to be seen in the pictures. That is the reason why it was decided to incorporate this area in the project, making the current housing units also part of the new housing project.

One of the uses in the lots that were associated in the site area is an Adventist church. Instead of making this church part of the new project, as done with the other uses, the church will have a new site, as marked in the map below.

The choice of changing the church area instead of considering the church as a part of the project comes from the fact that this church does not make a part in the social life of the site´s users.

Fig. 3.37 – Housing Area Picture.

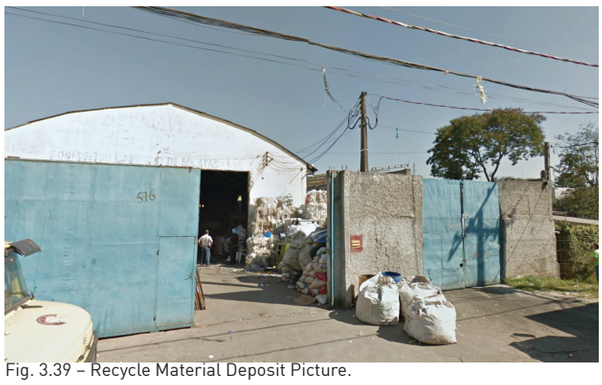


Fig. 3.39 – Recycle Material Deposit Picture.

Fig. 3.38– Church Picture.

Fig. 3.40 – Housing Area Picture.

Fig. - 3.41 -Mapping of the church new site.

3.4 CASE STUDIES

3.4.1 Villa Verde Housing - ELEMENTAL ARCHITECTURE

Fig.3.42– Picture of the project.

Fig.3.43 – Original and Expanded 1st floor plan.

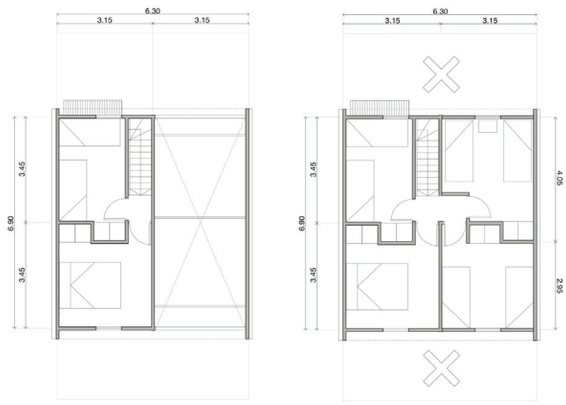


Fig. 3.44 – Original and Expanded 2nd floor plan.

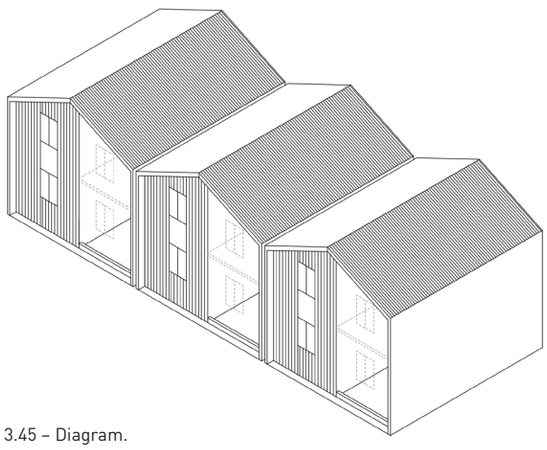


Fig. 3.45 – Diagram.

The project is from 2010 and it is located in Constitución, Maule Region, Chile. The architects thought about applying the principle of incremental construction and prioritization of the more complex components, leaving the project with a void that the families are expected to complete.

This way of designing at the same time that gives the possibility of a more a more dynamic project, where the users will be able to have their mark on the project, also makes it possible to the families to expand the houses according to their needs, with the basic structure already done, what assures the quality of the construction.

(Archdaily, 2013)

3.4.2 **Gifu Kitagata apartments –SANAA**

Fig.3.46– Picture of the project.

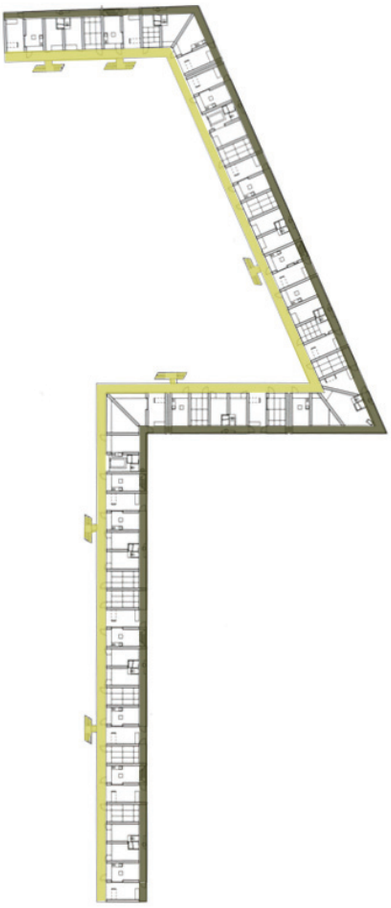


Fig. 3.47 – Project plan, highlighted are the two main circulations, in light green the public, which access is made by open stairs; the apartment rooms have access to this circulation; the darker green shows the internal apartment circulation, on the opposite side of the apartment.

This apartments building, designed by SANAA is part of a social housing project in which a courtyard lies between four separate housing blocks, designed by Akiko Takahashi, Kazuyo Sejima, Christine Hawley, and Elizabeth Diller.

The SANAA building concept is to have on every floor a long corridor, which gives access to the apartments and works like a public balcony; in connection to this corridor, each apartment has a private terrace that can be freely accessed.

According to the architect, since the building is made up of rental apartments, different families can live in this units, so they considered different types of groupings when designing it, and their building is formed by several kinds of housing units. The combination of the different plans generates complex elevations and sections.

The project has all the rooms equally lined up along the side that receives more sun; these rooms are linked by a narrow sunroom, which is an intermediate space between the interior and the exterior.

Each housing unit has a courtyard-like terrace; these terraces create holes in the building, reducing the visual impression of massiveness.

(Gifu, 2013)

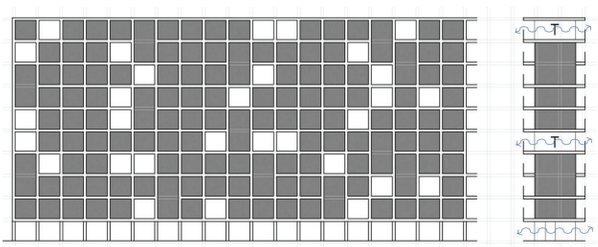


Fig.3.48– Project façade and section scheme.

3.4.3 **Vivazz, Mieres Social Housing - Zigzag Arquitectura**

Fig. 3.49 - Image from the inside of the courtyard; it is possible to see the use of the wooden elements in the façade.

Fig. 3.50 - Picture from the apartment terraces, composed of movable wooden shutters that, allows the user to control solar radiation and have the necessary degree of privacy at all times.

The project had as main objective to model the rigid traditional urban block of seven different heights to end up building a new volume of variable heights (three to seven stories), containing the complete residential program required. The rest of the program (storage rooms, garage and facilities) was designed in a common underground basement. It was desired the building to match the environment, voids and cuttings which allowed the view of the mountains in the empty spaces between the buildings, fragments of the Austrian landscape in the distance, enabling the sun and the air to enter the inner space at the same time. (Archdaily, 2013)

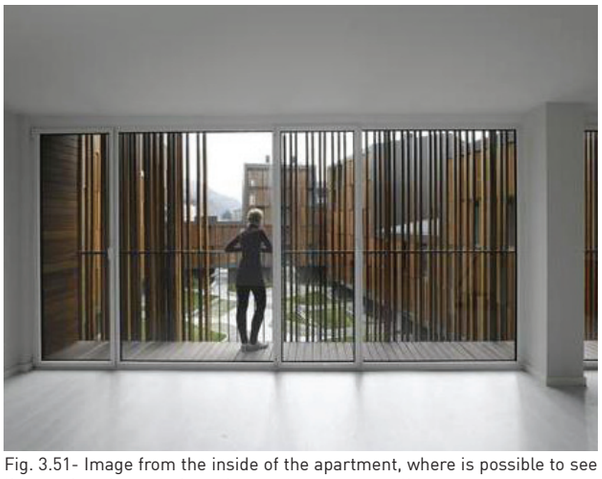


Fig. 3.51- Image from the inside of the apartment, where is possible to see the wooden elements from the apartment perspective.

3.5 ANALYSIS SYNTHESIS

3.5.1 CONTEXT

Through the context, the different realities and visions, it was possible to reach for the first design intentions; the need to build housing units concerned with the indoor climate; the security; energy economy; and interior spaces which allows the adaption. On top of that, to think about these different intentions, no matter for which social class the house is being built; therefore the need to get new solutions to the social housing design.

Energy-wise, according to the presented data, the main focus on the project needs to be on the reduction of the energy used with the electric shower, and with the indoor climate conditioning. And to do so, the existing guidelines from the 15220 Standard are not enough; being requested lower U-values and more effective strategies.

The climatic characteristics of the city made it possible to understand mainly the need of the sun inside the houses, for heating; and the possibility of using the amount of precipitation to reuse the rain water, also thinking about economy.

Blue House Certification

Aiming to reach the higher classification on the blue house certification many parameters had to be defined. Being the most important the flexibility of the project; thermic Performance, concerning the indoor climate performance; natural illumination; use of solar heating system; and the use of pluvial water.

3.5.2 SOCIAL - ECONOMIC

After analysing the current conditions in which the Village households are insert, the conclusion that can be taken into the design concerns is that many of the lack of opportunity which the area inhabitants live with, comes from the living situation. Once the place is seen as an area without expectations and qualities, the ambition to change the reality is low; nor the inhabitants reach for a better life condition, or the municipality creates better conditions.

As an architecture student, the challenge is to create a new environment, inside the existing reality, which, if built, would create a deeper change than only a good housing unit.

When taking in consideration the existing condition of the houses, the focus is one more time on the indoor climate, and the energy consumption. Having also the social importance to the existing community, and the need to create houses that are accessible to the different family needs.

3.5.3 MAPPING

From the mapping, the main characteristics of the area were understood, as the importance of the surrounding roads; and the context where the site is insert, whit all different typologies.

Also important to the project design, is the understanding of the river side, and the lack of gathering areas close to the site.

3.5.4 STUDY CASES

From all the researched references, three were chosen to be presented for the qualities that it could be translated on the project design.

The expansion understanding of the Elemental architecture was used to implement the flexibility thought on the project. To build the main structure of the house, which is actually only half of the overall possible size, living for the households to finish the other half in the way that best fits their needs.

Creating outdoor spaces, which at the same time that gives quality to the apartments, creates a dynamic on the façade, was the thought taken from the SAANA project.

And finally, the façade solution of the Zig-Zag Architecture; it was translated on the design project, the continue façade created by shading elements, and especially the relation between the apartment interiors and the façade.

4. DESIGN PROCESS

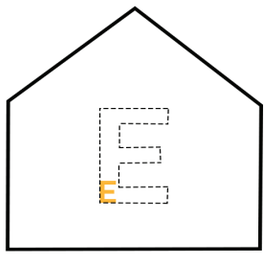
As explained on the method, the integrated design process consists on working with three different phases in a way which is possible to go forth and back; the analysis, sketching and synthesis.

To make it more clear the project presentation, the report structure is divided in context; analysis; process; and presentation. Inside this division, the design process consists on taking the conclusions from the analysis phase; and explaining all the steps passed in order to reach to the final design.

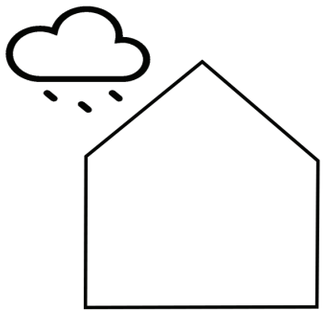
The presentation of the final design will be detailed with all the different elements that compose it, on the presentation chapter; where the synthesis and presentation phases will be compiled.

4.1 DESIGN PARAMETERS

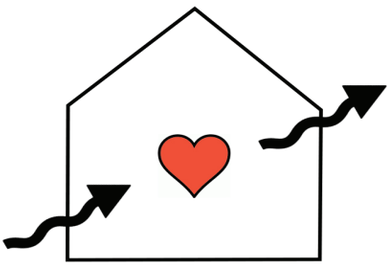
As a brief to the research and the analysis, the follow pa¬rameters explain the main concerns of the project de-sign, which were considered on every step, following the hierarch as listed below.



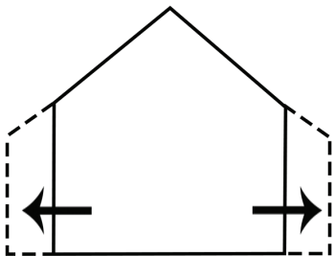
Low the energy consumption



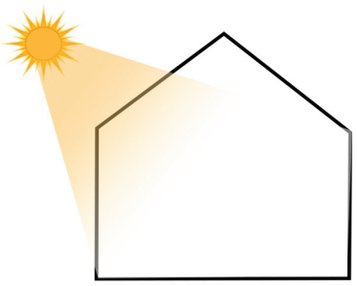
Use the rain water



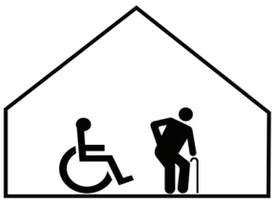
Create a healthy indoor climate



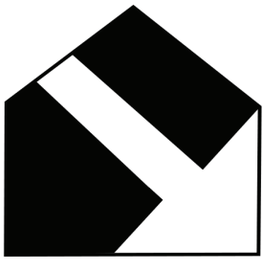
Make a flexible design, with the possibility of expansion



Use the sun heat



Create an accessible house to all users



Optimize the daylight

Create a house were the users will feel safe

4.2 PROJECT GUIDELINES

From the analysis understandings, minimum requirements were determined. With the aim for the best performance of the building, more restricted guidelines were established; and as a combination of both, the project program was created.

4.2.1 MINIMUM REQUIREMENTS

- Respect the minimum guidelines from the Bioclimatic Zone 1, given on the Brazilian technical normal (ABNT 15.220), which are:

Wall U-value less than≤ 2.5W/m²K
Roof U-value less than 2.3W/m²K

Use of Passive solar heating
Use of Thermic Inertia

– Zoning Parameters, from the municipality regulation:

Utilization Coefficient: 1 (19.146,00m²);
Occupancy Rate: 50% (9.573,00m²);
Permeability Rate: 25% (4.786,5m²);
Maximum high: 3 floors (up to 8 floors).

– My house my life Program minimum requests, considering that the project would attend the program, it needs to have in all the apartments at least the following rooms:

2 bed Rooms;
Living Room;
Kitchen;
Bathroom;
Laundry Room.

4.2.2 ESTABLISHED GUIDELINES

– Achieve the Gold Standard of the Blue House Certifica¬tion, which has as the main elements:

Flexibility on the project;
Leisure, social and sports facilities;
Thermic performance;
Natural Illumination and ventilation;
Solar Heating System.

-Indoor Climate
Do not have more than 25 hours above 27°C inside the apartments, and the same amount of hours below 15°C.

-Energy consumption
Reduce the energy consumption with only passive solutions;
Reach zero energy using passive solutions.

4.2.3 PROJECT PROGRAM

The project program and its areas can be understood on the table below; since there is more than one apartment typology, the apartment's area is approximated.

129 HOUSING UNITS	
INITIAL PROGRAM	2 BEDROOMS
	LIVING ROOM
	KITCHEN
	BATHROOM
	LAUNDRY ROOM
INITIAL AREA PER APARTMENT	50 m²
TOTAL INITIAL AREA	6.450m²
EXTENDED AREA PER APARTMENT	75m²
TOTAL AREA	9.675m²
1 LEISURE EQUIPMENT	
PROGRAM	1 CLOSED SPORTS FIELD
AREA	525 m²
1 SOCIAL EQUIPMENT	
PROGRAM	HEALTH CENTRE
	2 WORKSHOP ROOMS
	EVENTS ROOM
AREA	200m²
1 RECYCLE MATERIAL DEPOSIT	
PROGRAM	DEPOSIT
AREA	360 m²
TOTAL PROJECT AREA	10.760m²

4.3 PROJECT DEVELOPMENT

All elements forming the final design were thought on an integrated manner, since the beginning of the design process. This pro-cess will be explained aiming to give a better understand¬ing to the project presentation; where all the final solutions will be explained.

4.3.1 **INITIAL CONSIDERATIONS**

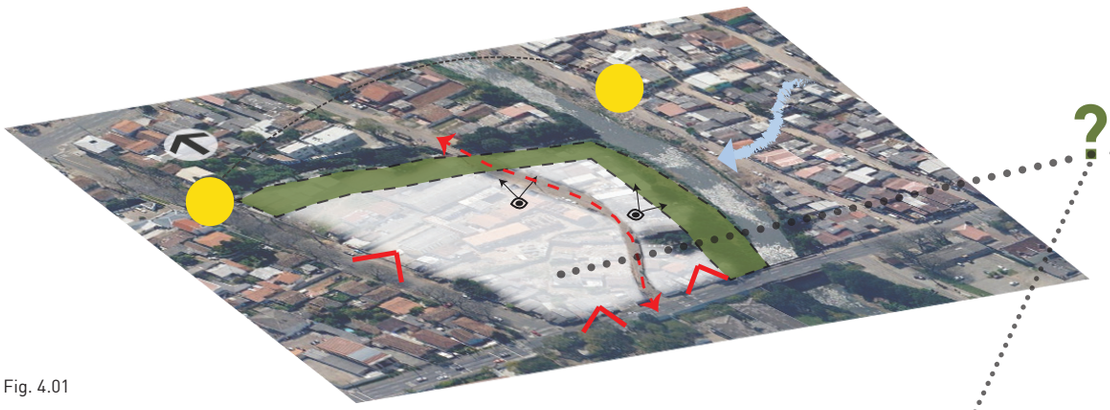


Fig. 4.01

In order to develop a project, the site constrains must be understood. The existing elements, which must be considered on the previous steps, such as the streets; the natural elements, water, trees and wind; the existing restrictions, as the 15m protection area along the rivers; and its potentials, as the possible use of this green area along the water; the main access to the site, and the existing way though the site.

Fig. 4.02 – Picture of the site, from the Torres Village.

4.3.2 **BLOCK ORIENTATION**

Fig. 4.03

It was defined a block form, with it the need to place the housing units on the site. The initial idea for the apartments was to have all the units facing east and west; having the sun and the wind as the main design parameters.

Once the apartments had all the same configuration, the blocks should have the same orientation in order to give the best indoor quality to all housing units. The drawings are representing the initial studies to the master plan configuration.

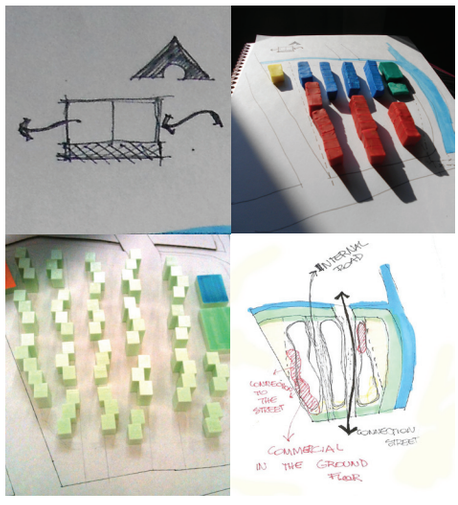


Fig. 4.04 – Initial sketches and model of the master plan design.

4.3.3 HIGH DENSITY – LOW DENSITY

A residential complex can follow a higher or a lower density pattern, being this an important definition to the final design. The low-density follows the single family house structure, and it can have a larger or smaller outdoor area; on the other hand, the high-density design is composed by apartment blocks, where the outdoor areas become common spaces.

To create a strategy to the project occupation there was the necessity to merge some of the qualities of the more urban environment, with a higher density, and some proper of the suburban areas and its lower density, in order to achieve sustainability at an environmental and social level. The low-density residential areas normally are preferred by the individual inhabitant, especially for the private outdoor areas; residential areas with a high-density can be a solution to the environmental issues and, if carefully designed, can integrate the different urban dynamics.

The security provided by each occupation also needs to be analysed on this context; the detached house is less protected from break ins than the apartment blocks. The picture (fig.4.06) shows the solution used by the Prado Village households to the new houses, since the project only provide the houses; each user is creating a barrier to the outdoor for its protection, lacking unit on the project.

The creation of apartment blocks, at the same time that offers better protection to the household, makes possible to have a stronger relation between the different blocks and the public spaces, creating a social interaction between the users.

Fig. 4.05 – House and Apartment typology diagram.

Fig. 4.06 – Picture from the new houses, after being occupied by households.

4.3.4 FLEXIBILITY

One of the design parameters of the project is the flexibil¬ity of the housing units; since the apartments have a re¬strict size, according to the conditions to attend the social programs, to give the possibility for the user to expand its house in the way that fits it better gives quality to the project.

Another reason that supports the need to create these flexible spaces is the fact that the houses program is the same to all the families assisted, but as shown previously, the users groups have a large variety.

Many studies were made, especially in the housing and the block scales to understand the best way to create these expansible houses, having in mind that the units might or might not be expanded and therefore it needs to be coherent before the expansion as well.

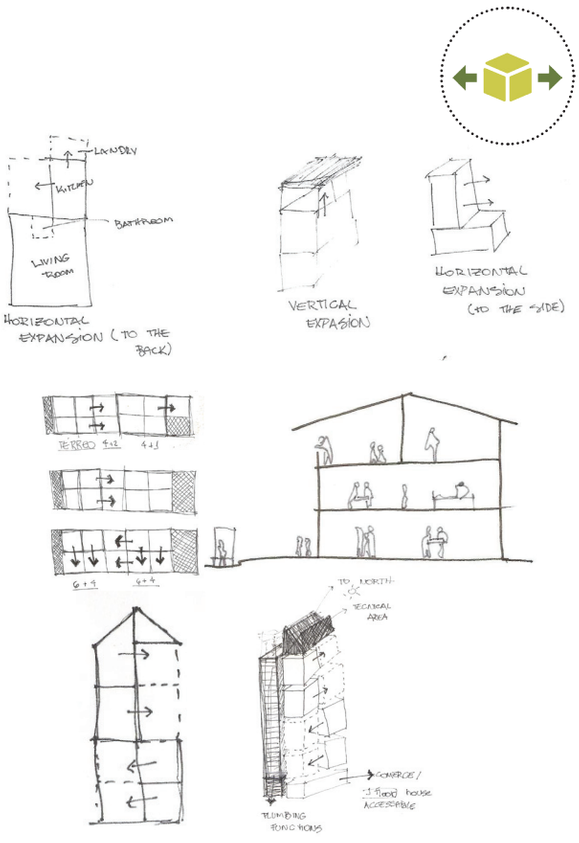


Fig. 4.07 – Sketches from different expansion directions possibilities. Since it is an apartment's block, the best expansion solution is the vertical or the horizontal, having in mind to not leave any room without daylight.

4.3.5 THE EXISTING BUILDING MASS

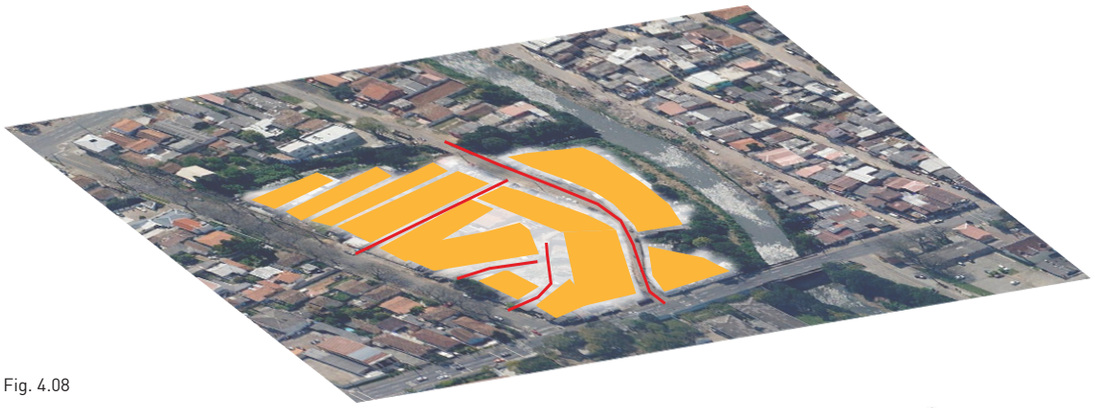


Fig. 4.08

At the same time that the blocks and apartments were being studied, in order to get to the best solution in terms of flexible design, the master plan started to be thought in order to relate more with the surroundings. Also, this contributed with the possibility of creating gathering points inside the project.

The first step was to get a better understanding on the existing occupation, once the area, even without good living conditions, has a great community dynamic.

The main streets and houses mass were studied and then translated on the diagram above.

Fig. 4.09 – Sketch diagram of the existing occupation.

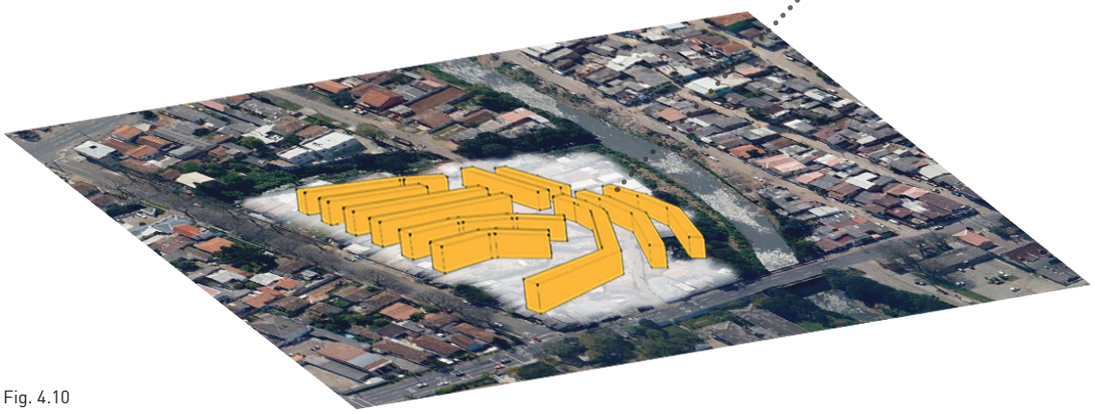


Fig. 4.10

Whit this new occupation possibility, the apartments were studied considering also a different block typology, facing north. The apartment studies, together with the combination of apartments creating the block, gave a dimension to the blocks and with this dimension it was possible to understand what would happen inside and outside the apartments, trying to reach the best features in all different dimensions.

The space between the blocks were also studied, giving enough space to the apartments, so that each of them can receive enough sun light and to create the gathering areas to the inhabitants.

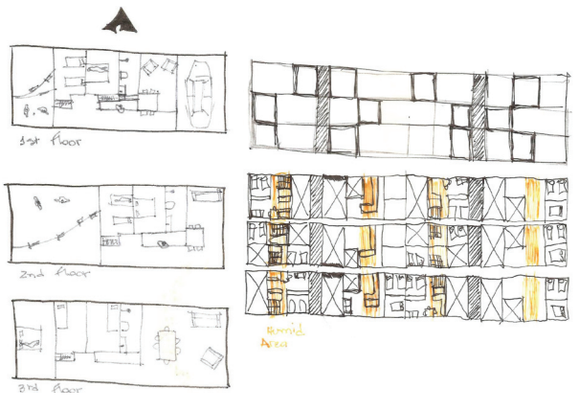


Fig. 4.11 – Block and apartments initial studies; considering both configurations, north and east/west.

4.3.6 **BLOCK DEFINITION**

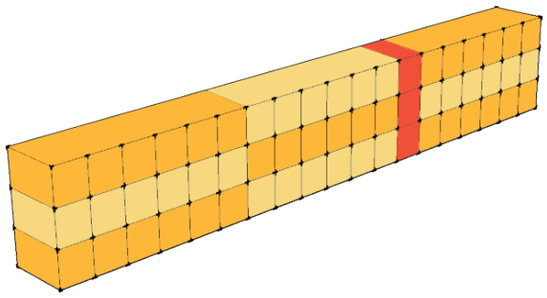


Fig. 4.11

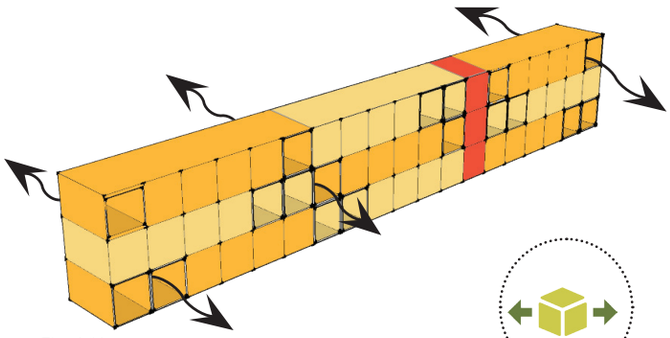


Fig. 4.12

The blocks are a composition of apartments, which have a common entrance. In order to have flexible apartments, the blocks were conceived in a way where the whole structure is ready to receive the future expansion. On the image (fig. 4.12) and on the blocks study models (fig. 4.13), it is possible to understand the presence of the expansion spaces on the façade.

This solution creates terraces to the apartments, looking for house qualities, inside the apartment block; it also makes it easy for the future household to expand the apartment if considers it necessary; and finally gives a dynamic to the façades, creating this "wholes". The dynamic will continue to exist after the expansions, considering that the window positions do not have to be followed by the users.

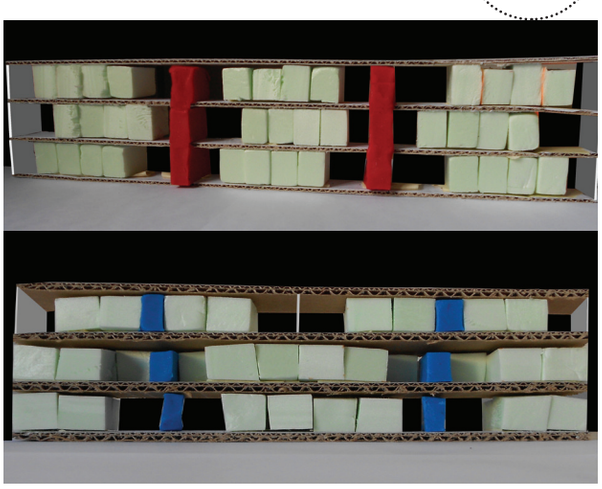


Fig. 4.13 – Study models of the blocks; on top is the north block, the bottle is the east/west block.

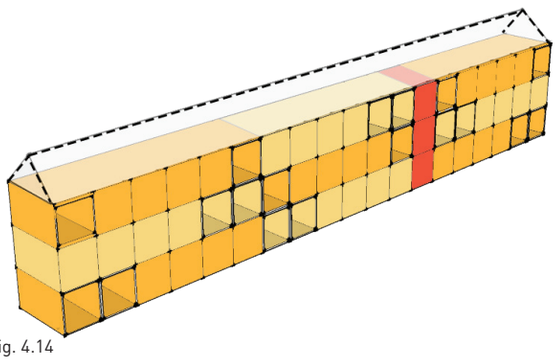


Fig. 4.14

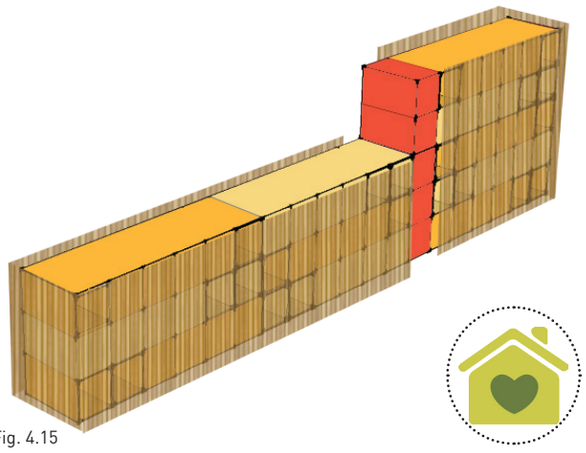


Fig. 4.15

The first studied form for the blocks was considering the pitched roofs; the idea was to have a house feeling, at the same time that receives the technical elements, such as the solar panels.

The plane roofs were also studied. When considering the two roof types, it got clearer that the reason for the pitched roof, that would be the technical use, the roof to the solar cells and under it to the water tanks, would be better resolved on the plane roof. The reason for that is that the project is not turned directed to north, what would not give the best performance to the panels; whit the plane roof it is possible to turn the panel to the best direction.

The plane roof also lets more possibilities to the façade solution, leading to a continue timber façade that protects the apartments from the direct sun on summer and gives identity to the project.

Fig. 4.16 – Block study considering the pitched and the plane roof.

4.3.7 FINAL MASTER PLAN

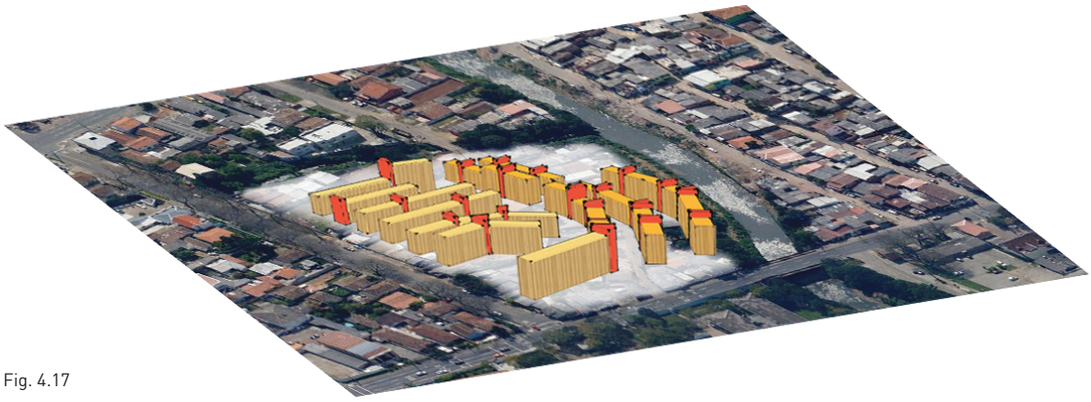


Fig. 4.17

The block and apartment studies let the blocks to have more than one height; the reason for it, is to create a dynamic composition, at the same time that gives the possibility of creating more apartments. The blocks are three, four and five storey.

It also got defined the materials for the structure, the building envelope and the shading devices. The difference between the apartments and the access got marked by different materials and heights; and the access becomes part of the structure.

Fig. 4.18 – Study of the material intentions.

Fig. 4.19

Since the social interaction is really important to the project, many areas were created with the intention to give the community gathering points. The main public area of the project is a linear park along the river that is visible to all the inhabitants of the project and not only to the ones living close to the river. There are also two main plazas, created to be common areas between the blocks.

The last components on the master plan organization are the social equipment, which are located taking into consideration who would use it. On the left side of the site is the recyclable material deposit, as the purpose was to have with an easy access from the street as it can be used by collectors from the surrounding areas, not only by the Prado Village households. The social and the leisure equipment were placed next to the linear park, creating a common use to the beset location of the park in order to allow everyone the possibility of appreciating it.

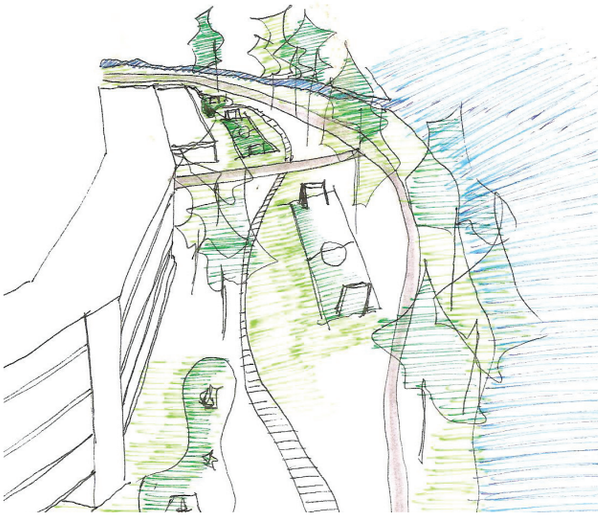


Fig. 4.20 – Sketch of the Linear Park.

4.3.8 APARTMENTS COMPOSTION

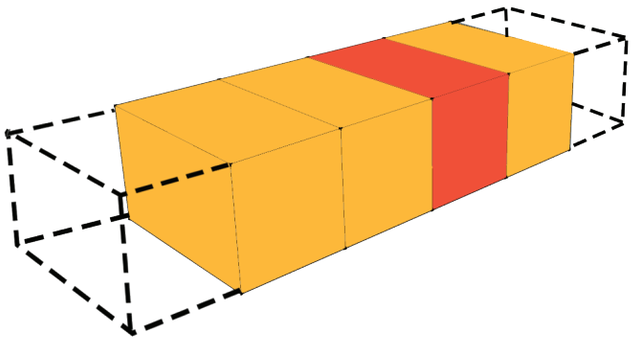


Fig. 4.21

In the different apartment typologies, the composition of the apartment modules changes; to explain the process the apartment facing north was chosen.

All the apartments are divided in modules; the main rooms are inserted into this modules. There are also expansion modules in each apartment. The main module of the apartment has the hydraulic functions, having the need to have hydraulic walls, which are connected from the first to the last floor, and finally connected to the water tanks.

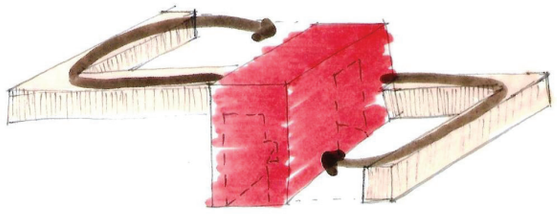


Fig. 4.22 – Sketch of the apartment´s composition concept.

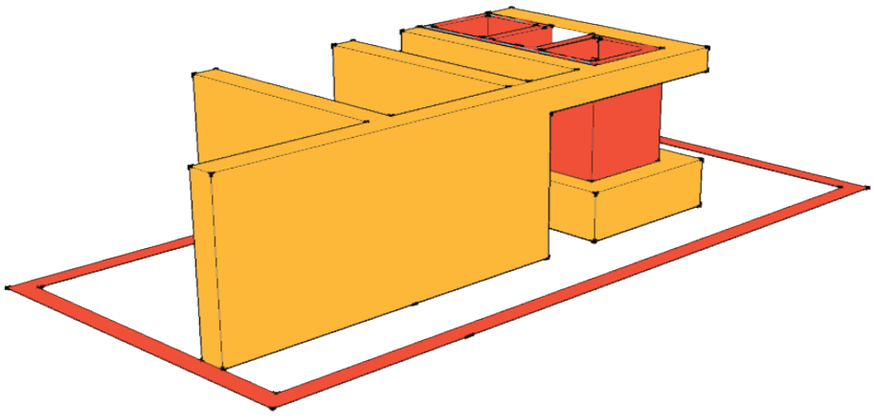


Fig. 4.23

The apartments are thought to attend the adaptable parameter together with the flexible, meaning that the furniture is responsible to delimit the rooms. The aim is for the best exploitation of the spaces, at the same time that it makes it easier for future changes in the indoor configuration.

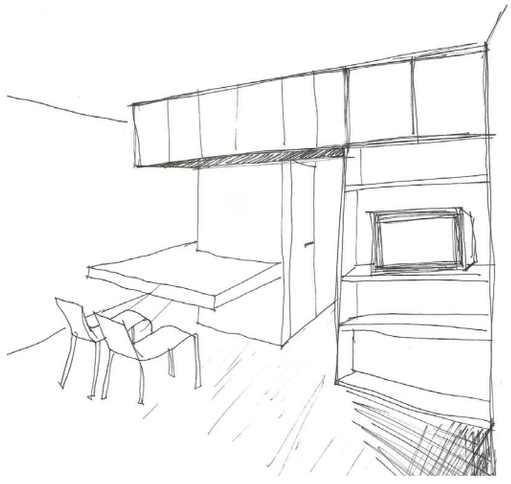
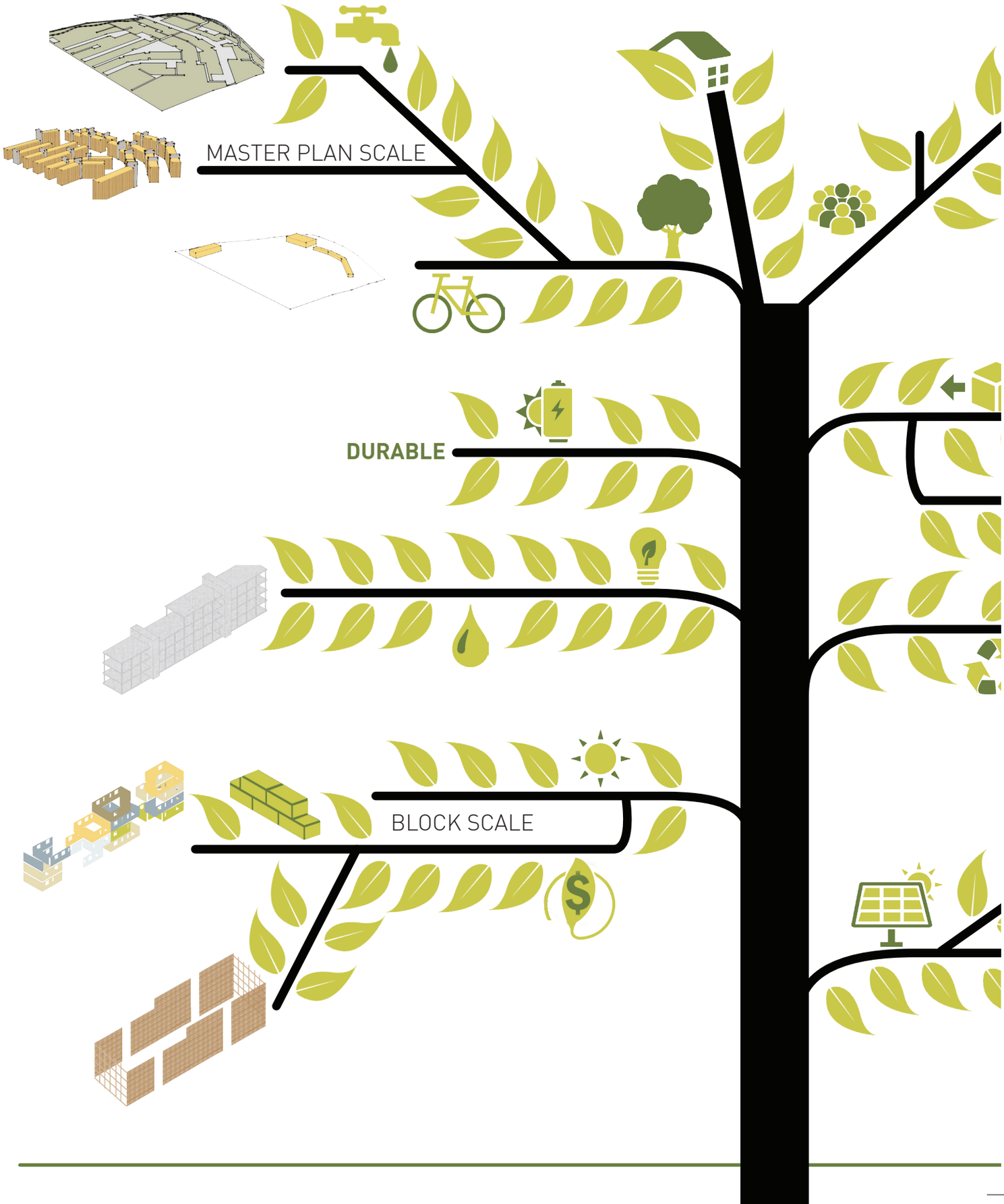


Fig. 4.24 – Sketch of the interior spaces, created by the furniture.

5. PROJECT

5.1 **CONCEPT**



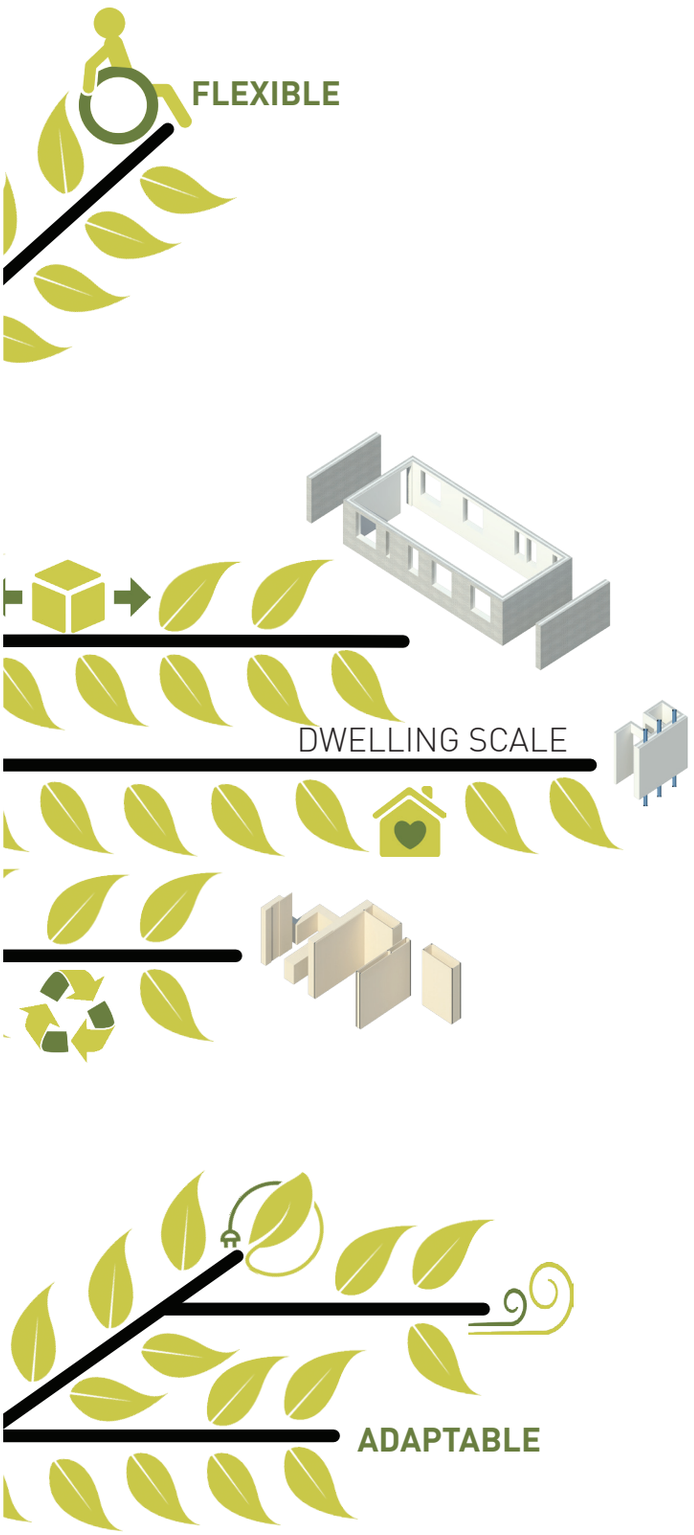


Fig. 5.01 – Diagram of the design concept; having the tree as the project, the branches are holding the leaves which together will compose the final project.

The project has the concept of creating a sustainable design through the interaction between different elements, in the three different scales: Master Plan; Block; and Apartment.

The main elements are the concern with the sun, energy saving, green areas, and so on; as well as being flexible, adaptable and durable; and are considered in all three scales, as represented on the diagram. (Fig. 5.01)

Inside the three scales, the interaction between elements happens in the same way, though the composition of different layers, in which the apartment becomes a block´s layer and the blocks a master plan´s layer.

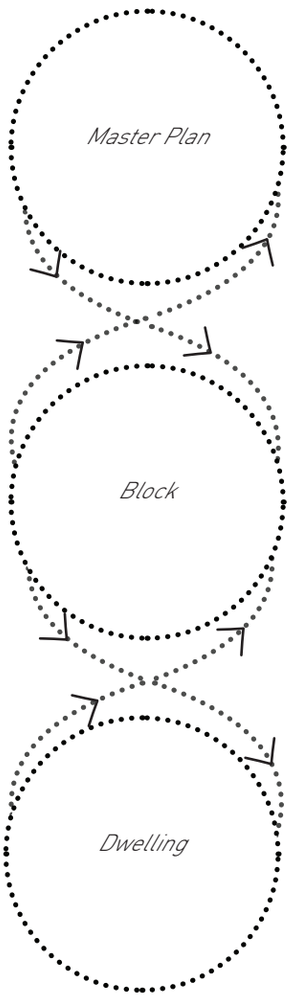
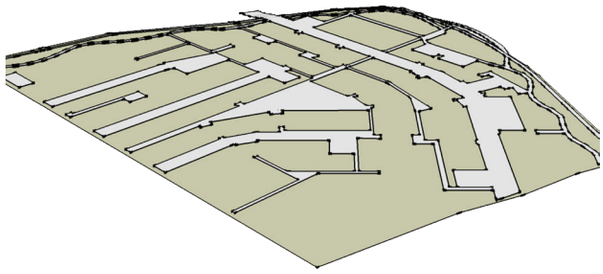
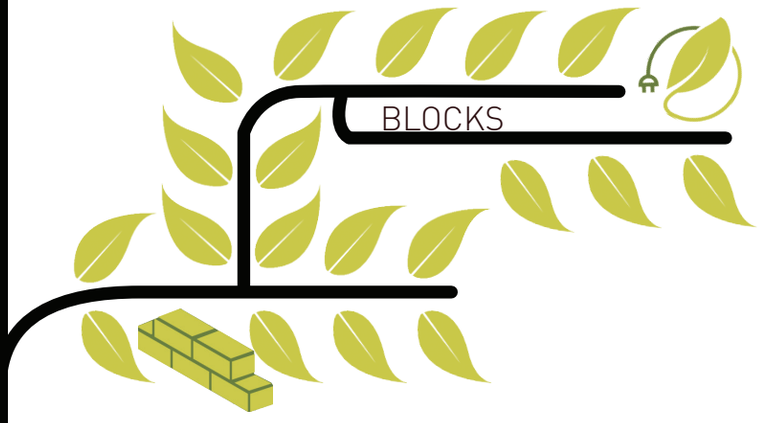


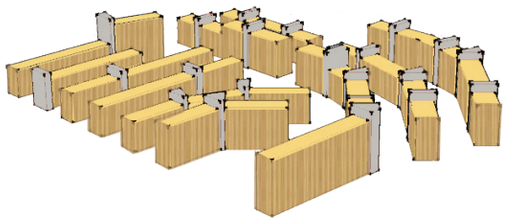
Fig. 5.02 – Diagram of the integrated design concept.

The project was designed in a integrated way, not only as explained on the method, concerning the project phases, but also considering the project scales; the presentation of the project is going from the master plan to the apartment scale, but the design was made going back and forward on the scales with the concern of having the best design solution.

5.2 **MASTER PLAN SCALE**







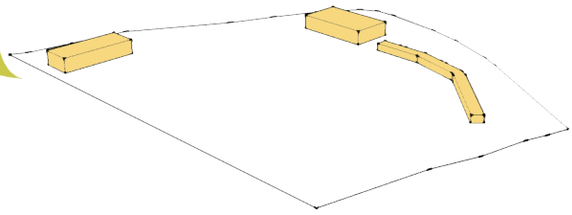


Fig. 5.03 – The three main layers composing the master plan scale are the green areas, with the paved and grassed areas; the blocks, 11 blocks with a total of 129 apartments; and the social equipment.

Fig. 5.04 – Master Plan

5.2.1 - PUBLIC AND SEMI-PUBLIC

The idea behind the open areas in the site is to create areas to be used by the Prado Village inhabitants, at the same time that they can feel safe in their houses. Therefore, it can be seen as public or semi-public areas, where the public areas can be used by the inhabitants of the surrounding areas; and the semi-public are the areas in between the blocks, that even though they are not closed, do not invite outsiders to use it.

The main paths are mixed-use, for pedestrians, bicycles and cars; it is possible to have cars between the houses, since the traffic along these paths will be low. The main reason for this, is that the mixed use allows to integrate the spaces dedicated to car, avoiding the presence of large and empty car streets, which create a barrier through the site. Its decision was also made when analysing the differences between the "regular" residential area and the Torres Village, where the life is on the streets, what do not happens on the regular streets, that becomes empty and boring.

Linear Park

Along the two rivers a linear park was designed in order to create a preservation area, at the same time that gives a leisure area to the inhabitants; the most important river and therefore where with more activities on the park, is the Belém.

The Belém River is considered the most important river of the city, since it starts and finishes in Curitiba, passing by 35 different neighbourhoods; in its 21km of extension; but unfortunately it receives all kinds of pollutants, especially from irregular sewer connections.

Fig. 5.05 – Belém River Picture.

There are different projects, from many organizations, with the aim of revitalizing the river; part of these projects have been trying to relocate the houses that are too close to the river, as the Prado Village.

A Linear Park along the river is also an existing project; the small linear park created in the project gives the possibility of a future connection to a bigger scale project. In the park, two lanes are being created, one for bikes and one for pedestrians, together with some sports fields, playgrounds and contemplation areas, with trees and benches.

Fig. 5.06 – Linear Park plan.

Fig. 5.07 – Perspective of the Linear Park.

Public spaces

Together with the linear park, two squares form the public gathering areas of the project. Both spaces are interacting with the master plan dynamic.

The first is a paved square, which contains equipment, such as playground and skate ramp. It is connected with the street and the linear park by the bike lane.

The second has the opposite concept; it is a green square, with a quiet and introspective feeling, composed by trees and benches; being a public area, it is opened to the street, inviting people to use the space.

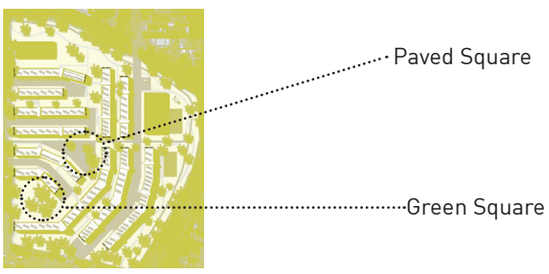


Fig. 5.08 – Perspective of the paved square.

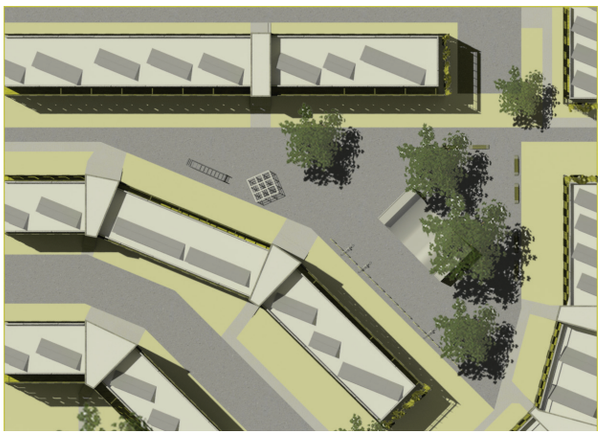


Fig. 5 .09 – Paved square plan.

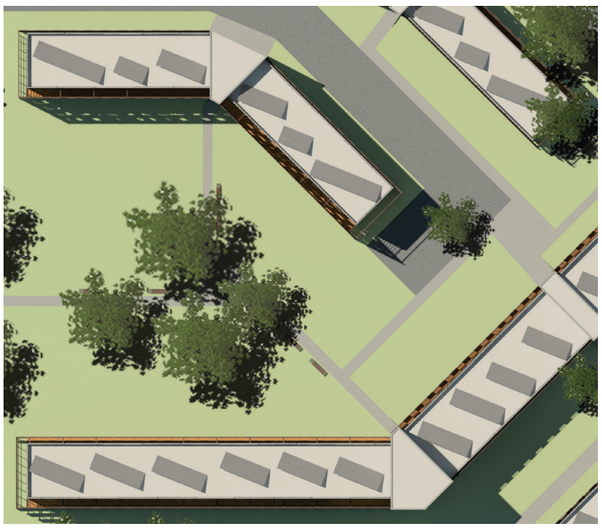


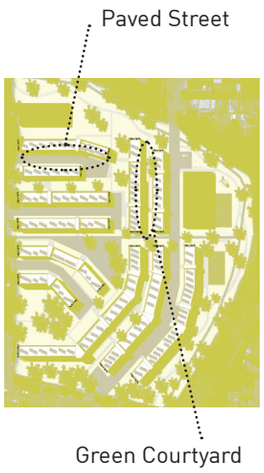
Fig.5.10 – Green square plan.

Semi-public spaces

The semi-public functions are the areas created in between the blocks; they are considered to be semi-public because of the privacy that is looked for the apartments.

It is divided on areas with a multi-functional path, where the cars can also access the site; the areas are paved, on the other side of the blocks the area is mainly grassed, creating a natural view to all the apartments.

The "front and back" are delimited for the semi-public area that is around; in the block there will be a further explanation on how this is changing the façade. The green side is the considered "front" of the block, and the paved side is the "back".



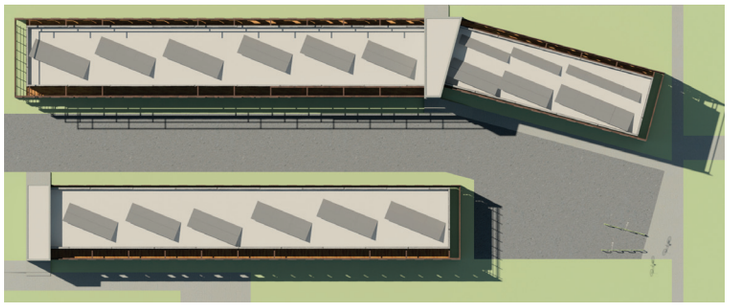


Fig. 5.11 – Plan of the paved street in between the blocks.

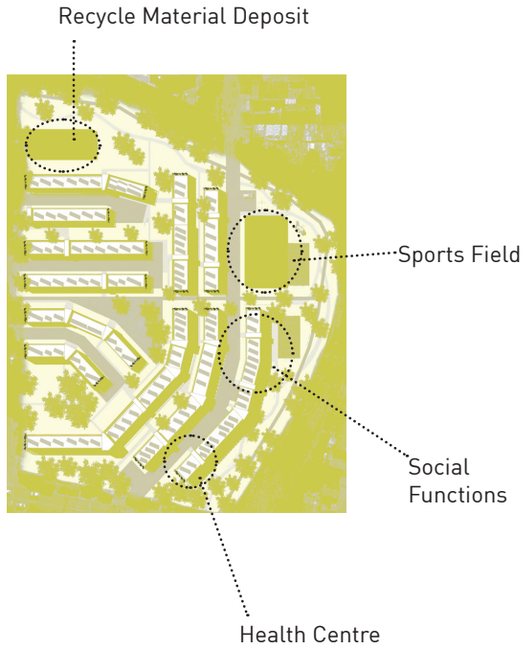
Fig. 5.12 – Plan of the green courtyard in between the blocks.

5.2.2– DISTRIBUTION OF FUNCTIONS

The project has an approximate built area of 15.000 m², of which up to approximate 14.000m² are dedicated to dwellings.

Despite the project main focus being the dwelling, some non-residential functions are integrated in the complex; a recycle material deposit; a closed sports field, that is integrated to the linear park sports zone; and some social equipment, such as small working spaces designated to workshops for the children living in the area, an events room destined to village´s reunions and a small health centre.

Besides these activities, along the blocks it it is possible to have some commercial activities, such as small shops and bars; this use was a part of the Village before the municipality intervention and through the expansion modules, the households can carry out these activities when the apartment is situated in the ground level.



Social Equipments

Together with the linear park, the main gathering point of the project, are placed the social function of the Village; there is only one block on the same side of the park and therefore it had received a different treatment on its ground floor, which created some permeability, giving access from the rest of the housing units and the river side.

The functions arranged with the block are a small health centre, workshop rooms and an events room for the local community and a small café/ restaurant.

The restaurant gives the opportunity to create an income for the inhabitants of the Village, it is connected to the main street and to the linear park, creating a direct connection between both parts.

The workshop and events rooms are areas to support the Village inhabitants, in order to provide them with a place for the children, which only go to school part time (morning or afternoons)and should not be on the street while the parents are working; different extra-curricular classes can happens on these rooms, such as music and and crafts, as well as sport classes since they have the sports fields that can also be used for this purpose.

Due to the need to organize these and other social events, the project counts with a meeting and events room and a small office.

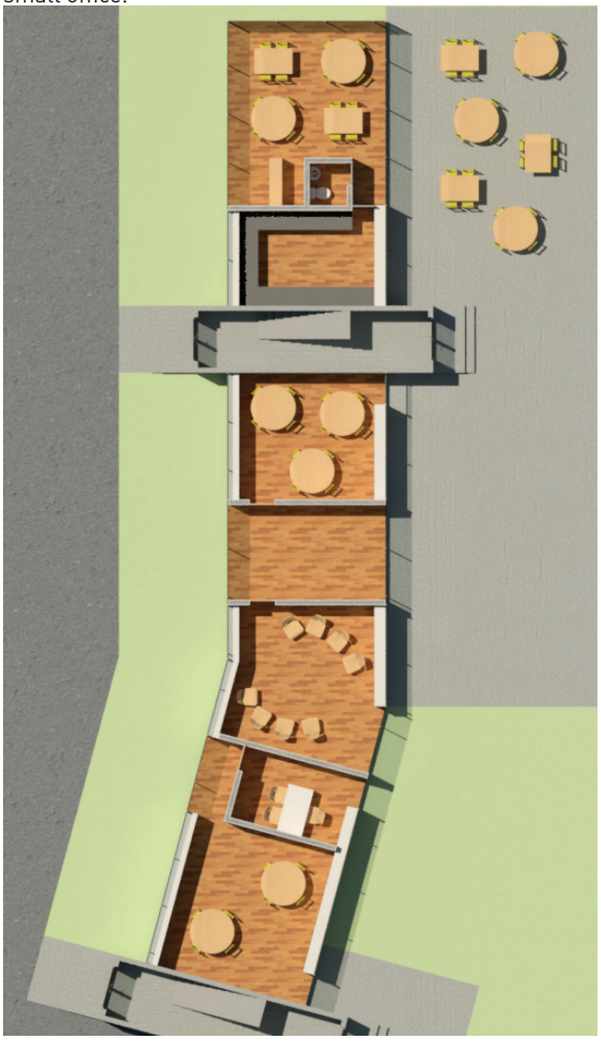


Fig. 5.13– Social equipment and restaurant Plan.

Health Centre

As is was stated in the context, in the interviews made with the Prado Village households it was said by all interviewee the fact that it is not always possible to access the existing Health Centre, in the Torres Village, due to the violence.

Therefore the project counts with a small health centre, with two outpatient rooms and a small reception area; the main focus of the centre is to give support to the community and if it is necessary, the patients can be taken to a larger health centre or to a hospital.

Its location, close to the Guabirotuba Street, was chosen to give an ease access to the surrounding areas inhabitants, since it is a public use. The flexibility is also a part of this room concept, if the existing health centre gets accessible again, this space can easily become another facility for the community.

Fig. 5.14 –Health Centre Plan.

Fig. 5.15 – Perspective of the health centre, seen from the Guabirotuba street.

Sports Field

The sports facility offers an indoor sports field, with a multi-sports court. This structure follows the blocks structure, although it has a protection against the rain it is not completely closed, but continue being an open space to the community; on the street side a small seating area, that closes until a certain height to the street, at the same time that opens out to the linear park.

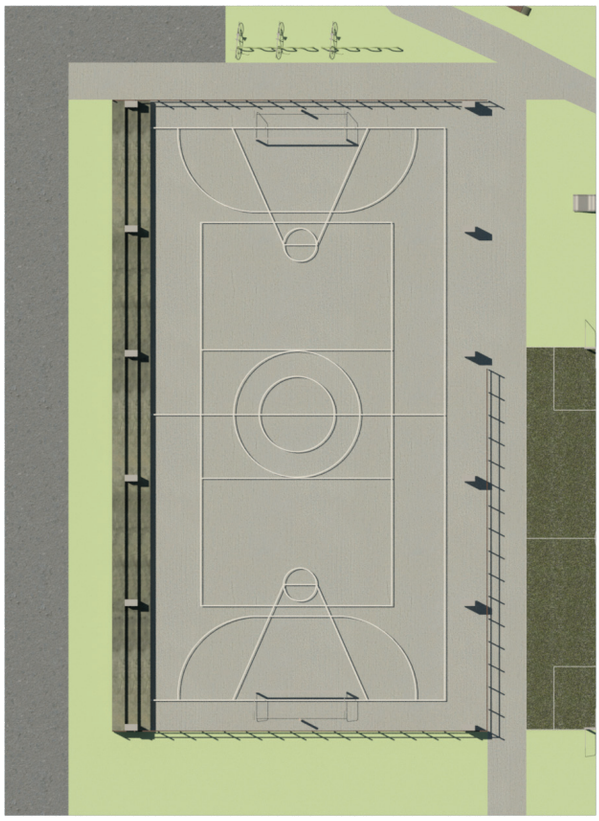


Fig. 5.16 – Sports Field plan.

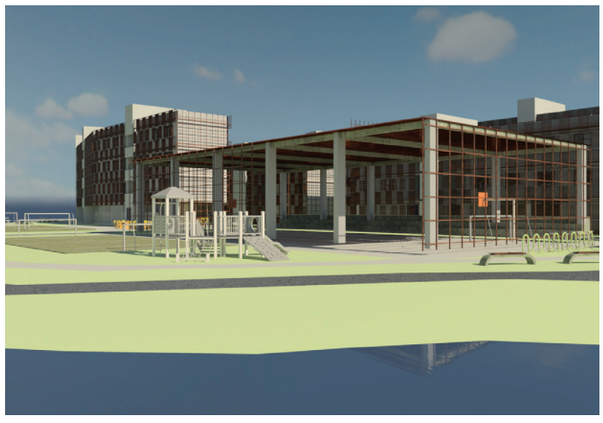


Fig. 5.17 – Perspective of the Sports Field seen front the Linear Park.

Recicle Material Deposit

The same way as the sports field, the recycle material deposit follows the blocks structure; it is closed with bricks, with the top opened on the sides in order to have fresh air inside the deposit. The façade counts with a green layer, making the volume part of the project´s green area.

Fig. 5.18 – Picture that illustrate the separation that is made on the deposit.

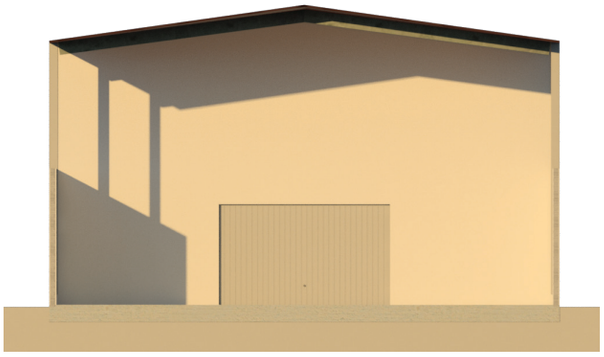


Fig. 5.19 – Section of the deposit.

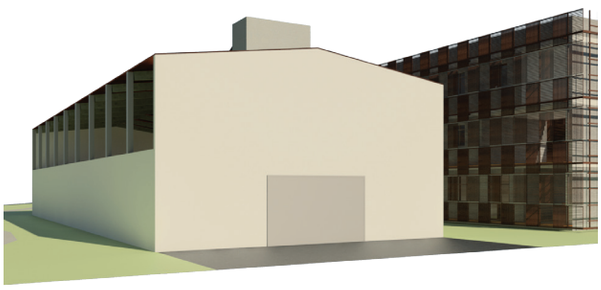


Fig. 5.20 – Perspective of the deposit seen by the Felipe Camarão street.

5.3 **BLOCK SCALE**

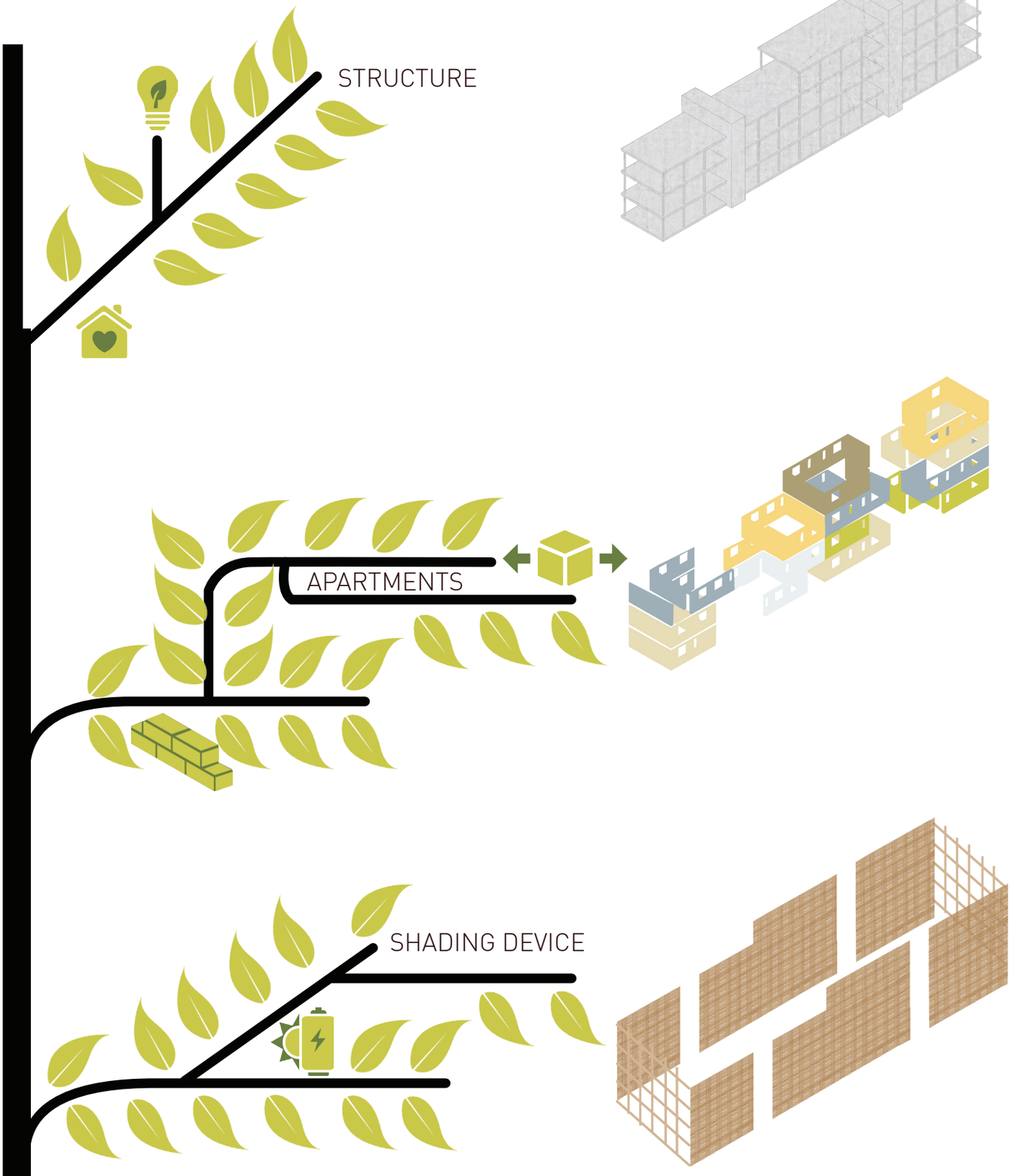


Fig. 5.21 - The blocks are composed by different elements, which together give the qualities expected to the design; as the image is explaining the main layers of the block are first the structure, the solid part of the building; the second layer is composed by the apartments main walls, on the drawing the apartments were colored in order to explain the composition of the apartments, but the material is the same, ecological brick; the last layer is composed by the shading devices; all the elements were put together in order to create a sustainable design, where the energy consumption and the indoor climate must be respect.

5.3.1 EAST/ WEST BLOCKS

As explained on the Design Process, there are two block typologies, the first with apartments facing east and west, and the second with apartments facing north. Both blocks have the same solutions for the structure, envelope and shading.

The east and west apartments are composed by two apartment typologies, one one-storey height, and one two-story height. The diagram is showing the composition of one block with different apartments and its expansion modules.

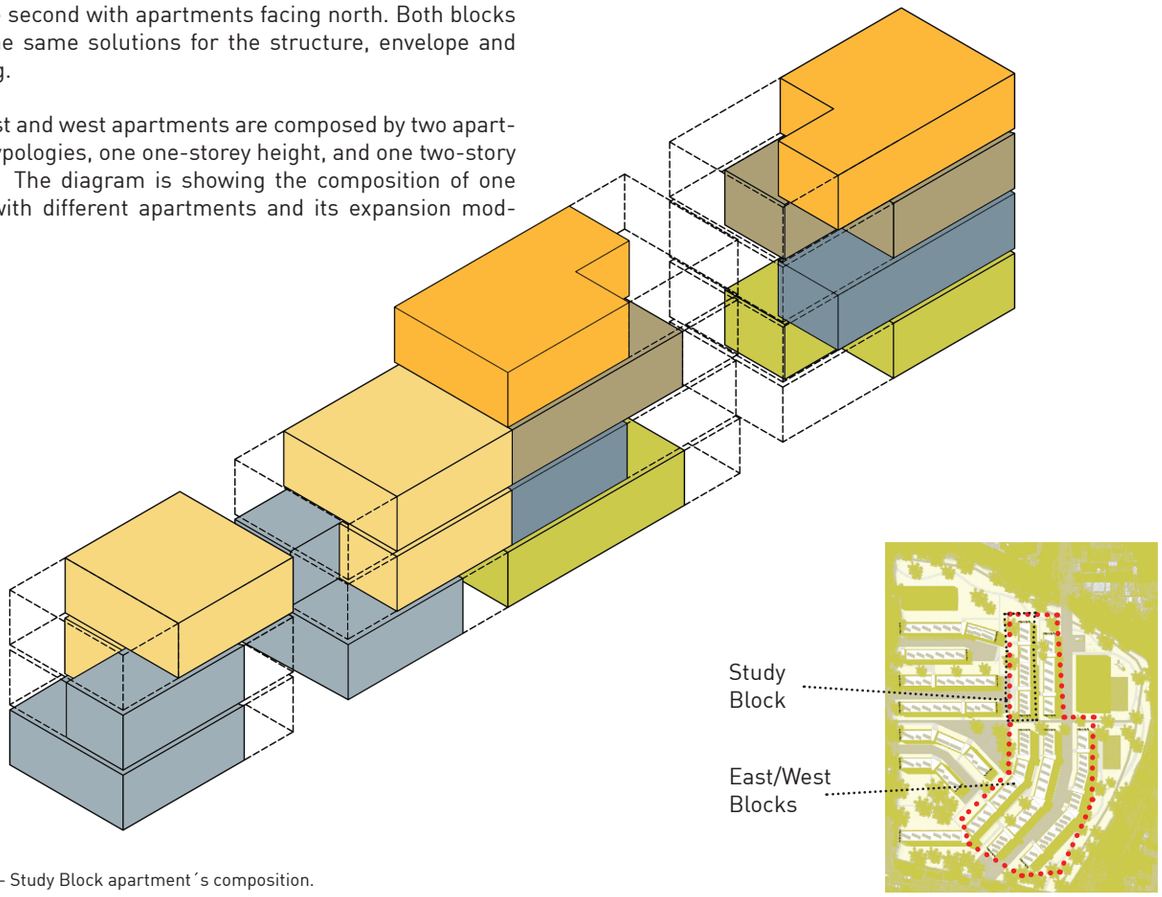


Fig. 5.22 – Study Block apartment´s composition.

Fig. 5.23 – Study Block perspective.

5.3.2 **NORTH BLOCKS**

The north blocks are composed by only one apartment typology, one-storey high. The diagram shows the composition of the apartments from one of the blocks.

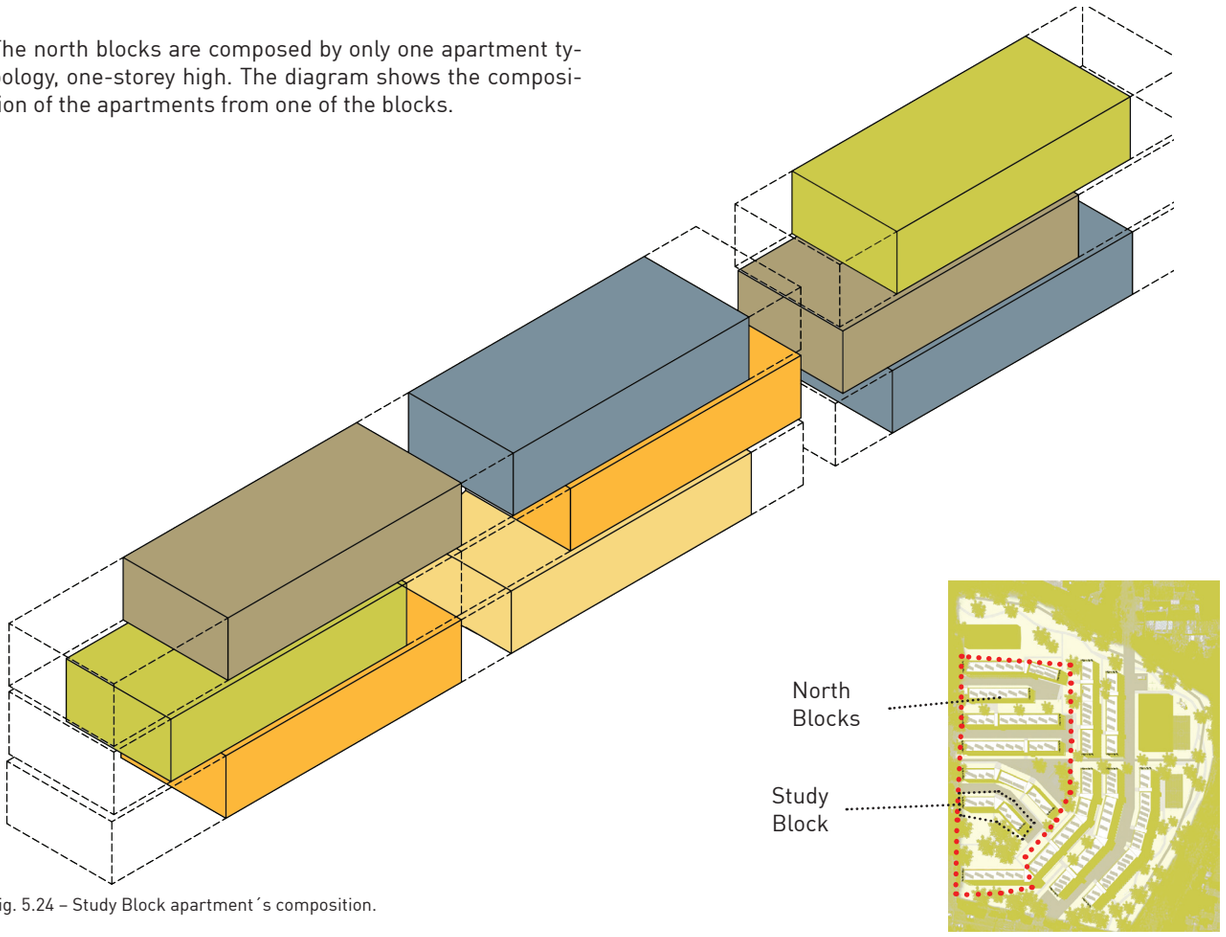


Fig. 5.24 – Study Block apartment´s composition.

Fig. 5.25 – Study Block perspective.

5.3.3 MATERIALS

Brick

When analysing the Soil-Cement Brick choice, the local labour was taken in consideration, since the brick construction is the most common in Brazil, besides that is has other advantages, as listed below:

It is a cheap construction;

It does not need mortar layers, creating less waste on the construction site;

It is lighter, needing a smaller foundation;

The hydraulic and electric tubing can pass by the holes;

It insolates through the holes;

It last longer than the regular brick.

Fig. 5.26– Soil-Cement brick.

When analysing the material performance to the indoor climate, it was decided to create double walls, with insolation in between; the calculations were made with and without the insolation, considering that it would possibly not be used, being an academic study it was chosen to show the best solution it can be achieved.

The chosen insulation was the PET wool, having in mind the use recycle material; the PET wool uses the bottle in the wool manufacture.

The final wall composition got the U-value of 0,27w/m²k.

Creating an external layer on the blocks, is the shading device, that work at the same time as handrail, with fixed elements, and as movable shading, which can be completely close or be opened and allow complete sun exposure to the apartments.

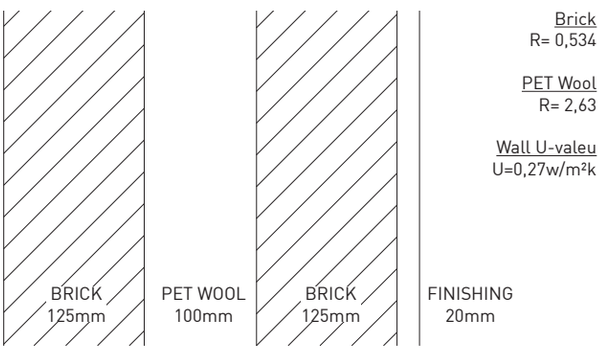


Fig. 5.27– Wall composition.

Concrete

The structure is being thought independently from the walls, thinking about the flexibility that is wanted in the project; considering that it is a social housing project and therefore the financial support would not allow for expensive solutions, the tradition concrete structure was chosen for the structure and soil-cement bricks for the envelope; which were chosen considering the easy installation, the local possibilities and the flexibility.

The concrete structure is composed by concrete columns and a concrete slab system, with EPS filling, considering the insolation.

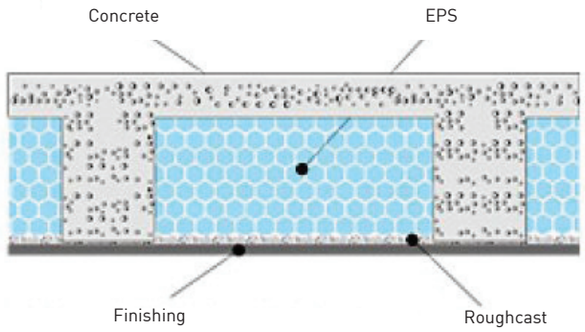


Fig. 5.27– Slab system scheme.

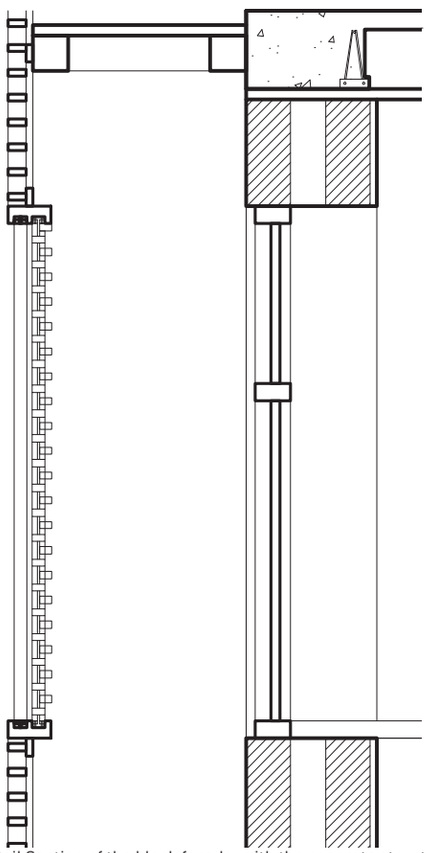


Fig. 5.28 – Detail Section of the block façade, with the concrete structure, the brick envelope and the timber shading system.

Wood

The external layer of the blocks are composed by a wooden system of the shading devices; the system has a main structure, which is connected to the building structure; the front of block, has a wooden floor on top of the structure, which allows to use it as a small terrace by the inhabitants; the shading devices are divided into a fixed layer, which works as a handrail and a movable layer, the "brise-solei" allows the sun to get into the apartments during winter and protect it during summer; the closer of the system happens with a wooden lattice, in which a climbing plant brings the surround green areas into the blocks façade.

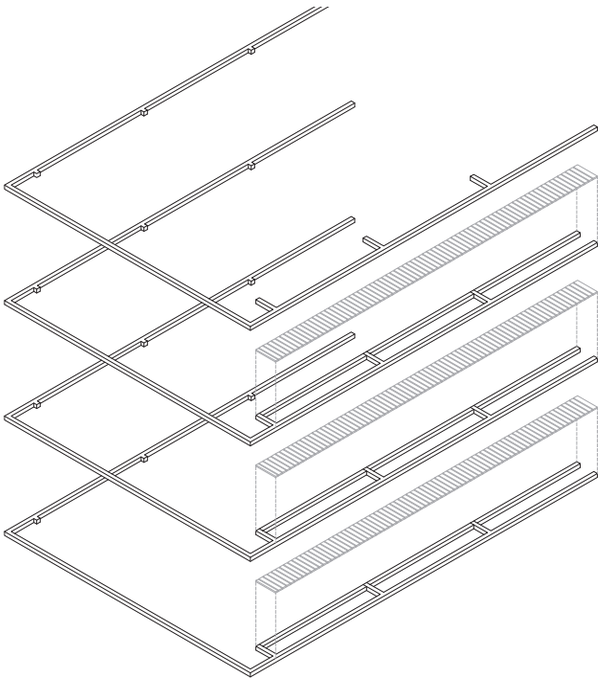


Fig. 5.29 – Wooden Structure; the perspective is showing the main structure of the shading system, this wooden structure is connected to the main concrete structure of the project. It is also being shown the wooden floor that creates a small terrace on the front façade.

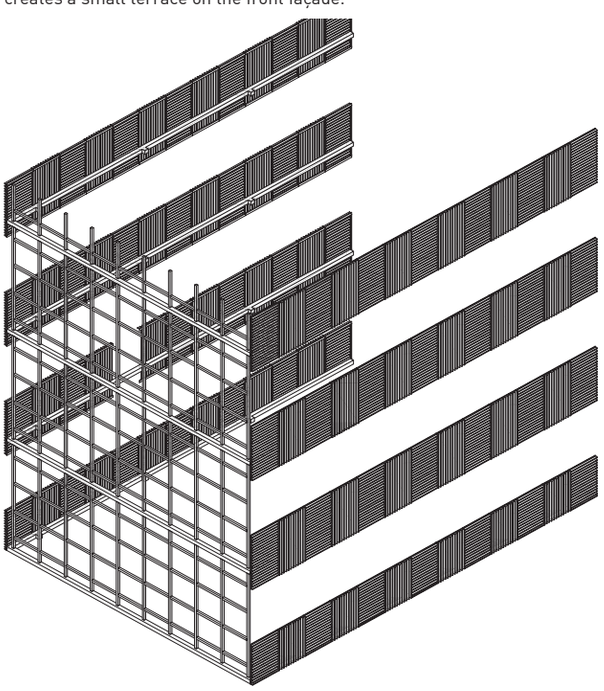


Fig. 5.30– Fixed Elements; the perspective shows the fixed elements of the façade, the handrail and the lattice, connected to its structure.

There are three forms of the movable devices, the first has vertical wooden strips; the other two have horizontal strips with different highs, making it possible to close them together. This system allows opening two thirds of the façade, getting 100% light in during winter.

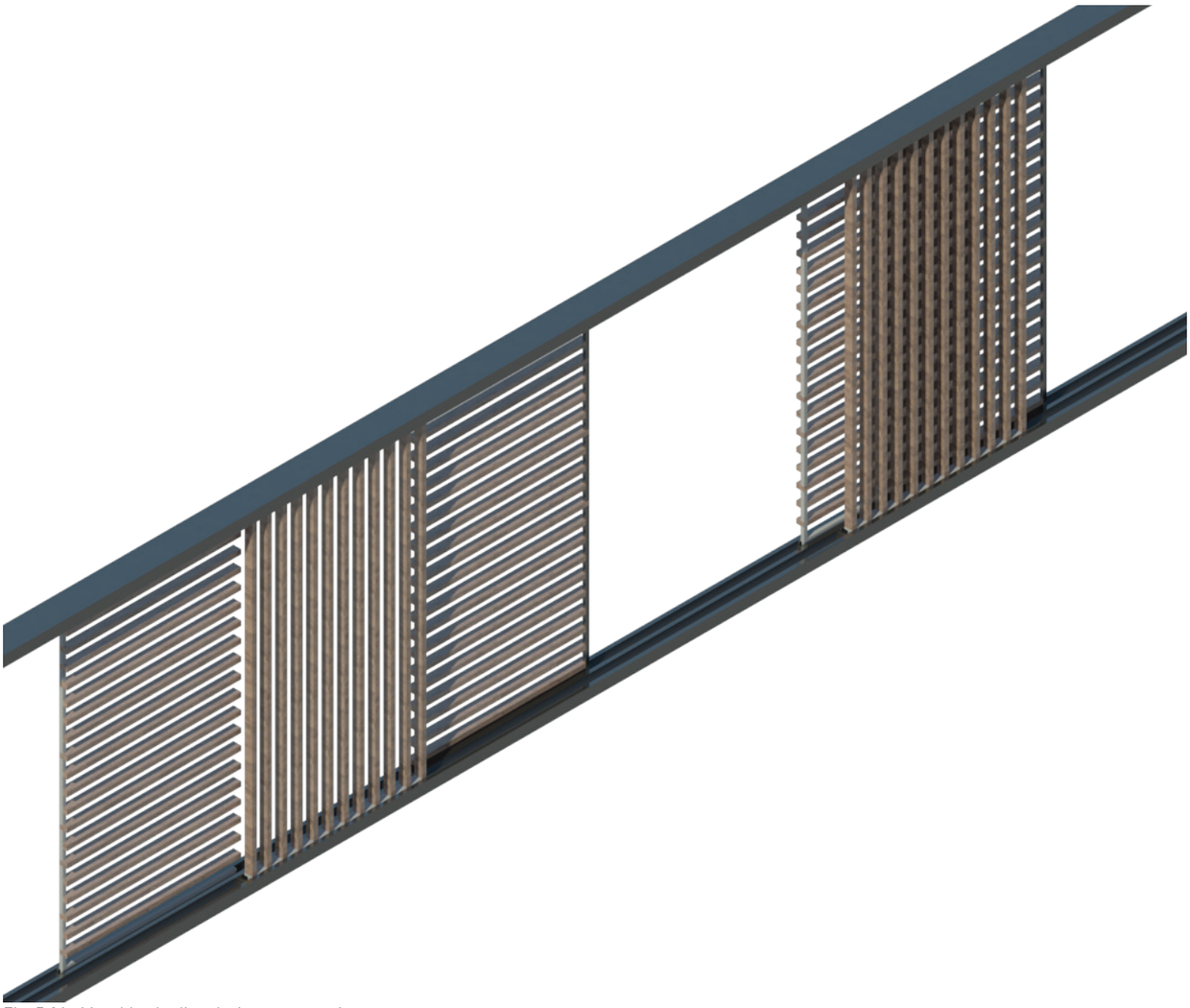


Fig. 5.31– Movable shading devices perspective.

Fig. 5.32– Closed façade view.

Fig. 5.33– Cross section of the block, escale 1:100; with the section is possible to see how the block elements are put together, the structure, envelope and shading system.

Fig. 5.35 – Closed façade view.

5.3.4 BLOCK CONSTRUCTION

Fig. 5.36– Block Longitudinal Section; the section is pointing out the water system, with the water tanks and the water pipes lanes.

The functionality of the block is connected to its structure and composition; regarding the water systems, the block has 3 different types of water tanks, the first type contemplates the cold water, it has to be divided into two tanks, one on the top of the building and a second one on the underground, the calculations for the tank volume is on the appendix; the second type concerns the heated water, the tanks are connected to the cold water tank and to the solar panels and directed to the apartments; the last type is for the rainwater collection, it also needs to be divide in two tanks, the first receive the collected water and it is on the underground, while the second store the treated water, to be used on the apartments, and save clean water on the functions that do not require it.

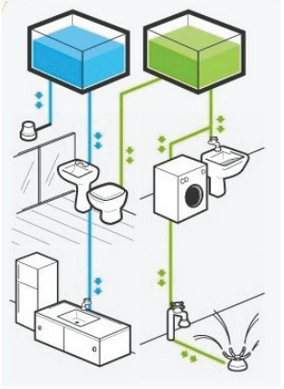


Fig. 5.37– Rain water system scheme.

5.3.5 **BUILDING PERFORMANCE**

The building is conceived in a way to reach a low energy frame, especially only with passive solutions. Since Brazil does not have any established standards regarding Sustainable measures and Energy consumption, the chosen requirements are from the Blue House certification, with enough to reach the Gold classification. The list of the Certification items, with the achieved ones, are in the appendix.

Regarding the Thermic Performance, the passive solutions start in the blocks orientation, with apartments the rooms facing north, west or east. The size of the windows allows heat gains during winter, while the envelope material prevents the heat loss; at the same time, the shading devices block the sun heat, and along with the natural ventilation allow a comfort temperature on the warmest days.

Using a BSim simulation, it was possible to reach a balance point between letting the sun heat get in the apartments on the coldest days and block it on the warmest. The openings sizes which along with the envelope material got the best results are 2.25m², around 28% of the room areas, with the insulated double wall, as stated before.

The graphs (fig.XX) are from one apartment facing east and west; different from the previous analysis done with the traditional social housing, the indoor temperatures are almost constant and do not follow that much the outdoor changes. The rooms facing west receive more direct sun heat and therefore have the temperatures higher, still keeping below 27°C, except for a few hours.

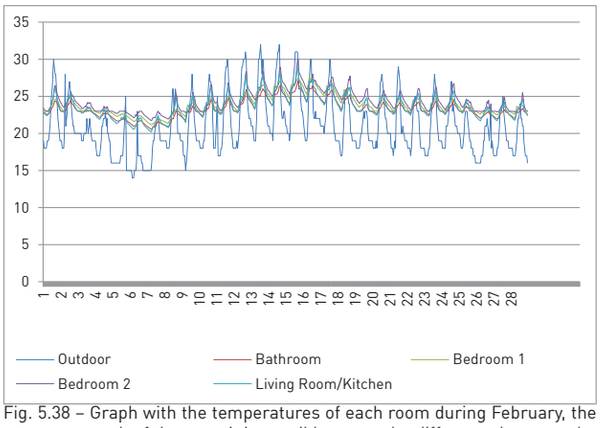


Fig. 5.38 – Graph with the temperatures of each room during February, the warmest month of the year; it is possible to see the difference between the indoor and outdoor temperatures, and it is also possible to notice the higher temperatures on the bedroom 2 and the living room, which are facing west.

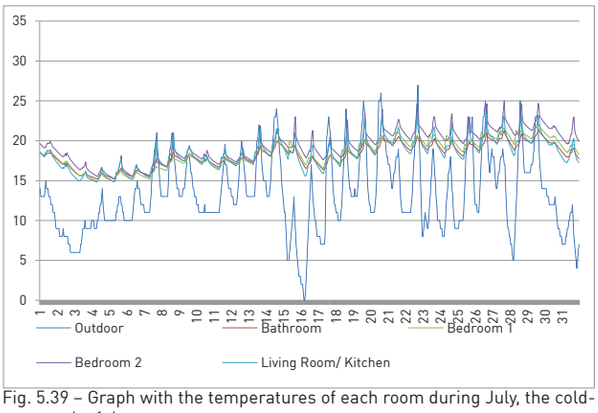


Fig. 5.39 – Graph with the temperatures of each room during July, the coldest month of the year.

When considering the energetic efficiency, the Certification asks for solar heating and energy alternative fonts, both are being used on the project. Going further on the energy consumption, analysis were made using the energetic consumption data from the south of Brazil, which consider the average consumption 140kwh/(Cidades, Energia, 2005); and it divides this consumption into Electric shower (25%), Indoor Conditioning (32%), Illumination (8%) and Appliances (35%). (REF)

Using only passive solutions, the energy consumption descends on the Indoor Conditioning and the Illumination; considering that the indoor climate is comfortable and do not need the use of artificial cooling or heating and the window openings are making it possible to use natural illumination. Thought simulation, made with the Velux and the BSim software, the dseign is reducing 95% on the indoor conditioning and 20% on the illumination consumptions, going from the 140 kwh/month to approximately 95.2 kwh/month.

In order to understand the improvement on the dwelling illumination and therefore the saving that can be made, Velux simulations were made both with the existing house project, presented on the context and to the projected apartments (fig.5.41), with the simulations for the whole year in three different times, 8:00, 12:00 and 17:00, a percentage on the improvement were taken, considering the difference about summer and winter time, which in averaged is 50% less light that is going to be consumed during the day periods; considering that during the night periods the natural light cannot be used, the reduction factor goes to 20% on the final illumination consumptions.

The indoor conditioning considers the use of electricity to create a comfortable indoor climate, making it warmer or colder. The reduction is of almost 100%, considering that on the existing design there was around 1.000 hours above 27°C and on the new it descends to only 17 hours, on the warmest room. For the hours below 15°C, the existing housing unit had around 1.500 hours, the new design has only 12 hours on the coldest room.

Considering that the electric shower has a large influence on the final consumption, the project is using solar water heating system; the system chose is Heliotek and to attend the local climate it is needed the use of 3 panels for each apartment, and a water tank of 500l, which are located on the blocks roofs. Thinking on the energy safe of the system, discounting rainy seasons where the electric shower will have to be used, it can be considered that at least 90% of the consumption will decrease, which would reduce the consumption to approximately 80kwh/month.

The energy calculations are being made considering the use of Photovoltaic Cells, which is not a current possibility to the social housing reality, again considering the academic value of this project and the aim to change this reality. In order to reach zero energy on the project, each apartment have to produce approximately 80kwh/month; it was chosen a Kyocera panel, which the month production is 30kwh/month and the panels are located on the roof along with the water heating system.

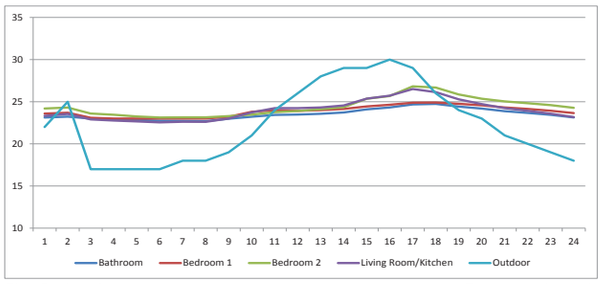


Fig. 5.40 – Graph with the temperatures during one day, February 11th, it gets more clear the inside temperatures of each room.

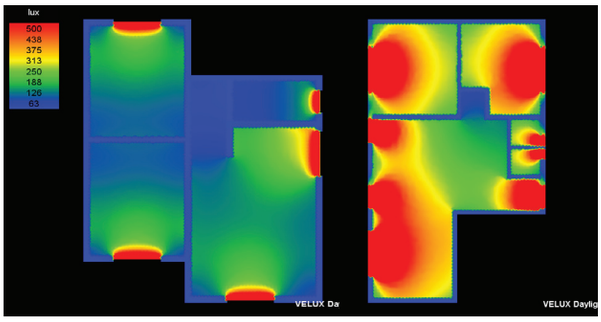


Fig. 5.41 – Image of the velux simulation on the left from the study house and on the right the designed apartment; these images are from 12:00 in June, winter time, and it is possible to understand the large difference in the sunlight illumination.

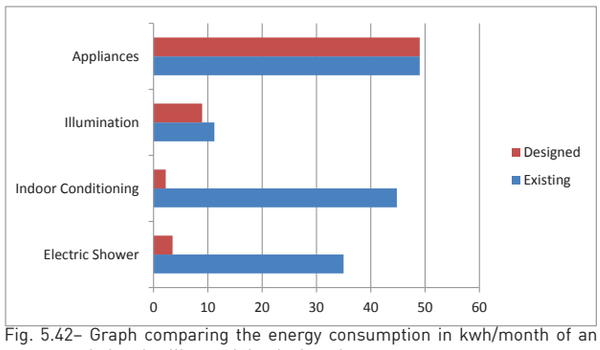
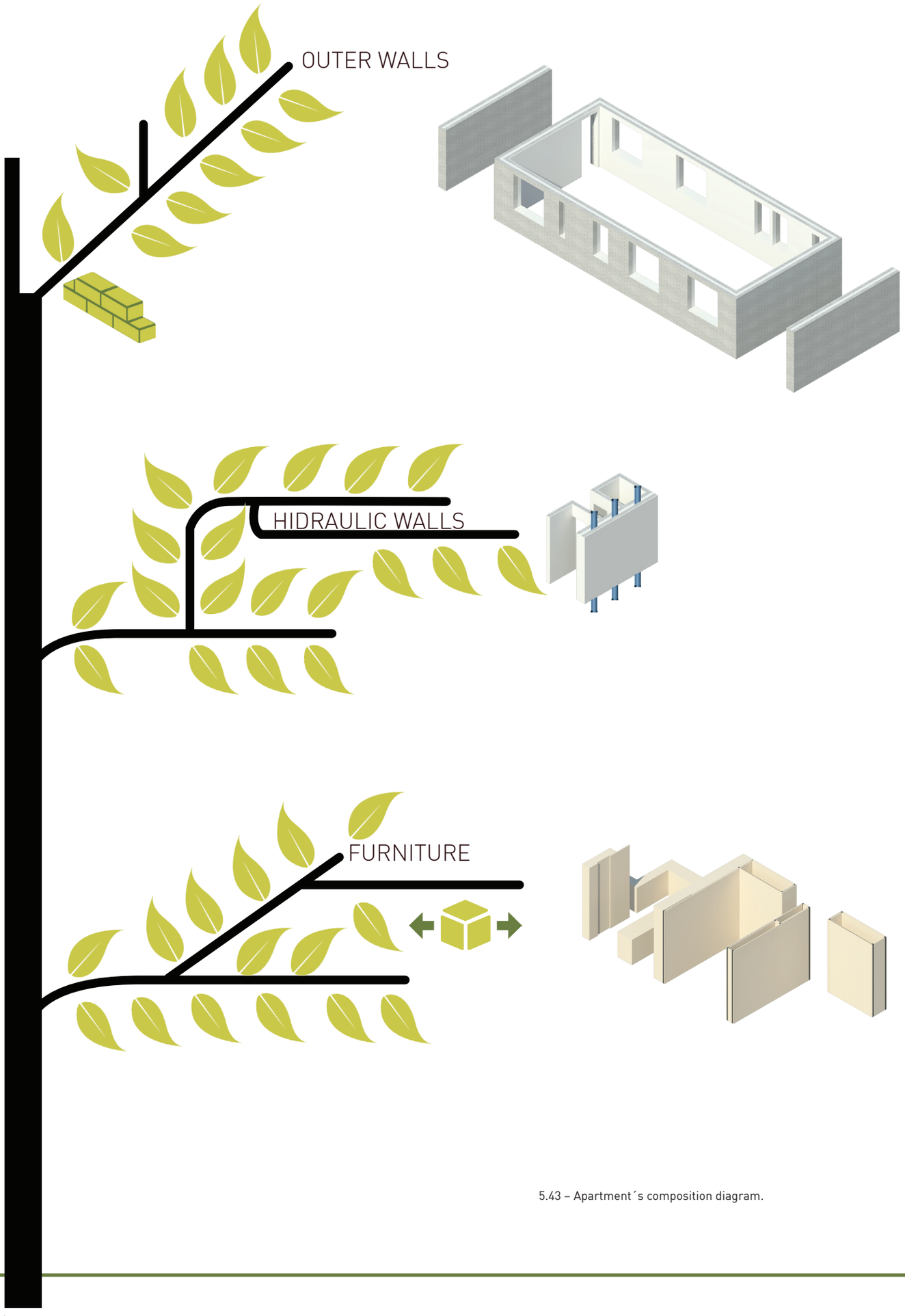


Fig. 5.42– Graph comparing the energy consumption in kwh/month of an average existing dwelling and the designed.

5.4 **DWELLINGS SCALE**



5.43 – Apartment´s composition diagram.

From the three main layers, which are forming the dwellings, three apartment's typologies were created. As explained on the other scales, there are two block types, one facing north and the second facing west and east; each block type needed a different apartament solution, considering mainly the indoor climate.

The first apartment attends the blocks facing north (fig.5.44), it has all the apartments facing north, receiving direct sun light, and it has opening in the two sides, allowing cross ventilation.

The second apartment (fig.5.45) attends the east and west blocks, it has openings on both façades, receiving sunlight from east and west and also allowing good natural ventilation.

The third apartment (fig. 5.46) has the similar characteristics from the second, since it also attend the blocks facing east and west; it is divided in two floors, though, having different indoor qualities.

All the apartments have the same concept, of having only the main walls, outer and hydraulic, and the apartment divisions made by the furniture.

The furniture is composed by a metallic structure, and a timber closer and shelves; considering the comfort and the privacy inside the rooms, insulated MDF boards, double in the room divisions.

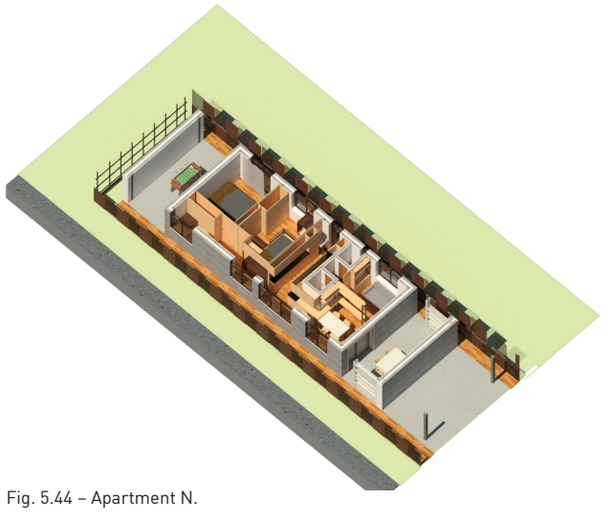


Fig. 5.44 – Apartment N.

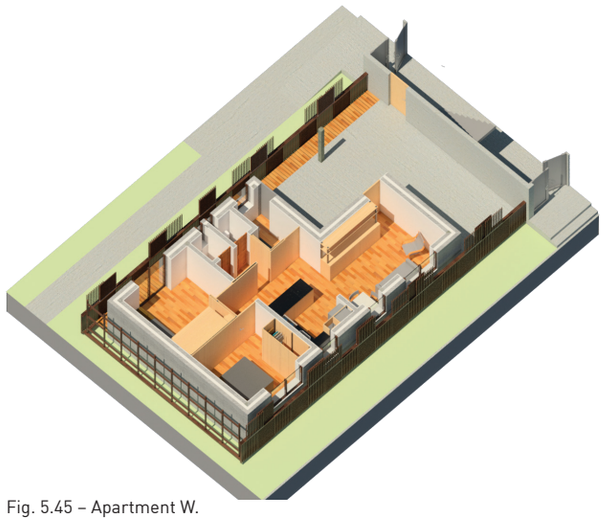
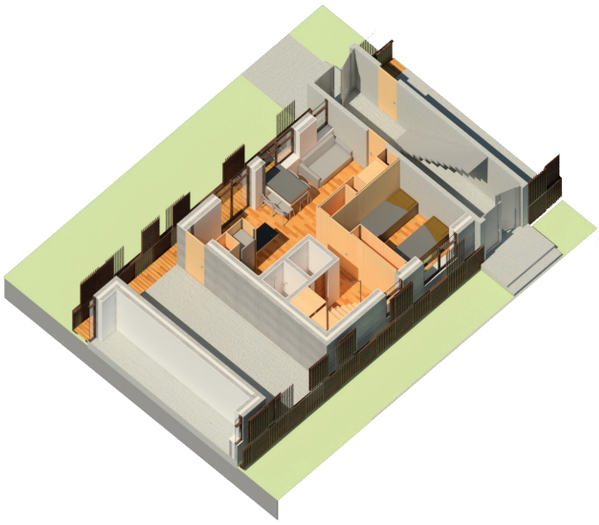


Fig. 5.45 – Apartment W.



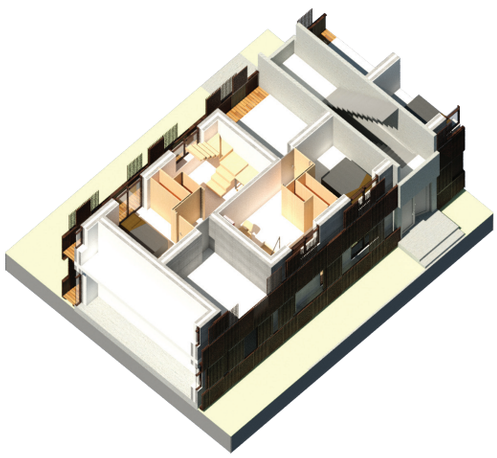


Fig. 5.46 – Apartment E.

5.4.1 **APARTMENT N**

The apartment N represents the apartments located on the block facing north; the map below shows the location of this specific unit. The apartment has four modules with the apartment´s main functions, and two modules for future expansion. Some of the solutions from the apartments might change according to its location on the block and on the site.

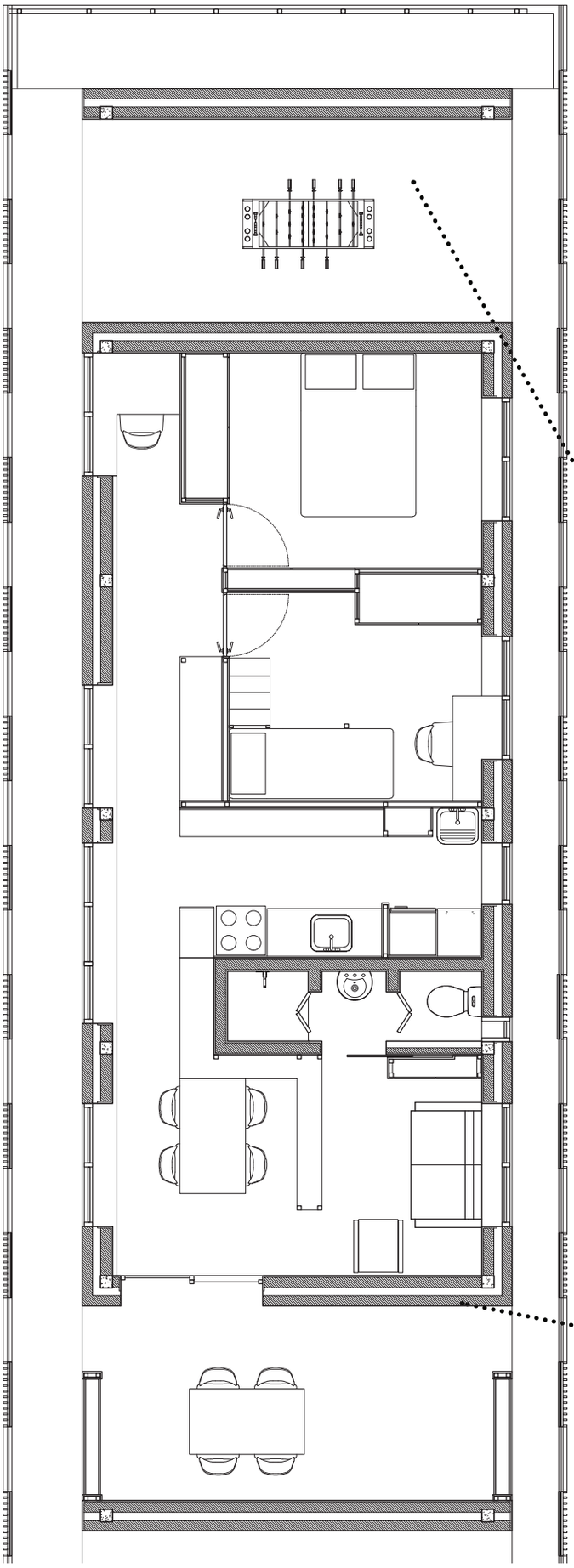


Fig. 5.47 – Apartment´s plan; scale 1:75

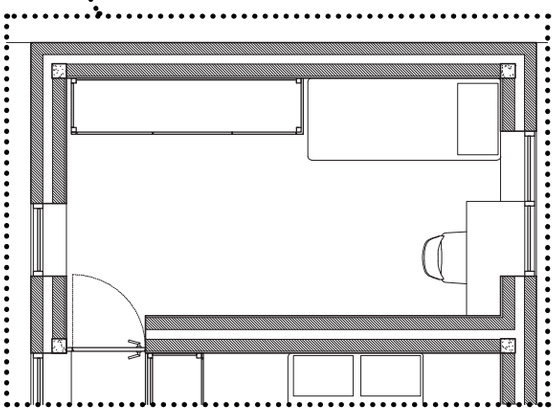


Fig. 4.48 – Possible expansion; larger living areas. Scale 1:75

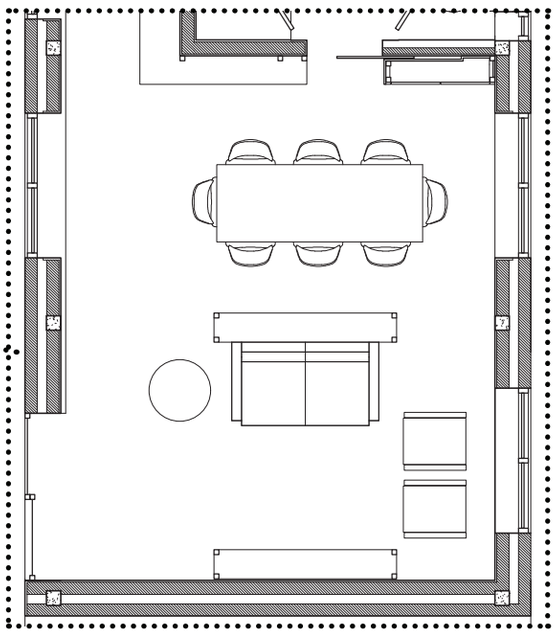


Fig. 5.49 – Possible expansion; one more room. Scale 1:75

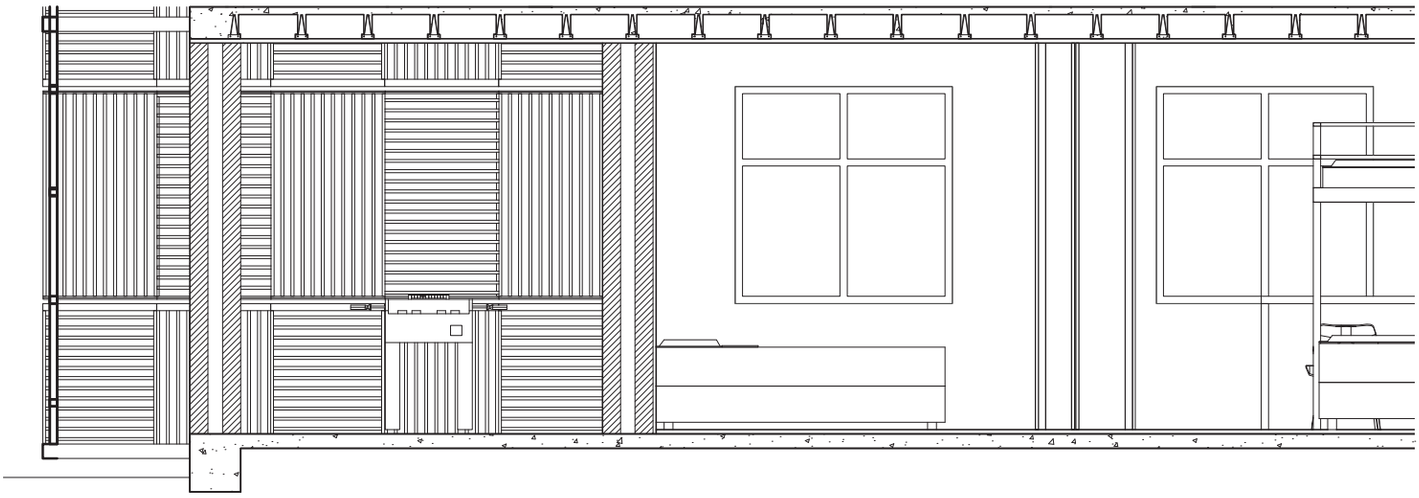


Fig. 5.50– Section that passes through the whole apartment, scale 1:50.
It is possible to understand all the rooms and the expansion modules.

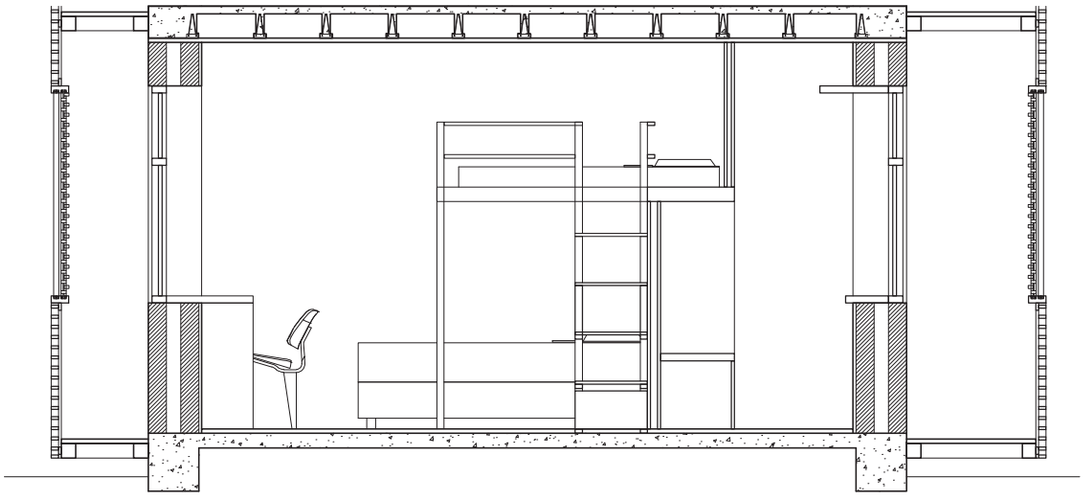
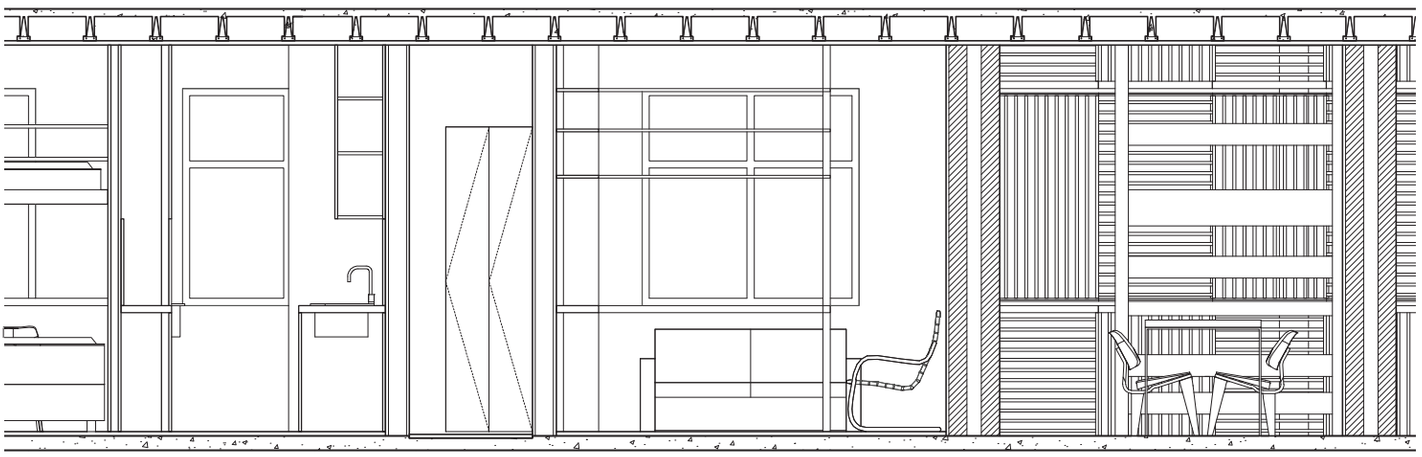


Fig. 5.51 – Section of the bedroom, scale 1:50.
The furniture in this case made it possible to create a double height bed at the same time that creates a bench on the hallway. The section also shows the shading system; which in this case creates two "balconies" the first, on the south, is responsible for the apartment's access; on the north, it is the small balcony existing for the block front.



Other solutions

The apartments on the ground floor can be handcap accessible, on these situations the bathroom has a different configuration, and there is more space reserved for circulation.

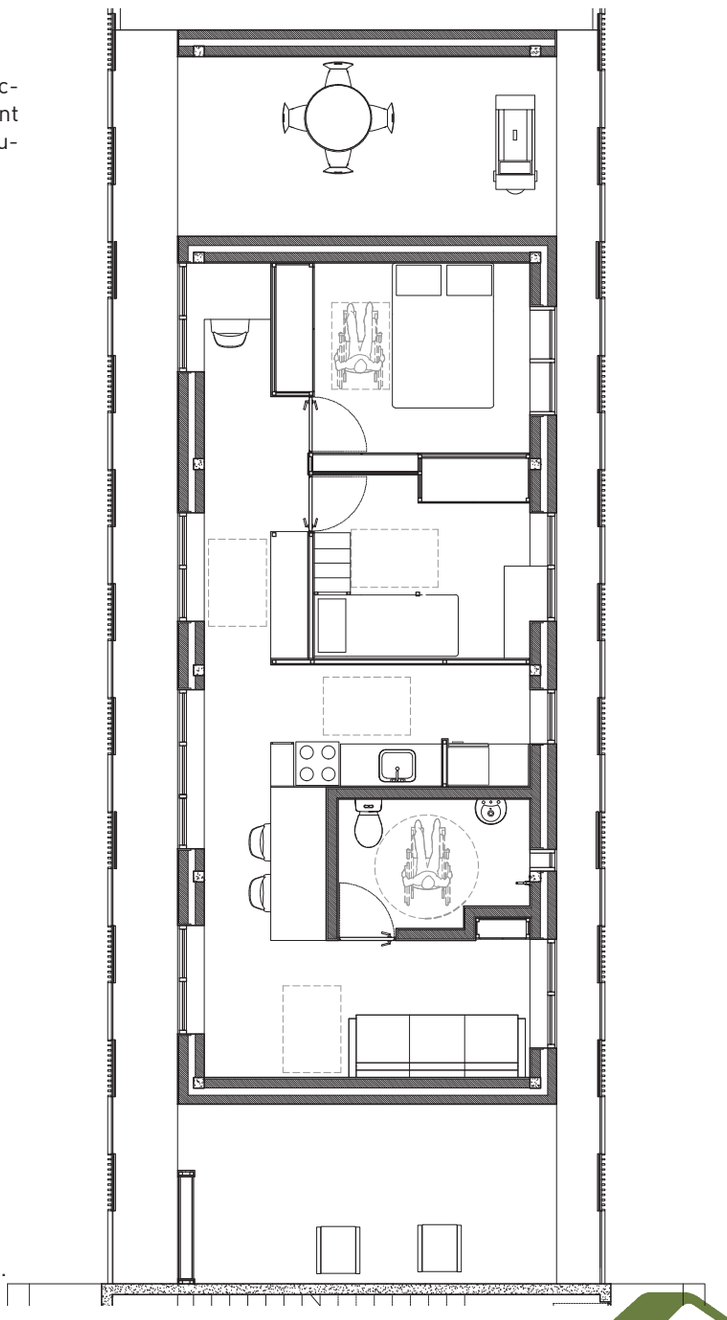


Fig. 5.52 – Plan of the accessible N apartment, scale 1:100.

Fig. 5.53 – Perspective of the apartment, seen from the entrance.

One different apartment solution regards when this has less privacy, because the access path passes in front of the south façade. The two expansion modules of each apartment can be together or separated.

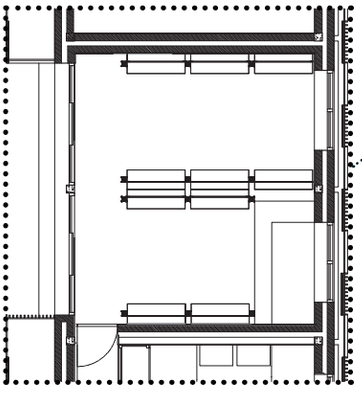


Fig. 5.54 – Possible expansion; small store.
Scale 1:100.

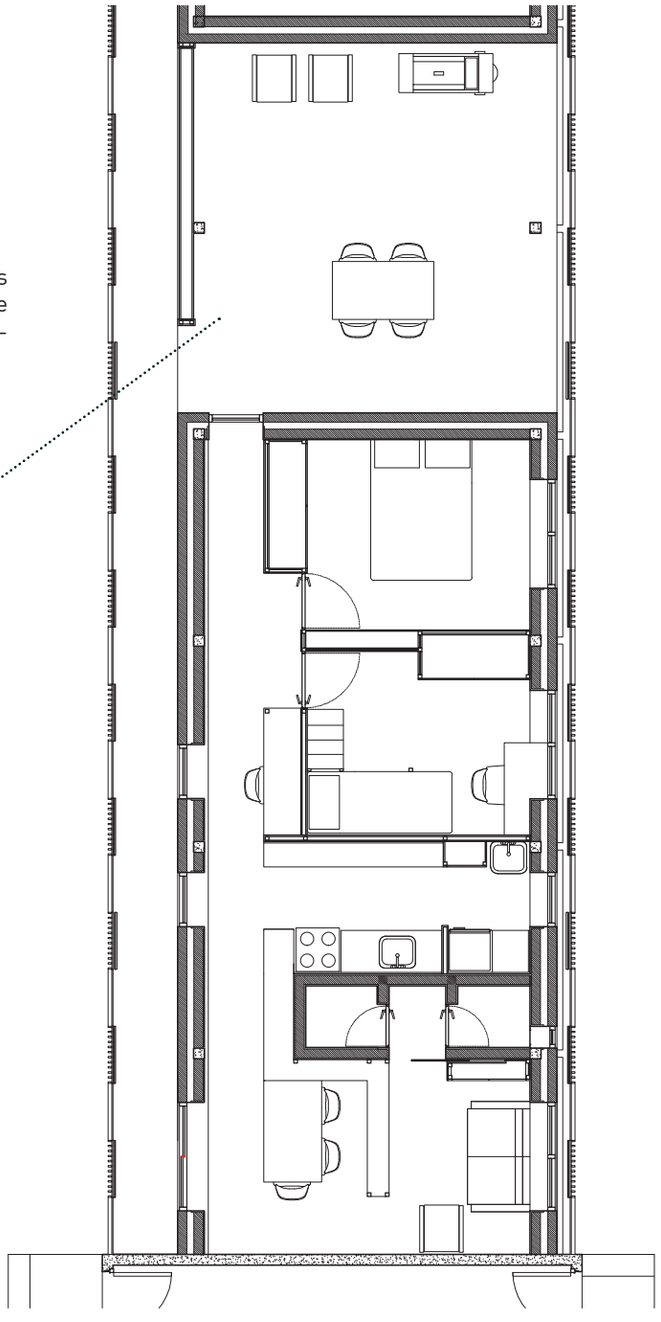


Fig. 5.55 – Apartment N Plan, scale 1:100.

5.4.2 **APARTMENT W**

The apartment W is the one-storey apartment of the East/ West blocks. The apartment has five modules with the main functions and three modules for possible future expansions.

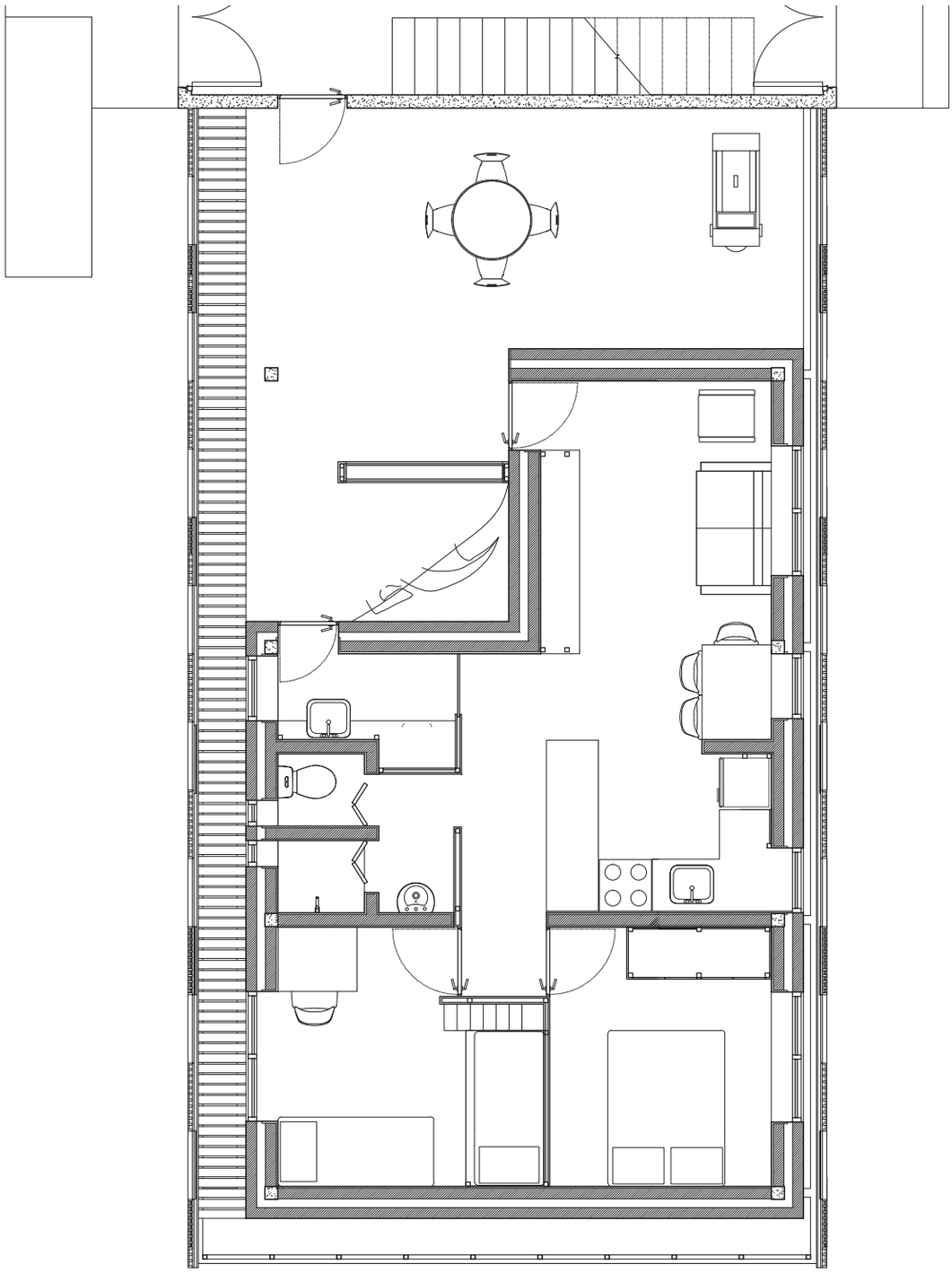
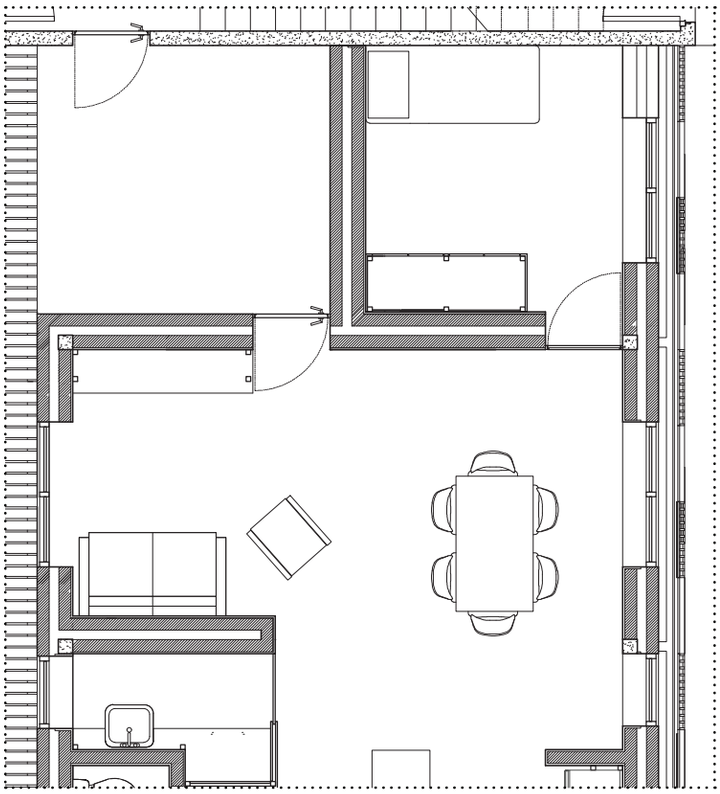


Fig. 5.56 – Plan of the apartment W, scale 1:75.



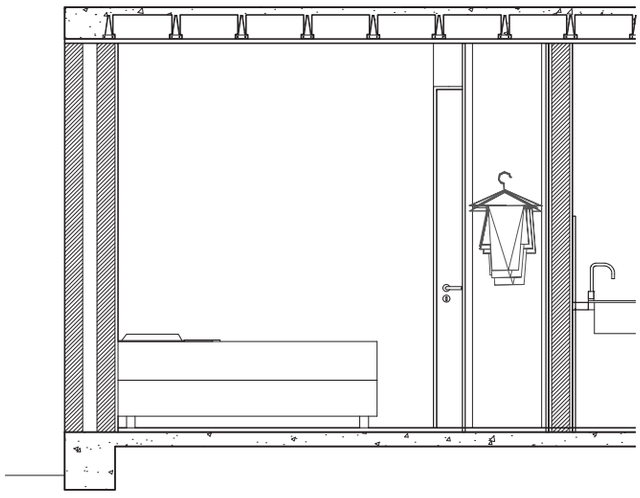


Fig. 5.57 – Possible expansion, scale 1:75. One extra room and a larger living and dining room.

Fig. 5.58 – Perspective of the living room.

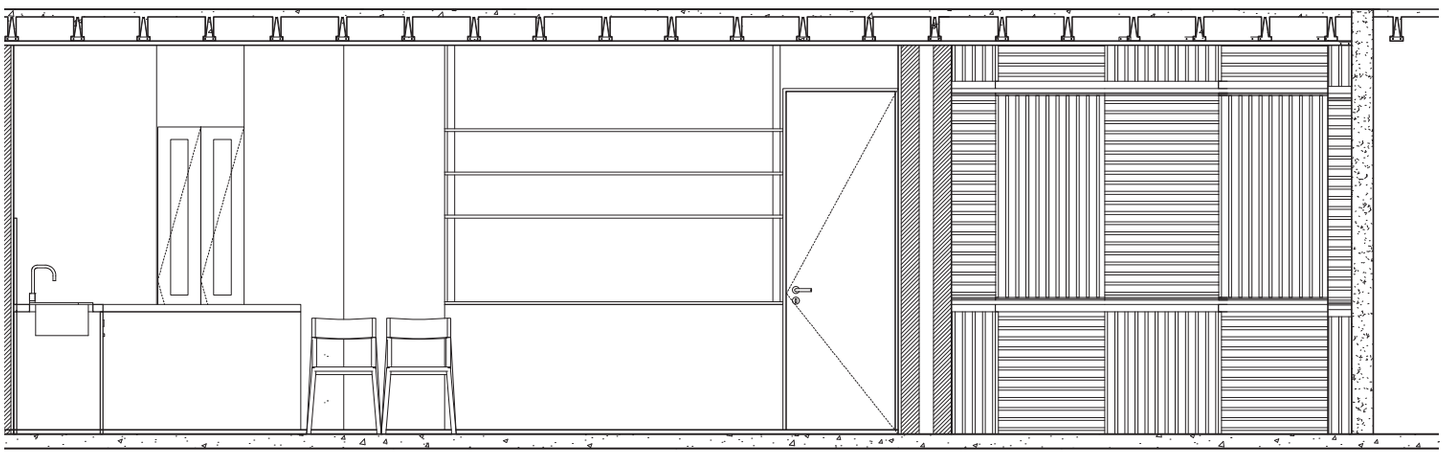


Fig. 5.59 – Section through the apartment. Scale 1:50

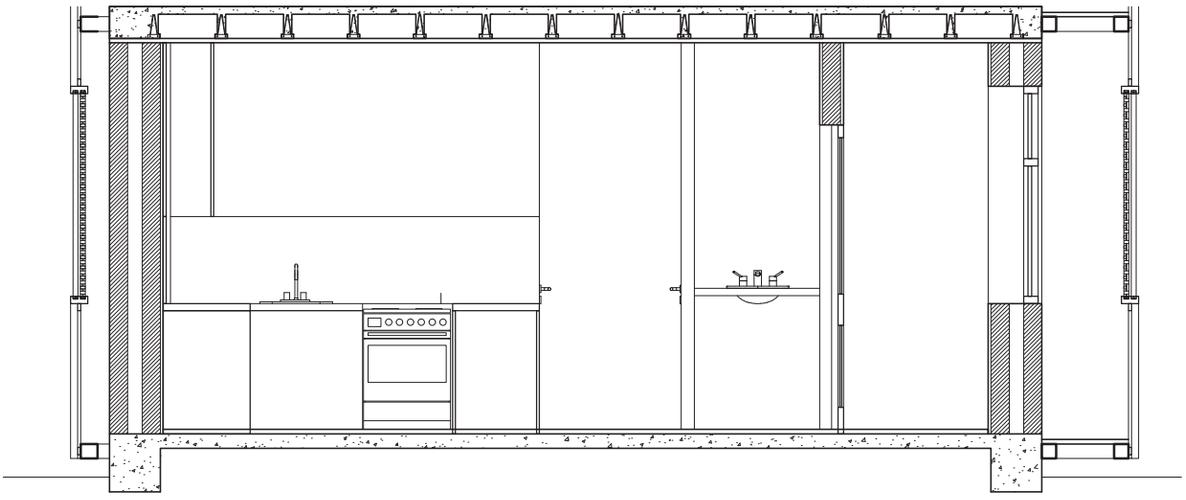


Fig. 5.60 – Section through kitchen and bathroom. Scale 1:50.

Fig. 5.61 – Plan of the accessible W apartment.

5.4.3 **APARTMENT E**

The apartment E is the two-storey apartment of the east/west blocks. The apartment has six modules with the main functions and three modules for expansion; from these, four main modules and two expansion are in one floor and the other two main modules and one expansion is on the other floor.

Study Apartment location

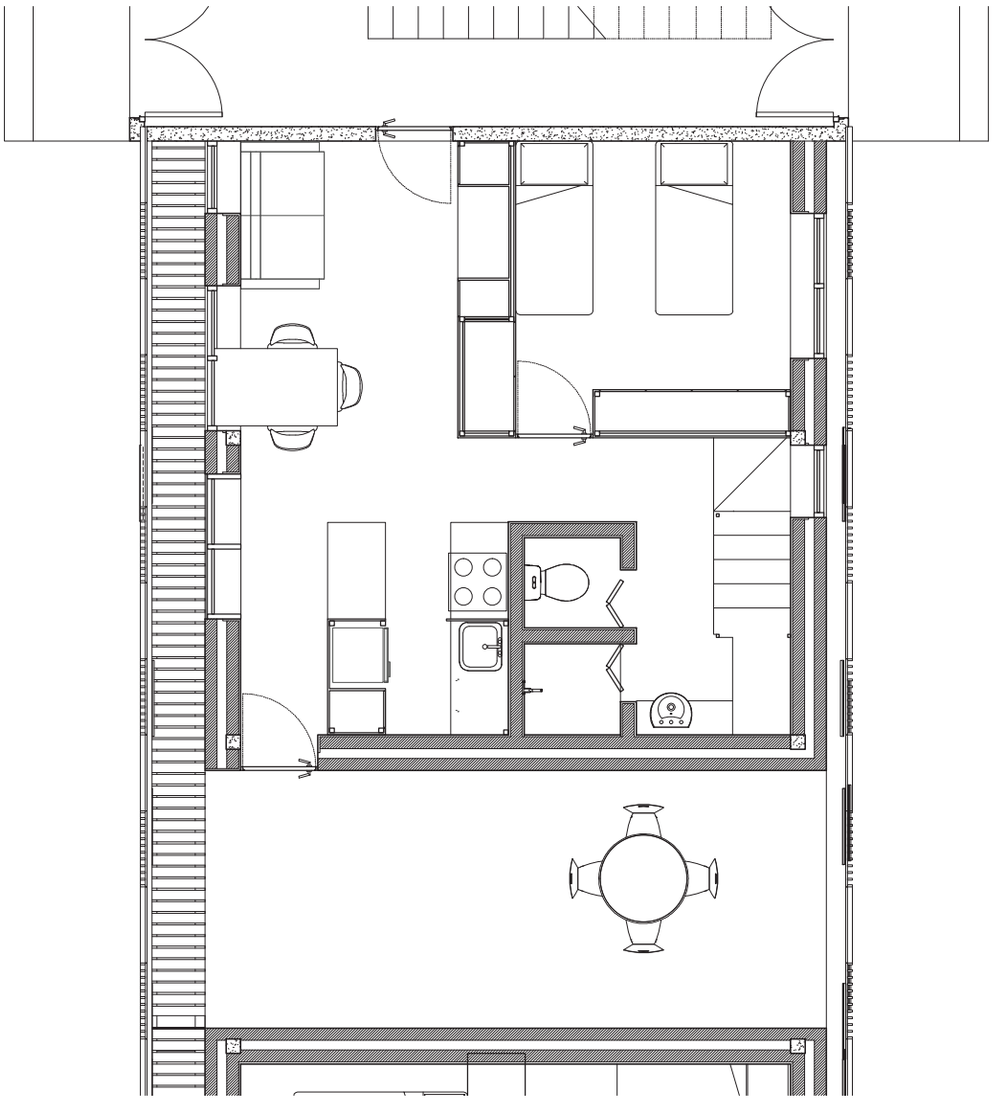


Fig. 5.62 – Plan of the apartment E first floor.

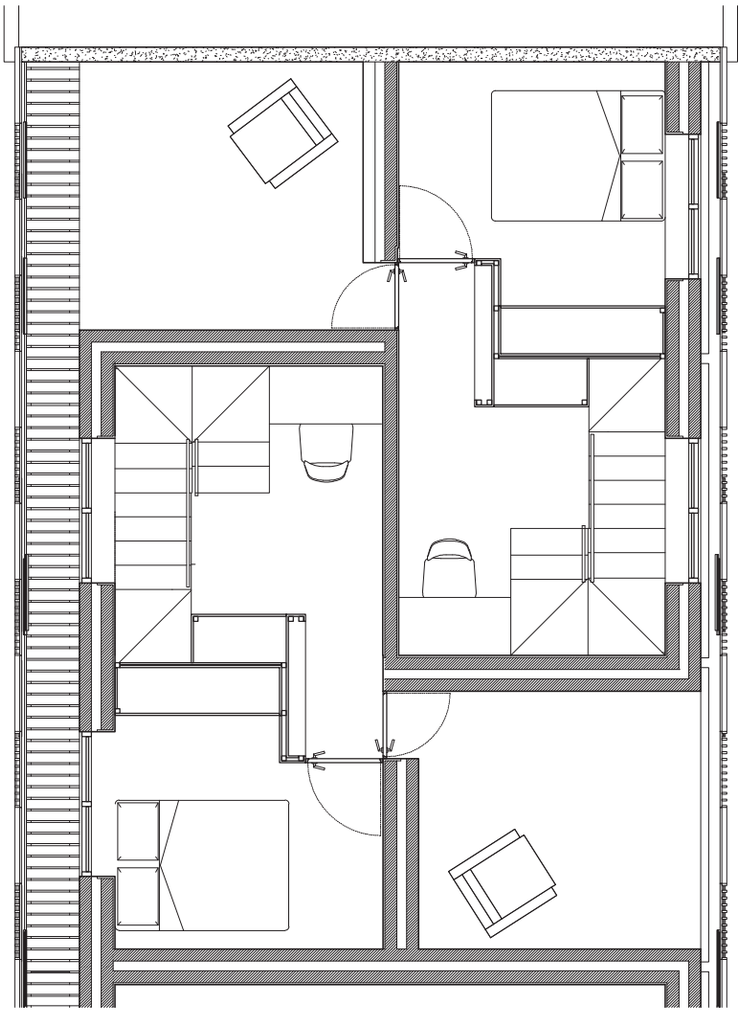


Fig. 5.63 – Plan of the apartment´s E second floor. The dashed part correspond to the other apartment that has the rest of the apartment on the block´s third floor..

Fig. 5.64 – Perspective of the apartment´s stairs, which have the same structure of the furniture, creating together with the stairs one more storing space.

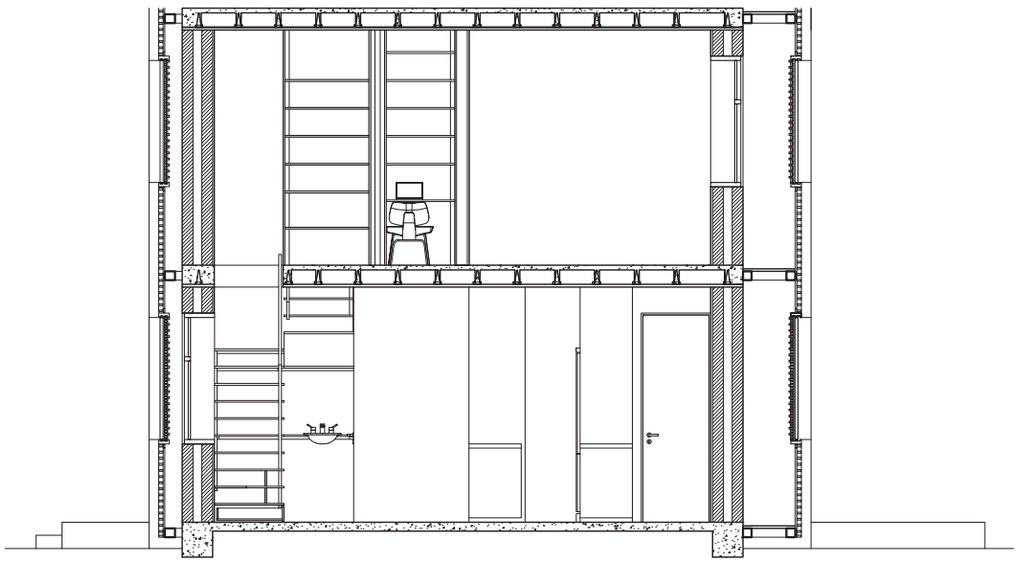


Fig. 5.65 – Section of the apartment E, scale 1:75.

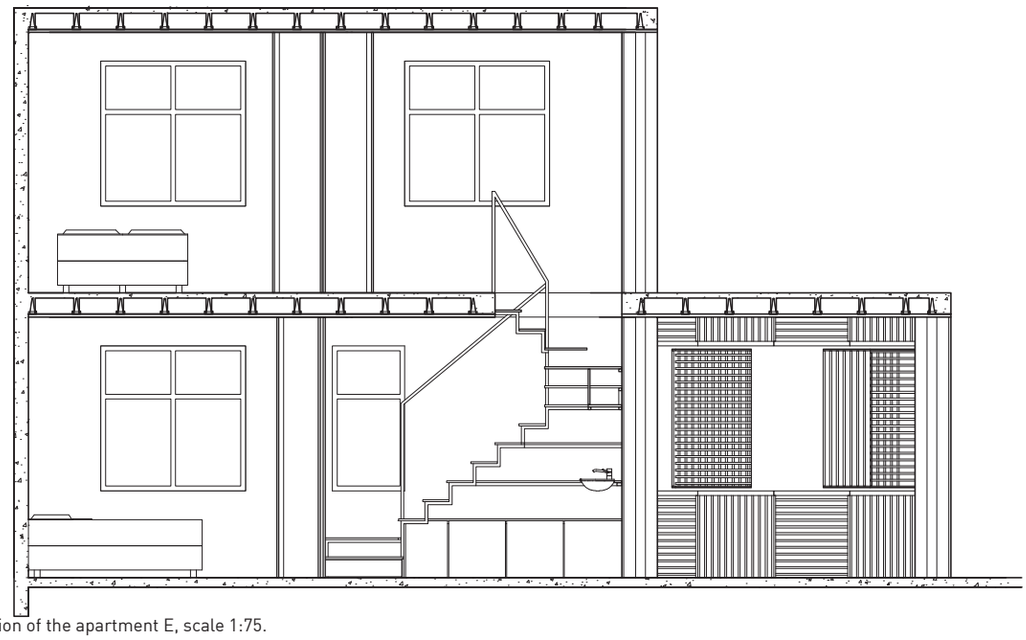


Fig. 5.66 – Section of the apartment E, scale 1:75.

6. REFLEXION

In conclusion this project has been challenging and enlightening at the same time. First for the theme, a sustainable housing complex in a social context in Brazil, trying to reach for a "Danish standard" design; the Brazilian reality and its relation with sustainability made it very challenging to find information and the best solutions, considering that the project could actually be built. Secondly, for the integrated design process, which is a holistic approach, and where all the aspects of architecture and engineering must be taken into consideration at the same time.

It has been a goal from the very beginning of the project to make a flexible design with the possibility to expand the homes and in that way give the opportunity to the household to have a design that corresponds to theirs needs. At the same time, reaching results as a comfortable indoor climate and the energy consumption reduction, using only the available technology.

As mentioned there have been many challenges along the way, the first challenge of sustainable architecture in Brazil, second challenge of the integrated design process, and the fact of having to work along, since many of the steps of the design process I had not many knowledge about, since my background from Brazil differs from the this design approach.

The Brazilian context led to a very detailed analysis phase, which helped a lot with the following design process. This research has been part, together with the achieved results, of the enlightening aspect of the project. After doing this project I have the wish to continue studying sustainable design and hope to be able to use all the knowledge that I have acquired to try to start changing the reality on this field, especially to the social housing.

Even though not all the studied process was related it on the report, nothing in the design happened without any reason, all along the technical and architectural advantages in mind. All three scales, master plan, block and apartment, with the different layers of each scale were thought always having in mind the main design parameters.

The interaction between urban and suburban environment in this project led to a flexible and verified result, where habitants have the possibility to self-actualize concerning the apartments, which grants identity.

7 APPENDIX

7.1 BLUE HOUSE CERTIFICATION

Table of the mandatory and optional items for the Blue House Certification.

CATEGORY 1 – URBAN QUALITY

Quality of the surroundings – infrastructure	Mandatory	Achieved
Quality of the surroundings – impacts	Mandatory	Achieved
Improvement of the surroundings		
Recovery of degraded areas		Achieved
Rehabilitation of buildings		

CATEGORY 2 – PROJECT AND COMFORT

Landscape	Mandatory	Achieved
Flexibility of the project		Achieved
Relation with the neighbourhood		Achieved
Local for selective collective	Mandatory	Achieved
Leisure, social and sports facilities	Mandatory	Achieved
Thermic performance – sealing	Mandatory	Achieved
Thermic performance – sun and wind orientation	Mandatory	Achieved
Natural illumination in common areas		Achieved
Natural ventilation and illumination of the bathrooms		
Suitability to the physic conditions of the site		Achieved

CATEGORY 3 – ENERGETIC EFFICIENCY

Lamps with low consumption – private areas	Mandatory	Achieved
Saving devices – common areas	Mandatory	Achieved
Solar heating system		Achieved
Gas heating system		
Individual measurement – gas	Mandatory	Achieved
Efficient lifts		
Efficient house hold appliances		
Energy alternative fonts		Achieved

CATEGORY 4 – CONSERVATION OF MATERIAL RESOURCES

Modular coordination		Achieved
Quality of the material and components	Mandatory	Achieved
Industrialized or pre-fabricated components		Achieved
Reusable formwork and anchor	Mandatory	Achieved
Control of the Construction and demolition wastes – RCD	Mandatory	Achieved
Concrete with optimized doses		Achieved
High-oven cement (CP III) and Pozzolanic (CP IV)		
Pavement with RCD		
Certificated wood		Achieved
Facility on the facades maintenance		Achieved

CATEGORY 5 – WATER CONTROL

Individual measurement – water	Mandatory	Achieved
Saving devices – sanitary vase	Mandatory	Achieved
Saving devices – aerators		
Saving devices – leaking regulatory system		
Pluvial water utilization		Achieved
Pluvial water retention		Achieved
Pluvial water infiltration		Achieved
Permeable areas	Mandatory	Achieved

CATEGORY 6 – SOCIAL PRACTICES

Education to the RCD management	Mandatory
Environmental education of the employees	Mandatory
Personal development of the employees	
Professional capacitation of the employees	
Inclusion of local workers	
Inclusion of the community in the project development	
Households´ orientation	Mandatory
Environmental education of the households	
Empowerment for the development management	
Actions for the mitigation of social risks	
Actions to generate jobs and income	

7.2 WATER TANK CALCULATIONS

The daily consumption is considered 150l per day, per person.

The daily consumption of the apartment is divided by the number of households, since the number might change in the houses, five persons are being considered to the calculations.

The daily consumption for one apartment is 750l/day.

Since the water supply is not certain in the Brazilian cities, it is necessary to consider three times the daily consumption in the calculations; therefore the house will not run out of water if the supply is interrupted.

The total consumption for one apartment is 2.250l – 2.25m³
From that volume 40% has to stay on a superior water tank and 60% on an inferior tank.

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Fig. 3.03 – Cohab-CT
Fig. 3.04 – Cohab- CT
Fig. 3.05 – 08 – Own Illustration
Fig. 3.09 – 10 – IPPUC, 2010
Fig. 3.11 – Own Illustration
Fig. 3.12 – Cohab-CT
Fig. 3.13 - Henry Milléo/ Gazeta do Povo.
Fig. 3.14 – Source: http://vilatorresdigital.com.br/#galeria
Fig. 3.15 – Source: http://www.publiqueideias.com/curitiba-lixo-que-nao-e-lixo-gente-que-nao-e-gente
Fig. 3.16 – Source: http://www.cohabct.com.br/galeria.aspx?id=671
Fig. 3.17 – Cohab-CT
Fig. 3.18 – Cohab – CT
Fig.3.19 – IPPUC
Fig. 3.20/21 – Own Illustration
Fig. 3.22 – IPPUC
Fig. 3.23 – Source: http://www.parana-online.com.br/editoria/cidades/news/498097/?noticia=CHUVA+CASTIGA+A+GRANDE+CURITIBA
Fig. 3.24 – Source: http://www.blogdajoice.com/wp-content/uploads/2013/05/avenida-das-torres1.jpg
Fig. 3.25 – Own illustration
Fig. 3.26 – Source: http://vilatorresdigital.com.br/#galeria
Fig. 3.27 – IPPUC
Fig. 3.28/29 – Google street view.
Fig. 3.30 – Own Illustration
Fig. 3.31 – Source: http://www.ogol.com.br/foto.php?id=3141
Fig. 3.32 – 34 – Google street view
Fig. 3.35 – Source: http://ippucweb.ippuc.org.br/BancoDeDados/Curitibaemdados/albumfotos.php?N2=24&pagina=1
Fig. 3.36 – Own illustration
Fig. 3.37 – 40 – Google Street view
Fig. 3.41 – Google maps
Fig. 3.42 – 45 – Archdaily, 2013
Fig. 3.43 – 48 – Gifu, 2013
Fig. 3.49 – 50 – Archdaily, 2013

Fig. 4.01 – Own illustration
Fig. 4.02 – Google street view
Fig. 4.03 – 05 – Own illustration
Fig. 4.06 – Own Picture, taken in February 2014
Fig. 4.07 - 24 – Own illustration

Fig. 5.01 –66 – Own illustration